CONSTRUCTING A VALVE VOLTMETER


# The Wireless World

MONTHLY
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COVERING EVERY WIRELESS INTEREST

JANUARY, 1940




No. 1051. Vol. XLVI. No. 3

# PRECISION METERS
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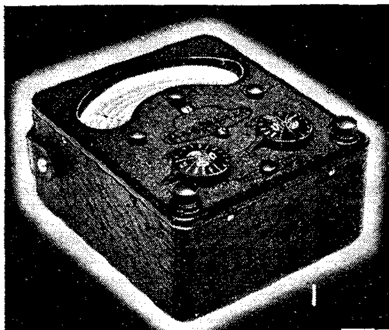

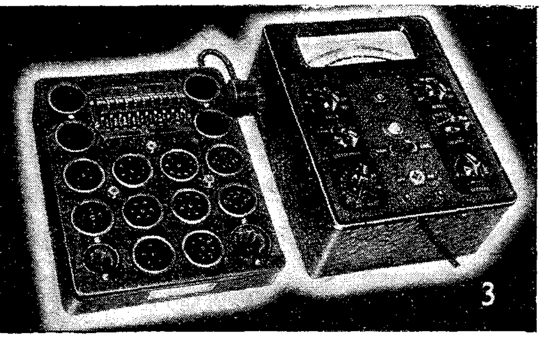

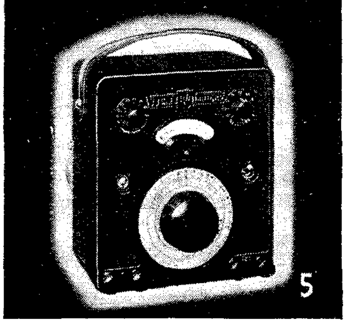


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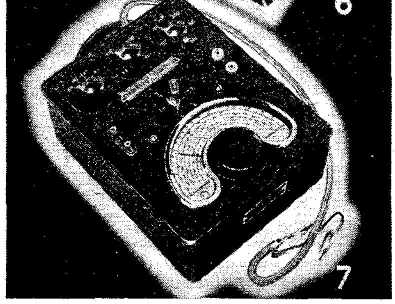

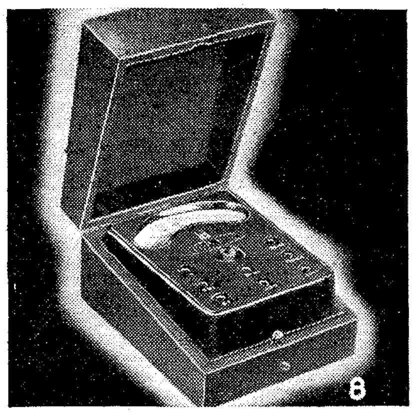


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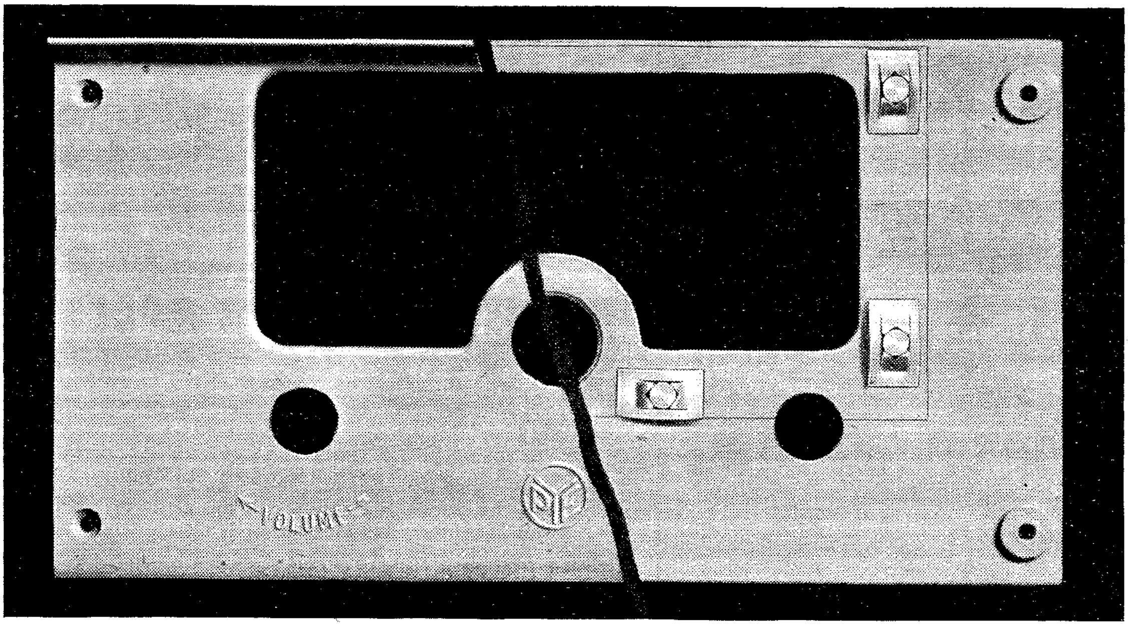

*Illustration shows Simmonds SPEED NUTS used for fastening the scale panel in position on the PYE Baby "Q" Receiver.*

*Photograph by courtesy of PYE LTD.*

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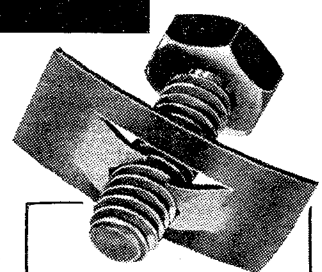

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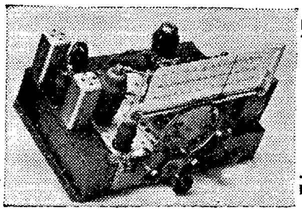

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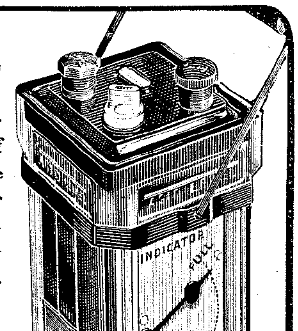


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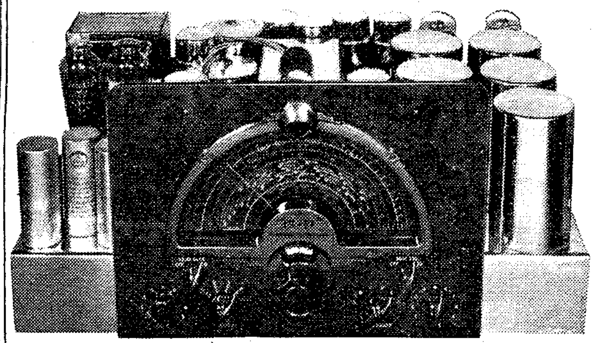

THE 15/17 CHASSIS

Now that real quality reception has been rendered impossible, a fascinating alternative can be found in "globe trotting" with a really hot receiver. In addition to this it is possible to obtain, under favourable conditions, very good quality indeed from some of the S.W. transmissions. It is necessary, however, to have a receiver with a superlative S.W. performance, and at the same time capable of really good reproduction.

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Such a receiver is the McMurdo Silver 15/17 with its sensitivity of better than one microvolt absolute, and output of 15 watts, with less than 2% total harmonic distortion, feeding into a 12" speaker.

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Have you heard the 10m Hams lately? Or the American high fidelity stations on 26mc/s? These are coming through very well just now.

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May we send you full technical details and illustrations of the various models?

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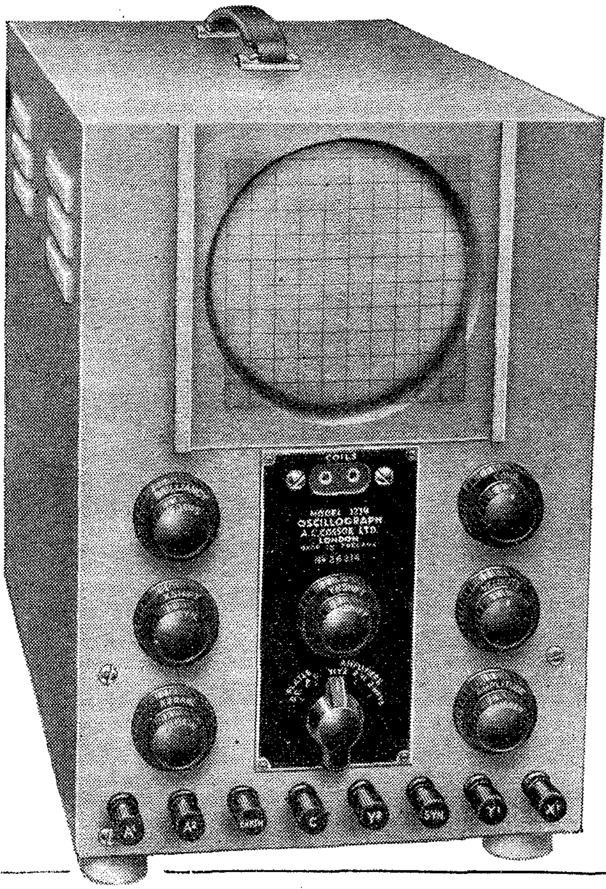
***HIGH VACUUM DOUBLE BEAM***



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The instrument uses the original Cossor hard valve linear Time Base, the frequency range of which extends to beyond 200,000 cycles, and provides positive synchronisation. The two amplifier valves used may be arranged to operate either independently on each Y plate, or in cascade with either a high gain (4,000) or a wide band-width (2,500,000 c.p.s.) on one Y plate. In this latter case the performance more than covers the full video frequency range requirements of television. Amongst numerous other features may be mentioned the frequency compensated amplifier gain control, automatic brilliancy control of the trace at higher Time Base speeds, Time Base flyback black-out, deflector coils, the provision of a calibration voltage, double mu-metal magnetic shielding and tandem controls.

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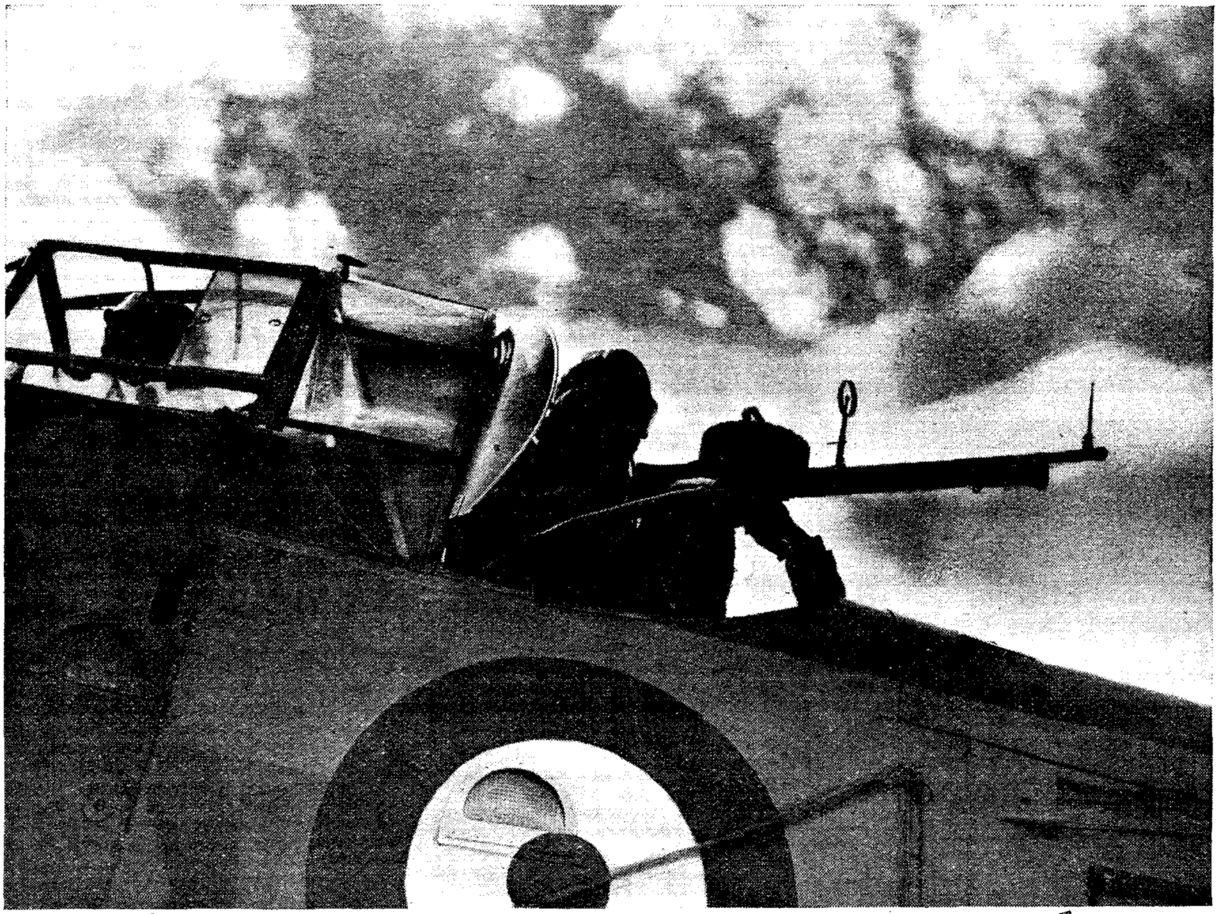
*As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.*


No. 1051 VOL. XLVI. No. 3

## JANUARY 1940


## Contents



UP IN THE CLOUDS MAYBE—BUT THEY MEAN BUSINESS

Maybe we're up in the clouds ourselves sometimes. Even idealistic, if you like, about our trading principles and our loyalty to those with whom we do business. But we cannot help feeling, as we look back on our many happy associations with some of the most important concerns in the country, that no one has lost by our upholding those principles. We're idealistic, yes ; but when it comes to doing a job we can safely say—" we mean business ".

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The
# Wireless World

COVERING EVERY WIRELESS INTEREST

ESTABLISHED 1911

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## Editorial Comment

# Sets for Active Service

IN last month's issue we pleaded that thought should be given to the production of suitable broadcast receivers for the use of members of the Forces on active service. Although the typical portable set may be convenient enough for units, it is often too heavy and bulky for small groups, and almost always out of the question for individuals, especially for those who are so situated that they stand most in need of broadcasting for entertainment, relaxation and information. For these, few if any of the standardised productions of the British industry are really practicable; as one of our querists put it, when writing from France for information on suitable apparatus, "the ordinary portable would be no more use to me here than a 100-guinea radio-gramophone."

Great interest has been shown in this question of "the soldier's set," and, in response to our invitation, a number of readers have put forward views on the features that it should possess. Several of their letters are printed in the present issue, and a consideration of the correspondence would suggest that at least two distinct types of receiver are needed; one for the larger unit or group, and another smaller set for the individual or small group.

As one of our correspondents, writing in the light of experience gained in 1914–1918, points out, transport of a receiver can generally be "wangled" by a unit, though not by the ordinary individual; this is put forward as an argument in favour of the loud-speaker set, serving a number of listeners. Another correspondent, with a similar idea in mind, suggests a two-unit construction, with the second unit in the form of an amplifier-speaker for community listening. It seems to be generally agreed that a simple and robust battery-fed receiver covering the medium waveband only, and with a straightforward three-valve TRF circuit, would be the most suitable.

Turning to the lightweight individual receiver, the problem of reducing weight and bulk to the necessary extent would seem to be much more difficult than in the case of the "group" set. Headphones and dry-cell valves are agreed to be essential features, and ideas as to the best circuit seem to be limited to the standard RF-det-AF three-valve arrangement or to the simple regenerative detector, with or without AF amplification. As so much emphasis is laid on the need for extreme compactness and lightness, the simpler type of set would seem to be more promising, especially bearing in mind the practical limitations imposed on designers

### *Valves for "Pocket" Sets*

Valves comprise one of these limitations, as there is at present little choice of British "miniature" types. An example of what can be done with suitable valves is given in our review this month of a receiver of American origin which in many respects provides an answer to the present demand. Even this receiver, compact and light as it is, does not represent ultimate possibilities; according to an announcement appearing elsewhere in this issue, an American manufacturer is about to produce still smaller valves, designed specifically for ultra-lightweight portables, for which a good performance is claimed with a 45-volt high-tension supply. With such valves as these there is no need to content oneself with crude regenerative detector sets.

Whatever circuit arrangements are decided upon for active service broadcast receivers, there is an argument for some degree of standardisation; as a correspondent points out, it would be a great advantage if replacement batteries and valves were to be made available through the N.A.A.F.I. That institution could hardly be expected to carry in stock a number of different types.

## Illicit Transmitters

### *Post Office Precautions*

*THREE* orders made under the Defence Regulations will enable the Postmaster-General to exercise more effective control than hitherto over wireless transmission in and from this country. Very little publicity has been given to these Orders, but their provisions are so wide that a large number of our readers are likely to be affected; all should make themselves familiar with the salient points which are summarised elsewhere in this issue.

Perhaps the most important clauses are those relating to the acquisition or supply of certain apparatus capable of use in a transmitter. Without a permit no one may "sell, purchase, let, hire, supply, dispose of, acquire or distribute" any of the apparatus enumerated.

Of the various items coming under this ban, the inclusion of "electronic valves capable of an anode dissipation exceeding 10 watts" has provoked most criticism and discussion. At first sight this would seem to apply even to the 350-0-350-volt power rectifying valves used in so many standard broadcast receivers. But, although these rectifiers actually dissipate over 10 watts, we understand that they are not considered as valves for the purpose of the Order. However, many output valves of the type used in quite modest sets do come within the scope of the Order, and so it is now forbidden either to buy or sell replacements without a permit.

Other items in the list do not call for special comment, although the inclusion of "spark coils, quenched and rotary spark gaps" may raise a smile. It is good to see that there is no mention of morse keys, and so no obstacle is placed in the way of those of our readers who are trying to increase their usefulness by learning the code.

The foregoing remarks, it should be emphasised, apply only to the "acquisition and supply" order, which presumably does not affect those who already have in their possession any of the items enumerated. Another Order forbids the *possession*, without a written permit, of any kind of wireless transmitter, transmitter-receiver, or "components capable of being assembled to form such a wireless transmitter." This last presumably refers to complete sets of parts, and so will not affect amateur transmitters who have already surrendered vital components. Former transmitting amateurs, and those who, but for the outbreak of war, were intending to apply for a licence, may well find that they are in possession of sufficient apparatus for the assembly of a complete transmitter. Those who are in this position should lose no time in applying for a permit or else surrender the apparatus.

It is clear that the Orders to which we have referred will place additional obstacles in the way of the illicit transmitter, and so all wireless men will cheerfully face the slight inconvenience caused by their operation. While on the subject, we may perhaps point out that those readers who think they have heard suspicious transmissions should communicate with the Post Office authorities—and not with us, as some of them have done. Some of the transmissions reported are, within our knowledge, quite legitimate ones, and those who are not quite sure of their ground are less likely to waste the time of the authorities if they confine their reports to suspicious signals which appear to emanate from their immediate neighbourhood.

## Wireless Men on Service

### *An Appeal for Comforts*

*ALL* our readers will naturally be favourably disposed towards an appeal issued by the Royal Signals Comforts Fund, as the Corps on behalf of which it is made includes a large proportion of wireless men. At the instigation of the representative Colonel Commandant, Brigadier H. Clementi Smith, a central committee has been formed for the purpose of collecting goods and distributing them.

The subscription list has been headed by a most generous donation from H.R.H. the Princess Royal. Donations in cash, or gifts of helmets, mittens, scarves, magazines, etc., will be gratefully received by the Hon. Secretary and Treasurer, Royal Signals Comforts Fund, at 95 Belgrave Road, S.W.1. Parcels marked "Comforts Fund" may also be delivered before noon each day at the following addresses: 1, Laverton Place, Courtfields Gardens, London, S.W.5, and 18, Trevor Place, London, S.W.1.

## Commercialising SW Broadcasting

### *A Regrettable Change*

*MANY* of those who are regular listeners to the American short-wave stations will deplore the decision by one of the great networks to commercialise its international service by including advertisements in the programmes.

In her position as a powerful neutral nation, America has special opportunities for rendering service to the world, and her short-wave broadcasters have risen nobly to the occasion. But constant reminders that their motives are not entirely altruistic may tend to lessen the feelings of gratitude at present entertained towards them.

# Probe Valve Voltmeter

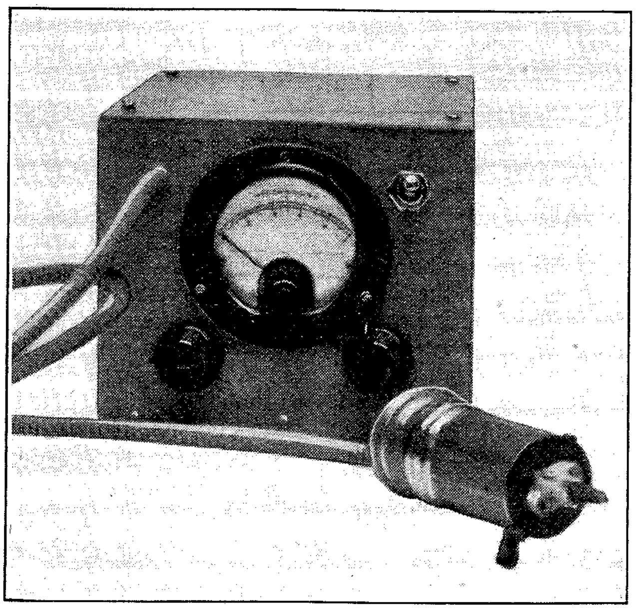
## DESIGN OF A COMPREHENSIVE BUT SIMPLE TEST INSTRUMENT

By HUMFREY ANDREWES AND F. A. LOWE

**In this article is described a valve voltmeter which can be built without a great deal of trouble. It includes the novel feature that the rectifying valve is built into an electric torch case, and attached to the main instrument by a multi-wire flex; the actual valve is thus able to be used as a probe when taking voltage readings, the disadvantages of trailing grid leads being avoided.**

TO the service engineer or serious experimenter a voltmeter is a very necessary and useful instrument. Many problems can often be solved much more quickly and with far less mental effort if the voltages in a radio receiver can be easily ascertained. But it is, of course, essential that the accuracy of the voltmeter should be reasonably good, and that it should be mechanically and electrically robust, and easy to handle. Most important of all, however, is that its connection to the points across which the voltage is to be measured should not appreciably alter working conditions.

The misleading results given by the use of a relatively low-resistance voltmeter to measure the anode voltage of a valve in which the total anode resistance is high is a matter of common knowledge. It forms, however, a typical example of the necessity of making sure that the instrument used is suitable for the measurements to be made. With the ordinary DC and AC voltmeters available in most service departments, only a limited number of tests can be made. Usually, the receiver under test must be treated as a whole, and individual measurements on the gain of the different parts are difficult, if not impossible, to obtain. This means that it is sometimes difficult to isolate the gain of the IF from that of the RF or even the AF amplifier. Under such conditions loss in the sensitivity of a receiver may take some considerable time to trace.



The completed valve voltmeter

In the issue of *The Wireless World* for May 4th, 1939, the authors described, under the title of "A Cheap Valve Voltmeter," an instrument which was simple and inexpensive to make, and had many uses. The impedance of this meter was, however, rather low on the low voltage ranges, and could not be used for many tests on a modern radio receiver. Where, for example, it is desired to check the gain of the RF or IF amplifiers, check the alignment of band pass circuits, or measure the input to the first AF stage, a really high impedance meter is essential so that the circuit may not be disturbed by the introduction of the measuring instrument. Again, for most of such measurements, not only must the input impedance be high over the audio frequency range, but also, nowadays, at the ultra high frequencies used for television. Where such a meter is used for measurements on the radio frequency circuits in a receiver, even if the DC resistance of the input circuit is high, the shunt capacity across the input terminals must also be low. Long leads from the instrument to the receiver may also cause trouble, as they will increase the shunt capacity and may also cause instability in the receiver.

With a view to overcoming some of the difficulties encountered with the "Cheap Valve Voltmeter" referred to above, the authors have designed the voltmeter to be described below. In the design the following points were kept in mind. In the first place the input impedance was to be of the order of six megohms. In the second place it was thought desirable to make the voltmeter a direct reading one, if possible, using as an indicating instrument a 0-1 mA DC meter. To obtain a reasonably linear scale a diode circuit was selected. Thirdly, it was desired to obtain a full-scale deflection with an input of 1 volt RMS, the sensitivity being artificially reduced when greater inputs were to be dealt with.

If, however, a diode alone is used, it is obvious that the conditions are impossible. The difficulty might have been overcome by using a very sensitive galvanometer instead of a 0-1 mA meter, but such instruments are very expensive and not mechanically very robust. It

Probe Valve Voltmeter—

was therefore decided to employ a triode as a DC amplifier after the diode circuit, and a simplified form of the circuit is shown in Fig. 1. The AC voltage to be measured is applied across the resistance R1, which is about six megohms. The diode V1 rectifies the AC voltage, and a DC voltage is produced across the condenser C1. The triode V2 is biased to a suitable point on its characteristic, so that the positive potential across C1 causes a rise in the anode current of V2 without causing grid current to flow. The grid leak R2 is also about six megohms, and completes the DC circuit of the diode. We now have a circuit of high impedance input in which the rise in anode current of V2 is proportional to the AC voltage applied to R1. If we then choose a suitable valve for V2 and work it on the straight portion of its curve, a reasonably linear scale will be obtained.

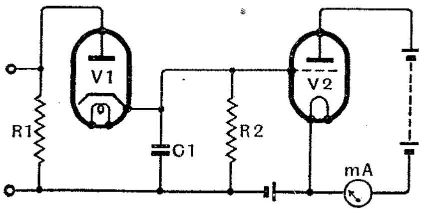



Fig. 1.—The fundamental circuit of the meter.

Let us now consider the practical application of such a circuit under the conditions laid down above. In the first place, we want to use a 0-1 mA meter to measure the change in anode current of the valve V2, and, if possible, arrange so that a 1 mA reading represents 1 volt RMS applied to the terminals of our voltmeter. If the valve V2 were biased practically to cut off, and its characteristics were such that a 1 mA rise in anode current was obtained, we should be working it on a very non-linear portion of its curve. If, however, we work farther up the curve at, say, 2 mA, and then balance out the standing anode current through the meter, so that it only reads the *change* in anode current, we get a far more satisfactory arrangement. Such a circuit is shown in Fig. 2. To adjust the milliammeter to zero, the current through R3 with no AC voltage applied must equal the steady anode current. This may be done in two ways. Either R3 must be made variable, or, as was found better in practice, the grid potential must be made variable so that, after finding a suitable value for R3 (about 750 ohms), the anode current is always the same when the milliammeter reads zero.

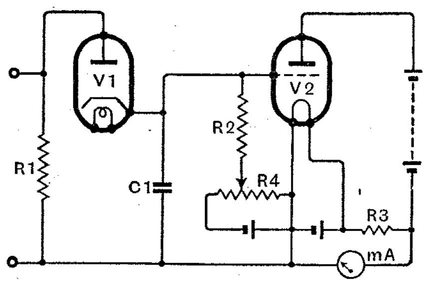



Fig. 2.—By balancing out the standing anode current as shown here, it is possible to work on a more favourable part of the valve characteristic.

Such a circuit was, therefore, tried out experimentally, and it was found possible by careful adjustment of the circuit values to obtain a 1 mA change in anode current of the valve V2 for 1 volt RMS applied across R1. The valves chosen were, for V1 a Mazda television diode type D1, and for V2 a Marconi type LP2. It is necessary to use a triode having a high mutual conductance, and a number of different types were tried out before the required sensitivity was obtained. Unfortunately, the scale is not perfectly linear, due presumably to the slight curvature of the valve characteristic. It will be seen, however, from the calibration curves given later, that the error is not very great, and that over at least the upper portion of the scale of the milliammeter the readings may be taken direct to within 10 per cent.

### Practical Points of Design

As the diode heater voltage is four and the triode two, it is convenient to use two 2-volt cells in series, and utilise one of these for the negative bias on the triode. One other point may perhaps be mentioned at this stage. It is well known that with a diode circuit of this type without any AC voltage applied across the resistance R1, a small current will flow round the circuit through R1 and R2 due to the space charge in the diode. This current will produce a small positive potential across R2, and necessitates a slight increase in the setting of the grid bias potentiometer to obtain the correct negative bias on the grid of V2.

We now have a meter having a range of 0-1 volt AC, and must consider the question of extending the range of the meter. The DC potential developed across R2 is proportional to the AC voltage applied to the resistance R1, and it follows, therefore, that if R2 is made into a potentiometer, as in Fig. 3, any AC voltage reading can be obtained up to the maximum safe AC voltage which may be applied to the diode, which in this case is about 200 volts.

We thus arrive at the complete design, the circuit of which is shown in Fig. 4. In order to obtain the advantage of the use of the D1 diode, which was, of course, primarily designed for television purposes, and has, therefore, a very low self capacity, the meter is divided into two parts. The diode and its associated components were mounted in a metal cylinder, on the top of which was a well-insulated terminal. An earth terminal was mounted on the side of the cylinder so that the earth connection might also be made as short as possible. The triode, milliammeter and other components were mounted in a separate metal box, and the two units connected together by a length of flexible metal tubing. In this way it is possible to connect the voltmeter to the circuit, at the point where the voltage is to be measured, with extremely short leads. The general

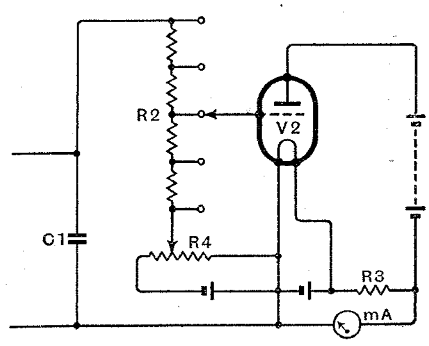



Fig. 3.—Different voltage ranges are obtained by adjusting the potential divider R2.

**Probe Valve Voltmeter—**

view of the voltmeter constructed by the authors is shown on page 83. A second view showing the meter connected to a commercial radio chassis illustrates the advantage of the flexible tube and diode "head." This type of instrument has sometimes been called a "goose-neck" or a "probe" voltmeter for obvious reasons.

In designing an instrument of this type it is obvious that individual requirements will modify the design, and it is not, therefore, proposed to give full working details, but rather to show the general arrangement and indicate the various points over which special care must be taken by those who wish to build the voltmeter.

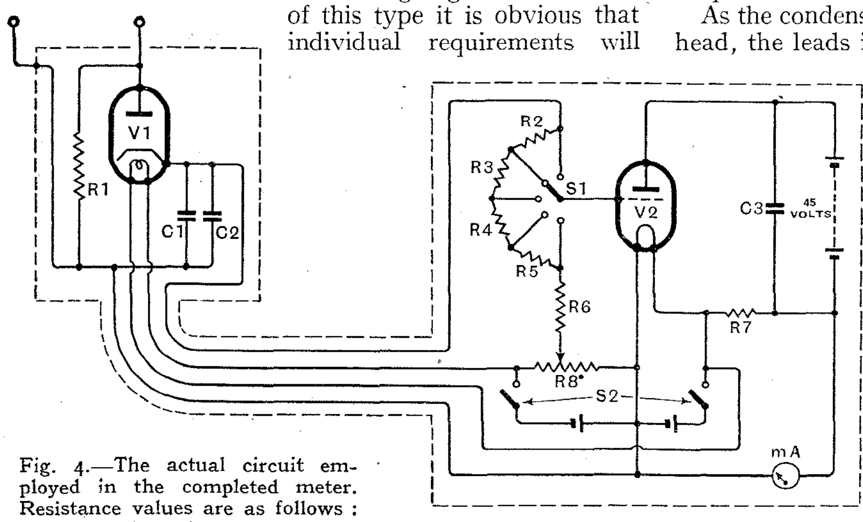
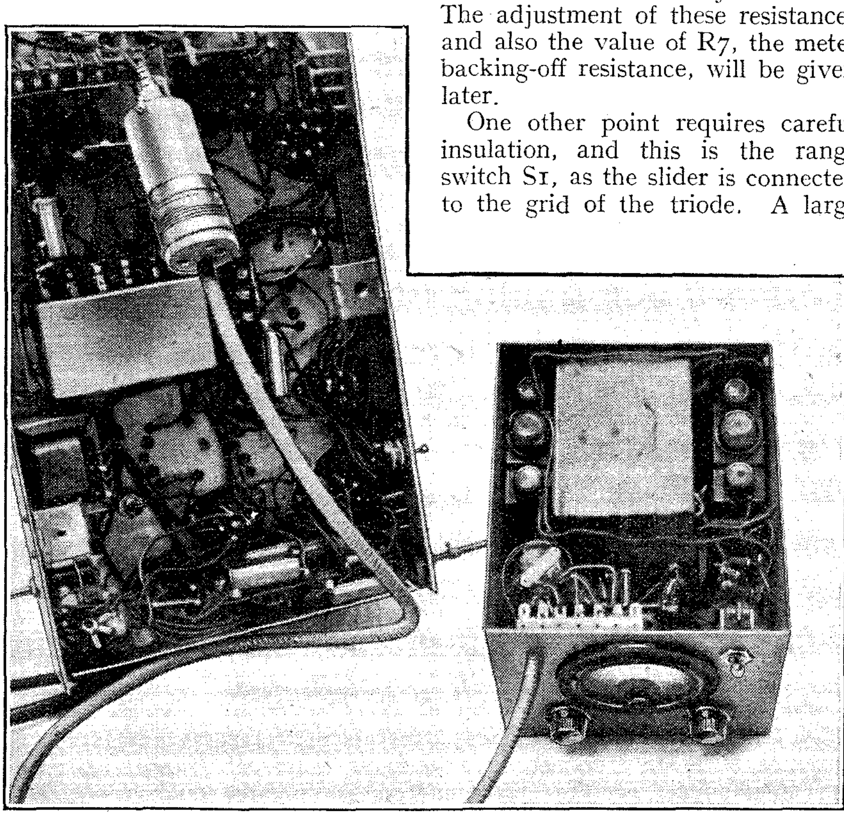



Fig. 4.—The actual circuit employed in the completed meter. Resistance values are as follows: R1, 6 megohms, ¼ watt type; R2, 5 megohms (2 megohms in series with 3 megohms); R3, 0.6 megohm (0.1 megohm in series with 0.5 megohm); R4, 0.3 megohm (0.5 megohm with 2 megohms in parallel); R5, 70,000 ohms (50,000 ohms in series with 20,000 ohms); R6, 21,000 ohms (20,000 ohms in series with 1,000 ohms); R7, 750 ohms (500 ohms in series with 200 ohms and 50 ohms), ¼ watt type; R8, 10,000 ohms potentiometer. Other components are: Condensers: C1, 0.1 mfd., paper type; C2, 500 $\mu\mu$F, ceramic type; C3, 1 mfd., paper type; Valves: V1, Mazda D1; V2, Marconi LP2. Switches: S1, 5-way (Bulgin); S2, double-pole QMB (Bulgin). Meter: 0-1 mA DC milliammeter (Weston.)

In the case of the instrument actually constructed by the authors and shown in the photographs, an electric torch container was used to house the diode "head." The D1 valve holder, resistances, and condensers were mounted on the cap which normally screws on the bottom of the torch. The input insulator was mounted on the end of the cylindrical case, which had been cut off to a suitable length so that the lead to the anode of the diode was as short as possible. When the voltmeter is used for very high-frequency measurements the case may be removed to reduce the self capacity, and a connection taken direct to the anode of the diode. Two condensers are connected between the cathode of the diode and earth, one being a 0.1 mfd. and the other in parallel with it being a 0.0005 mfd. ceramic for use on very high frequencies.

As the condensers C1 and C2 are mounted in the diode head, the leads in the metal tube only carry DC potentials, and so no special care need be taken to keep the capacity between the wires low, but the lead connected to the cathode of the diode must be well insulated, as the leakage path on this lead must be high compared with six megohms, the value of the triode grid potentiometer. In the early experiments poor insulation on this lead was found to reduce the sensitivity of the instrument considerably. The value of the grid bias potentiometer is not important. In the caption to Fig. 4 are shown the values of the resistances, and also how the values were obtained from standard resistances by selection. The adjustment of these resistances and also the value of R7, the meter backing-off resistance, will be given later.

One other point requires careful insulation, and this is the range switch S1, as the slider is connected to the grid of the triode. A large hole should be made in the metal case, and a very good quality insulation bush used. The switch S2 is a double-pole one, as it is necessary to disconnect both



The "probe" is here shown being applied to a receiver under examination.

**Probe Valve Voltmeter**—

sides of the accumulator. In the case of the meter shown in the photographs, the batteries were also included in the main case for the sake of compactness. If it is preferred, a flexible lead may be brought out or terminals mounted for external batteries to be used. A small 45-volt HT battery is used, and although small variations are permissible the stated voltage should be adhered to fairly closely.

One important feature of this design is that the meter may be calibrated at 50 cycles and will still hold its calibration up to 45 megacycles. The instrument described was calibrated against a standard Avometer, and subsequently checked against an expensive laboratory

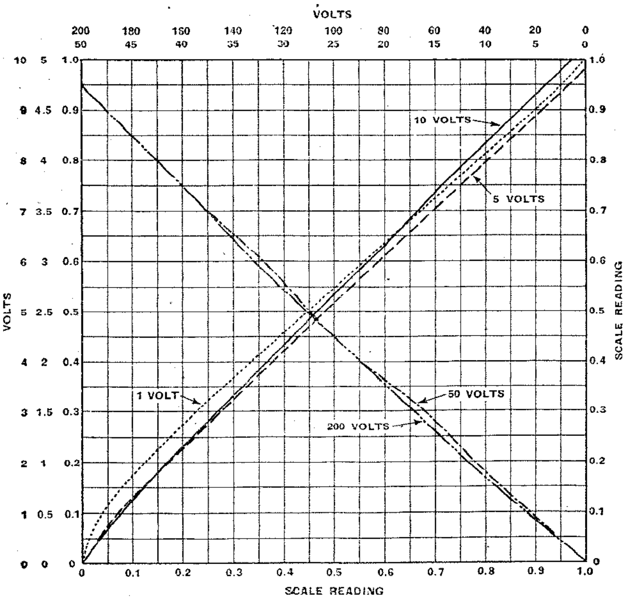



Fig. 5.—The actual dial readings obtained on the various ranges are given above.

valve voltmeter on a television receiver. The accuracy was found to be quite good. Checks were also made at approximately 1 megacycle, and also on lower frequencies.

### Calibrating the Meter

The method of calibration and adjustment was as follows: The 4-volt heater winding of an ordinary mains transformer was used as a source. As the 1-volt reading on the Avometer is rather low on the scale, the transformer winding was connected to an amplifier with a low impedance output transformer so that any voltage from 0 to 10 volts could be readily obtained. A high-resistance potentiometer was connected across this output, and the slider connected to the valve voltmeter. The potentiometer was then set so that one-tenth of the output voltage was applied to the valve voltmeter. In this way the calibration could be made down to 0.05 volt Adjustments were now made until a full-scale reading of 1 mA was obtained on the valve voltmeter for 1 volt AC applied.

The sensitivity is largely controlled by the value of R7 and the grid bias potentiometer R8. In the case of the instrument described, the value of R7 was found to be 750 ohms, and in this case R8 was adjusted to practically the full bias position. With different samples of triode this value for R7 may vary slightly, but the adjustment is quite simple. To adjust the values of the resistances of the range switch, the following procedure should be adopted. If the instrument is made up with standard resistances as shown in the resistance table, the values may then be adjusted to give the correct maximum readings for each scale. This may be most easily done by adjusting the highest voltage range first and then the next, as small alterations in the values of R6 and R5 will not appreciably affect the other ranges. To obtain the higher voltages for calibration the high impedance output of the amplifier was used, no potentiometer being necessary as the calibration was taken direct from the Avometer readings. In Fig. 5 are shown the calibration curves of the voltmeter so obtained.

### Modifying the Design

The use of an amplifier as described is not, of course, essential, and various other methods may be employed. It should be noted that the curves should be used to obtain accurate readings, particularly at the lower end of the scale, but that above 0.5 scale reading the various readings will be sufficiently accurate for many purposes. As the scale tends to open out at the bottom, quite accurate readings down to 0.05 volt can be obtained, a feature which does not apply to many types of valve

**READINGS FOR CALIBRATION CURVES**

| Scale Reading of Milliammeter | VOLTS | | | | |
|---|---|---|---|---|---|
| | 1 volt range | 5 volt range | 10 volt range | 50 volt range | 200 volt range |
| 1.0 | 1.0 | 4.9 | 10.25 | 52.0 | 210 |
| 0.9 | 0.895 | 4.42 | 9.3 | 47.5 | 190 |
| 0.8 | 0.81 | 3.98 | 8.3 | 42.5 | 170 |
| 0.7 | 0.72 | 3.5 | 7.35 | 37.5 | 150 |
| 0.6 | 0.636 | 3.05 | 6.3 | 32.0 | 132 |
| 0.5 | 0.545 | 2.58 | 5.35 | 27.5 | 111 |
| 0.4 | 0.46 | 2.10 | 4.35 | 22.5 | 90 |
| 0.3 | 0.366 | 1.6 | 3.3 | 16 | 68.5 |
| 0.2 | 0.275 | 1.12 | 2.3 | 11.3 | 47 |
| 0.1 | 0.17 | 0.65 | 1.25 | 5.6 | 24 |
| 0.05 | 0.12 | 0.35 | 0.7 | 2.8 | 11 |

voltmeter. The time constant of the meter will be found to be reasonably good, as the meter comes to rest very quickly. This is another important feature, as with many quite expensive laboratory instruments quite an appreciable time must elapse before a reading can be taken.

In conclusion, the authors feel that the construction of such an instrument as that described will well repay the little patience which is necessary, and that the instrument will prove a valuable addition to existing equipment, more especially for service work on broadcasting and television receivers.

# Civil Wireless Schools

## TRAINING THE R.A.F. VOLUNTEER RESERVE

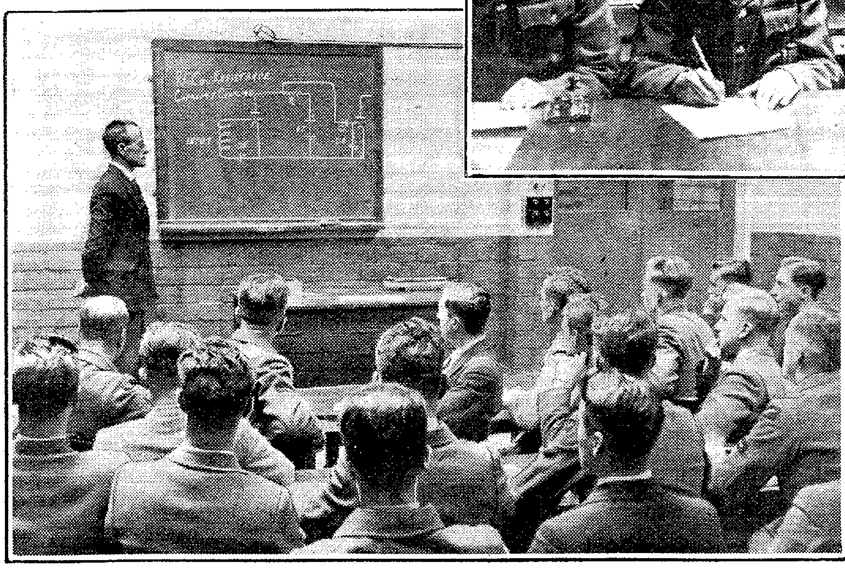
By "SENTINEL"

REGULAR wireless operators in the R.A.F. have a thorough and comprehensive training at one or other of the electrical and wireless schools, but these are unable to cope with the demand during hostilities, and supplementary civil schools have had to be set up.

Training wireless operators in wartime is not radically different from the same thing in peacetime, although the restrictions on the radiation of signals present something of a problem regarding advanced training. The elementary training is the same under all conditions, consisting chiefly of alternate periods of morse instruction and lectures on electrical and radio theory. Practical demonstrations of electrical phenomena are a useful method of maintaining interest in a somewhat dry subject, especially if a few sparks can be conjured forth.

The requirements now are for men with average intelligence who can send and receive morse intelligibly at a speed of 20 words a minute. They must be thoroughly conversant with military procedure and regulations (which are more complicated than those set forth in the P.M.G. Handbook), and well grounded in the principles of wireless, besides knowing how to manipulate, to the best advantage, the various types of equipment likely to be met. Attention has to be paid to visual signalling, both semaphore and Aldis lamp, to meet Service needs.

An intensive course of training, with a view to producing men of the required standard in the shortest possible time, was prepared some months ago by the responsible authorities. The time allowed to produce the results is not long, and has been declared much too short by many. Nevertheless, the attempt is being made, and the indications so far point to a successful outcome.



At a Civil Wireless School. Instruction in the principles and practice of wireless . . .

. . . alternates with periods of coaching in morse code transmission and reception.

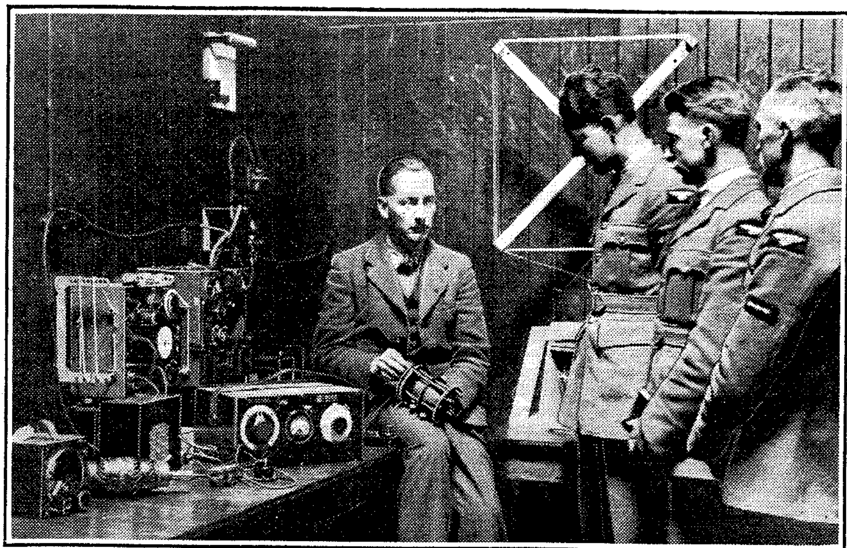
The creation of a civil wireless school, working against time under present-day conditions, presents something of a problem. Premises have to be secured, and modifications amounting almost to rebuilding have to be carried out in the briefest possible time.

Rooms for signalling instruction have been created out of stables; lecture rooms from garages. Buildings have been transformed internally, by co-operation between builders, joiners, electricians and radio staff. Desks were wired for buzzer practice whilst construction was proceeding, and hammer noises provided a background of interference worse than engine noise. In one special instance three weeks elapsed from notice of imminent arrival of trainees until the school was working smoothly with a full complement of lecture rooms and demonstration labs. The trainees arrived two days behind the aforesaid "imminent" notice, and as the two days were Saturday and Sunday there was little time for preparation. During the in-

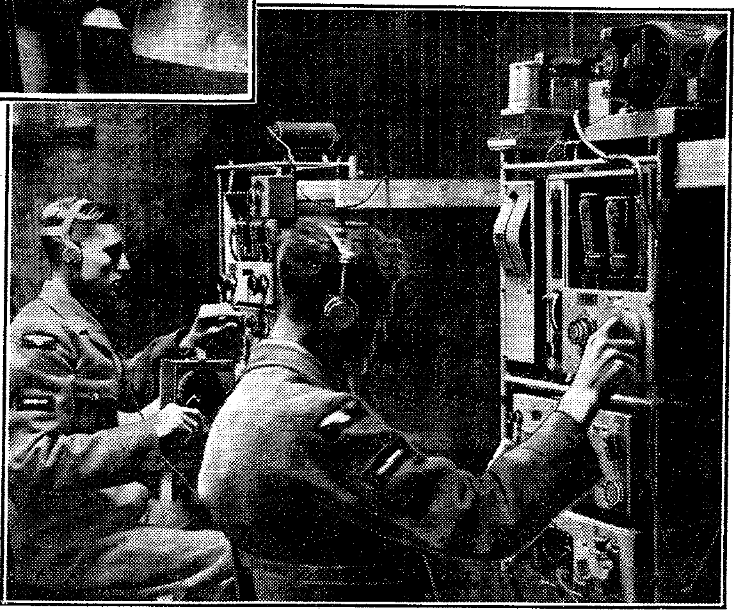
Civil Wireless Schools—

terim period, from "arrival" until "school ready," the classes were held in a local hotel, with a minimum of discomfort to guests or staff. The hotel ballroom was partitioned off into classrooms by using draught-screens, and dining-rooms and lounge were pressed into service.

Portable blackboards were set up, and a number of valve oscillators with loud speakers quickly constructed and made to give tongue, while staff recruiting was proceeding. By the time that the trainees had been provided with billets, the hotel rooms were ready for



The functions of the various components of transmitters and receivers are explained, and finally . . .



. . . the more advanced students are given opportunities to manipulate the controls of working apparatus.

lectures. Card and dining tables were laid together to make buzzing tables for groups of eight to ten trainees.

The first trainees arrived at 9 a.m. on Monday. The first wireless lecture was delivered, through a dance-band amplifier, simultaneously to all classes at 1.30 p.m. the same day. Total audience was several hundreds, and notes were duly made of interesting points. After a lecture of 1½ hours, buzzing was started, and the temporary school was working. An instructor was allotted to each class, and work proceeded fairly smoothly until better quarters were ready.

Meanwhile, a local estate had been requisitioned, and workmen quickly made conversions. What had been the staff quarters, with stables, garages, workshop and courtyard, were converted into a complete school unit, with eleven full-sized class-rooms and three demonstration laboratories.

Owing to more pressing requirements it was not possible to obtain any Service apparatus. Large quantities of morse keys, telephones, stationery, etc., had to be purchased locally, and this was difficult in the first few days of the war. However, the difficulties were surmounted and the necessary equipment, sufficient to provide full instruction for several hundred pupils, obtained and installed. In order to equip the demonstration rooms, resort was made to low cunning. The argument used was that the trainees should be made familiar with the appearance and performance of the various bits and pieces that go to make a wireless set, whether transmitter or receiver. As one coil, condenser, resistance, battery, etc., looks much the same as another and the proper one not being available, we must use the other. We are well satisfied with the results.

Junk dealers provided the answer at a most reasonable cost. The assortment provided was full and varied. We obtained such widely varied items as hot wire meters (as well as other types of meters) and an induction coil that gives an 8 inch spark. Electromagnets, Leyden jars, transformers, etc., were obtained in sufficient quantities at a price to delight any radio fan. We even obtained a good working goniometer and an excellent armature.

The principle followed in the instruction is to avoid mathematics absolutely. Nothing outside simple arithmetic has been allowed to enter the syllabus, and demonstrations follow lectures as closely as possible. We have now three complete installations in use which were never intended for such use. They provide excellent instruction in basic principles, and in tuning, until more specialised equipment can be obtained. Direction finding has not been overlooked, and a local joiner has made us two good frames.

The trainees take a very great interest in their work and their social life has not been neglected.

# Amplification by Impact

## DEVELOPMENTS IN ELECTRON MULTIPLICATION

THE electrons which form the discharge current through an ordinary valve are supplied from a heated filament or cathode; hence the name *thermionic* which comes from the Greek word *thermos*, meaning warm. In the electron-multiplier, on the other hand, the working current is built up of "secondary" electrons, which are produced by bombarding a cold cathode with primary electrons.

All matter, as we know, is made of atoms, and these, in turn, consist of electrons which rotate in more or less fixed orbits around a central nucleus. If we had a sufficiently powerful microscope to observe what happens when a free or primary electron is projected against an apparently solid target, we should see that it ends its flight by plunging—not against a truly solid surface but into a seething mass of "atomic electrons." The effect of the impact varies according to the composition of the target. If the latter is a fluorescent screen, as, for instance, in a CR tube, the collision is followed by a momentary flash of light. The reason is that the projected electron jerks one of the atomic electrons out of its usual orbit, and without knocking it completely away from the nucleus, causes it to lose a certain amount of energy. In this particular case the energy so liberated is immediately converted into a "photon" or bundle of light-waves.

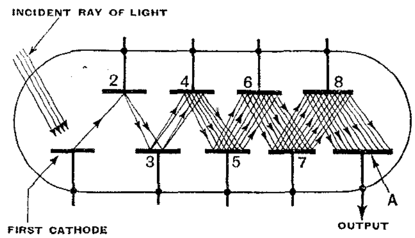
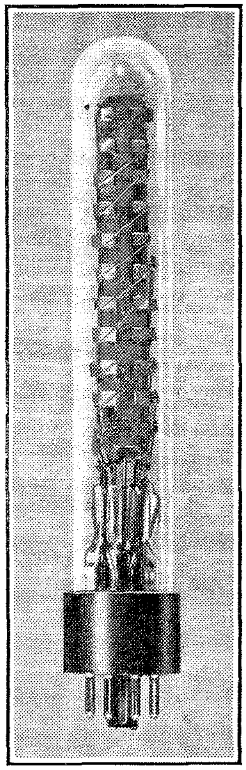



Fig. 1.—Simplified diagram showing the principles of electron multiplication by impact.

In the case of certain metals, however, the force of the impact is sufficient to break the bonds of the metallic atom, so that one or more of its electrons are "splashed out" into space, like the drops of water thrown up when a stone falls into a pond. But electrons set free in this way do not necessarily fall back whence they came, under the force of gravity—as do drops of water. If there is an electric field of force in the neighbourhood, they are attracted by it and will flow along the positive gradient of that field. Similarly, a magnetic field can be used to herd the electrons together and make them move in a given direction as a compact beam.

The production of secondary electrons by impact has been known for a long time, but it is only recently that we have learned how to use electric and magnetic fields for collecting the liberated electrons and controlling their subsequent movements systematically. One result is the development of the electron-multiplier—a type of amplifier in which a stream of electrons is projected from one "cold" cathode to another—in regular succession, producing fresh electrons automatically at each impact. The new tube possesses qualities which rival those of the valve, both as an amplifier and generator of electric oscillations and as a highly sensitive relay.

Recently, too, specially sensitive materials have been found which are capable of producing an unusually copious emission of secondary electrons when bombarded. A "target" electrode coated with cæsium-silver-oxide, for instance, will liberate from ten to twelve secondary electrons for every high-speed primary electron that strikes against it. A six-stage multiplier, fitted with such targets, gives an amplification of over ten million to one—or an output current of ten amperes when excited by the light received from a candle several feet away. Even when bombarded with slow-moving electrons, corresponding to twenty volts or less, the emission-ratio of a cæsium-silver target is of the order two to one, so that the multiplier can now be used with comparatively low values of HT supply.



This photograph, supplied by courtesy of the Science Museum, shows one of Dr. Vladimir Zworykin's early electron multipliers.

Fig. 1 illustrates the operation of the standard form of multiplier, in which a series of cold targets or cathodes 2—8 are arranged in pairs along the length of the tube. The first cathode may be heated, if it is desired to start with a liberal supply of primary electrons, or it may be a cold electrode coated with a light-sensitive material. The other target electrodes 2—8 are covered with a highly-emissive coating, and carry progressively-increasing positive voltages.

### Stage-by-Stage Multiplication

A ray of light projected on to the first cathode releases electrons by photo-electric action. These are attracted by the positively-charged target 2, against which they strike, releasing secondary electrons which are in turn attracted towards the more positive target 3. And so the process goes on, every electron "multiplying" itself at each succeeding stage, until the amplified

**Amplification by Impact—**

stream is finally collected by the anode A.

In the schematic arrangement shown, some of the free electrons would, in practice, succeed in travelling straight along the centre of the tube towards the anode A without making impact against each of the targets in turn, and so would fail to contribute their proper quota to the output. To prevent this, the targets can be arranged in the same plane, as shown at 1—5 in Fig. 2, a combination of electric and magnetic fields of force being used to force the electrons to "hop" from one target to the next in regular succession. As before, the targets 1—5 carry progressively increasing positive charges, the static field of force so created being reinforced by that from an upper set of accelerating electrodes 2A—6A. The latter are biased so that the voltage on 2A is equal to that on target 2, the voltage on 3A is equal to that on 3, and so on. In addition, an external winding (not shown) produces a magnetic field in a direction at right-angles to the main axis of the tube, e.g., downwards through the plane of the paper.

### Deflector Action

Under these conditions, electrons leaving the cathode are first attracted towards the accelerating electrode 2A. When they reach the half-way point, however, they are bent to the right, along the axis of the tube, by the action of the magnetic field from the external winding. They then come within reach of the positive voltage on target 2, and are attracted downwards to strike against it. The same process occurs at each successive stage, so that the discharge stream passes from one target to another in regular succession along the dotted-line path, being multiplied, as before, at each successive impact.

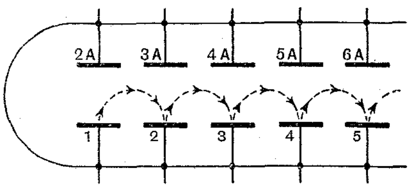



Fig. 2.—Showing how the electrons are made to "hop" from stage to stage in between targets mounted in the same plane.

In another well-known type of multiplier a single pair of target plates are placed opposite to each other, and are connected across an external tuned circuit. Placed midway between the targets is a ring-shaped anode, which carries a positive voltage and normally allows a free passage to the electron stream. When a ray of light is directed on to one of the targets, some electrons are released and are drawn forward by the positive voltage on the ring-shaped anode. Owing to the speed at which they travel, they pass straight through the ring-shaped anode and reach the opposite target, which, at that precise moment, is made positive by the voltage built up across the external tuned circuit. The secondary electrons produced by this first impact are then attracted back by the ring-shaped anode, and again pass through it to reach the first target, where they liberate more secondary electrons. In this way the oscillating stream is rapidly built up, until the point comes when the ring-anode begins to collect the amplified current.

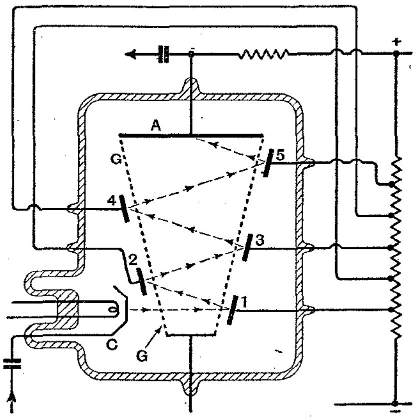



Fig. 3.—A recent development in "zig-zag" multipliers.

Fig. 3 shows one of the latest forms of multiplier which, in some degree, combines the features of both the types previously mentioned. The novelty of this construction lies partly in the conical arrangement of the target electrodes 1—5, and partly in the use of a similarly shaped "accelerating" grid G. The latter attracts the secondary electrons released from each target and speeds them on their way towards the next target along the path indicated by the arrows.

In this particular case the initial stream of primary electrons is supplied by a heated cathode C. As they emerge they are attracted through the positive grid G towards the first target 1, which, like all the other targets, is coated with a highly-emissive material. The secondary electrons produced by the first impact are then drawn away by the grid G towards the second and more positive target 2, the process being repeated at each of the successive stages 3, 4 and 5 until the amplified current finally reaches the collecting anode A.

The grid G prevents the formation of any space-charge likely to clog either the emission or the free movement of the liberated electrons, whilst the conical shape of the electrodes provides a longer path for the stream as it passes from stage to stage, so that more space is made available for the electrons as they increase in number.

## Club News

***Croydon Radio Society***

**Headquarters:** St. Peter's Hut, Ledbury Road, South Croydon, Surrey.
**Meetings:** 1st and 3rd Thursdays in the month at 8 p.m.
**Hon. Sec.:** Mr. E. L. Cumbers, 14, Campden Road, South Croydon, Surrey.

Meetings will, temporarily, be bi-monthly instead of weekly. On November 8th Mr. Stuart Davis demonstrated his new quality gear, including a 50-watt amplifier, a *Wireless World* tone control unit, and a contrast expander. Mr. Davis also gave a demonstration of home recording. On December 6th Mr. R. W. Gilpin lectured on "Recording and Reproduction on Film." The next meeting will be at 8 p.m. on Thursday, January 4th, 1940, when Mr. P. G. A. H. Voigt is giving a lecture and demonstration.

***Surrey Radio Contact Club***

**Headquarters:** 79, George Street, Croydon.
**Hon. Sec.:** Mr. S. A. Morley, 22, Old Farleigh Road, Selsdon, Surrey.

The November meeting was devoted to a talk by Mr. L. C. B. Blanchard on "The 28 Megacycles Band." It was resolved to have the annual "Hamfest" as usual, the date fixed being December 15th. The club are now publishing their own monthly magazine entitled "Q.R.X." The price is threepence.

***Ashton-under-Lyne and District Amateur Radio Society***

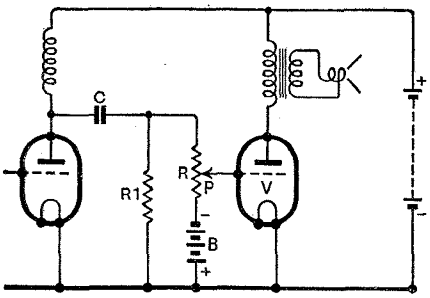
**Headquarters:** 17a, Oldham Road, Ashton-under-Lyne, Lancs.
**Meetings:** Wednesdays, at 8 p.m.
**Hon. Sec.:** Mr. K. Gooding, 7, Broadbent Avenue, Ashton under-Lyne, Lancs.

Several members are now in the Services, but it has been decided to carry on as usual so far as it is possible, and a programme of lectures is being prepared. In addition to the usual Wednesday meetings, members will meet at 2 p.m. each Sunday.

# Economising in HT Consumption

## ANODE CURRENT DEPENDENT ON VOLUME

ECONOMY in HT consumption is neither here nor there when the supply can be taken from the mains, but it is a very different matter in a battery-driven set where the cost of HT current usually works out at between £4 and £5 per unit. Thus it is obviously desirable that every milliamp drawn from the HT battery should be made to pull its full weight.



Method of "ganging" volume and HT consumption.

The output valve of a receiver is responsible for most of the HT consumption and in the accompanying diagram (Patent 511912) it will be seen that matters are so arranged that the current drawn from the HT battery by this valve rises and falls, automatically, with the setting of the volume control. In other words, the energy taken from the HT battery is kept proportionate to the actual speech-frequency output with the result that there is no unnecessary waste. The *modus operandi* is simple

As will be seen, the preceding valve is coupled to the output valve through a condenser C and a resistance R from which a volume-control slider P is taken to the grid. The resistance R is in series with a grid bias battery B and also with a second resistance R1, so that the current from B through the two resistances gives a potential gradient. The result is that when the slider P is moved upwards, to give maximum volume, the grid becomes more positive, and more anode current is taken. On the other hand as the control P is moved down, to reduce volume, the negative bias on the valve increases and the current drawn from the battery automatically falls off.

The initial grid-bias value is chosen so that for any setting of the volume control, the maximum voltage-swing brings the working point of the valve down to the lower bend of its grid-volts anode-current curve. The result is that the most favourable conditions in the matter of current consumption from the HT battery are always maintained.

## Bad Short-wave Conditions

### A GLOOMY FORECAST

"ETHACOMBER," who contributes regularly on conditions obtaining on the short-wave bands, apologises for his absence this month, but hopes to resume in our next issue. He prophesies that the present abnormally bad conditions for night-time propagation will last until February. This does not apply to long-distance transmissions during daylight hours, which are not greatly affected.

# Henry Farrad's Problem Corner

## No. 42—Contrariness of an Intervalve Transformer

101, Tooley Street,
South Ham.

Mr. H. Farrad.

Dear Sir,

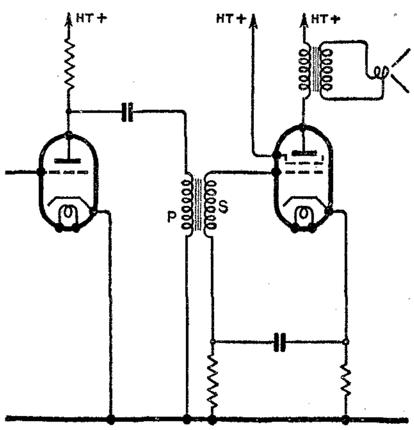
I am writing about a difficulty I have struck, hoping you will be able to give me a word of advice concerning it.

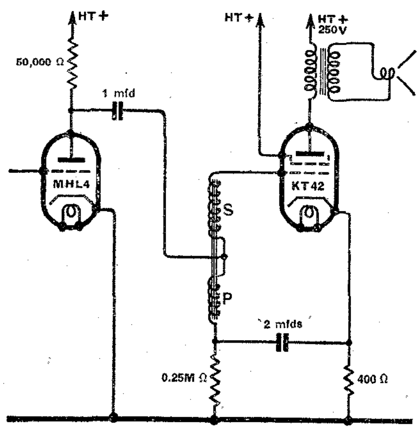
I was not getting quite enough AF amplification with an ordinary 1 : 3 ratio transformer-coupled stage in front of the output valve, so I reconnected it as an auto-transformer to give a ratio of 1 : 4. Actually, the results are very disappointing; the amplification is far less than before. The circuit diagram is enclosed, and I have checked it carefully; also all the components are O.K. There is no use telling me the transformer primary is reversed, giving only 1 : 2 step-up, because I have made sure about that. That being so, I cannot understand why I'm getting less amplification than before.

Yours truly,

N. F. Back.

*What is the explanation of this unforeseen result? Henry Farrad's solution is on p. 104.*



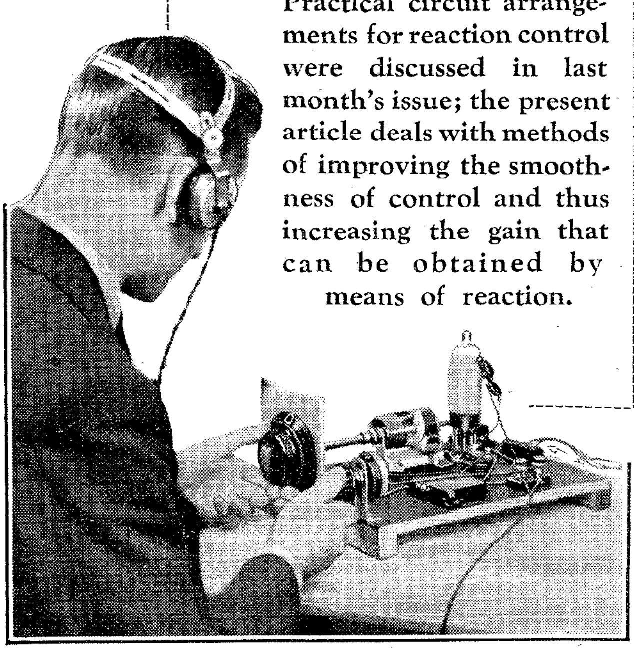




The diagram on the left shows the original intervalve coupling of Mr. Back's set, while on the right is shown how the circuit was modified for auto-transformer coupling.

# Smooth Reaction

## AVOIDING "PLOPPINESS" AND BACKLASH

**Practical circuit arrangements for reaction control were discussed in last month's issue; the present article deals with methods of improving the smoothness of control and thus increasing the gain that can be obtained by means of reaction.**



IN a small communication receiver regeneration is often needed at intermediate frequency in order to increase the adjacent-channel selectivity. With the usual intermediate frequency of 465 kc/s or so the correct method of control with the Colpitts circuit is a variable condenser $C_1$ in Fig. 1 (repeated from last month's article). This is a particularly convenient circuit arrangement, although there are many possible variations of it. For this frequency, $C_1$ should have a maximum capacity of some 150–200 $\mu\mu$F with a low minimum, $R_1$ can be 50,000 ohms or so, and $L_1$ should have an inductance greater than 2,000 $\mu$H. The valve can well be a small triode with a mutual conductance of some 2 mA/V and an AC resistance of the order of 10,000 ohms. $C_{gc}$ is the grid-cathode capacity of the valve; in some cases, however, it is advisable to augment it by an additional capacity of 10 $\mu\mu$F or so. It has been found that this leads to much smoother reaction.

When regeneration is used at signal frequency on short waves the conditions are different. Whether it is used merely to increase pre-selection in a small communication receiver or to give the necessary sensitivity in a straight set, a voltage or resistance control is necessary. With a triode the circuit of Fig. 1 can be used and stray capacities are usually sufficient for $C_1$, though, as just suggested, it may prove advisable to augment $C_{gc}$ a little. $L_1$ can be a short-wave choke and $R_1$ a good quality variable resistance of some 10,000–20,000 ohms maximum value. The same difficulties in the choice of a resistance apply as in the case when it is connected straight across the tuned circuit, but to a lesser extent.

The alternative control, by varying $g$, is best applied to a screened tetrode or pentode valve and a suitable circuit is shown in Fig. 2. The resistance $R_1$ of Fig. 1 will probably no longer be needed and regeneration is controlled by varying the screen voltage by $R_3$. Although this scheme overcomes the difficulties associated with the choice of a suitable component for $R_1$, it has two drawbacks.

The first is that changing the screen voltage is likely to have some effect upon the static valve capacities, and so on the tuning. The second is that varying the screen voltage alters the operating conditions of the valve as a detector-amplifier; this is especially so when resistance coupling to a following stage is used.

### Screen Voltage Considerations

There is an optimum screen voltage for performance as a detector-amplifier, and for proper reaction effects it is necessary to adjust the other circuit constants so that the valve oscillates at this voltage. Under normal conditions when the valve is not oscillating the screen voltage is sub-optimum. It is not usually satisfactory to arrange matters so that the screen voltage is above optimum in the oscillating condition in the hope that it will be about optimum in the non-oscillatory, because one cannot be certain of avoiding an excessive screen voltage. Overvoltage is usually more harmful to performance than undervoltage, especially when resistance coupling to a following stage is employed.

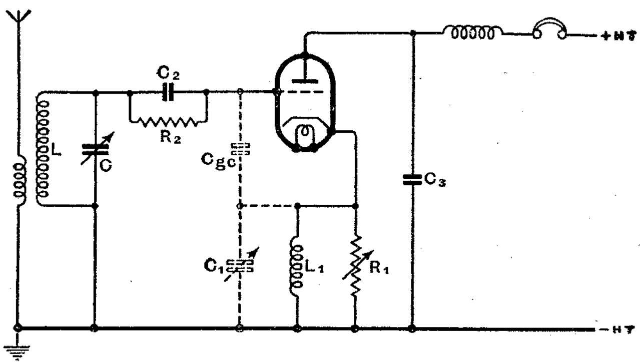



Fig. 1.—This diagram, which is repeated from last month's article, shows a version of the Colpitts circuit which is particularly convenient, since the tuning condenser can be earthed.

This particular circuit is only suitable for indirectly-heated valves, since the cathode cannot be earthed. With battery valves a modified arrangement must be employed, and the circuit of Fig. 3 is probably the best. Neither side of the tuning condenser C is earthed, so that it must be operated through an insulated extension

**Smooth Reaction—**

shaft in order to avoid hand-capacity effects. In many cases it will be possible to replace $L_1$ by a resistance $R_1$ of 50,000 ohms or so.

The Hartley circuit is easier to use with battery valves, but is more difficult to analyse and harder to get working nicely at very high frequencies. The usual circuit for an indirectly-heated valve is shown in Fig. 4. The tuning coil has a total inductance $L = L_1 + L_2 + 2M$ where M is the mutual inductance between the two parts $L_1$ and $L_2$. It is not difficult to show that if the circuit capacities $C_{gc}$ and $C_1$ are truly negligible and if the coupling between $L_1$ and $L_2$ is so tight that $M^2 = L_1L_2$ the effective inductance of the circuit is L and is unaffected by changes in the valve. A regeneration control which acts by varying the electrode voltages will then give no change in tuning.

In practice, $M^2$ can never equal $L_1L_2$; it is always smaller. The requirement for constancy of L at any frequency is then $M + L_2 = \mu\ (M + L_1)$; in other words, the ratio of the inductances of the two parts of the coil must equal the amplification factor of the valve. The tapping, therefore, must be towards the grid end of the coil. This is contrary to normal practice, which

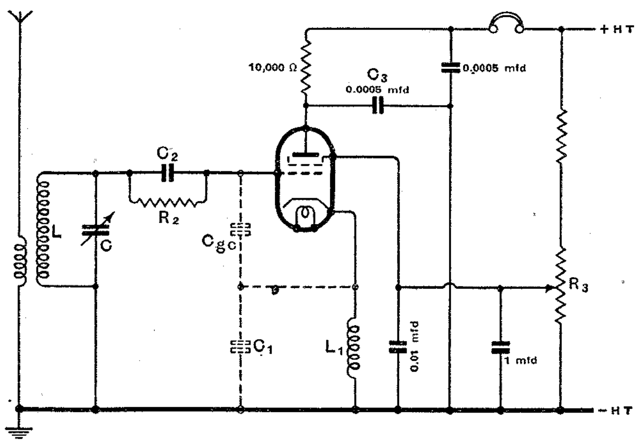



Fig. 2.—For high-frequency work a screened tetrode or pentode is very convenient, as the screen voltage can be varied for a regeneration control.

places the tapping point towards the anode end as shown in Fig. 4. This may seem a little confusing at first, for the tapping is shown towards the earthy end of the coil. In this case, however, the earthy end is the anode end, for the anode and screen are earthed to radio-frequencies through the condensers $C_2$ and $C_3$.

Under normal conditions, however, there are probably more cases where the circuit capacities are not negligible than there are where they can be ignored. For them to be negligible it is necessary that $\omega^2L_2C_1\ (1 - k^2)/(1 + M/L_1)$ and $\omega^2L_1C_{gc}\ (1 - k^2)/(1 + M/L_2)$ be small compared with unity; $k^2$ is the coefficient of coupling and equals $M^2/L_1L_2$.

To get an idea of the quantities involved assume that the coil is centre-tapped and the coupling is 50 per cent. Then $L_1 = L_2$, $k = 0.5$, $M = L_1/2$ and the requirement is that $0.5\omega^2L_1C_1$ and $0.5\omega^2L_1C_{gc}$ be small compared with unity. At 30 Mc/s we might well use a total tuning capacity of 25 $\mu\mu$F, which would need an inductance of 1.1 $\mu$H and so make $L_1 = 0.36\ \mu$H.

The values of $C_1$ and $C_{gc}$ are hardly likely to be less

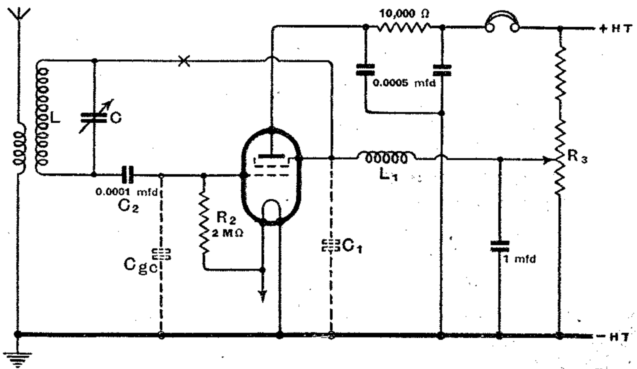



Fig. 3.—With a battery valve the circuit of Fig. 2 must be rearranged in this form. Neither side of the tuning condenser can now be earthed.

than 10 $\mu\mu$F and may well be as high as 15 $\mu\mu$F. Taking the latter figure we find $0.5\omega^2L_1C_1 = 0.098$, which is a good deal smaller than unity but hardly small enough to be negligible. Matters are worse if we use a smaller tuning capacity. Suppose we halve it; we shall have to double the inductance and this also doubles $L_1$ and so doubles the value of $0.5\omega^2L_1C_1$. A higher frequency, however, will not affect it. Suppose we double the operating frequency, then the inductance must be reduced to one-quarter and the value of $0.5\omega^2L_1C_1$ remains unchanged. The important thing, therefore, is to keep the ratio of $C_1$ and $C_{gc}$ to the total capacity small; in other words, keep $C_1$ and $C_{gc}$ as small as possible and do not use too small a value of tuning capacity. In connection with $C_1$ and $C_{gc}$ it must be remembered that these represent not only the valve and wiring capacities, but also the self-capacities of the two sections of the coil.

It can be seen, therefore, that the Hartley circuit is more likely to function well at low and moderate frequencies than at high because it is difficult to employ a reasonably large tuning capacity at the latter. These results are in accordance with practical experience.

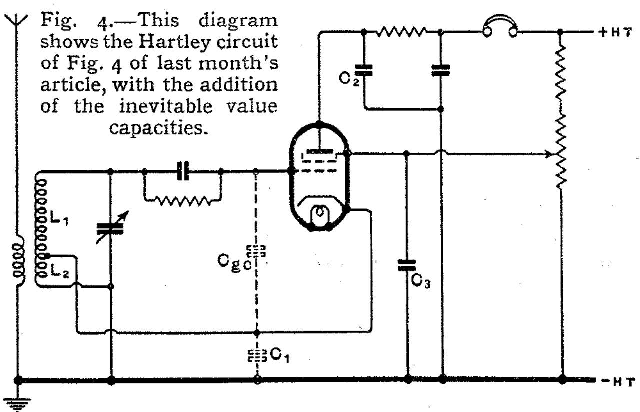



Fig. 4.—This diagram shows the Hartley circuit of Fig. 4 of last month's article, with the addition of the inevitable valve capacities.

Methods of using the Hartley circuit with battery valves are shown in Figs. 5 and 6. In Fig. 5 neither side of the tuned circuit can be earthed, so that pre-

**Smooth Reaction—**

cautions against hand-capacity effects must be taken. In Fig. 6 the tuning condenser has one side earthed but a coil is needed in the positive filament lead. This coil should be wound turn for turn with the main winding so that it is as nearly as possible identical with the coil between earth and negative filament and coupled to it as tightly as possible. Alternatively an RF choke can be used in the positive filament lead, but this component must be of very low DC resistance—certainly not more than 0.2 ohm with an average valve.

This by no means exhausts the possible ways of obtaining reaction effects. One arrangement, which was very popular in America in the early days of broadcasting, is shown in Fig. 7. A variometer $L_1$ is used as a reaction control. The input resistance of the valve is negative when the anode circuit load impedance is inductive, the feed-back taking place through the grid-anode capacity $C_{ga}$. Although simple, the circuit is hardly suitable for modern purposes, since the change of input capacity with varying reaction is quite large. Unfortunately, the limiting conditions which lead to a substantially constant input capacity cannot well be met with practicable values of components.

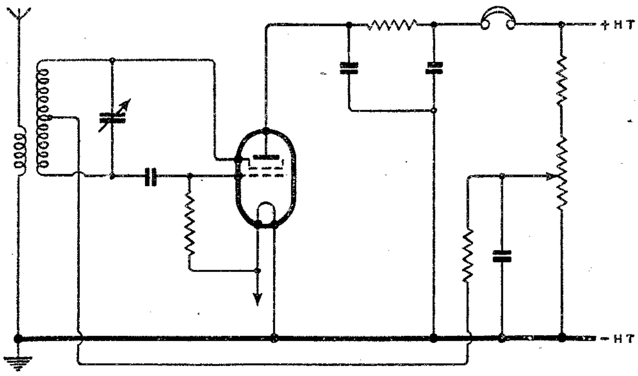



Fig. 5.—With a battery valve the Hartley circuit usually takes this form.

The change of effective input capacity with regeneration is not the only important matter connected with reacting circuits. In many, if not most, cases the attainment of smooth reaction free from backlash is also very important. In apparatus in which critical reaction is used it is of supreme importance.

### Conditions for Good Control

For smooth reaction the transition from the non-oscillating to the oscillating condition must take place gently. Suppose we have a small signal applied to the grid of a valve and we increase reaction until it oscillates. As reaction is increased the signal on the grid gets larger and larger, because it is made up of two parts—the original signal and a voltage returned to the grid from the anode circuit.

Conditions are stable as long as there is a power loss in the grid circuit as a whole, but with increasing reaction a condition is at length reached at which the energy fed back to the grid circuit equals or exceeds the loss. With perfectly linear valve characteristics and an unlimited power source, the grid circuit voltage would then build up to infinity. In practice a valve is only approximately linear over a portion of its characteristic

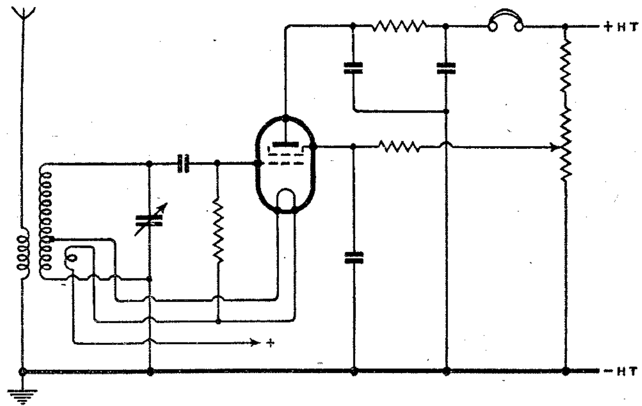



Fig. 6.—A modified Hartley circuit is shown here. One side of the filament is taken to the tapping on the coil and the other to positive LT through a coil coupled to the main winding.

and becomes markedly non-linear outside that range. When the amplitude sweeps over the non-linear portions there is a change in mutual conductance; at length it falls and limits the amplitude to a finite value.

If we take a valve with its grid negatively biased towards the anode current cut-off point A in Fig. 8, we can see that a small voltage will sweep over the small range BC around A. The mutual conductance is low, for it is the change of anode current for a given grid voltage change.

With sufficient reaction the amplitude builds up and becomes larger so that it soon sweeps over DE. The average valve oscillates more readily than it did initially. The amplitude goes on building up and the mutual conductance falling, but beyond about FG the signal drives the valve into grid current. The grid then takes power from the input circuit and tends to reduce the amplitude, and at length an equilibrium condition is reached.

The increase of mutual conductance with amplitude at the start, however, is a very serious drawback, for it

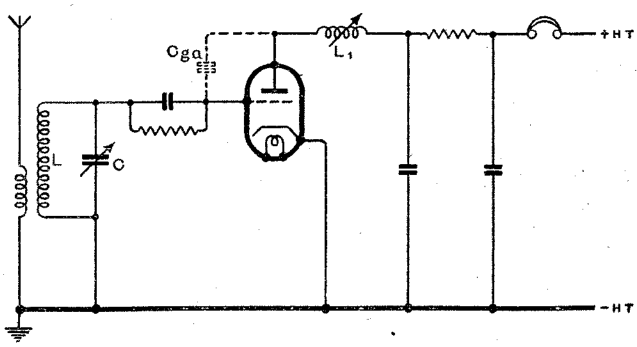



Fig. 7.—An early American circuit in which feed-back occurs through the grid-anode capacity $C_{ga}$.

leads to a very rapid increase in amplitude as soon as oscillation commences and this causes the familiar "plop" in the phones. It also causes backlash, for it is clear that as the mutual conductance is higher when the valve is oscillating than when it is not, weaker reaction coupling must be used to stop it oscillating than to start it.

A valve operating under these conditions is actually an anode-bend detector, and it is well known that this detector is not good for reacting purposes. If the bias is reduced so that the conditions are nearer those of an amplifier, matters are greatly improved and it is possible to arrive at a condition giving smooth reaction. In general, the bias should err on the low side so that grid current flows at a moderate value of RF grid voltage and so quickly starts to limit the amplitude.

### Changing Mutual Conductance

In most cases, however, the best results are secured with a grid-leak and condenser. The operation is then quite different and more complicated. As before, we get the rising RF amplitude on the grid tending to increase the mutual conductance, but at the same time the mean grid potential moves in a negative direction with increasing amplitude through the grid rectification effect. This increasing bias on the valve tends to decrease the mutual conductance and if it predominates over the first effect smooth reaction is secured.

Referring to curve A, Fig. 9, with a bias initially about zero the working portion is towards the middle of the straightest part of the characteristic. When the amplitude increases the grid potential moves somewhat negative, but does not greatly reduce the mutual conductance. The amplitude, in fact, tends to increase the mutual conductance nearly as much as if the bias were fixed.

Now if the characteristic were of the form B, it is clear that quite a small change in grid potential will bring the valve to anode current cut-off, where the mutual conductance is zero. Consequently, although the tendency is for the mutual conductance to rise because of the direct action of the increasing amplitude on the valve, there is a still greater tendency for it to decrease because of the increasing grid bias. The net result is a decreasing mutual conductance with amplitude; reaction is then smooth.

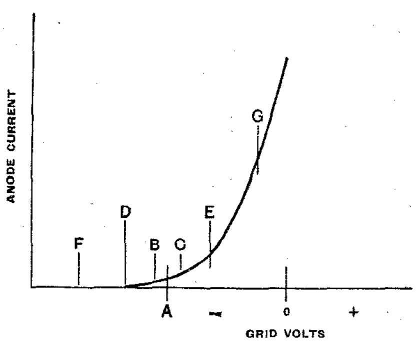



Fig. 8.—A typical valve curve is shown here. If the bias is fixed at A a small signal swings over the range BC. Larger signals swing over DE and FG.

The condition of curve B is secured with a low anode voltage in the case of a triode, or a low screen voltage with a tetrode or pentode. It has been known for very many years that a low voltage is much more conducive to smooth reaction than a high one. Its use, however, entails one disadvantage. It may be very good for the reception of weak signals but it tends to limit the output on stronger ones.

On tuning in a moderately strong signal one finds that as one comes into resonance more and more reaction is needed to bring the valve to the oscillation point, and the volume from the signal does not seem as great as it ought to be. What happens is that the bias developed by the grid rectification of the signal is large enough to bring the working point well down on the grid-volts-anode-current curve and so lower the mutual conductance. More feed-back is needed to come to the oscillation point and the AF gain contributed by the valve falls.

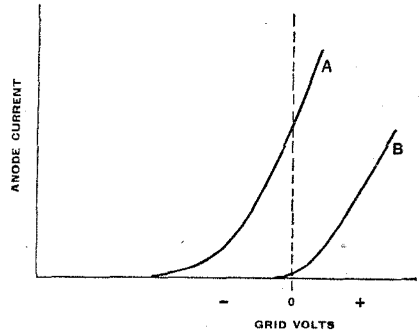



Fig. 9.—Two valve curves are shown here. A is for a fairly high anode voltage and B for a low voltage.

It is not always possible completely to eliminate this effect. It is reduced to a minimum by using as high an anode (or screen) voltage as possible consistent with smooth reaction.

### Inconstant Grid-Cathode Resistance

The variation of the grid-cathode resistance of the valve with amplitude is another important factor. With large amplitudes it tends to settle down at a value about equal to one-half of the value of the grid leak. With very small inputs, however, it can be higher or lower, depending on the value of the grid leak and the potential of the point to which it is returned. If the grid leak is fairly low, and especially if it is returned to a point positive with respect to the cathode, the grid-cathode resistance may be quite small for small signals. The resistance then increases as the amplitude grows and damps the input circuit less, thus increasing regeneration effects. This naturally makes for "ploppy" and ineffective reaction.

On the other hand, if the grid leak is of high value, and especially if it is returned to a point of negative potential, the grid-cathode resistance can be much higher for weak signals than for strong. The input circuit then becomes more heavily damped with increasing signal strength, which helps greatly in securing smooth reaction.

These points—a low anode voltage and a high resistance leak returned to a slightly negative point—represent very old advice for securing smooth reaction and they are as important to-day as ever. They are not points, however, which make for low distortion, but are just the opposite. This is not very important in practice because critical reaction is only needed for weak signals for which rectification will in any case be non-linear and the weak signals will often themselves be distorted.

Test Report

# H.M.V. Model 1200

## AC SUPERHET (SIX VALVES + RECTIFIER AND TUNING INDICATOR), PRESS-BUTTON TUNING WITH AFC AND AUTOMATIC WAVERANGE SELECTION

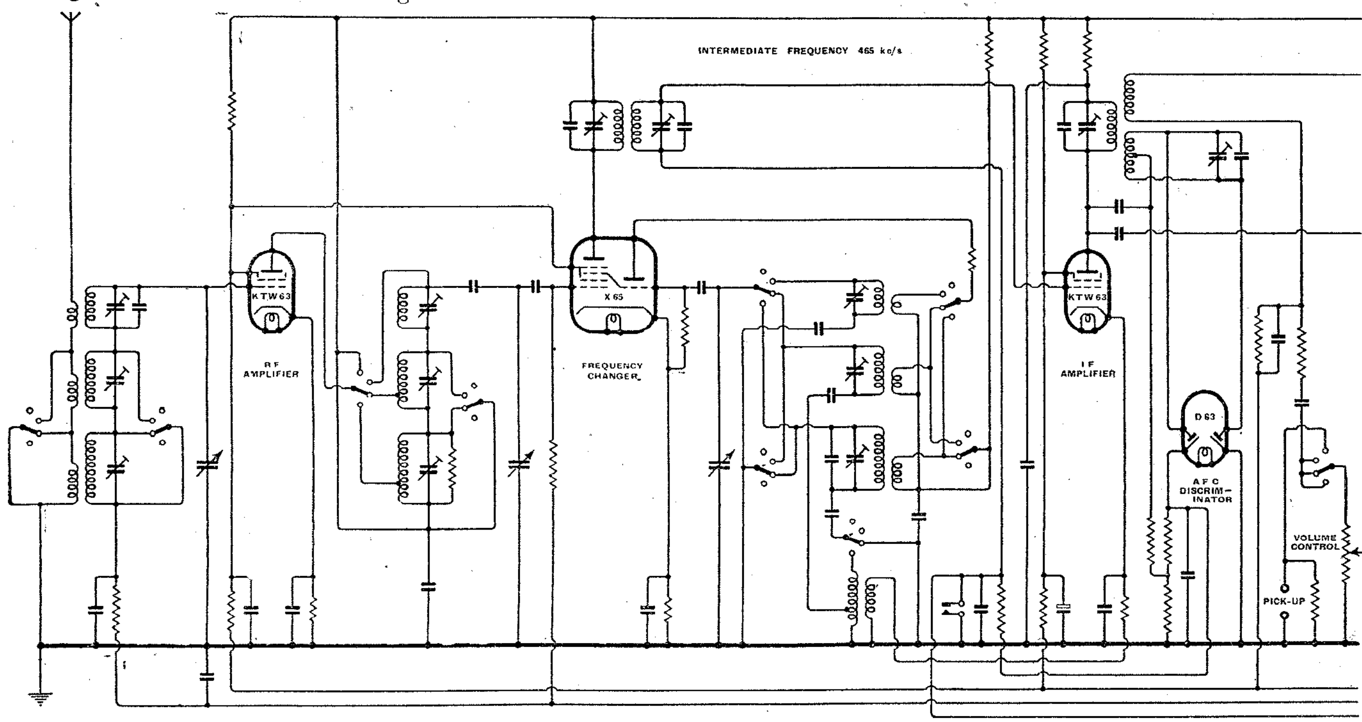
**PRICE: 21 gns.**

THE chassis incorporated in this table model receiver and also in the H.M.V. Model 1600 Autoradiogram has an unusually comprehensive specification. It is the type of instrument one could recommend without the usual preliminary enquiries to find the special interests of the listener. However specialised or catholic his tastes may be, he will find them amply satisfied by this set.

For quality reproduction there is a 10-watt output stage with negative feed-back operating an elliptical diaphragm loud speaker giving wide-angle projection of sound. The short-wave enthusiast will find a vernier tuning dial and an efficient RF stage to give him the necessary margin of sensitivity with adequate second-channel suppression, while for arm-chair listening on medium and long waves the fully automatic tuning system will select the appropriate waverange, find the station required and tune it accurately at the touch of a button. Manual tuning is supplemented by a two-way motor "cruising" drive for moving rapidly from one part of the scale to another.

**Circuit.**—Aerial coupling transformers with high-impedance primaries lead to the tetrode RF stage, which is tuned-anode coupled to the triode-hexode frequency changer. Both these stages are controlled from the AVC line, but not the IF valve, which in this receiver is required for DC amplification in connection with the automatic frequency control circuits.

Circuit diagram of the H.M.V. Model 1200. The IF stage is used also as a DC amplifier for the control current of the permeability AFC unit.



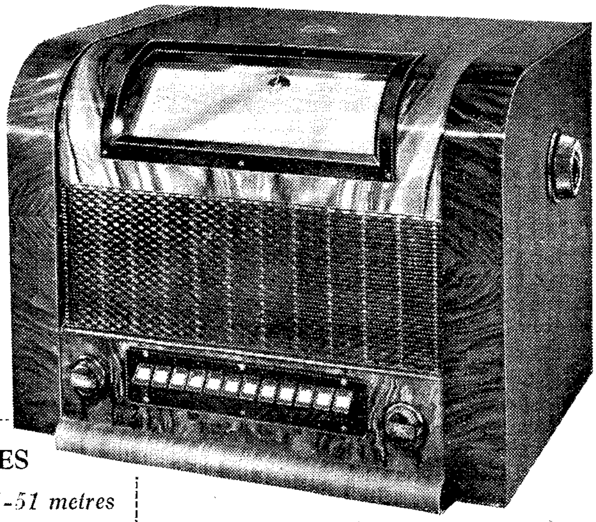

A centre-tapped third winding on the output IF transformer is connected in a balanced circuit to the anodes of the diode discriminator. Any out-of-balance potential which appears across the resistances in the cathode circuit of this valve is applied to the grid of the IF amplifier, and the resulting change in anode current alters the inductance of the AFC "transformer," one winding of which is connected in the cathode return lead, and the other in series with the oscillator tuning circuits on medium and long waves. The AFC input is short-circuited while the motor tuning mechanism is in motion and also when the keys for normal manual tuning are fully depressed. It is, however, possible to keep the AFC circuits on manual tuning by lightly touching one of the other buttons, so that all keys return to the "off" position.

Negative feed-back is applied from the secondary of the output transformer to the cathode circuit of the first AF amplifier. The characteristics of the feed-back system evidently call for a comparatively low resistance at this point, and to increase the delay voltage to the required value the screen potentiometer current for the earlier valves is returned to earth via the cathode resistance of the second detector valve. Tone control is affected by an adjustable resistance-capacity filter between grid and anode of the tetrode output valve.

***Performance.***—In most of the receivers which pass through our hands it is usually possible to point to some distinguishing characteristic in the performance which may help the reader to decide if it is the type of set he is looking for. The difficulty in the Model 1200 is to decide which of its many excellent points can fairly be singled out for special mention; and therein lies its distinguishing characteristic, namely, that of the well-balanced "all rounder."

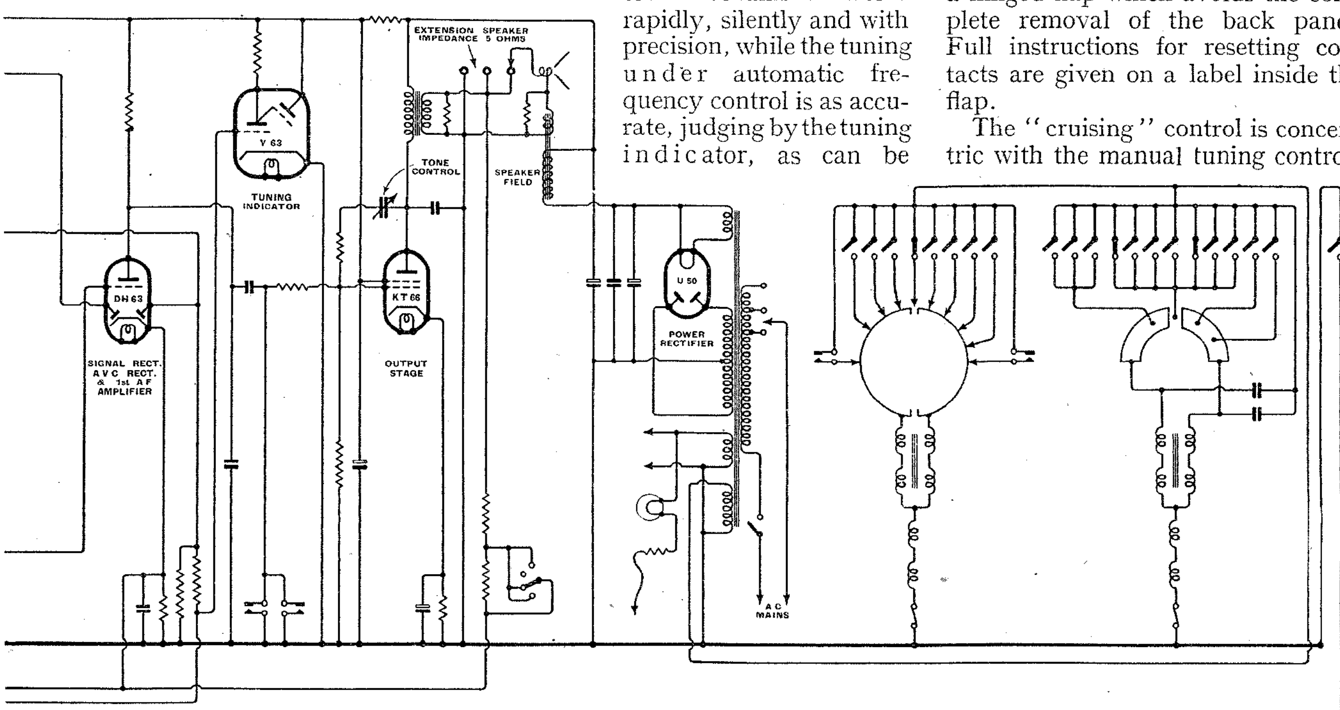
Quality of reproduction leaves nothing to be desired either in fullness of tone or spaciousness of distribution on orchestral items. Speech is natural, and the crispness and clarity required for solo instruments and small musical combinations is not lacking. In particular, the set handles pianoforte tone and transients faithfully.

On all wavelengths the receiver shows a uniformly high overall sensitivity and an ability to bring in distant stations with the minimum of background noise and an entire absence of self-generated whistles. There is no evidence of second-channel repeat tuning points on short waves, and the selectivity on medium and long waves gives adjacent channel separation on all but powerful local stations where not more than $1\frac{1}{2}$ channels would normally be lost on either side.



| WAVERANGES | |
|---|---|
| *Short* .. .. | *16.5-51 metres* |
| *Medium* .. .. | *195-560 metres* |
| *Long* .. .. | *750-2,000 metres* |

The waverange and station selector mechanism works rapidly, silently and with precision, while the tuning under automatic frequency control is as accurate, judging by the tuning indicator, as can be achieved by manual tuning. Incidentally, the electron tuning indicator is adjusted to give a high degree of sensitivity on weak signals without prejudicing its effectiveness on the local station.




***Constructional Features.***—Separate motors are employed for driving the waverange selector and the station homing drum. The latter is provided with a test lamp and lead for adjusting push-buttons to new station settings. Access to the station selector drum is facilitated by a hinged flap which avoids the complete removal of the back panel. Full instructions for resetting contacts are given on a label inside the flap.

The "cruising" control is concentric with the manual tuning control, and under motor drive the full length of the scale is traversed in six seconds. A ratio of 64 to 1 is provided for the manual drive, which is very comfortable to handle when tuning in short-wave stations.

***Makers.***—The Gramophone Co., Hayes, Middlesex.

# Current Topics

RECENT EVENTS IN THE WORLD OF WIRELESS

## TRANSMITTING GEAR

**P.M.G. Controls Supply, Possession and Operation**

THE Postmaster-General has issued orders under the Defence Regulations prohibiting, except under the authority of a Post Office permit, the supply or acquisition of wireless transmitters—telegraphy, telephony, television, navigational beacons, etc.—transmitter-receivers, and certain apparatus which may be used as parts of transmitters.

HF inductors, spark coils, quenched and rotary spark gaps, line carrier telegraph and telephone equipment, valves capable of an anode dissipation exceeding 10 watts, quartz crystals and HF equipment capable of generating frequencies higher than 10,000 c/s are included in the list of apparatus, the supply or acquisition of which is prohibited by this Order, which came into force on November 25th.

A further Order, which came into force on December 15th, prohibits the possession of transmitters. By this Order no person, unless holding a special permit granted by the Postmaster-General, is allowed to possess or have under his control any type of transmitter or transmitter-receiver, or apparatus capable of being assembled as a transmitter. A third order concerns the use of transmitters.

Applications for permits should be made to the Engineer-in-Chief, Radio Branch, General Post Office, Harrogate, Yorkshire, on forms which may be obtained at any Head Post Office.

The penalties for the infringement of these regulations, which apply to the whole of the United Kingdom, include imprisonment up to two years, or a £500 fine, or both.

## CRYSTAL SETS

**Popularity in Germany**

THE popularity of the crystal set is growing in Germany. The reason for this is said to be the unobtrusive manner in which the set works. The usefulness of the crystal set is increased by the employment of high-power transmitters. Some difficulty is experienced in the matter of selectivity, but with a good aerial and a favourable situation, a crystal set can be quite satisfactory.

The price of crystal sets, without earphones, in Germany is at present equivalent to approximately 5s. at par.

## NATIONAL WIRELESS REGISTER

**More Openings**

THE National Wireless Register inaugurated by *The Wireless World* has, we understand, proved to be of great value to the three services, and entrants are still being placed.

There are vacancies still for amateur wireless operators who wish to enlist in the Army for duty with the Royal Corps of Signals. Men aged from 23 to 55 years who are not in Government service or who have not already enrolled in the National Wireless Register can be considered. Full particulars can be obtained from the Secretary of The Wireless Telegraphy Board, c/o The Admiralty, Whitehall, London, S.W.1.

Provided that volunteers have some knowledge of morse operating, it is not essential that they should have attained a high degree of skill, as facilities for practice and training will be available after enlistment.

For those with general wireless qualifications who have not yet enrolled in the National Wireless Register forms are still available from the above address.

## COMMERCIAL SHORT-WAVE BROADCASTING

THE National Broadcasting Company of America has introduced commercial broadcasting from its international short-wave stations WRCA and WNBI. Programme time is available to sponsors for the full period of the stations transmitting period—sixteen hours a day.

Increased interest in international broadcasting has been stimulated by the war, and American business concerns anxious to take advantage of this to develop their oversea markets are negotiating with the N.B.C.

The six-language service covers Europe from 2 to 9 p.m., G.M.T., and the twenty Latin American countries from 9 p.m. to 6 a.m., G.M.T.

## RADIO RESEARCH AT THE N.P.L.

AN Abstract of Papers published by members of the staff of the National Physical Laboratory during the year 1938 has just been issued by H.M. Stationery Office at 1s. net (postage extra). A section of the publication deals with wireless subjects.

## WIRELESS WATCHES

**British Merchant Ships**

A RECENT order made by the Lords Commissioners of the Admiralty laid down rules regarding the keeping of watches by wireless operators on board British merchant ships which, if at sea more than eight hours, must carry two operators.

In the absence of other instructions a continuous watch must be kept when three or more operators are on board. A continuous watch must also be kept if only two operators are carried and the time at sea does not exceed forty-eight hours. If, however, the hours do exceed forty-eight, a watch of sixteen hours a day must be kept. An eight-hour watch must be provided where one operator only is available.

## CANADA'S S-W STATION

**Britain's Second Line of Defence**

ALTHOUGH the Canadian Broadcasting Corporation has, for reasons of economy, decided to shelve the proposed extensions and improvements to the Dominion's stations, there is every likelihood of the erection of a short-wave station.

Writing in the Canadian *Financial Post*, a correspondent points out that Canada could, by short waves, ensure coverage for a large part of the world. "It is contended," says the writer, "that in broadcasting, as in other spheres of war, Canada should be the second line of Britain's front."

In 1938 and 1939 representations were made by the C.B.C. to the House of Commons urging the necessity for the provision of a short-wave station, and although the special Parliamentary Committee unanimously agreed to the plan, its recommendations have not yet been implemented by Parliament. The primary objection was the expense, for it was estimated that it would cost $400,000.

## WIRED WIRELESS

IN order to remove the present legal disabilities preventing electricity undertakings from entering into agreements with concerns for the re-diffusion of broadcast programmes over their distributing mains, the Council of the Incorporated Municipal Electrical Association is considering a draft clause to amend the Electricity Acts.

## BROADCASTING IN NEW ZEALAND

### National and Commercial Systems

APPROXIMATELY 84 per cent. of the houses in New Zealand are equipped with wireless receiving sets. So opens the annual report of the Dominions National Broadcasting Services for the past financial year. At the end of the year under review there were 19.61 licences per hundred of the population, whereby New Zealand maintained its position of third in the world in respect of the density of licences to population.

The report is in two parts, one covering the National Broadcasting Service, which operates fourteen stations varying in power from 0.03 kW to 60 kW, and the National Commercial Broadcasting Service, which was then operating four transmitters.

In co-operation with the Railways Department a mobile station was built in a railway unit to undertake a tour of the major towns of the North Island.

## SUPPRESSING TROLLEY-BUS INTERFERENCE

IN a recent paper on trolley-buses, which normally would have been read before the I.E.E., but was instead circulated to members, Mr. G. F. Sinclair, of the London Passenger Transport Board, spoke of the large-scale experiments carried out on London trolley-buses to reduce their electrical interference.

The system now in use includes only two liberally current-rated chokes, one in each of the two main master-controller feeds, in conjunction with a centre-tapped condenser filter connected across the line and chassis. The centre-tapped condenser filter is used to short-circuit the high-frequency potentials appearing between the trolleys and the chassis, and provides efficient suppression of interference within the wavelengths of 200 and 1,500 metres.

## FRENCH LICENCE FEES

ON January 1st an increase will be made in the French wireless receiving licence fees. Owners of valve sets for domestic use will have to pay Fr.90 instead of Fr.50, whilst crystal receivers will be rated at Fr.15. The licence for receivers in public places used for free entertainment will be Fr.180, and those in buildings charging for admission will be rated at Fr.360.

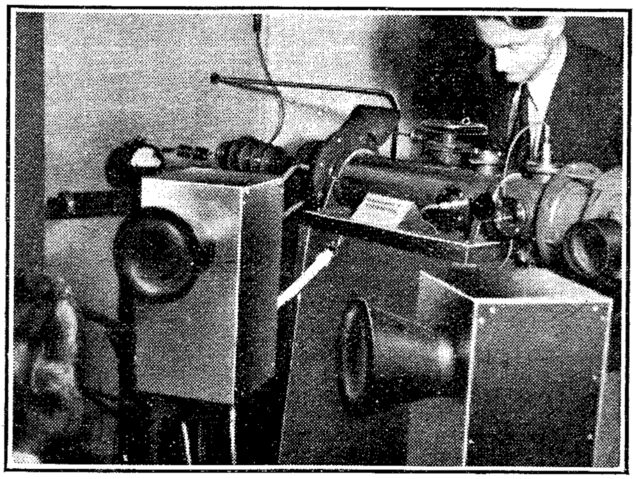
## SWISS BROADCASTING

SOME misunderstanding may have arisen from the note under the above heading in our November issue. The fact is that there are *two* broadcasting organisations in Switzerland. The commercial wireless telegraph and telephone concern, Radio-Suisse, is, as usual, operating the League of Nations station, Radio-Nations, and not the Swiss Broadcasting Company.

The broadcasting company which is licensed by the Government to operate the Swiss broadcasting stations has had its licence temporarily suspended, and has been taken over by the Ministry of Posts, Telegraphs and Telephones.

## TELEVISION ON THE CONTINENT

ALTHOUGH the clock has been put back so far as television in England and France are concerned, there are still countries on the Continent that are proceeding with its development. In Rome the regular daily transmissions are continuing and Berliners have once again had the opportunity of seeing television. It is understood that the Berlin transmissions are by cable link to the television viewing rooms which were reopened, and it was announced that programmes would be relayed to similar public viewing places in other towns. There is, of course, no news of the standard receiver being marketed.



The television scanning equipment demonstrated at the recent Swiss National Exhibition.

The Swiss National Exhibition at Zurich, which, like its immediate predecessor in 1914, heralded a war, provided an opportunity to demonstrate some television receivers, and an entirely Swiss-built television transmitter. The system uses the light spot from a cathode-ray tube, which, after passing through a lens, scans the object to be televised, and the lighted object is picked up by two light-sensitive cells. Throughout the Exhibition, which closed on October 29th, daily demonstrations were given on the six receivers in a darkened hall. The frequencies used were 45 and 41.5 Mc/s. It is thought that but for the outbreak of war the transmitter would have been moved to a site on the hills surrounding Zurich for continued experiments.

## FROM ALL QUARTERS

### Nonagenarian

SIR AMBROSE FLEMING, F.R.S., the well-known pioneer, who by his experimental work with the Edison effect produced the first practical diode, celebrated his 90th birthday on November 29th.

### Wireless-controlled Model Aircraft

A READER who is interested in the subject of wireless control of model aircraft would like to get into touch with others having similar interests and who preferably have reached the stage of putting their ideas into practice. Letters addressed to this office will be forwarded.

### South Shields Marine School

THE principal of the South Shields Marine School, Dr. J. Hargreaves, announces the reorganisation of the wireless department to meet the increased demand for wireless operators for the merchant service. Students, who need not have a previous knowledge of wireless, must be at least sixteen years old. Day and evening classes are available for the course, which is from four to six months.

### Indian Radio Exhibition

THE first All-India Radio and Science Exhibition will be held in the University Hall, Lahore, from December 27th to January 10th.

### Gramophone Records

THE combination of the black-out and the single programme broadcast by the B.B.C. with inferior quality reception in many areas has stimulated an increased demand for gramophone records as a

**Current Topics—**

form of home entertainment. The October sales figures were 25 to 30 per cent. up on last year's results, and it has been calculated that for every hundred records purchased in November, 1938, 134 have been bought during November, 1939.

### Educational Opportunity

A SPECIAL full-time day course in the principles of wireless and television, which will last about twelve weeks, is to be given in the Electrical Engineering Department of the City and Guilds College, London, S.W.7, from Wednesday, January 3rd. The number of students for the course, the fee for which will be £20, will be limited to thirty. Full particulars are obtainable from the college registrar.

### Cossor

SIR LOUIS STERLING has been elected vice-chairman and managing director of A. C. Cossor, Ltd., Mr. J. H. Thomas having resigned his managing directorship. Mr. Thomas has also tendered his resignation as chairman of the R.M.A.

### Egyptian Transmissions

EXPERIMENTAL transmissions are being radiated each evening between 6.30 and 8.30 G.M.T. on a frequency of 7.865 Mc/s (38.14 metres) from the new 10-kW Egyptian short-wave station.

### The G.E.C. Journal

THE General Electric Company has decided that during the war the G.E.C. Journal will be published twice a year instead of quarterly. The next issue will appear in February.

### For the B.E.F.

EDISWAN are sponsoring a series of concerts broadcast from the Radio International station on 212 metres on Sundays from 3.45 to 4 and from 6.15 to 6.30 p.m. The concerts form part of a series approved by the French Government the aim of which is to provide "home atmosphere" for the British troops in France.

### R.C.A. Profits

AN increased profit of nearly $300,000 was made by the Radio Corporation of America and its subsidiaries during the third quarter of 1939 as compared with the same period of 1938. The net profit for the first nine months of the year, however, has dropped by nearly $80,000 as compared with the first three quarters of 1938.

## NEWS IN ENGLISH FROM ABROAD: Regular Short-Wave Transmissions

| Country : Station | Mc/s | Metres | Daily Bulletins (G.M.T.) |
|---|---|---|---|
| **America** | | | |
| WNBI (Bound Brook).. | 17.78 | 16.87 | 2.0‡, 3.0 a.m., 4.0‡, 5.0. |
| WRCA (Bound Brook).. | 9.67 | 31.02 | 3.0 a.m., 5.0. |
| WCBX (Wayne) .. | 6.17 | 48.62 | 6.55 a.m. |
| | 9.65 | 31.09 | 4.0 a.m. |
| | 11.83 | 25.36 | 1.55 a.m., 2.45 a.m.†, 8.30*, 9.55†, 10.50, 11.30. |
| | 15.27 | 19.65 | 6.30‡. |
| | 21.56 | 13.91 | 1.0, 2.0†, 4.0*†. |
| WGEO (Schenectady).. | 9.53 | 31.48 | 8.30†, 9.55, 11.25‡. |
| WGEA (Schenectady).. | 15.33 | 19.57 | 5.0, 9.55, 10.15†. |
| WPIT (Pittsburg) .. | 11.87 | 25.26 | 3.0 a.m., 11.45. |
| | 15.21 | 19.72 | 2.0‡, 4.0†, 5.0, 6.0. |
| | 21.53 | 13.93 | 1.0‡, 2.0. |
| WCAB (Philadelphia) .. | 6.06 | 49.50 | 11.30 (11.45 Wed., Thurs., and Sat.). |
| | 9.59 | 31.28 | 1.55, 4.0, 6.55 a.m., 11.30 (11.45 Sun., Tues. and Fri.). |
| | 15.27 | 19.65 | 5.15, 7.0, 11.0. |
| WRUL (Boston) .. | 6.04 | 49.67 | 11.0‡. |
| | 11.73 | 25.58 | 4.0 a.m., 8.0. |
| | 11.79 | 25.45 | 8.30. |
| **Italy** | | | |
| I2RO3 (Rome) .. .. | 9.63 | 31.15 | 12.30 a.m., 6.18, 9.15. |
| I2RO4 .. .. .. | 11.81 | 25.40 | 12.30 a.m., 11.0 a.m., 3.55, 6.18. |
| I2RO6 .. .. .. | 15.30 | 19.61 | 12.30 a.m., 3.55. |
| I2RO8 .. .. .. | 17.82 | 16.83 | 11.0 a.m. |
| I2RO9 .. .. .. | 9.67 | 31.02 | 11.16. |
| IRF .. .. .. | 9.835 | 30.52 | 12.30 a.m. |
| IQY .. .. .. | 11.76 | 25.70 | 12.30 a.m. |
| **France** | | | |
| TPB6 (Paris-Mondial) .. | 15.13 | 19.83 | 8.15 a.m. |
| TPB11 .. .. .. | 7.28 | 41.21 | 7.0. |
| TPA2 .. .. .. | 15.243 | 19.68 | 11.0 a.m., 7.0. |
| TPA4 .. .. .. | 11.718 | 25.60 | 1.30 a.m., 4.30 a.m., 5.15 a.m. |
| TPB7 .. .. .. | 11.885 | 25.24 | 3.0 a.m., 8.15 a.m., 7.0. |
| **Ireland** | | | |
| Athlone .. .. .. | 9.59 | 31.27 | 5.45, 9.0 (9.5 Sun.) |
| | 17.84 | 16.82 | 5.45, 9.0 (9.5 Sun.) |
| **Germany** | | | |
| DJA (Zeesen) .. .. | 9.56 | 31.38 | 5.15 7.15, 11.15. |
| DXB .. .. .. | 9.61 | 31.22 | 9.15 a.m., 10.15 a.m., 2.15 7.15, 8.15, 9.15. |
| DJB .. .. .. | 15.20 | 19.74 | 10.15 a.m., 2.15. |
| OLR5A (Podébrady) .. | 15.23 | 19.70 | 7.50. |
| SP48 (Warsaw) .. | 6.11 | 48.86 | 7.45. |
| **Yugoslavia** | | | |
| YUA (Belgrade) .. | 6.10 | 49.18 | 9.0. |
| YUC .. .. .. | 9.50 | 31.56 | 9.0. |

| Country : Station | Mc/s | Metres | Daily Bulletins (G.M.T.) |
|---|---|---|---|
| **Russia** | | | |
| RNE (Moscow) .. | 12.00 | 25.00 | 9.30, 10.30, 12 midnight. |
| RW96 .. .. .. | 6.03 | 49.75 | 8.0, 10.30, 12 midnight. |
| | 9.52 | 31.51 | 8.0, 10.30. |
| | 15.18 | 19.76 | 8.0 a.m. |
| RKI .. .. .. | 7.51 | 39.89 | 9.30, 10.30. |
| | 15.04 | 19.95 | 12.0 midnight. |
| RAL .. .. .. | 9.60 | 31.25 | 8.0, 9.30, 10.30, 12.0 midnight. |
| RWG .. .. .. | 7.36 | 40.76 | 9.30†, 10.30†. |
| — .. .. .. | 8.06 | 37.22 | 8.0. |
| — .. .. .. | 11.64 | 25.77 | 11.0 a.m. |
| — .. .. .. | 11.90 | 25.21 | 9.30, 10.30†. |
| **Japan** | | | |
| JZJ (Tokio) .. .. | 11.80 | 25.42 | 8.5. |
| JZK .. .. .. | 15.16 | 19.79 | 1.15 a.m. |
| JVW .. .. .. | 7.25 | 41.34 | 8.5. |
| **China** | | | |
| XGOY (Chungking) .. | 11.90 | 25.21 | 10.0. |
| **Spain** | | | |
| FET1 (Valladolid) .. | 7.07 | 42.43 | 7.45. |
| EAQ1 (Madrid).. .. | 9.86 | 30.43 | 3.25. |
| **Australia** | | | |
| VLR (Melbourne) .. | 9.58 | 31.32 | 8.45 a.m. (9.20 a.m. Sun.), 12.30 (12.15 Sun.). |
| VLR3 .. .. .. | 11.88 | 25.25 | 2.20 a.m., 8.30, 10.30. |
| **Finland** | | | |
| OFD (Lahti) .. .. | 9.50 | 31.58 | 8.0 a.m., 9.40, 11.30. |
| | 15.19 | 19.75 | 8.0 a.m., 9.40, 11.30. |
| **Hungary** | | | |
| HAT4 (Budapest) .. | 9.12 | 32.88 | 12.15 a.m. |
| — .. .. .. | 15.34 | 19.55 | 2.15†. |
| **Portugal** | | | |
| — .. .. .. | 3.71 | 80.80 | 8.0 (Tues., Thurs. and Sat.) |
| **Turkey** | | | |
| TAP (Ankara) .. .. | 9.46 | 31.70 | 8.15. |
| **Rumania** | | | |
| — .. .. .. | 9.28 | 32.33 | 9.45‡. |
| **Manchukuo** | | | |
| Hsinking .. .. | 11.77 | 25.48 | 2.50, 6.30, 9.0. |
| **Newfoundland** | | | |
| St. John's .. .. | 9.48 | 31.64 | 10.30. |

All times are p.m. unless otherwise stated. * Saturdays only. † Sundays only. ‡ Sundays excepted.

# New Ideas

**RECENT ADVANCES IN WIRELESS TECHNIQUE**

## Flexible Glass Insulation

**AN IMPORTANT DEVELOPMENT IN COIL CONSTRUCTION**

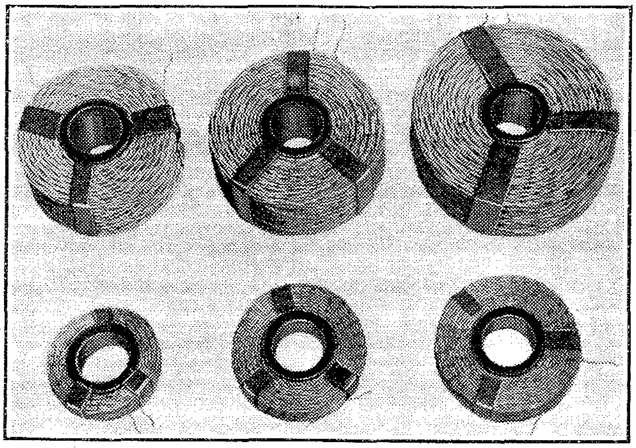
IT is well known that glass forms one of the most reliable of insulators, and it has been widely used in electrical work of all kinds, including radio. For some time past experiments have been going on, chiefly in America, with the production of flexible glass for replacing cotton, silk, and similar substances as a means of insulating wire. A considerable degree of success has attended these experiments, and, according to a writer in a recent issue of *Electronics*, this new substance—usually known as fibrous glass—has already been employed to a considerable extent in power engineering work, and latterly it has been applied successfully to radio and other branches of high-frequency engineering.

This insulating material is made up of glass fibres of almost incredible tenuity; their diameter is only 0.0002in. The fibres can be produced either in short lengths or in continuous strands. Yarn made from these fibres is quite flexible and can be woven into tape or cloth suitable for replacing the customary silk or cotton covering of wires.

Coils wound with wire covered by this insulating material are able to withstand considerably higher temperatures, are less affected by corona, and resist moisture more effectively than the more conventional type. For a given current, the wire may be of much smaller cross-sectional area when using glass insulating material, since although the wire will attain a relatively high temperature it will not have the destructive charring effect which would be the case with cotton or silk. Consequently, it has been greatly employed in electric railway service, enabling small and light units to be used, a very important point in such a case. There are now twenty-five manufacturers of electric motors in the U.S.A. who can supply glass-insulated types.

In considering the possibilities of glass-insulated coils for radio work, it is worthy of note that with this type of insulation the American Institute of Electrical Engineers permit a much greater temperature rise than when cotton is used. The actual figures are 55 degrees Centigrade for cotton and 75 degrees for glass. Glass insulation is, of course, still too much of an innovation for much data to have been gathered by prolonged experience. Laboratory experiments have, therefore, been conducted by dissipating heavy overload voltages of equal value through cotton and glass-insulated coils. The coils used were identical in every respect except that of insulation. It was found that, whereas the cotton coils failed after thirty minutes, the glass ones were still going strong after twenty-nine *hours* when the tests were concluded. This fact will give some idea of the value of this method of insulation.

As a result of the data obtained in these tests, it was possible to design glass-insulated anode chokes to take the place of cotton-insulated ones in certain transmitting apparatus, the new coils being required, of course, to dissipate the same wattage over the same radio-frequency band as the old ones. A useful comparison can be had by reference to the photograph of these choke coils which accompanies this note. The small glass-insulated coils performed equally as well as their cotton counterparts, but were operated at a much greater internal temperature, which, by reason of the fact that the insulation used was glass, was, of course, quite immaterial. The weight of the glass coils was only 25 per cent. of the older type, the figures for diameter and length being 67 per cent. and 43 per cent. respectively.



*Courtesy Electronics*

A comparison between cotton-insulated and glass-insulated coils. The glass-insulated ones at the bottom have identical characteristics with their bulky counterparts above.

Similar saving of weight and bulk, as well as the other advantages of glass insulation already mentioned, have been obtained in the case of other components. This has, for obvious reasons, proved of great value in aircraft apparatus. In addition, the much greater resistance of glass to moisture absorption is proving to be another very strong point in its favour.

### Resistances and High Temperature

One of the most useful appliances of this fibrous glass insulation is in the construction of the various anode and other resistances of a modern receiver, which have to dissipate a certain amount of heat. Already, according to an article in *Communications*, glass-insulated resistances have been marketed specially for use in radio receivers. For a given wattage the resistances are considered more compact than the ordinary type. This is due simply to the fact that a much bigger temperature rise may be permitted without fear of charring the insulating material. Actually, it is claimed that these

**New Ideas—**

resistances may be operated at red heat without damage, although, needless to say, this is ordinarily not done. This fact, however, has attracted the attention of manufacturers of such domestic devices as small electric irons and electric soldering irons.

## New Midget Valves

### STEP TOWARDS THE "POCKET" RECEIVER

IT would seem that the really portable broadcast receiver, with a weight and cubic content about a quarter that of the typical British product, has scored a big success in America. Still further reductions in weight and size are foreshadowed by the introduction by the Radio Corporation of America of a series of four miniature valves, with a diameter of rather less than three-quarters of an inch and an overall length of two inches. Of almost equal importance is the fact that these new valves are designed to operate efficiently on an HT voltage as low as 45.

The success of the small American portable is largely due to the use of dry cells for filament heating, and so it is not surprising that the new valves are designed for that form of LT supply, the filaments being rated at 1 4 volts, 0.05 amp. (except for the output pentode, which consumes 0.1 amp.).

An RF pentode (Type 1T4), pentagrid frequency changer (Type 1R5), a diode-pentode (Type 1S5), and a power output pentode (Type 1S4) comprise the series. The RF pentode is internally shielded, and, when used with a shielded holder, is stated to have a grid-to-anode capacity of no more than 0.01 $\mu\mu$F. A better performance than that obtained from a normal battery-type pentagrid frequency changer operated at 90 volts HT is claimed for the 1R5 worked at 45 volts. When used for its normal function as a second detector-AF amplifier, the 1S5 diode-pentode gives a much greater gain than a diode-triode. An output of 50 milliwatts at 10 per cent. distortion is obtained from the pentode with an anode current of only 3.5 mA. at 45 volts.

Constructionally, the new miniature valves are of the single-ended glass type, without a top cap, and the lead-out wires, which pass through a glass disc forming the base, act as contact pins.

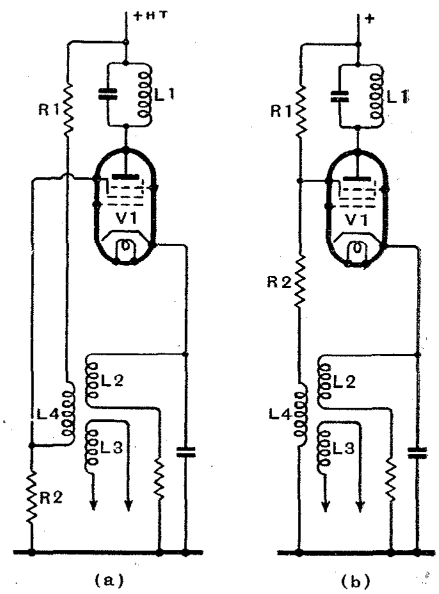
## Improving AFC

### USE OF PERMEABILITY PRINCIPLE TO CONTROL FREQUENCY VARIATION

THERE are many methods by which automatic frequency control—or automatic tuning control, as it is sometimes called—can be applied to a receiver. One, which is of more than passing interest, has been developed by engineers of the Gramophone Company.

Referring to (a), the valve V1 represents the first AF valve in a superhet receiver, or any other valve which has no AVC voltage applied to its grid. A coil L2, connected in the cathode lead, is wound upon a core of high permeability. This core may be of mu-metal or iron dust. A second coil L3, wound upon the same core, is connected with the tank circuit of the local oscillator of the receiver. A third coil, L4, also wound on the same core, but in the opposite sense to L2, is so connected that its DC polarisation is opposite to that of L2.

The current through L4 over a range of values usual in practice may be represented by $I_1 = m_1V + C_1$ where $m_1$ and $C_1$ are constants and V is the voltage of the HT supply to the valve. $C_1$ will be zero when L4 is fed directly through a resistance R1 from the HT supply, but, in general, it may be positive or negative, depending upon the position at which this third coil L4 is inserted in the valve circuit. Thus if L4 is connected between the screening grid of the valve and the HT supply as shown in (a), $C_1$ may be a negative constant. If, on the other hand, L4 is connected to screening grid and earth, as shown in (b), $C_1$ may be a positive constant. If values of cathode current are plotted against HT voltage over the same range of values, a straight line will be obtained represented by $I_2 = m_2V + C_2$ where $I_2$ = cathode current,




These circuits differ solely in the relative positions of R1, R2, L4, and the connection of the screening grid.

V = the voltage of the HT supply, and $m_2$ and $C_2$ are constants.

$C_2$ may be positve or negative, but, in general, will be negative.

If, now, $n_1$ represents the number of turns on L4, and $n_2$ represents the number of turns on L2, then the effective ampere turns are

$$n_1(m_1V + C_1) - n_2(m_2V + C_2)$$
$$= (n_1m_1 - n_2m_2)V + (n_1C_1 - n_2C_2).$$

By so selecting the number of turns on the auxiliary coil and the first coil respectively, so that $n_1m_1 = n_2m_2$, the ampere turns may be made independent of variations in the supply voltage.

In the static condition the value of the ampere turns required will be determined by the characteristic of the iron core employed. Assuming this value to be denoted by $\theta$, then there will be optimum values for $n_1$ and $n_2$, which can be determined from the relations $n_1m_1 = n_2m_2$ and $n_1C_1 - n_2C_2 = \theta$.

In has been found that considerable improvement in stability with variations in the HT supply are obtained without selecting the optimum values for $n_1$ and $n_2$.

This method can also be applied to deal with similar problems in connection with selectivity control by variable permeability.

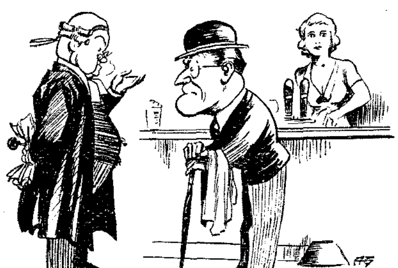
# Unbiased

By FREE GRID

## *A Psychological Faux Pas*

SINCE my earliest days I have always regarded judges and lawyers with the greatest respect as being people set apart from other men where learning and wisdom are concerned, and it has taken the war to disillusion me. The other day I happened to drop in at a well-known hostelry near the Law Courts to advise the landlord on a technical matter upon which he had consulted me. I was very astonished to find ensconced in the bar a very well-known barrister of my acquaintance, who on catching sight of me tried to dodge behind the barmaid, but on seeing that I had spotted him, he hastily informed me that he had come to give the landlord certain legal advice concerning the licensing regulations. Since my friend is definitely in the hundred guinea class where legal advice is concerned, I can only suppose that, as a result of the war, pubs. must be doing very well.

As my legal friend happens to be a very keen wireless amateur, and, of course, a reader of this journal, it was not unnatural that our talk drifted to wireless matters, and in



I asked for his opinion.

the course of our conversation I asked him for his considered opinion of an article in the December issue, as it contained a number of statements with which I profoundly disagree.

To my astonishment I found that not only had my friend not read it, but he had not even bought the last issue of this journal. In response to my wondering enquiry he told me that he did not intend to be forced into putting his signature to any contract no matter how many contract forms the Editor tucked in among the pages of *The Wireless World*.

Thoroughly mystified, I asked him to explain himself. It appears that the November issue contained a form which readers were invited to fill up and hand to their newsagents, the aforementioned form being a request to reserve a copy of *The Wireless World* every month. My friend is, by virtue of his legal training, so wary of putting his signature to anything that he had preferred to miss his paper rather than commit himself as he thought to a permanent obligation.

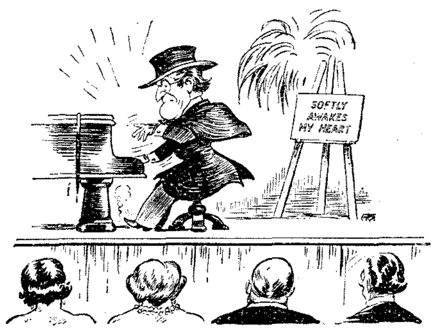
The whole affair has rather upset me, as it occurs to me that if a legal luminary like my friend mistook this for a contract, ordinary citizens will certainly do so. These forms were supplied, of course, to enable the newsagent to know from month to month how many copies to order. This has become important because of the Government's restrictions on the use of paper which necessitates the strictest economy on the part of the publishers in the number of copies printed.

Even when I had convinced my friend that a form of this sort given to a newsagent, no matter whether verbal or written, did not imply any long term obligation, he was still loath to fill one in, but eventually agreed to accept my advice and speak to his newsagent, so that he could satisfy himself personally that he would be able to get his *Wireless World* and yet cancel the order any time he liked.

I have been able to show him, too, that by ordering all his papers in this way he is helping economy in paper, saving wastage in returns of copies printed in excess of requirements and helping the newsagent to avoid having papers left on his hands for which under wartime restrictions he will no longer be reimbursed.

## *Drift*

A READER who has evidently taken up his pen in anger, asks me when British or any other wireless manufacturers are going to produce a receiver which is absolutely free from frequency drift. Frankly, I suppose that the answer is never. After all, why should we expect a wireless set always to remain constantly in tune any more than we do the piano? We all expect the




No mean pianist.

piano to be retuned from time to time, so why not the wireless set? If, of course, a wireless set is *always* requiring to be retrimmed there is something wrong with it, just as there is in the case of a piano that requires unduly frequent retuning.

This does not, however, alter the fact that every set ought to be retrimmed from time to time. Soon, I venture to say, the professional set-tuner or set-trimmer will pay regular calls to our homes just as piano-tuners do now. I myself am no mean pianist, and I always retune my piano not only every time I play but every time the weather changes. My portable receiver, also, is retrimmed every time I take it from one room to another, just as a violin is retuned immediately it has been brought into the concert hall, no matter if it has been tuned immediately before coming into the hall. I mention this fact as some people are devoid of all ear for music and often mistake this tuning-up business for part of the overture. There is, perhaps, some justification for this,

Unbiased—
as it does bear a strange resemblance to some of the B.B.C.'s chamber music.

I do not think, therefore, that we can ever expect manufacturers to produce a set that never needs re-trimming; nor do I think that such a set would be altogether desirable, at any rate under present conditions, when so many European transmitters seem to be addicted to drift both in a radio and a rhetorical sense. What *is* desirable is a set which will drift in synchrony with the drifting of the transmitter to which it is attuned.

Such a set, wonderful as it may seem, is already available, and has been available for some considerable time. I refer, of course, to the type of set which is fitted with automatic frequency correction. A moment's thought will make the fact clear that such a set will, and does, retune itself according to the exact frequency coming in from the transmitter. It not only corrects its own errors of drift, but those of the transmitters also.

# The Empire Market

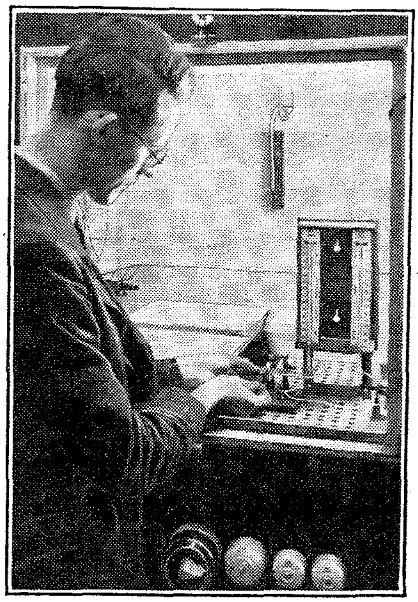
**A UNIQUE OPPORTUNITY FOR BRITISH SET MANUFACTURERS**

IT is surprising that a bigger effort is not being made at the present moment by British wireless manufacturers to increase the number of receivers sold abroad. Circumstances are now very favourable for British wireless sets to obtain a footing in many foreign countries as well as in the various parts of the Empire. There is a particularly large demand at the present time for broadcast sets capable of bringing in the news bulletins radiated by European stations in various foreign languages.

It might well be supposed that American radio manufacturers would not be slow to seize upon this opportunity, and such has been the case, but British manufacturers possess one advantage over their American rivals, and that is the favourable sterling exchange rate, which enables them to offer their products at competitive prices. This, coupled with the fact that such German competition as existed is now completely eliminated, puts the British manufacturer in a particularly favourable position.

The majority of receivers sold for use in non-European countries will be used in a tropical or sub-tropical climate, and it is, therefore, useless for manufacturers to attempt to export the ordinary all-wave sets which are made for use in this country. Receivers are required which incorporate components made of materials specially chosen to stand up to the climatic conditions which they are likely to meet with.

The climate of any country lying within 30 degrees or so north or south of the Equator may be summed up by the expression "heat and humidity," and special precautions must be taken against it. The photograph on this page shows one of the special humidity testing cabinets established for this purpose by the G.E.C.—one of the few British firms to take its export business seriously. These cabinets are arranged so that not only can any desired degree of temperature and humidity be obtained, but also so that regular cyclic changes, such as would be experienced in a tropical country, are automatically brought about.



**Checking "climatic" conditions in the G.E.C. Tropical Test Cabinet.**

In addition, however, to special tropical tests, the various parts of the receiver are subjected to very stringent ordinary tests, since it must be remembered that sets sent abroad are often installed in places many hundreds of miles from the nearest service engineer. One of the most interesting of these tests is the pin-prick test for enamel-covered wire. The wire is fed slowly through a bath of mercury and a source of EMF is connected between the mercury and the wire. A pin-hole is instantly detected by the passage of a current which operates an automatic apparatus which counts the number of pin-holes in the length of wire under test.

## Henry Farrad's Solution

**(See page 91)**

THE biasing resistor decoupling arrangement, consisting of the 2-mfd. condenser and 0.25-MΩ resistor, was quite adequate in the original circuit, because the impedance of the condenser even at the lowest audible frequency is so much less than 0.25 MΩ that the grid return is effectively to the cathode for signals, while going to $-$HT for the steady bias potential. Signal potentials set up across the 400-ohm biasing resistor by signal currents in the output circuit are therefore not fed back to the grid.

In the new circuit, however, the 0.25 MΩ is effectively short-circuited by the MHL4 valve, the 1-mfd. coupling condenser, and the primary of the transformer. The signal potentials developed across the biasing resistor are also across the above circuit in series with the 2-mfd. condenser. As the primary of the transformer is certain to have a considerably greater impedance than the other three components combined, nearly all the negative feedback voltage appears across it, and is stepped up by the secondary before being applied to the grid. The negative feedback is therefore very heavy and the amplification greatly reduced.

Considered another way, if the previous stage produces a signal voltage of $+1$ volt (relative to $-$HT) at the junction of P and S, this is increased to $+4$ on the grid by step-up action. The resulting signal current might amount to a drop of $+2$ volts at the cathode. The grid voltage *relative to the cathode* would then be $-1$ volt, causing a reversal of the above action until a condition of equilibrium, corresponding to a lower amplification, was reached.

The cure is either to revert to the old arrangement, or, if the extra gain is wanted, to decouple by shunting the bias resistor with a 25-mfd. or preferably 50-mfd. electrolytic condenser.

# Letters to the Editor

THE EDITOR DOES NOT NECESSARILY ENDORSE THE OPINIONS OF HIS CORRESPONDENTS

## *The Soldier's Set*

WITH reference to the Editorial Comment in the December issue on the problem of devising a suitable portable set for use on active service, the following suggestion may be useful.

Bearing in mind that the chief objections to the typical portable set is its bulk and weight, let the principle of unit construction be introduced into this field. So that, divided into, say, two units, the portability problem is solved.

The first unit could contain the frame, RF and detector stages, with the necessary HT and LT batteries, and would be a complete receiver in itself for the use of one person listening with headphones. Dry-battery LT is essential, but this is a simple matter—two "point one" valves in series from a 4½-volt torch battery.

The second unit could be designed to provide for a group or community; that is, an LF amplifier and loud speaker to plug into the first unit instead of the telephones. This unit should also contain its own HT and LT batteries, and might be of a single pentode stage, push-pull, QPP, or two triodes with series filaments and parallel anodes.

The units should be contained in strong, light wooden cases of similar size, say, 13in. by 13in. by 4in., with a carrying strap.

With a carefully made RF unit, the 12in. frame has very good reaching-out qualities, but provision should be made for the use of aerial and earth.

Four or five years ago I made a headphone set similar to the first unit mentioned above, all contained in a 12in. record-carrying case. The absence of a heavy and messy accumulator made it a joy to carry and handle. Only the medium wavelength was used, and I would suggest the same band only in a service set so as to avoid extra coils and switching, and increase efficiency on the band used.

I have, more recently, used a 4½-volt torch battery in a two-valve deaf-aid with filaments in series, and find that the larger size, such as the Ever-Ready No. 295, has a long and useful life, the valves only taking about a third of the current used by a torch bulb.

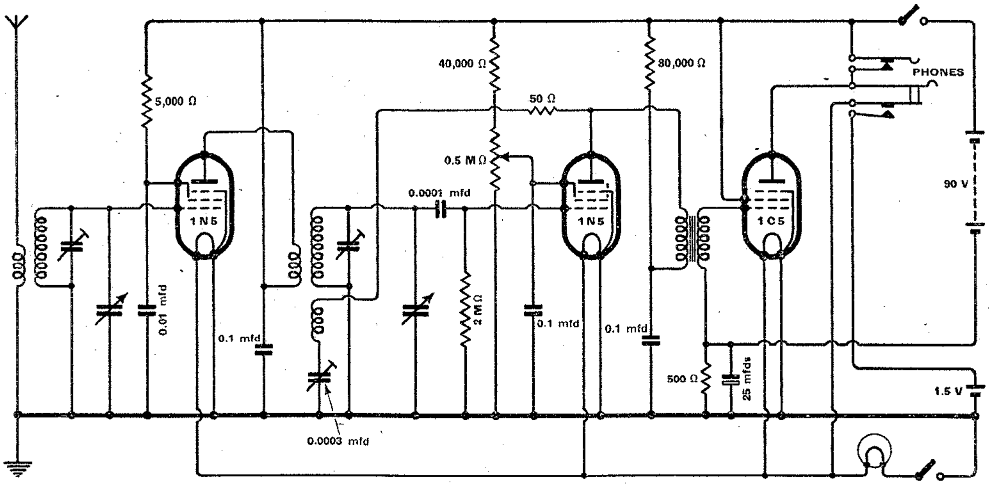
Manufacturers are, as a rule, reluctant to embark on new and untried ideas, but I feel sure that the units I have outlined above would be an answer to the quest for "Sets for Active Service." A. ADAMS.

London, S.W.1.

I WAS interested in your remarks about receivers for active service in the current issue. During the latter half of September I designed such a set, and a brief description may be of interest to your Service readers.

The set uses a three-valve circuit, and, complete with batteries, is housed in a rexine-covered plywood case 12 by 4½ by 4½ inches. It fits nicely in the bottom of a Service pack and weighs two ounces under nine pounds. Extras are a pair of headphones (or a single earpiece) and a length of wire for the aerial.

The circuit is perfectly straightforward. Eddystone 4- and 6-pin coils are used and the valves are of the 1.4 volt type running off a single dry cell. The HT battery (for which I hope I shall be able to get a replacement) is a Drydex type X394A, 90-volt unit. The 2-gang condenser is a Bulgin CV22. Reaction control is by detector screen potentiometer, the reaction condenser being preset; the HT switch is ganged to the potentiometer.



Captain Horniman's set: "It fits nicely in the bottom of a Service pack."

In order to keep dimensions to a minimum, the valve holders for the two 1N5 valves are sunk about ¼ inch in the chassis. The inside of the front and bottom of the case is lined with copper foil.

W. D. HORNIMAN, Capt.

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AS one who served in the last war and is now in the wireless industry, I would like to respond to the invitation in your Editorial. Perhaps some expressions of opinion will help any set manufacturers who are considering the production of sets specially intended for those on active service.

In 1914-1918 a portable gramophone was the most treasured possession of almost every unit right up to the infantry company headquarters in the line. Apart from the obvious requirements of compactness and ability to

**Letters to the Editor—**

stand rough usage, a suitable set should include these features:—

(1) All dry batteries.

(2) Some sort of open aerial can always be fixed up with an improvement in the performance by comparison with a frame aerial.

(3) A loud speaker rather than headphones is practically essential because, whereas the individual has not enough "luggage allowance" for even the smallest set, transport can be "wangled" by a group.

(4) It is important that the set should tune to 212 metres, the wavelength of the new "Radio International" station.

(5) The set must be definitely non-radiating, as sooner or later sets which disclose their position to sensitive DF apparatus are bound to be forbidden in forward positions.

Possibly arrangements could be made to sell suitable sets as well as replacement batteries and valves through the N.A.A.F.I. H. G. AYTOUN KAY.

The Benjamin Electric, Ltd.
London, N.17.

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AFTER reading the Editorial Comment and correspondence columns of the December 1939 issue of your valuable paper, I have formed the following conclusions as being necessary in any receiver suitable for entertaining the soldiers on service, especially those in France:—

(a) Receiver to be of the 3-valve TRF type.

(b) Headphones to be used, each receiver being able to operate a number of pairs.

(c) Waverange 200-550 metres.

(d) Frame aerial with provision for outdoor wire of the "Throw-out" type.

(e) Dry-battery operation both for HT and LT.

(f) Lightweight construction in all respects.

These features incorporated in a suitably designed receiver, would, in my opinion, provide a soldier with means of entertainment from the Home Service programme after dark (when, presumably, most listening would be done) and during daylight from the Radio International station.

Although additions and refinements of many varied types could be used, it is very doubtful whether these would be of any great use to the persons required to be entertained!

Perhaps these few details, together with those of other readers, may solve what is quite a problem.

Thanking you for keeping up the fine qualities of *The Wireless World*. KEN. G. PAYTON.

West Bromwich.

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IN response to the Editorial Comment in your December issue regarding small portable receivers, may I offer a few ideas?

I have carried out some experiments with midget sets and find that a very convenient solution to the HT supply problem is to use a small power valve for the detector, as this type of valve will oscillate on an HT supply of nine volts or so. I made up a midget set in a box 6 inches by 4 inches by 2 inches, using a Tungsram P220 and a midget iron-cored coil with two 1½-volt unit cells in series for the low-tension supply. With this set, using 18 volts HT and an indoor aerial, good reception of three English stations (before the war) was obtained from the Spanish border of France. In England, the Home Service and several foreign stations were received at very good headphone strength using a very much smaller coil and a good outdoor aerial. An AF pentode may be used, but the HT consumption will be greater and the results are not appreciably improved.

If any reader would like further details of this type of set, I should be very glad to supply them.

Headley, Bucks G. N. S. TAYLOR.

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### *Public Listening*

**From our former Berlin Correspondent**

ALTHOUGH I have been a contributor to your pages since 1926, this is the first time that I have asked for space in your correspondence columns. My reason for doing so is to bring to your notice a matter that is of particular importance in times of crisis and war.

In the course of my travels on the European Continent in the past few years I have found that in a large number of countries it has become the usual custom to place radio receiving sets in as large a number of places accessible to the general public as possible. Nearly all the countries in Europe nowadays use the broadcasting system as a means of direct communication between the authorities and the people. Famous men often address the people in this manner. Very often these speeches are held at a time when some part of the population is engaged in work or otherwise not at home; people on the streets or on their way to a restaurant. In many European countries they have the opportunity of listening to the radio either at the door of a radio dealer's shop or at the doors of, and inside, department stores, or in a restaurant, café, or hotel.

In Switzerland almost every winter sports hotel has a radio set, and the guests foregather to listen eagerly to the news in these exciting times.

In Britain, obstacles seem to exist which prevent any public dissemination of news bulletins and speeches (except in special cases) in places generally frequented by the man-in-the-street. This seems a pity. The opportunity ought to be given for people who are away from home to listen to important news in hotels, cafés, and restaurants. It is not necessary to go to the lengths which prevail in Germany that all service and eating have to cease when the news is "on," but it seems that the public ought to have some easy means of listening-in when in town.

I had an interesting experience last March when I was in London on a visit. The Prime Minister was to make an important speech. It was impossible for me to listen-in in any public place. I had to pay for admission to a News Theatre that was relaying it. Unfortunately, that News Theatre had weak reception during the first half of the speech, and later, when speech became louder, there was considerable electrical interference. A. A. GULLILAND.

# Cathode By-pass Condensers

## SIMPLE METHOD OF SELECTING VALUES

By W. T. COCKING

THE choice of the value for the cathode bias resistance by-pass condenser is often made largely by guesswork backed by experience, and this is in spite of the fact that it is by no means difficult to calculate. The value needed for a given drop in response at low frequencies, however, depends on many factors. The anode AC resistance and amplification factor of the valve, as well as the bias resistance and coupling resistance, play their part.

Fig. 1 shows a typical resistance-coupled stage, and in what follows it is assumed that $C_2$ and $C_3$ are large enough to be neglected over the range of frequencies considered. Then we need not take the decoupling resistance $R_4$ into account, and we can consider R and $R_3$ together as a resistance $R_2 = RR_3/(R_2+R_3)$. With a triode valve having an AC resistance $R_a$ and an amplification factor $\mu$, we can find the best value of capacity $C_1$ for our purpose with very little computation with the aid of Fig. 2.

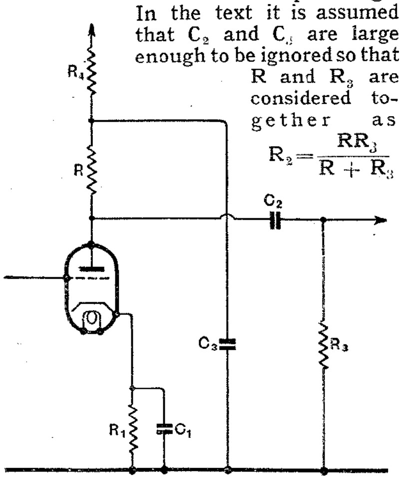



Fig. 1.—The basic circuit of a resistance coupled stage. In the text it is assumed that $C_2$ and $C_3$ are large enough to be ignored so that R and $R_3$ are considered together as $R_2 = \frac{RR_3}{R + R_3}$

The steps are as follows:—

(1) Decide on the drop in response tolerable at a desired low frequency $f = \omega/6.28$.

(2) Evaluate $\frac{R_1(1 + \mu)}{R_a + R_2}$

(3) Read off $\omega C_1R_1$ from Fig. 2.

(4) Evaluate $C_1$.

In the case of tetrodes and pentodes, $R_2$ is usually small compared with $R_a$, and can be ignored in comparison; also, $\mu$ is very large compared with unity. With these valves, therefore, we can substitute the simpler expression $gR_1$ for $\frac{R_1(1 + \mu)}{R_2 + R_a}$ with negligible error. If the screen of the valve is well decoupled to cathode, $g$ is the normal mutual conductance (in amperes per volt); on the other hand, if the screen decoupling is returned to negative HT, as is more usual, $g$ is the mutual conductance with screen and anode strapped. This figure is not usually quoted, but in general it is not very different from the normal one; it may be about 20 per cent. higher.

Capacity is obtained in farads, while resistance and frequency should be in ohms and cycles per second respectively.

### A Typical Example

As an example, consider a triode with $\mu = 40$, $R_a = 15{,}000\Omega$, $R_2 = 50{,}000\Omega$, and $R_1 = 2{,}000\Omega$. What should be the value of $C_1$ for a drop in response of 0.5 db. at 25 c/s? We have $\frac{R_1(1 + \mu)}{R_a + R_2} = \frac{2{,}000\ (40 + 1)}{15{,}000 + 50{,}000} = \frac{82}{65} = 1.26$; from Fig. 2, $\omega C_1R_1 = 5.55$, therefore $C_1 = 55.5/(6.28 \times 25 \times 2{,}000) = 1.765 \times 10^{-5}$ F. $= 17.65\mu$F.

Now take the case if a pentode with $g = 9$ mA/V. and $R_1 = 100\Omega$. We have $gR_1 = 0.9$ and $\omega C_1R_1 = 4.5$; consequently, $C_1 = 287\ \mu$F for the same frequency and response as before. This is a very large, but not impossibly large, capacity; the need for care in using valves of high mutual conductance is evident.

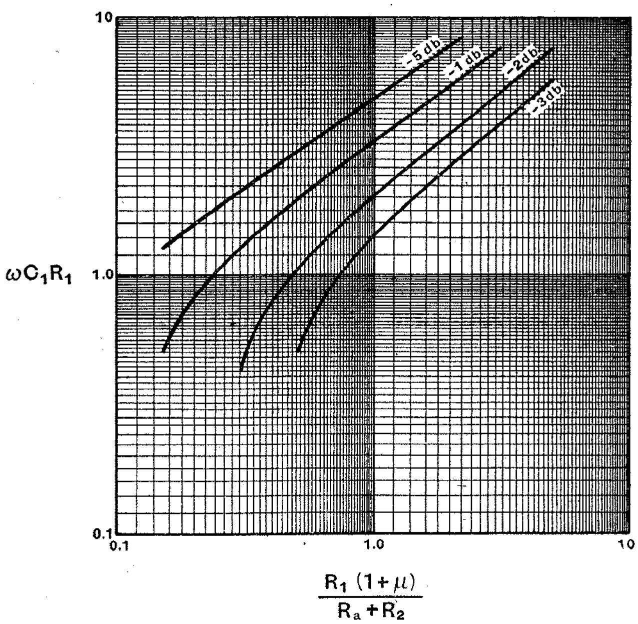



Fig. 2.—These curves enable the value of $\omega C_1R_1$ to be readily determined for the selected drop in response. Their use is explained in the text.

## BOOKS RECEIVED

**Look After Your Car.** By the Technical Staff of *The Autocar*. Pp. 116. Published by Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1. Price 2s. 6d. net, by post 2s. 9d.

Car maintenance described in simple non-technical language for the benefit of the average owner-driver. Where necessary, instructions for carrying out the various operations are supplemented by photographs.

**Photograms of the Year, 1940.** Edited by F. J. Mortimer, Hon. F.R.P.S., Editor of *The Amateur Photographer and Cinematographer*. Published by Iliffe & Sons Ltd., Dorset House, Stamford Street, London, S.E.1. Price 5s. (paper covers); 7s. 6d. (cloth bound), postage 6d.

This annual publication, which has now been in existence for upwards of half a century, has once more made its appearance. It contains nearly one hundred photographs and also articles from the pens of leading workers.

# DON'T BE TIED TO ONE ROOM RADIO

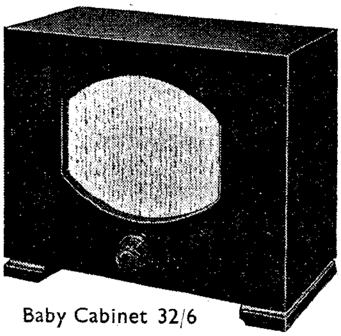
Reprinted from "Wireless World," November.

*Finally there is a question of comfort and convenience in listening which under war-time conditions assumes greater importance than in normal times. One or two suitably-disposed extension speakers can make a world of difference in this respect.*

Do you frequently miss interesting items on the radio because you do not happen to be in the room where your receiver is installed? Then you need an extension speaker. Stentorians are generally chosen because of their quality of reproduction, their handsome cabinets and their very moderate cost. Don't be tied to one room radio any longer. Your dealer will gladly demonstrate.

| CHASSIS MODELS | |
|---|---|
| Senior | 46/3 |
| Junior | 35/9 |
| Baby | 26/- |
| Midget | 19/3 |

| CABINET MODELS | |
|---|---|
| Senior | 69/3 |
| Junior | 54/6 |
| Pendant | 54/6 |
| Cadet | 43/6 |
| Handy | 21/6 |



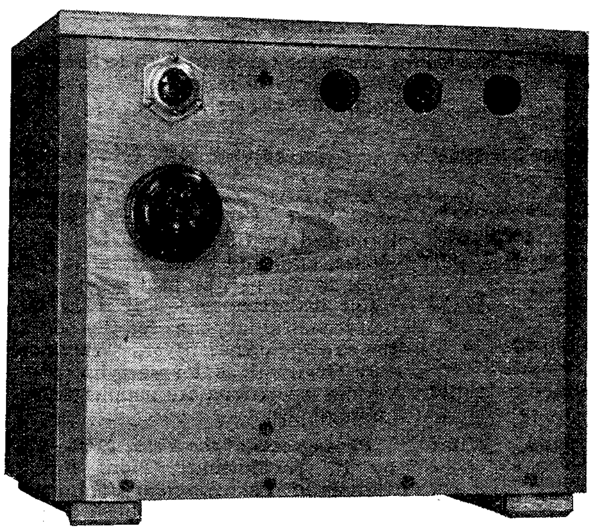
Baby Cabinet 32/6

## Stentorian

**The perfect extra speaker for any set.**

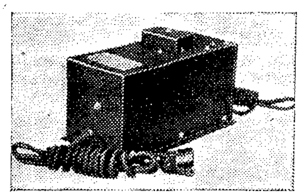
WHITELEY ELECTRICAL RADIO CO., LTD., MANSFIELD, NOTTS.

# HAPPY NEW YEAR TO EVERYBODY



*Obvious New Year Resolutions:—*

1. To Win the War as fast as possible.
2. Buy one of SOUND SALES latest Battery Chargers or Reserve Lighting Equipments, which will keep your car battery always charged, ensuring an instant start, even if you can only get enough Petrol for weekends—or to keep the "Dug-out" cheerful if you need to use it (we hope you don't).
3. To get as much fun as we possibly can out of the cheapest form of entertainment, and the most direct form of news . . . RADIO ! You can be assured of clear cut speech, and music at its best from SOUND SALES Dual Suspension Auditorium Speaker—"the speaker without a dialect," especially when used in conjunction with the latest S.S. Single H.F. Quality Feeder Unit, and the famous 346 type 6 watt Amplifier—**TOTAL COST WITH SPEAKER £20, PLUS 10 PER CENT.**



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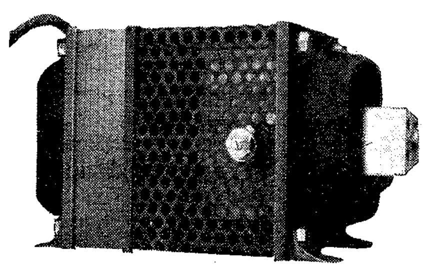

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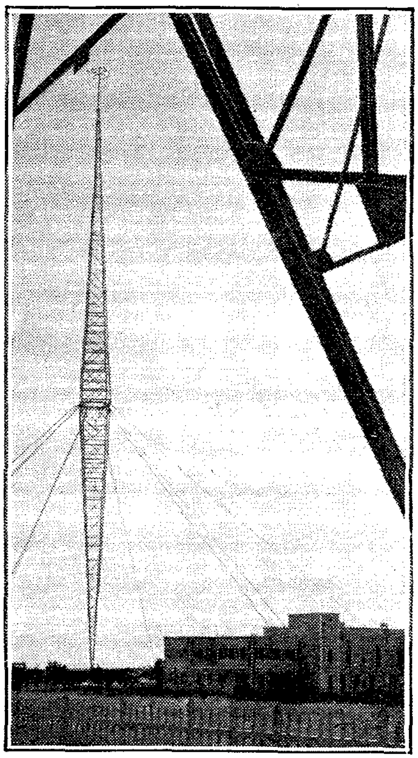
# Aiming Aerials

## HOW THE ANGLE OF RADIATION CAN BE CONTROLLED TO SUIT THE PURPOSE

By "CATHODE RAY"

THERE is one matter connected with aerials that appears to give some readers trouble, so I am continuing my comments on the subject. It is "low-angle radiation" and "high-angle radiation," so often referred to in discussing fading, reception over long distances, new transmitters, and so on. In dealing with aerials in general I mentioned that the directions in which they radiate—or pick up—can be controlled, but did not go into details. Obviously in communicating between two fixed stations, as distinct from broadcasting, it is an advantage to concentrate radiation in a beam towards the receiving station instead of scattering it all around. Even in broadcasting it is sometimes desirable to confine radiation within certain angular limits—at the Start Point station, for example, where the area to be served lies wholly on the northward side.



What may not be so obvious is the desirability of controlling the angle of radiation in a vertical plane, that is to say, the angle between ground level and skywards. It might seem at first sight that the proper thing to do is to radiate horizontally only, except perhaps for stations sending to aircraft. That is quite correct so far as receivers within a moderate radius are concerned. Radiation sent at any upward angle is just wasted. For listeners at a rather greater range (I'm sorry to be so vague, but the limits are not exact, and anyway they vary with the wavelength) upward radiation is worse than wasted, because at that distance it has been reflected by the upper layers of the atmosphere and has come to earth again. "The more the merrier," you may say; but it is not quite so simple as that. The downcoming sky waves *may* strengthen reception coming direct over the surface; but as waves are not waves unless they have both ups and downs, it doesn't follow. If the ups all coincide, well and good; but if the ups of one lot arrive in step with the downs of another—as may well happen, seeing they have travelled different distances—the result is a partial or complete neutralisation, and reception fades. What actually happens is that the different lots of waves arrive at random, sometimes co-operating, sometimes conflicting; and reception varies from abnormally strong to nothing at all. AVC helps, up to a point, but can't supply what isn't there.

It is possible to distinguish a third zone of reception, because the ground wave is absorbed by the earth and by obstructions erected on it, until beyond a certain range it is too weak to count. The sky wave stands the journey much better, and, if circumstances permit it to be reflected to very distant parts of the earth, reception there may be quite strong. It is still liable to a certain amount of fading, however, because several sky waves, travelling by different routes, may conflict on arrival.

The three zones, then, illustrated in Fig. 1, are (1) the local service area, reception being by ground wave only, and therefore steady; (3) the long-distance area, the ground wave having died out, reception being possible only if the sky wave is reflected suitably, and is often subject to fading; and (2) the intermediate range, in which both waves are of comparable strength, so that fading is severe.

With medium broadcast wavelengths, the intermediate distance may be as near 30 miles (at the 200-metre end of the medium band), but is generally more nearly 100 or even farther at the 540-metre end. Increasing the power is not in itself really very helpful, because both ground and sky waves are equally strengthened and are liable to combine to give even bigger fades. But if the aerial can be designed so that the radiation previously sent upwards is thrown horizontally, the ground wave is correspondingly strengthened. That alone increases the range, but it is still

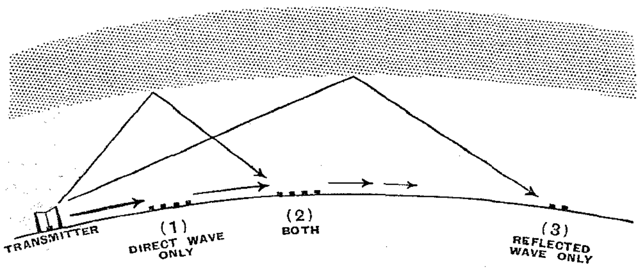



Fig. 1.—Illustrating the three zones of reception around a transmitting station.

further increased by the elimination of the intermediate zone, because when the fading is eliminated by abolishing the sky wave it is possible

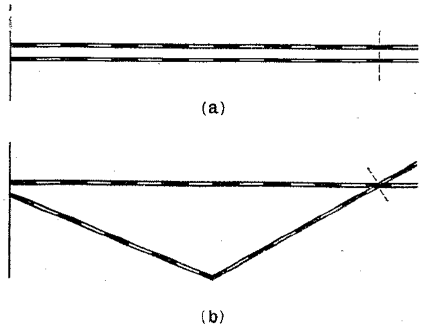



**Fig. 2.—Interference between different sets of waves illustrated by alternately black and white strings. So long as they run parallel from the start all the blacks come together. But if they follow different paths black may conflict with white.**

to get good reception with a weaker ground wave and hence at a greater distance. Low-angle aerials are therefore sometimes called anti-fading aerials. They might also be considered as anti-interference aerials, because elimination of the sky wave enables stations outside the service (zone No. 1) area to work on the same wavelength without being jammed by the downcoming radiation. Waves of medium length are not reflected to the ground at great distances, so are unsuitable for reaching zone No. 3. Medium-wave stations should therefore generally have low-angle aerials, to eliminate zone (2) and extend zone (1) as far as possible.

## Long-distance Work

Short waves are very rapidly weakened by travelling over the ground, but are reflected to great distances. Here, then, is a case for avoiding horizontal radiation and concentrating on an upward angle that best suits the wavelength, range to be covered, and atmospheric conditions.

Altogether, there is a need for some means of concentrating radiation at whatever angle is most suited to the service to be given.

The ways of doing this are sometimes very complicated and sometimes quite simple—in principle, though not always in execution.

They are all based on the same thing that causes fading when two sets of waves combine—the fact that negative neutralises positive. It can be visualised by imagining strings with equal sections alternately black and white, to represent the positives and negatives, or crests and troughs of waves. One double section—black and white—represents one wavelength. If a number of strings are stretched parallel, each with black at one end, then black and white sections coincide all along the line (Fig. 2(a)). But if they travel different distances as at (b), angles are found where black comes alongside white, representing places where waves interfere and cancel out.

Up to the present we have taken for granted that the aerial itself is so small that the radiation spreads out from it as if it were a single point. But if its size is taken into account, then obviously radiations from different parts of it are going

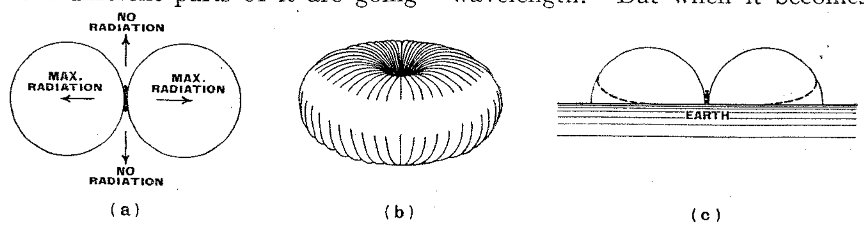



**Fig. 3.—(a) Radiation diagram for a vertical aerial that is very small compared with the wavelength. Actually to present the whole picture, a solid diagram (b) is needed. When the aerial is earthed only the upper half exists, (c), and the diagram may have to be modified as dotted to allow for the imperfect conductivity of the earth.**

to cause complications by interfering with one another.

Before we can see how this is going to work out, it is necessary to know what any single small part does on its own. For fundamental reasons, any such small section of aerial radiates most at right angles and none at all endwise. At intermediate angles the radiation is of intermediate strength. The usual way of showing this is by drawing a line around it at a distance proportional to the strength of radiation. Around the short vertical section the diagram is like Fig. 3(a). But this shows only the radiation to left and right, on the surface of the paper; to include what comes out at all other angles a solid figure like a depressed bun (b) must be imagined.

So a vertical aerial that is very short (compared with the wavelength) radiates strongest horizontally all round, and not at all vertically; but the radiation at quite high angles is not so very much less than horizontally. Therefore, although fairly suitable for broadcasting, it is certainly not ideal. Incidentally, my preceding article will help to show that the same result is given if the lower end of the aerial is earthed, except that the downward half of the radiation is reflected and strengthens the upper half (c), and the imperfections of the earth may lead to modifications somewhat as shown dotted. Of course, if the aerial is suspended horizontally instead of vertically the radiation diagram must be turned with it, and then horizontal radiation is seen to be good broadside-on from the aerial, and nil from the ends.

There is not much departure from this state of affairs for any length of aerial up to about a quarter of the wavelength. But when it becomes much longer the radiation from different parts of it begin to interfere very noticeably. To see this, just consider what happens if the aerial

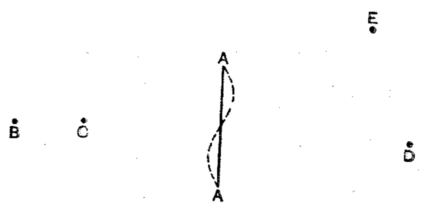



**Fig. 4.—How reception at various points, B, C, D, and E, depends on their situation relative to a full-wavelength aerial AA is explained in the text.**

is a whole wavelength long; drawn as the line AA in Fig. 4. The usual method of showing the strength of radiation from different parts (regardless of angle) is by drawing a wave or part of a wave along the aerial. In our example, of course, one whole wave just fits. This means that at any selected moment the radiation from the top half is, say, positive, and that from the lower half is negative. Any points in the horizontal plane, such as B, C and D, are equidistant from both halves, so the equal positive and

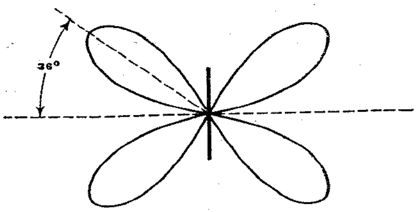



Fig. 5.—Full radiation diagram for the aerial of Fig. 4.

negative radiations exactly cancel out. Instead of horizontal radiation being a maximum it amounts to nothing at all. The reasons for zero endwise radiation still hold good. Is there, then, no radiation perceptible anywhere?

### High-angle Radiation

Consider a point such as E. When positive radiation from the top half of the aerial has reached it the corresponding negative radiation from the lower half, farther away, has still a little way to go. The radiation that does reach E from the lower half at that moment is therefore some that started a little earlier. If it happened to be half a cycle earlier (the time taken for the radiation at any part of the aerial to change from maximum negative to maximum positive) it would have been positive, so that positives from both halves would reach E simultaneously; similarly for the negative halves. For it must be remembered that the radiation from any part of the aerial is not a stationary thing, it is continually alternating from positive to negative and back. If the above description is actually true of the point E—and there is no reason why it should not be—it is clear that it gets strong radiation. The explanation is, of course, very rough, but the exact situation can be worked out mathematically, and the radiation diagram is found to be as shown in Fig. 5. If the surface of the earth comes where the horizontal dotted line is drawn, the lower radiation is, of course, suppressed, and maximum radiation takes place all around at an upward angle of 36°. This is a very big contrast to Fig. 3, and definitely undesirable for medium-wave broadcasting.

The diagrams for some aerials, especially those several wavelengths long, are very complicated, with multiple "lobes" of radiation. The aim in designing highly directional—"beam"—short-wave aerials is to eliminate all except one very strong narrow lobe at the desired angle, and for this purpose stacks and arrays of separate aerials are combined into one vast system.

Going back to the problem of medium-wave broadcasting, the best arrangement for all-round work at as low an angle as possible is found to be a single vertical radiator slightly more than half a wavelength high. The radiation diagram is then something like Fig. 6. As supporting masts in the neighbourhood are very likely to upset the distribution, the modern tendency is to make an aerial of a mast, either a self-supporting tower (American) or guyed (British)—no pun intended. For a wavelength of 200 metres the height is therefore a little over 100 metres, say 350 feet, which is reasonable. For 540 metres it is

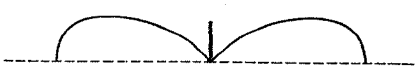


Fig. 6.—Radiation diagram for an aerial just over half a wavelength long.

about 1,000 feet, which begins to look like real money, to say nothing of aircraft risks. So all sorts of dodges have been tried for reducing the height without spoiling the radiation diagram. One method is to mount a big ring at the top to increase the capacity.

As for broadcast receiving aerials —well, obviously they are well below optimum. It is only for short waves that the angles can be effectively controlled within the dimensions of a suburban garden. All sorts of special short-wave aerials are sold with this end in view. The tilted wire television aerial* is a good example.

*The Wireless World August 31st, 1939.

# B.B.C. Oversea Service

## EXPANSION OF EMPIRE SERVICE FOR WORLD COVERAGE

IT may not be generally known how rapidly this offspring of the B.B.C. Home Service has grown during the past twelve months or so. The B.B.C.'s original Charter, granted in 1925, contemplated a service within the United Kingdom only, and it was not until 1932 that the Empire Service started. This, like the Home Service, was originally confined to transmissions in English, and it was not until the beginning of 1938 that the first foreign language transmission was undertaken by the B.B.C. To this service, which was in Arabic, were very soon added news bulletins in Spanish and Portuguese, destined for Latin America.

It was on September 27th, 1938, the day of Mr. Chamberlain's broadcast at the height of the Munich crisis, that the B.B.C.'s first transmissions to European countries were radiated. These were news bulletins in French, Italian and German, and transmissions to Spain, Portugal and South Africa in their respective tongues were added during the following year.

Since the outbreak of war many additions to the foreign language news service have been made, and the languages now used, in addition to those already mentioned, include Czech, Greek, Magyar, Polish, Rumanian, Serbo-Croat and Turkish.

From "Somewhere in England" the B.B.C. Oversea Service transmits 54 news bulletins a day. Of this number 23 are in English and the remainder in 16 foreign languages. One of the three Polish bulletins was being read when this photograph was taken. In the foreground can be seen the control panel.

Until the outbreak of war there was but one service—the Empire Service. It was, however, realised that broadcasting would play a vital rôle in the conflict, and that there was immediate need on the one hand of expansion of technical and programme arrangements and on the other of unification within the inevitable limits of world time differences, wavelengths and available transmitters. From the Empire Service has therefore sprung the Oversea Service, which comprises three main groups of transmission. What virtually incorporates the Empire Service, but is more widely radiated than in peacetime, is known as the World Service—primarily in English. This aims at providing transmissions each morning and evening to all parts of the English-speaking world. Next is the European Service in which is radiated news, talks and entertainments in twelve Continental languages. The third section incorporates the Arabic service and the bulletins in Afrikaans, Greek and Turkish.

The World Service, which is radiated on short waves only, is now transmitted almost continuously throughout the twenty-four hours. The European Service, which is radiated not only on short waves, but, during the hours of darkness, also on 261.1 metres, is transmitted for nineteen hours each day.

At present the B.B.C. is transmitting on 15 of the 21 frequencies which have been notified for use by the station.

At the outbreak of war, 20 news bulletins were transmitted daily in the Empire Service, whereas the number now broadcast, in 17 different languages, in the Oversea Service is 54. This vast expansion has necessitated a considerable increase in staff, which has risen from approximately 100 to 250. This number, however, does not include the Oversea Intelligence Department, which has a staff of about the same number.

Mr. J. Beresford Clark, the Assistant Controller, B.B.C. Oversea Service, explained at a recent Press Conference, at which representatives from the Empire and oversea Press were present, that a welcome feature of the B.B.C.'s World Service since the war has been the extent to which items in its programmes, especially news bulletins, talks and authoritative official pronouncements, have been retransmitted by oversea broadcasting stations. In Australia, for example, 164 of the 167 oversea items retransmitted by Australian stations during September came from the B.B.C. In Portugal, the Emissora Nacional, the official broadcasting station, has radiated the Portuguese news bulletin ever since its inception.

The Director of the Oversea Intelligence Department referred to above is Mr. Malcolm Frost. Some of the special duties of this organisation were explained by him at the Conference. The monitoring service which was referred to last month, and has a staff of nearly 100, comes under Mr. Frost's direction. So far as the oversea transmissions are concerned, one of the most important tasks of the Intelligence Section is the provision of data relating to the listening habits of the country to which it is proposed to direct transmissions. Such details as the number and types of receivers in use, and the stations normally listened to, are of vital importance. For this purpose, a team of over 1,000 voluntary co-operators throughout the world are in touch with the Intelligence Section, and are a valuable source of information on the reception and effects of B.B.C. transmissions and their counterpart in foreign propaganda.

### ELECTRIC RAZORS

IN our November issue, Free Grid lamented the fact that there appeared to be no emergency power supply available for operating his mains-driven electric razor. We are informed by the Schick Dry Shaver Company that this lament is without foundation so far as their standard 110 volt 9 watt shaver is concerned, as, for some considerable time past both the Vidor and the Ever Ready Companies have been producing special dry batteries for it. To use battery supply it is only necessary to unplug the voltage-dropping unit which is supplied for normal 200 to 250 volt AC or DC mains operation.

# KDKA's Anniversary

### BROADCASTING IS GROWING UP

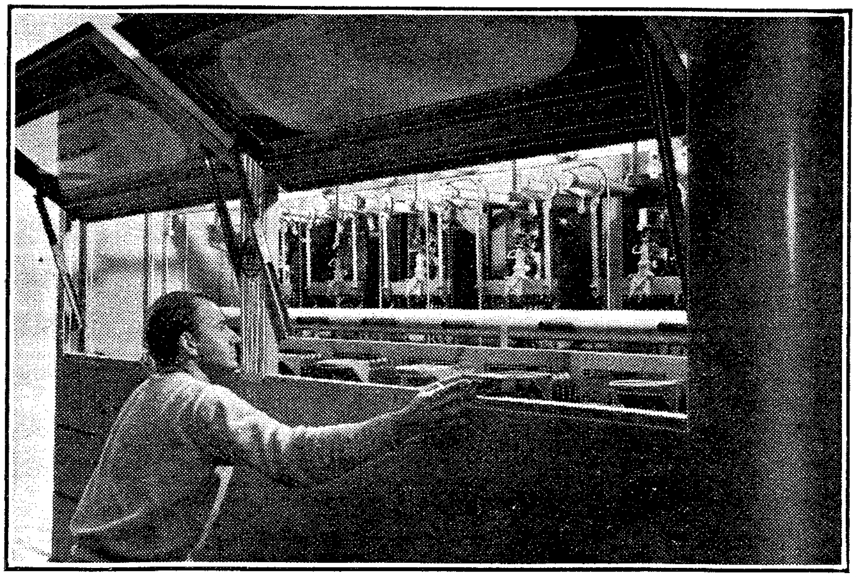
TO celebrate the 19th anniversary of its inauguration, the Westinghouse station at Pittsburgh, Pennsylvania, the world's first broadcaster, has just started to radiate from a new 50-kW transmitter installed in the suburbs of the city at Allison Park. At present the station is radiating only the standard amplitude-modulated programme on 980 kc/s, but the 718-ft. aerial tower shown in our cover illustration will ultimately support the aerial for the WPIT short-wave transmitter as well as that for an experimental frequency-modulated high-fidelity service.

Several features that, it is claimed, have never previously been used at a broadcasting station are to be found at the new KDKA. Perhaps the most novel of these is what is described in America as "radio air conditioning." That expression may conjure up visions of heating by means of high-frequency currents; actually, however, it refers to the utilisation of heat generated by the transmitting valves, which are of the air-cooled type. After circulation through the cooling ducts of the valves, the heated air is used to warm the station building. Little, if any, additional heating is needed, as the station is normally in operation for 18 hours a day. In case of need, however, the "free" warmth obtained from the valves may be supplemented by electrical heaters housed in the ventilating ducts of the building.

Push-button valve changing is another development introduced by Westinghouse engineers. Any one of the six power rectifying valves may be charged immediately by means of an "automatic relay shift" which obviates manual charging of valves in the rectifier unit and involves practically no interruption of the service.

### FERGUSON RADIO

MR. J. B. FERGUSON has resigned from the directorship of Ferguson Radio, Ltd., but will continue to act as consultant to the company. He is shortly leaving for the U.S.A. to make his usual annual survey of radio conditions in that country.



Interruptions due to the failure of rectifier valves are minimised at the new KDKA by means of this "push-button" valve-changing relay system, by the use of which a new valve may be thrown into circuit without loss of time.

# Random Radiations

By "DIALLIST"

## The Stuff to Give the Troops

SPEAKING as one of the allegedly bloodthirsty and licentious soldiery, I can say wholeheartedly that a set specially designed for the use of the troops is one of the big wants of the day. Give us the right thing and we'll buy it like hot cakes. What do we want? Well, something like this. It must be a portable set; it must be small, it must be light. It can be extremely simple, for there is no need now for it to take in the long waves. A receiver working on the medium waves alone would, therefore, probably satisfy a large number of potential buyers. But if it were possible to get respectable results on a frame from stations on the 25-metre and 31-metre bands, these might be included as well. Circuit? With the directional properties of the frame available as a potent aid to selectivity, a simple "straight" arrangement might suffice; but I think that it would be better to use the superhet circuit owing to the wonderful sensitivity that it makes it possible to obtain from a small number of valves.

## B/AC/DC

The ideal set for army use should be able to work anywhere, no matter whether there are mains supplies or not. And if there are such supplies the set should be able to use AC or DC equally well. That boils down to a set that is operable by batteries or by AC or DC mains. Further, the batteries should be dry, for there are places where accumulator charging is impossible, and in any case accumulators can be a bit messy if a set has to travel rough! There was, if you remember, one set at the Exhibition which incorporated the low-voltage low-current battery valves and worked either off its own dry batteries or off AC or DC mains. That idea is just what is needed as the basis of a soldiers' set. Other essential points are these. It must be inexpensive; it must stand up to knocking about; and it *must* be pretty well proof against the effects of damp; if you doubt that necessity, I wish you could see the morass in which I've been living for weeks now!

## More Radiograms

ONE result of the black-out, particularly since we made this year's belated change from B.S.T. to G.M.T., has been an increasing demand for means of providing entertainment in the home. We used to talk of "long, dark evenings"; now we really know what those words mean! With only one B.B.C. programme on tap, the wireless receiver by itself couldn't entirely fill the bill; but, given a good stock of records, the radiogram does what is wanted. Hence it is not surprising that sales of these instruments have soared. Lots of people, too, have gone in for the playing-desk attachments that can be used with any receiver which has pick-up terminals. Others have added pick-ups to ancient gramophones and given them a new lease of useful life. It doesn't matter how old the gramophone used for this purpose is so long as it will rotate records steadily at the right speed. Clockwork gramophone motors are wonderfully long-lived. I spent an hour or two the other day fettling up a veteran, and it's now going beautifully. I washed it in paraffin first of all to remove the dust and grime of years, then gave it a thorough lubrication with good, thin oil. A few small adjustments here and there and the monkey-gland treatment was complete; my veteran was thoroughly rejuvenated. I'd like to know how old that motor was!

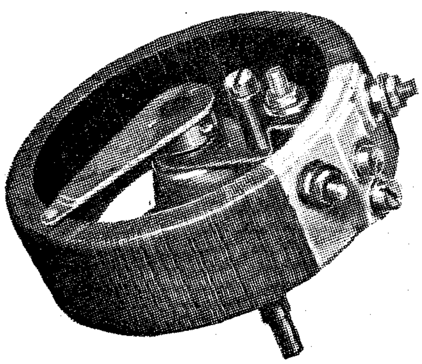
## Opportunists

EVERYONE has heard of the ramp of breaking up HT batteries and selling the cells from them at fourpence or more apiece for pocket torch refills. I was amused, though, to see the other day an advertisement offering cardboard tubes in large quantities. These tubes were described as specially suitable for converting HT cells for use in flashlamps. That strikes me as a wondrous fine instance of opportunism! You feel the want, we do the rest! The battery position is improving, but it is still not too good, for certain kinds of HT batteries are difficult to come by, and some of those offered are pretty poor things. It pays better, I imagine, to make torch batteries. The ingredients of the cells aren't (or shouldn't be) in the same proportions; but the cans are of the same sizes and the demand for flashlamp refills probably keeps the can-making machines fully occupied. It won't be long now, in all probability, until the battery makers are able to give us all the HT batteries we need. Meanwhile, if a set uses some special

# Fox Potentiometers

**A RANGE OF WELL-MADE HEAVY-DUTY RESISTANCES**

DESIGNED for heavy duty in transmitters, PA equipment and electrical apparatus, these potentiometers are toroidally wound on rigid ceramic formers. The method of winding ensures mechanical and electrical reliability, and it is claimed that the resistances will withstand immersion in cold water after a 100 per cent. overload.



**Fox 200-watt toroidally wound potentiometer.**

The contact stud is of large diameter and is riveted to a laminated spring contact arm. The bearing is supported by a cast aluminium bracket which is bolted to the ceramic ring former. A paxolin spindle is used, and any number of potentiometers may be ganged together.

At the moment two sizes are available: 100-watt, 3in. in diameter; and 200-watt, 4in. in diameter. The former is available in resistance values from 12 to 7,500 ohms, and the latter from 12 to 15,000 ohms. The resistance variation follows a linear law.

A 500-ohm 200-watt resistance submitted for test was run for a considerable time at its maximum rating without deterioration.

The makers are P. X. Fox, Ltd., Newlaithes Road, Horsforth, Yorkshire, who specialise in all types of toroidal coil winding.

type that isn't available, it isn't as a rule difficult to adapt standard types by the exercise of a little ingenuity and the use of extra wires and wander plugs.

## Compulsory Interference Suppression

ONE of the worst blows that the war has dealt to wireless so far is that it has seen the shelving—probably for the duration—of the long-promised anti-interference legislation. German enthusiasts are luckier, for their Government issued an ordinance some weeks before the outbreak of war making it compulsory to have suppressors fitted forthwith to all kinds of radiating appliances, including car ignition systems. Fearsome pains and penalties were scheduled for all who failed to comply. Would that we had done likewise! As it is, petrol rationing has automatically cut down to some extent the amount of car ignition interference on the short waves; but in many localities interference from other sources has certainly grown worse. Domestic appliances of all kinds are being turned out without any attempt being made to reduce their radiating properties. I'm afraid that when the war is over there'll be such quantities of these appliances in use that it will be impossible to introduce any anti-interference legislation that does not give a long period of grace.

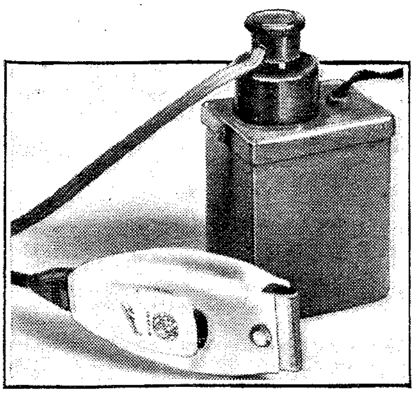
## Study Requirements

IF British manufacturers of broadcast receivers are to benefit from the present position, they should make a real study of the needs of listeners in Empire countries. If they don't bother to do so, but export on the take-it-or-leave-it principle, they may sell sets now, but they'll cease to do so when trade flows freely again and the painstaking foreigner is competing once more for custom. That mistake has been made too often in the past. Here's an example. A young relative of mine stationed in Northern India is a keen wireless man and specially interested in short-wave reception. He'd had several of the British sets that were available out there, but none that he bought filled the bill. The other day I had a letter from him in which he became almost lyrical over the performances of a foreign set that he'd acquired before the supply dried up. It provides first-rate short-wave reception because, he explained, it has enough valves to make it adequately sensitive and it is fitted with real band-spread tuning. Nothing very outstanding about that, you may say. There are plenty of British sets with those features. Yes, but they didn't appear to be available where he was. The foreigner came along with just what was wanted and got the order. That's what our folk must buckle to and do from now on.

## Old Stagers

AMAZING what ancient sets are appearing in some of the shop windows nowadays—and apparently finding a pretty ready sale. For all their age, many of them are obviously unused. I noticed the other day half a dozen receivers of one particular type in a window. They bore no makers' name, but the design is a distinctive one and I have a fairly clear recollection of seeing it at Olympia and afterwards some 4 or 5 years ago! The sets now on view are, I suppose, surplus stock of that season. They must have been stored away and forgotten. Certainly they'd be written off as of no value. Now they have emerged from their hiding places and I've no doubt they will give good enough service to folk who want cheap sets and don't ask for anything much beyond the home programme and perhaps one or two of the French stations.

## HT Vibrator for Shavers



This emergency power supply for Electric shavers is of particular interest to wireless men as one of its main features is freedom from interference with ordinary broadcasting. It consists of a vibrator which steps up the output from a six volt accumulator, and is manufactured by Masteradio, Ltd., who specialise in vibrators for HT supply. Used in conjuction with the Schick Dry Shaver shown in the photograph it causes no interference to the B.B.C.'s early morning physical jerks, even when the wireless receiver is installed in the same room.

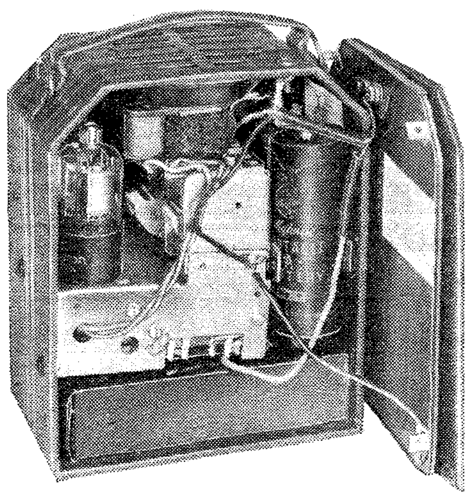
Test Report

# "Mighty Gem" Portable

## SUPERHETERODYNE RECEIVER WEIGHING ONLY $3\frac{1}{2}$ LBS.

MUCH interest has been shown in this neat little instrument which has recently made its appearance in the large stores and on station bookstalls. It measures only $6\frac{3}{4}$ x $5\frac{1}{2}$ x $3\frac{1}{2}$in.—less than the standard gas mask container—and its weight complete with batteries is $3\frac{1}{2}$lb. Yet the designers have contrived to build into it the equivalent of a 5-stage superheterodyne circuit with AVC.

In this they have been helped by a new multiple output valve, the 1D8, which has been added to the range of 1.4 volt valves. This valve contains a single diode rectifier, triode first AF stage, and a pentode



A miniature two-gang air dielectric tuning condenser and short 1.4 volt valves contribute to the remarkable compactness of the receiver chassis.

output valve capable of giving 200 milliwatts with 90 volts HT or 90 milliwatts with the 60 volts actually available in this set.

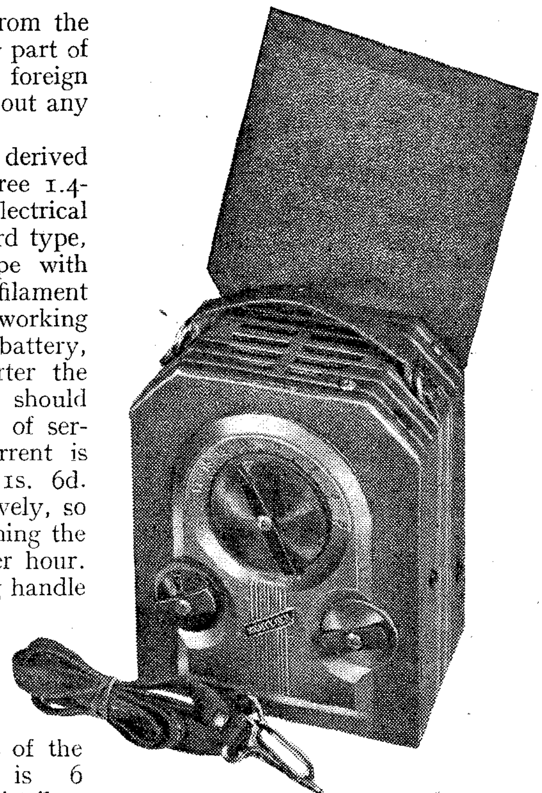
An efficient moving iron loud speaker incorporated in the top of the set makes the most of this output and, probably because the back is totally enclosed, there is a surprisingly high proportion of bass frequencies in the response.

The signal is picked up on a frame aerial hinged to the back of the set, and the overall sensitivity is sufficient to give a good signal from the B.B.C. Home Service in any part of the country. After sunset, foreign stations can be received without any difficulty.

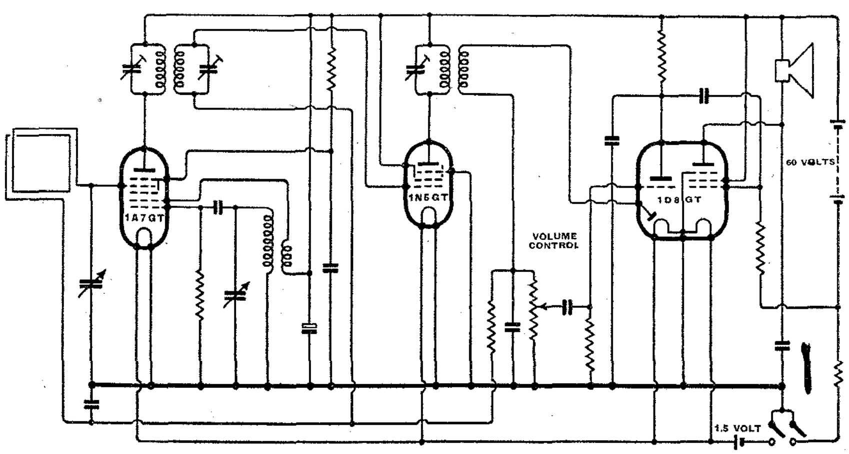
Both HT and LT are derived from dry cells, and the three 1.4-volt valves are of the same electrical characteristics as the standard type, but are of the "GT" type with short bulbs. The $1\frac{1}{2}$ volt filament heating cell lasts about 60 working hours and the 60-volt HT battery, which is of about one-quarter the capacity of standard size, should give about the same length of service. The normal HT current is 7 mA. Replacements cost 1s. 6d. and 5s. 9d. respectively, so that the cost of running the set is about $1\frac{1}{2}$d. per hour.

A flexible carrying handle is fitted at the top of the set and a shoulder strap and waterproof case are available as extras. The price of the "Mighty Gem" is 6 guineas, and the distributors, who carry stocks of replacement batteries, are H. H. Linton and Co., Ltd., 2, Holborn Buildings, London, E.C.1.

Both in range and volume this receiver gives a remarkable performance for its size.



Front view with frame aerial raised for reception. The tuning dial is calibrated on a kilocycle basis and the other knobs are for the volume control and on-off switch.




Circuit diagram of the "Mighty Gem" portable. A pentagrid frequency-changer is followed by one IF amplifier and a final stage which combines the functions of signal and AVC rectifier, first AF amplifier and output valve.

# Recent Inventions

**Brief descriptions of the more interesting radio devices and developments disclosed in Patent Specifications will be included in these columns.**

### "NOISELESS" SWITCH

THE ordinary type of switch makes or breaks the controlled current instantaneously, and is therefore a fertile source of "clicks" and other disturbing noises in any wireless set within range. Interference of this kind could largely be avoided if the switch were made somewhat less rapid in its action, and the inventors disclose one method of securing this result.

The contacts are made in the form of two metal discs which are brought together or separated by any suitable lever action. The lower disc is surrounded by an annular pad of aerated rubber or felt, saturated with an electrolyte, and the upper disc first makes contact with this pad before being finally pressed into contact with the lower metal disc. The make or break of the current thus takes place in two stages, instead of being instantaneous. The electrolyte contains glycerine, and is also protected by a cover so as to minimise evaporation.

*F. R. W. Strafford and Belling and Lee, Ltd. Application date, February 26th, 1938. No. 511674.*

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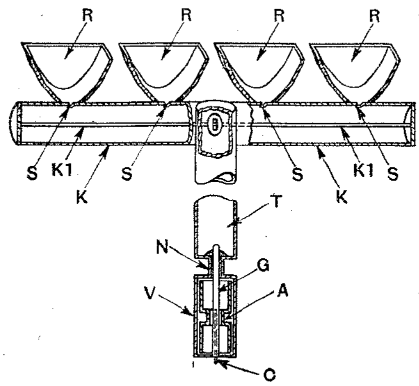
### CENTIMETRE WAVES

RELATES to the production, amplification, and detection of very short waves by making use of coaxial transmission lines, and of tubular conductors or so-called dielectric guides.




Generator and radiator for microwaves.

As shown in the drawing, centimetre waves are generated by a thermionic device V, comprising a cathode C, grid G, and anode A, the space in which they are mounted forming a tuned "resonator" chamber, in which the waves build up. The grid G passes through a neck N, which, in effect, forms a coaxial transmission line coupling to a hollow tube T or "dielectric guide." This is terminated by a cross-piece formed as a two-conductor transmission line, comprising an external tube K and an internal core K1, to which horn-shaped radiators R are coupled at regular intervals. The short-wave energy built up inside the line K, K1, is transferred to the radiators through slot-shaped openings S, and is then radiated into space as a directed beam.

*O. Bormann (J. Pintsch). Convention date (Germany), September 15th, 1936. No. 507473.*

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### DF BEACON AERIALS

FOR DF work over long distances using short wavelengths it is desirable that the transmitter should radiate only vertically polarised waves, and that any horizontally polarised components should be carefully eliminated. This is particularly the case with aerial beacons which are designed to send out either a sharply defined beam which is made to rotate continuously at a given speed, or which sends out a pair of "overlapping" beams in order to mark out an air route to be followed by an aeroplane.

In practice, it is found that waves having a horizontal component are likely to be radiated from any beacon station erected over an earth which is not uniform or homogeneous. It has also been found that this effect can be offset by slightly inclining the aerial, so that it is, in effect, strictly vertical to the "electrical" earth—although at an angle to the ground as viewed by the eye. The invention accordingly consists in mounting the dipole elements of a beacon transmitter on a tripod or similar support, so that they can be inclined at any desired angle to the ground.

*R. J. Berry (communicated by C. Lorenz Akt.). Application date, June 28th, 1938. No. 511322.*

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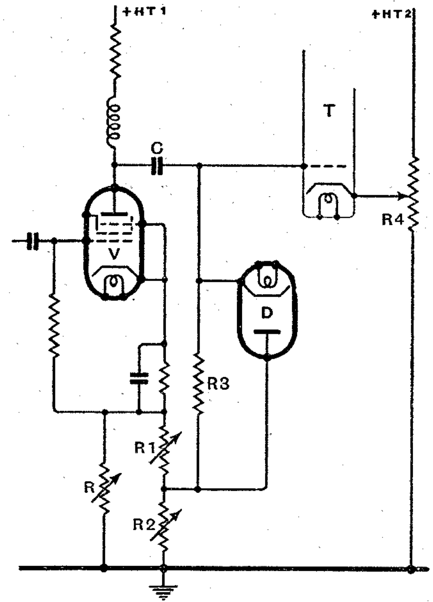
### PICTURE CONTRAST CONTROL

THE invention discloses an arrangement for regulating picture contrast in a television receiver by means of negative feedback. The method has the advantage of not affecting the frequency response of the receiver to any noticeable extent. At the same time, provision is made for restoring the DC component in order to keep the overall brightness of the picture in step with slow changes of illumination at the transmitting end.

The variable resistance R, which is common to the input and output circuits of the "vision" pentode valve, provides the negative feedback used for contrast control, by regulating the amplitude of the signal voltages applied through the condenser C to the grid of the cathode-ray tube T. A diode D is shunted across the output from the pentode V to a point between two resistances R1, R2, which form a potentiometer bridge across the feedback resistance R, and the voltage developed by the load resistance R3 of the diode is used to restore the DC component required to keep pace with slow changes in illumination. A tapping on




Using negative feedback to regulate picture contrast.

the resistance R4 provides a control for the mean picture brightness.

*Kolster-Brandes, Ltd., and C. N. Smyth. Application date, February 4th, 1938. No. 510715.*

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### CAR AERIALS

THE figure reproduced on the following page shows a rod-type of aerial A, with means for swinging it down from the operating position drawn in full lines to the out-of-use position, shown in dotted lines, where the aerial lies parallel with the roof of the car. The mounting M is made of comparatively resilient or elastic material, and is pushed from inside the car through a hole formed in the sheet-metal framing H, just above the windscreen.

The aerial proper ends in a ball or

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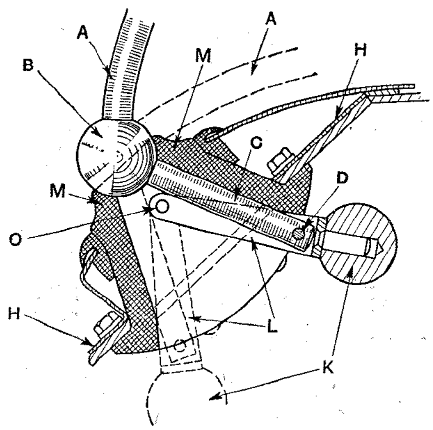
## Recent Inventions—

knob B, which seats firmly on the mounting M, but there is an inside arm or projection C, which is hinged at D to an operating arm L fitted with a knob K. This operating arm is pivoted at a




Retractive car aerial.

point O, and is of shorter radius than the other arm, so that there is a toggle action which tends to "snap" the aerial A into either the full-line or dotted-line positions, as the knob K is moved up or down from inside the car.

*Daimler-Benz Aktiengesellschaft. Convention date (Germany), March 23rd, 1938. No. 508777.*

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### AUTOMATIC CONTRAST CONTROL

IN an AF amplifier, suitable for gramophone reproduction, part of the pick-up voltage is shunted from the main amplifier on to the grid of an auxiliary valve, the output transformer of which is fitted with two separate secondaries. One of these is arranged to filter out the higher audible frequencies, and the other the lower audible frequencies, which are separately rectified.

The resulting voltages are used to apply automatic contrast control to the main amplifier valve, the control voltage for the lower audio frequencies passing through a filter having a longer time constant than that used for the upper frequency control. By reversing the polarity of the derived voltages, they may be used for contracting the volume range instead of expanding it.

*N. V. Philips Gloeilampenfabriekin. Convention date (Germany), January 19th, 1938. No. 512118.*

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### CATHODE-RAY SCANNING

IN the type of television transmitter in which an electro-static image is built up on a mosaic screen, which is then scanned by an electron beam, there is always the possibility that the flyback path of the beam may pass over and partly destroy the electrostatic image already formed on the line about to be scanned. This difficulty is sometimes avoided by applying a beam-suppressing voltage to the *wehnelt* electrode during the line and frame flyback periods. Unfortunately this tends to produce large signalling potentials, which result in the picture showing an unnaturally bright or dark margin.

According to the invention, the beam is not suppressed, but is controlled by a square-topped impulse (preferably derived from the line scanning oscillator) which forces the electron beam during its flyback motion to pass over a portion of the mosaic screen that has already been scanned. In this way it cannot impair any of the electrostatic charges from which the signalling currents are derived.

*Baird Television, Ltd. (communicated by Fernseh-Aktiengesellschaft). Application date, February 11th, 1938. No. 511048.*

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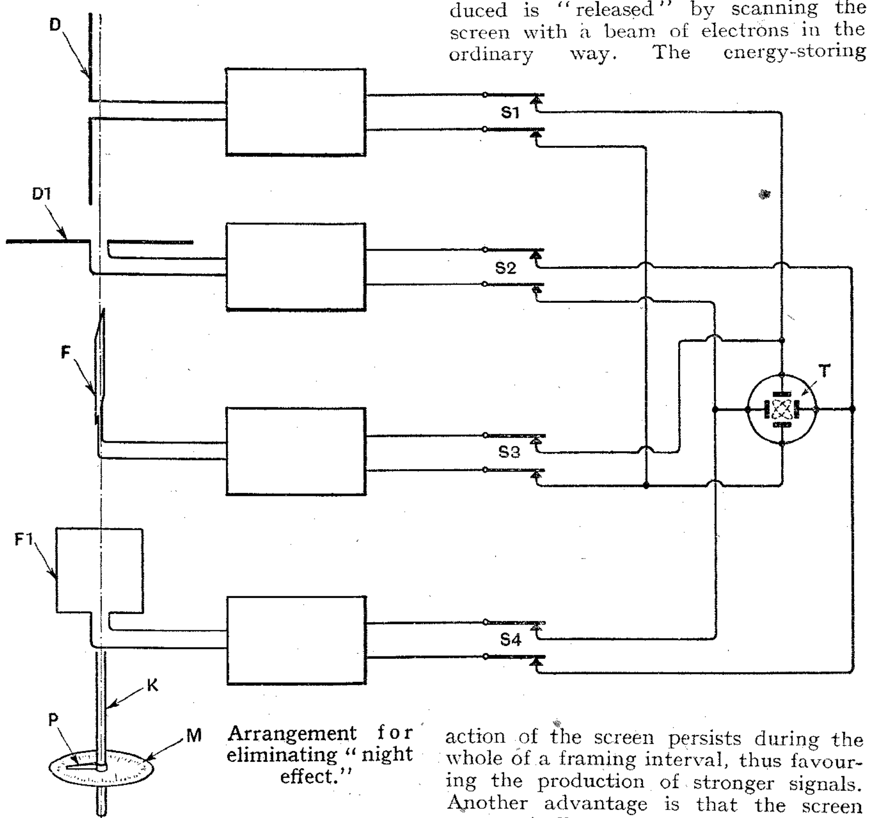
### DIRECTION FINDING

THE figure shows an arrangement for finding the direction of an incoming wave free from "night effect" or "aeroplane error." Two dipole aerials D, D1, mounted at right-angles to each other, are connected through amplifiers to the two pairs of deflecting plates in a cathode-ray tube T. Two frame aerials F, F1, also set at right-angles to each other, are similarly connected to the CR tube, switching relays S1, S2, S3, S4, being provided to ensure that the pick-up from the two sets of aerials reaches the deflecting plates alternately.




Arrangement for eliminating "night effect."

The dipole aerials produce an elliptical trace on the fluorescent screen of the tube, which represents the direction of the electrostatic component, whilst the frame aerials produce a second ellipse showing the direction of the magnetic component of the incoming wave. The shaft K, on which all the aerials are mounted, is then rotated until the two ellipses (shown in dotted lines) coincide on the fluorescent screen of the tube. A pointer P then shows the true direction of the wave on a scale M.

*Standard Telephones and Cables, Ltd. (assignees of Le Materiel Telephonique Société Anonyme). Convention date (France), September 17th, 1937. No. 509731.*

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### TELEVISION SCREENS

TELEVISION signals are derived from a photo-sensitive screen made of alkali halides, such as potassium chloride, which, in common with certain luminous phosphors, possess the property of developing light-storing "centres" (somewhat analogous to those involved in ordinary photography).

A screen of this kind is used as a substitute for the mosaic-cell electrode in a television transmitter of the Iconoscope type. The picture to be transmitted is focused upon the screen, and the "latent" photo-electric energy so produced is "released" by scanning the screen with a beam of electrons in the ordinary way. The energy-storing action of the screen persists during the whole of a framing interval, thus favouring the production of stronger signals. Another advantage is that the screen automatically reacts to slow changes of intensity, corresponding to variations in the background illumination of the picture being transmitted.

*Scophony, Ltd., and A. H. Rosenthal. Application dates, February 25th and December 2nd, 1938. No. 511796.*

Wireless World



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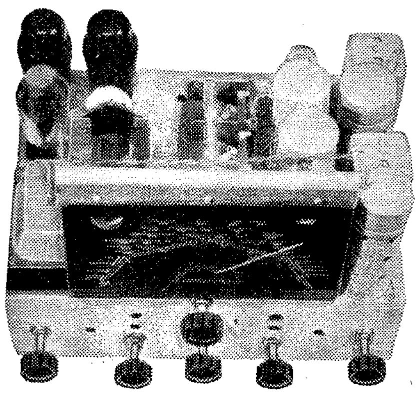

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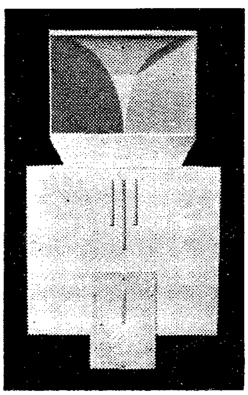

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A.C. and D.C. Motors from 19/6; new and second-hand, guaranteed; also repairs department.—Easco, 1-3, Brixton Rd., S.W.9. 'Phone: Reliance 1694. [0644

# *A few suggestions on* EASY L-R-S TERMS

**(or Cash as you prefer)**

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**THE LONDON RADIO SUPPLY COMPANY**
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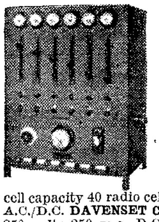
## WINTER CHARGING.



Fine **DAVENSET A.S.C.4.**, 4 circuit A.C. mains Charger for up to 80 cells. List price £32. Sale **£14/10/-.** Charge regulators and indicators on panel with switch volt control Four circuits of ½, 1, 2 and 2 amps., or 3 of 1, 2 and 2½ amps., etc., or one of 50 v. 6 amps. 10 amp. Fine set that will quickly earn its cost and show a good profit. A great bargain at **£14/10/-.** Other chargers at bargain prices are below. Call and see during daylight.

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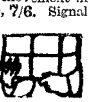

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SEND for Lists of These, and also electrolytic condensers, line cords, resistances, etc.

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REQUIRED Immediately, 46-range Universal Avometer Model 7, in second-hand or shop soiled condition; must be in perfect order; please write, with details, to Box 1271, c/o *The Wireless World.* [8778

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PREMIER RADIO.

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ALL Articles Fully Guaranteed. Postage extra.

5/-.—Parcel of useful components, comprising condensers, resistances, volume controls, coils, wire, circuits, etc., etc., value 25/-. 5/- per parcel.

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7/6.—24 assorted tubular condensers, up to 2 mfd., 7/6 for 24; Telsen 3-range meters (volts and milliamps), 4/-; Morse tappers, 2/11.

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DUBILIER Electrolytic Condenser Banks, replacement for Marconi, H.M.V. and G.E.C., 570-volt working, 14+7+7+3+3+20+10 mfd.; 3/- each.

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A Suitable Amount Must be Included for Postage.

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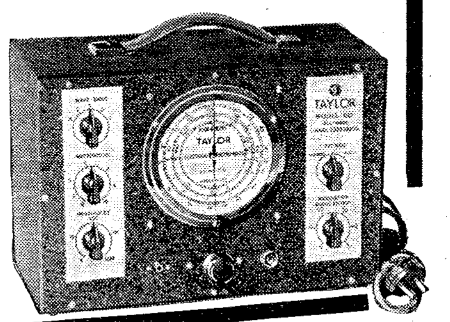
# ALL WAVE SIGNAL GENERATOR

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## 12w. PUSH-PULL TYPE

**any single ratio to order**

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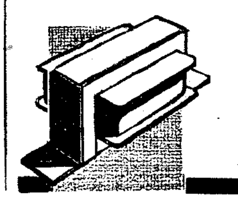

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ELLIPTICAL Speakers, Celestion, suitable Ekco replacements, 750 and 1,250 ohms, less transformers, speech 25 ohms, new, handle 8 watts, carry up to 120 m.a.; 3/9 each to clear.

SPEAKERS, pairs, brand new, elliptical cone speakers, made by first class firm, quality of reproduction outstanding, push-pull pentode transformer, fields 325 ohm for smoothing choke, 8,600 as bleeder, circuit available, handle 10-15w.; 12/9 pair.

HEAVY Duty Mains H.F. Chokes, Goltone, 75w. high inductance type, 1/6; 180w. low inductance type, 1/-.

MAINS Transformers, drop through chassis type, top cover with mains adjustment, input 200-250v., outputs 350-350, 80 m.a. 4v. 2½a., 4v. 4-5 amp., heavy jobs, 6/9 each.

B.1 0.05 Non-inductive Tubulars, 350v. wkg., new stock, 1/3 doz, 9/- gross; Cornel-Dublier mica, sizes 001, 002, 003, 1/3 dozen.

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PLESSEY Fully Screened 2-gang Condensers, short spindles, with top trimmers, 2/9; Plessey midget 2-gangs semi screened, 2/9; both 0005 straight type.

PLESSEY 3-gang Straight Type Condensers, top trimmers, fully screened, brand new, 2/9; Cossor 3-gangs ditto, 1/9, or 12/- dozen.

FERRANTI Air Core Type Tuning Coils, transformer wound, can be used as band pass, tuned grid with reaction, chassis type; three for 2/6, with coil connections.

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MAGNAVOX 7in. Cone Speakers (8in. overall), ribbed pattern, ideal replacement speakers, 2,000 ohms pentode transformers; 7/-, new.

SATOR ½meg. Pots with Switch, 1/3 each, 7/9 dozen; 10,000 ohm broad base tone control type, less switch, 1/3 each, 6/9 dozen

ELECTROLYTICS, B1, 20×20 mf. at 350v., 25×25v., 1/3; size 3in.×2¼in., B.1 2×2×2, 400v., peak, 1/3 each, 9/- dozen; 25×25v., 1/3; Plessey 30×8×2, 300v. wkg., 1/6 each, 12/- dozen.

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ASSORTED Resistances, 50 for 2/6; 1-watt carbon, U.S.A. make, reasonable assortment given, sizes approx. 450-12,000-17-60-70-90-120 thousand ohms.

PUSH Back Wire, 18g., 50 yards, 3/6; Systoflex 1½ mm., ½ gross, 5/-; twin screened 2×14-36, British made, 12 yards, 2/6; minimum quantities.

REX Type Switches, 4B. 2P. 4w., with shorting plate on 5 switches, 2/6 each, length 7in., spindle 2in.; ditto, 3w. 4P. 3B., 1/6; 3w. 3P. 3B., with shorting plate, 1/6; 3w. 2P. 4B., 1/6; any combinations of this item supplied; screens, 3in.-¾in.×3in.-⅝in., 5 for 1/3.

TRIMMERS on Porcelain Plessey, double and single, 50-100-200-160 ohm. approx.; 50 for 2/6; special price quantities.

PLESSEY 6,500 ohm. 8in. Speakers, with pentode transformer, 6/6; U.S.A. valve screens (goat), complete, 3 for 1/4.

SCREENED Leads about 4 yards, 3-way, two only screened, 1/3; extra heavy for car sets, with spades, 1/3, 2¼ yards.

HAMMERLUND 30mm. Midget Trimmers on Pazolin, 1/9 dozen; ultra type brown knobs, octangle, plain arrow, L.S. 1/9 dozen, 8/6 gross assorted, 10/6 gross plain or arrow.

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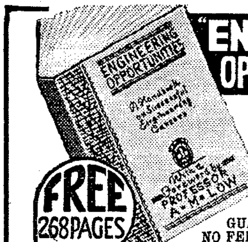


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