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EDITORIAL COMMENT

Sound Amplification

Prejudice and Neglect of Opportunity

SPEECH and sound amplifying equipment is finding its way into all sorts of applications in our daily life. Whereas in days gone by speakers to large gatherings strained their voices, whilst those in the audience strained their ears, in the effort to establish communication, to-day there is no longer any necessity for speakers to be put to this exertion, nor for their audiences to suffer such inconvenience.

Sound amplifying equipment, wherever it can be made available, can do away with that state of affairs. Yet still we find many occasions where sound amplification is needed but prejudice still holds out against its utilisation. It cannot be denied that early attempts at amplifying speech at public meetings and elsewhere were so crude as to provide an excuse for a good deal of prejudice against the principle, but recent progress in the design of equipment, as well as the acquisition of experience in installing apparatus of this kind, should by now have convinced the most sceptical.

The theatre is an outstanding example of the need for sound amplification. It may be that familiarity with the cinema, where the sound intensity is normally fairly high, has made people dissatisfied with the theatre by comparison, or it is possible that gradual changes in what may be described as the technique of the stage have tended to make stage dialogue more intimate and, therefore, more difficult to follow by a large audience. But whatever the reasons, there is no doubt that amongst a growing proportion of the public the theatre is losing its appeal, for the reason that so much dissatisfaction is felt at the inability to hear, or the strain of trying to do so.

Prominent people in theatreland have recently expressed grave concern regarding the future of the theatre as a result of decreasing public interest, yet the ability perhaps to regain for the theatre its former popularity is available at an almost negligible cost to theatre managements. If efforts are to be made to take advantage of this means of reinstating the theatre, it should be done now, before the continued comparison of the amenities of the theatre and the cinema from the point of view of adequate sound intensity has gone too far. There is to-day no need to make sound amplifying apparatus obtrusive ; it is possible to so arrange matters that the audience is almost unaware that amplification is being employed, yet an enormous improvement can result in the general appreciation of the performance.

Electrical Interference

Public-spirited Attitude

MOST of our references to the subject of electrical interference have been in the nature of complaints either of the severity of interference or of the delay in putting forward legislation. This time, however, we wish to put on record our appreciation of the public-spirited attitude of the many firms and individuals who, to our knowledge, have been prepared to go to considerable expense and trouble to eliminate interference which has been of no consequence to themselves but only to neighbours to whom they had no legal responsibility. Many of these cases have provided experience for Post Office engineers which subsequently will be used for the free benefit of others.

How a Receiver is Designed.—XI.

The Battery Quality Amplifier

HIGH-FIDELITY APPARATUS FOR THE BATTERY USER

DESIGNING equipment for high quality reproduction entails no great difficulty when it is for operation from AC supply mains, for it is easy to obtain the necessary power supply in a cheap and suitable form. It is much more difficult, however, to design equipment for DC mains operation because, although the necessary power can be obtained as cheaply as with an AC supply, it is not in such a suitable form for operating an amplifier, since one is limited to a voltage somewhat less than that of the mains. The difficulties, however, can be overcome, as was shown by the design of the DC Quality Amplifier which appeared in this series of articles.

When we come to consider the possibility of building an amplifier for battery operation, however, matters are entirely different and it is exceedingly difficult to obtain a really high standard of quality with reasonable economy in operation. The difficulty is entirely one of the power supply, and if there is no limit to the current which can be taken from the HT supply system there is no more difficulty in building a battery-operated amplifier than one working from the mains. No dry battery could deliver the current needed by a large output stage for more than a short period, however, and the result is that such an amplifier will prove very uneconomical to run. The difficulty can be got over by using HT accumulators for the supply, but frequent recharging is necessary and many people do not consider an HT accumulator convenient.

Types of Output Stage

For dry battery operation most people consider a current of about 10 mA. at 120 volts the maximum which should be allowed. This represents an HT power of 1.2 watts. If this whole power is used in the output stage so that we leave nothing for the earlier valves, we could not obtain an output to the loud speaker of more than 1.2 watts, even if the output stage were 100 per cent. efficient. In practice, a single triode operating under Class A conditions will have an efficiency of 20-25 per cent. for really high quality purposes, so that the maximum output is of the order of 240-300 mW. only.

A higher efficiency can be secured from a pentode and possibly an output of as much as 500 mW. might be obtained, but this would not be with the low degree of distortion associated with the term "high quality reproduction." In order to obtain a higher efficiency the methods usually known as quiescent push-pull and Class B were devised. In these systems the peak output power can be greater than the average power drawn from the battery and quite large outputs are actually obtainable on peaks. For a consumption such as that given above, it might be possible to obtain two or three watts output on peaks with this type of output stage. The battery, however, must be capable of supplying a peak power of about twice the output obtained, with the result that the peak current is very heavy.

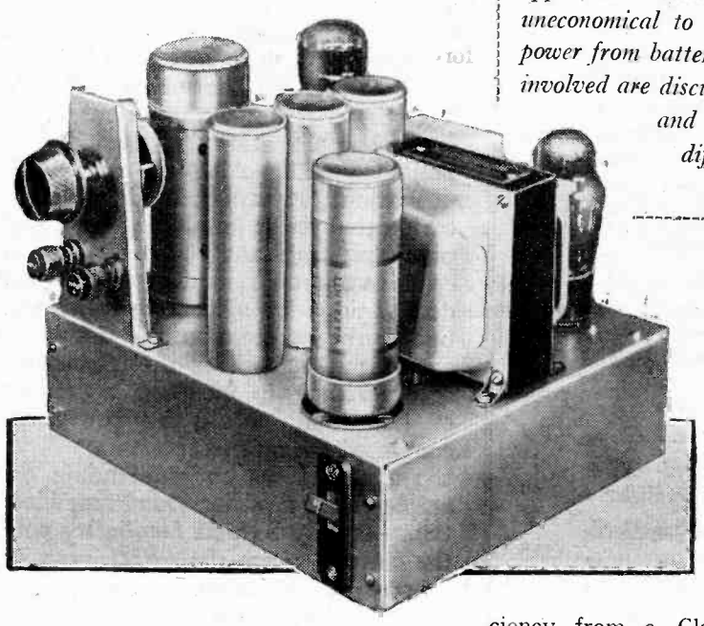
With a 120-volt supply, for instance, and an output of 3 watts on peaks, the peak current would rise to as much as 35 mA. This high peak current is not good for the battery and the result is that the life of a battery operating a stage of this nature is less than that of one which drives a Class A stage consuming the same average current.

There is also another point; for correct operation a quiescent type of output stage demands that the DC resistance of the HT supply should be very low. Now a battery ages in two ways; its voltage falls and its internal resistance increases. The latter means that there is an additional fall of voltage on load, but with a Class A stage there is no other harmful effect. With a Class B stage, however, the additional resistance introduced may cause serious distortion. It is not uncommon to find, therefore, that a battery which will still give good service with the Class A stage gives poor results when using a quiescent type of output stage.

Even apart from such questions of power supply, Class B and quiescent push-pull cannot be considered as ideal from the point of view of quality. They depend for their operation on the distortion introduced by one valve being cancelled by that introduced by another, and in practice this cancellation is never quite perfect. The result is that an appreciable amount of distortion is often observed, even at quite small outputs; in fact, it is sometimes even greater at small output than at large. Where a really high standard of quality is desired, therefore, such systems can hardly be considered and the problem of design really resolves itself into obtaining the maximum efficiency from a Class A stage and in obtaining the most economical form of power supply.

There is little doubt that over long periods the most economical form of battery power is the accumulator. The use of HT accumulators is straightforward and calls for no special discussion, but for those who object to their use for one reason or another there is an alternative supply. It is possible to use a single

IT is well known that it is extremely difficult to secure a high standard of reproduction from battery apparatus because it is usually uneconomical to obtain the necessary power from batteries. The problems involved are discussed in this article and a way out of the difficulty is shown.



A view of an amplifier designed for car-battery operation. The vibrator can be seen in the near corner.

The Battery Quality Amplifier—

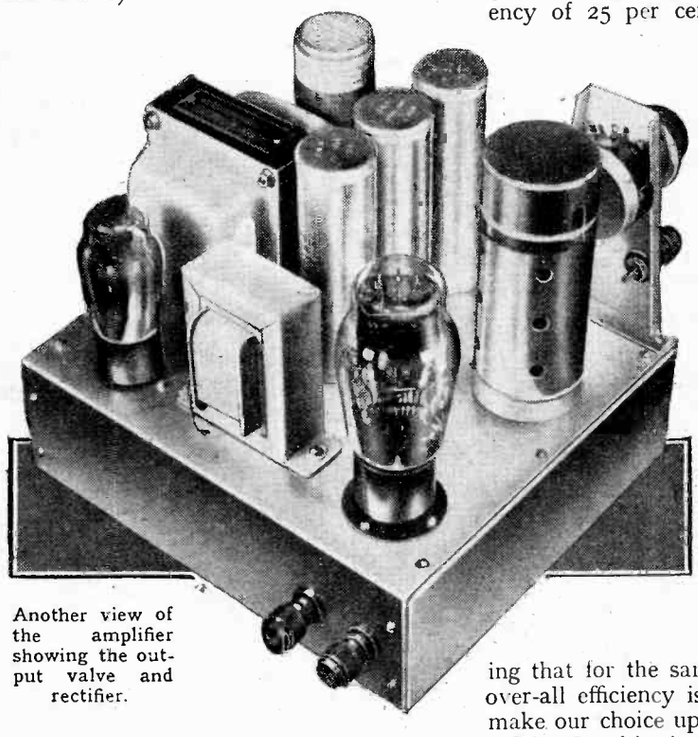
accumulator of 6 or 12 volts for operating the valve filaments and for providing an HT supply with the aid of a vibratory HT supply unit. There is, of course, a loss of power in such a unit, for the efficiency does not normally exceed 70 per cent. and may be as low as 50 per cent. In spite of this, it is a very attractive way of obtaining the HT supply and is convenient, since a single battery can be used for supplying the whole amplifier. It will therefore be well worth while to work out the design of an amplifier on these lines, and it will be particularly instructive as the method of attack must differ considerably from that of mains-operated equipment.

In general, we shall have to use a car-type battery, and it is probably inadvisable for the current drain to exceed about 6 amps. This represents a power of 36 watts from a 6-volt battery, or 72 watts from a 12-volt battery. If possible, of course, we should naturally use a 6-volt battery, since it is cheaper, both in first cost and in re-charging. Now a Class A output stage will have an efficiency of roughly 20 per cent., so that if we require an output of 3 watts we must allow 15 watts for the HT supply. With an efficiency of 70 per cent. in the HT supply unit, this represents a total power of 21.4 watts from the battery, leaving about 14 watts for the valve filaments. This is ample and we shall probably be able to operate from a 6-volt battery with a lower current drain than 6 amps.

Tetrode v. Triode

The first step in design is to choose the output valve and we obviously require one with a 6-volt filament or heater, for although a lower voltage valve could be used and the surplus voltage dropped in resistance, this is rather wasteful. We have also to choose between a triode, tetrode and pentode. The tetrode and pentode are normally reckoned to have a higher efficiency than the triode, in that the output is greater for the same power wasted in the anode circuit, that is, for the same product of anode volts and anode current. The pentode and tetrode, moreover, require a lower value of grid bias, which means that there is less power wasted in producing it. On the other hand, the tetrode and pentode require a screen supply and several watts are normally wasted here. In the case of a DC mains set, this is quite unimportant because there is no real limitation to the power supply and our difficulties are connected with the low voltage available, consequently, the low grid bias required by tetrodes and pentodes is then a very big point in their favour.

With AC equipment, and with a battery amplifier used with a vibratory HT supply unit, it is power that is important rather than voltage or current alone. The use of a high value of grid bias is only indirectly disadvantageous in that power is necessary to produce it, but the need for providing screen current is certainly a disadvantage because this entails a wastage of power which may more than offset the power loss in producing the grid bias of a triode. Some output tetrodes do consume a very small amount of screen power and also require a very small grid bias. Such valves are obviously the most suitable types to use. At the present time, however, such valves are not available with a 6-volt or even a 13-volt heater, since they are intended for use either in AC sets (4-volt heater) or AC/DC sets (26-volt heater).



Another view of the amplifier showing the output valve and rectifier.

An examination of the valves available shows that there is actually quite a small choice for the output stage. It is hardly possible to use two valves in push-pull while maintaining a reasonable power consumption unless we go to a pair of small pentodes consuming some 20 to 30 mA. apiece only. The use of such valves, however, is inadvisable because in push-pull they demand a very high load impedance for which it is difficult to obtain a suitable output transformer. In the 6.3-volt range, therefore, our choice really narrows down to two types of valve, which are exemplified by the American 6A3 triode and the American 6F6 pentode or British KT63 tetrode.

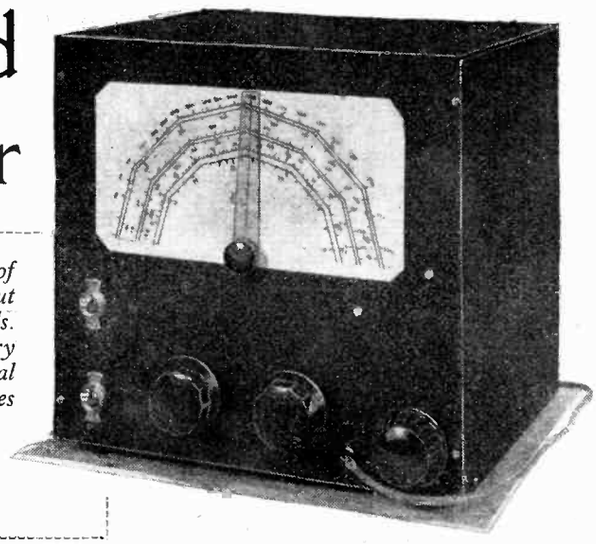
Comparing the first and last of these we find that the 6A3 requires 6.3 watts filament power, since the valve is actually rated for working at 6.3 volts. The figures are given in the accompanying table, and the HT supply should be 250 volts for the anode and 45 volts grid bias with a current of 60 mA. The total supply should thus be 295 volts and the power is consequently 17.7 watts. The total power taken by the valve and its bias supply will be 24 watts and it gives an output of the order of 3.2 watts, so that the over-all efficiency is 13.3 per cent. Now the KT63 takes 0.7 amp. for its heater at 6.3 volts, a power of 4.4 watts; the anode current is 34 mA. at 250 volts, which is 8.5 watts, the screen current is 5.5 mA. at 250 volts, or 1.375 watts, and the bias is 16½ volts, which must be developed with a current of 39.5 mA., a power of 0.65 watt. The total power is just on 15 watts and the output is given as 3 watts, an over-all efficiency of 25 per cent. This is considerably better than the case of the triode, but we have not yet considered the amount of distortion for which the output figures are quoted. The figure given for the KT63 is for 7 per cent. total distortion, whereas that for the 6A3 is for 5 per cent. If we take the output of the KT63 for 5 per cent. total distortion the output is only 2.15 watts, giving an over-all efficiency of only 14.35 per cent., which is as near as no matter the same as for the 6A3. Seeing that for the same distortion a similar over-all efficiency is secured, we have to make our choice upon another basis.

We do this in two ways; first we remember that, in general, a given percentage distortion does not sound as bad when it is nearly all second harmonic as when it is made up of a mixture of second and third harmonics in more or less equal proportions, and possibly with an admixture of even higher harmonics. Secondly, the output of the KT63 for 5 per cent. distortion is less than we need, for in an amplifier of this nature we should not aim at an output of less than about 3 watts. We decide, therefore, to use a 6A3. As this valve requires a large input, a fairly high gain amplifier is needed before it and it is obvious that this must consume as little current as possible. Fortunately, we are not limited here to any great degree, for it is possible to build an RC coupled amplifier which will take less than a milliampere from the HT supply and yet give high gain and a good frequency response with ample output.

	6A3			KT63		
	Volts.	Current.	Power Watts.	Volts.	Current.	Power Watts.
Heater ...	6.3	1.0 A.	6.3	6.3	0.7 A.	4.4
Anode ...	250	60 mA.	15.0	250	34 mA.	8.5
Screen ...	—	—	—	250	5.5 mA.	1.375
Bias ...	45	60 mA.	2.7	16.5	39.5 mA.	0.65
Total ...	295	60 mA.	24.0	266.5	39.5 mA.	14.925
Output ...	—	—	3.2	—	—	2.15

All-Wave Modulated Test Oscillator

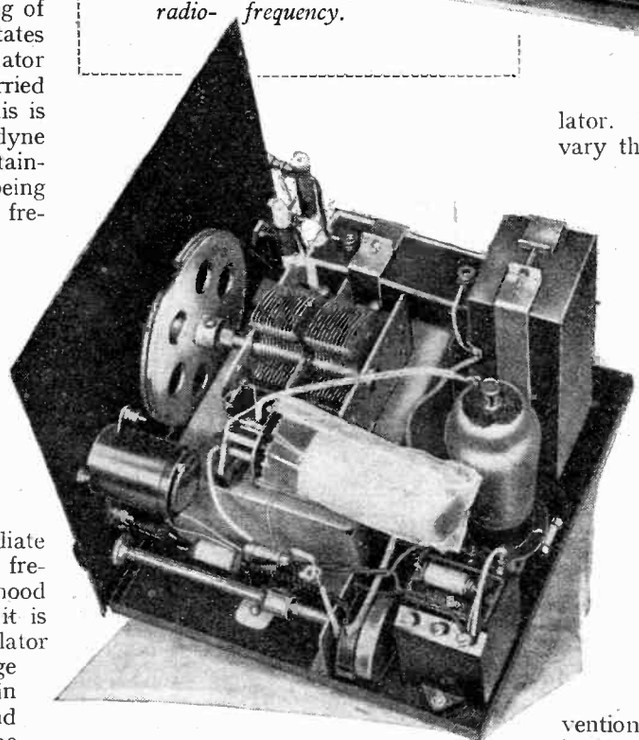
BATTERY-OPERATED OSCILLATOR FOR MODERN SET TESTING



IN this oscillator a range of some 10-2,000 metres without gaps is obtained in six bands. Two valves, operated from dry batteries, are used with a special modulation circuit which enables the output to be controlled without affecting the radio-frequency.

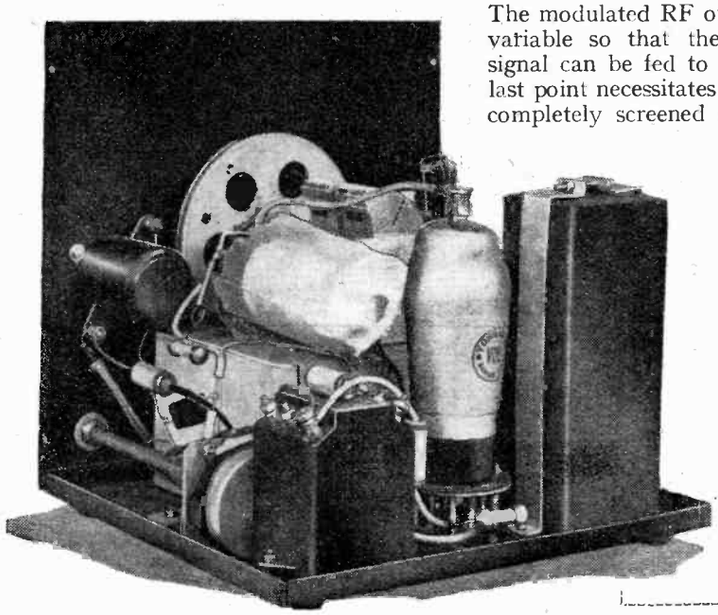
THE adjustment of the ganging of a modern receiver necessitates the use of a calibrated oscillator if the process is to be carried out with rapidity and certainty. This is especially the case with a superheterodyne because the accuracy of ganging obtainable depends upon the IF circuits' being lined up accurately to their correct frequency. In adjusting such a receiver the first step is always to trim the IF amplifier to its correct frequency, for unless this is done with a reasonably high degree of accuracy correct ganging of the signal frequency and oscillator circuits cannot be achieved.

The tuning range of a modern all-wave receiver usually extends from some 10 or 13 metres to 2,000 metres, with a gap around 550 to 1,000 metres in which the intermediate frequency lies. The intermediate frequency is usually in the neighbourhood of 465 kc/s, but in older receivers it is commonly 110 kc/s. A test oscillator should, therefore, have a tuning range of 10 to 3,000 metres (100 kc/s) in order to cover all requirements, and this range should be continuous. The oscillator should be modulated at an audio frequency so that an audible signal can be obtained through the AF stages of the receiver for cases where ganging is carried out by judging the loudness of the loud speaker output, or by means of an output meter connected across the loud speaker. The modulated RF output should also be variable so that the required value of signal can be fed to the receiver. This last point necessitates the apparatus being completely screened so the coupling between the oscillator and receiver takes place only through the desired path.



The provision of a variable output brings several problems in its train; the conventional modulated oscillator has two valves, one being an RF oscillator and the other an AF oscillator. The output of the latter is used to vary the anode voltage of the former to effect modulation and the modulated RF output is often taken from a small coil coupled to the tuned oscillator circuit. With this arrangement it is difficult to find a method of varying the output which does not affect the oscillator frequency to some extent. This is troublesome in practice because it means that on varying the output it is necessary to retune the oscillator slightly, and it also makes the calibration unreliable.

A different arrangement has accordingly been adopted in this oscillator, and, as will be seen from the circuit diagram, a buffer valve is used between the RF oscillator and the output circuit. This valve serves also as AF oscillator and modulator. A conventional triode RF oscillator is used and its control grid is connected to the control grid of a heptode. The two inner grids of this valve form the grid and anode of a Hartley-type AF oscillator. This oscillator uses a 3-henry iron-core choke tuned by a 0.01 mfd. condenser C6, and it is of the grid leak type with a grid condenser C5 of 0.01 mfd. and grid leak R4 of 0.25 megohm. The AF potentials on the oscillator grid vary the electron stream, and a further variation is effected by the RF potentials on the control grid. The result is that whereas the anode current would vary only at radio frequency if the oscillator electrodes were at a fixed potential, the RF amplitude of anode current varies with the audio frequency on the oscillator grid, and this is actually modulation.

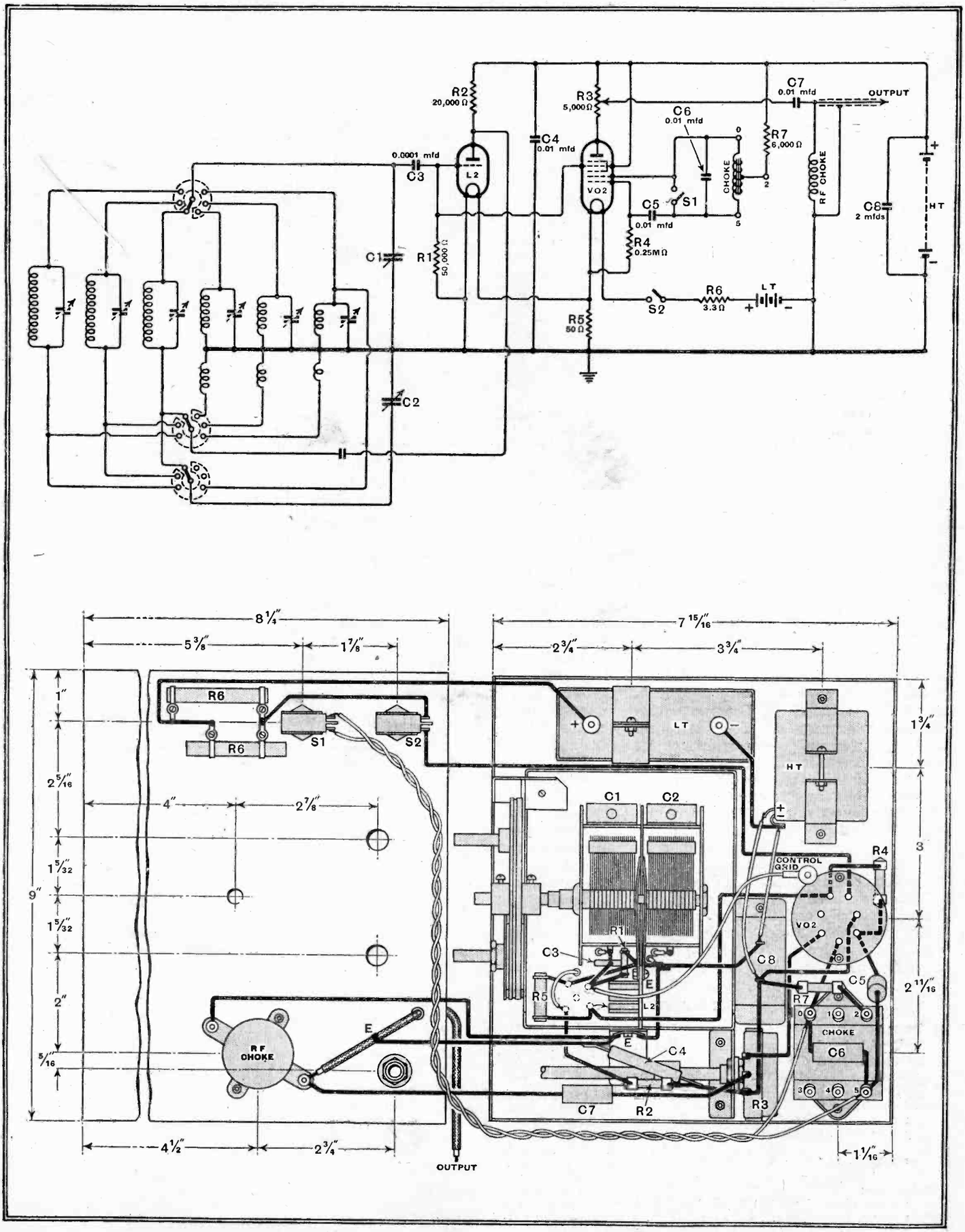


A rear view of the oscillator with the cover removed.

The Output Control

This modulated RF current sets up a voltage across R3 and any desired proportion of this can be picked off by means of a slider. This component, therefore, forms the output control. The condenser C7 is included to insulate the output, and the RF choke is necessary in order to pre-

CIRCUIT DIAGRAM, LAYOUT AND WIRING GUIDE



The holder for the VO2 valve is spaced from the base and mounted by two brass spacers through which the fixing screws pass.

All-Wave Modulated Test Oscillator—

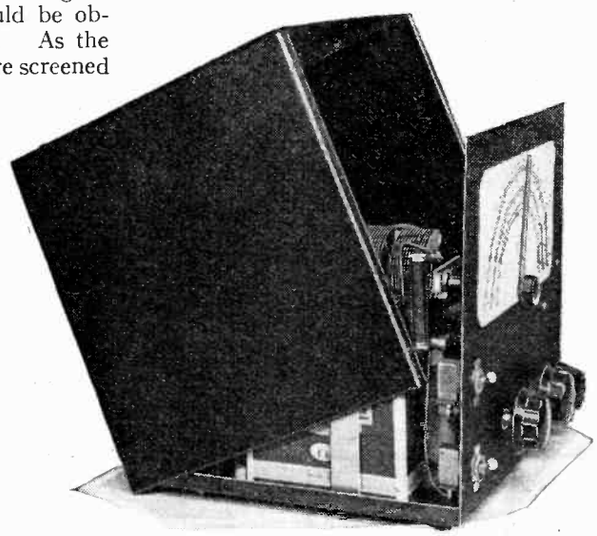
vent any appreciable proportion of the AF voltage appearing on the output. Without this choke it would be found that with the RF oscillator not functioning an output at audio frequency would be obtained, and this is undesirable. As the grid and anode of the heptode are screened from one another, varying the control R3 has a negligible effect upon the grid circuit and hence the oscillator frequency stays constant.

The RF oscillator is of more or less conventional type, and a triode valve, with grid leak and condenser, is employed. A two-gang condenser is used for tuning, and on the three short-wave ranges two sections are connected in series to form a Colpitt's oscillator. On the next two bands one section is used alone with the circuit of a reaction coil oscillator, the capacity on these bands thus being double that on the short-wave ranges. On the longest waveband of all a reaction coil oscillator is again used, but the two sections of the condenser are now connected in parallel, thus giving still larger capacity.

Battery Operation

Experience shows that for a test oscillator which is used normally only for short periods at a time, dry-battery operation is very reliable and a long life is obtained from the batteries. It is especially convenient when it is desirable for the batteries to be included in the containing cabinet, and it has accordingly been adopted in this case. The two valves have their filaments connected in series, and the L2 has a 50-ohm resistance R5 connected across it, since it takes a lower current than the VO2. As the two valves require 4 volts together and the battery is 4.5 volts, a series resistance R6 of 3.3 ohms is included. It should be noted that this resistance actually consists of a 5-ohm and a 10-ohm resistance in parallel.

A 60-volt small-capacity HT battery is adopted which feeds the screen of the heptode directly and the anodes of this valve and of the RF oscillator through R3 and R2 respectively. A dropping resistance R7, of 6,000 ohms, is used in the feed to the oscillator anode of VO2. This value has been chosen experimentally to give a good waveform of AF output at a suitable amplitude for modulation.



The cover is held in place by self-tapping screws and can readily be removed for battery or valve replacements.

The output obtainable from the equipment is somewhat dependent on wavelength, owing to the inevitable stray capacities between the anode of the modulator and its filament. The result is that the output obtainable falls off as wavelength goes down and the degree of modulation obtainable also varies somewhat. The values selected, however, give a good compromise between the conflicting factors, and it will be found that an output adequate for all normal requirements is obtained at all wavelengths, and that the waveform of the modulated output, although not perfect, is amply good enough for all ordinary purposes. It does not, of course, reach the standard of a laboratory instrument and is unsuitable for any work involving the measurement of amplitude distortion. For the purpose for which it is intended, however, such deviations from perfection in waveform are negligible and the use of an instrument giving perfect waveform would be no advantage for ganging purposes.

The full range of 10 to 2,000 metres is covered by the oscillator on fundamental frequencies, but by the use of the second harmonic of the lowest wavelength range it is useful down to 5 metres.

The construction of an oscillator of this nature is quite straightforward and normally the greatest difficulty lies in the calibration. This difficulty has been in the past great enough to deter many from building such apparatus, for there is actually no simple method of calibrating an oscillator without comparing it with a standard. The difficulty has been got over in this case by using a commercially available tuner, which is supplied by its makers ready calibrated and which will maintain its calibration with reasonable accuracy provided that the specified valves are used. It should be noted that it is necessary to keep to the specified types for both valves, since both are in connection with the tuning system. This tuner includes the valveholder for the RF oscillator, and this is wired to the internal parts, and the components R1, R5 and C3 are mounted on it. In addition to the tuning and range-change switch the controls include the output potentiometer R3 and on-off switch S2, and the modulation switch S1. When this switch is closed it short circuits the AF oscillator coil and an unmodulated RF output is obtained. This is not often required, so that it can be omitted if desired. A screened output lead is used, terminating in two crocodile clips, the screening being naturally one of the connections to the apparatus. This should always be connected to a point at earth potential, and for the adjustment of IF circuits it is usually most satisfactory to clip the inner lead to the grid of an IF valve. When it is required to inject the signal into the aerial and earth terminals it is sufficient to connect the output to these terminals.

The normal practice is, of course, to interpose an artificial aerial, but in view of the high output impedance of this oscillator, such an arrangement would be impracticable. This is one of the penalties which must be paid for having an output control which does not affect the oscillator frequency and which is at the same time simple and inexpensive. In practice, it means that the final alignment of the *aerial* circuit should be carried out on a signal with the aerial attached.

LIST OF PARTS USED

1 Tuner	**B.T.S.**
1 Case, with brackets, screws, etc.	**B.T.S.**
1 RF Choke, RFC	"Kinva" Standard Type
1 Tapped Choke, 3H.	**Varley DP18**
Fixed condensers:	
1 0.01 mfd., mica, **C4**	**T.C.C. "M"**
3 0.01 mfd., tubular, **C5, C6, C7**	**T.C.C. 451**
1 2 mfd., 250 volts working, **C8**	**T.C.C. 65**
Resistances:	
1 6,000 ohms, ½ watt, **R7**	**Bulgin HW11**
1 20,000 ohms, ½ watt, **R2**	**Bulgin HW19**
1 250,000 ohms, ½ watt, **R4**	**Bulgin HW28**
1 5 ohms, 10 watts, **R6**	**Bulgin AR5**
1 10 ohms, 10 watts, **R6**	**Bulgin AR10**
1 Potentiometer, wire-wound, 5,000 ohms, **R3**	**Reliance TW**
1 Valve holder, 7-pin (without terminals)	**Clix Chassis Mounting, Standard Type V2**
2 Switches, SP, on-off, **S1, S2**	**Bulgin S80T**
1 Length screened sleeving	**Goltone**
1 Plug-top valve connector	**Belling-Lee 1175**
1 Coupler, ¼ in. bore	**Bulgin 2005**
1 Panel Bush, ¼ in. bore	**Bulgin 1048**
1 Battery, 4½ volts, 3-cell	**Ever-Ready 126**
1 HT Battery, 60 volts	**Drydex X418**
Miscellaneous:	
2 lengths systoflex, small quantity No. 18 tinned copper wire, 2 crocodile clips, 4 in. Paxolin rod, ¼ in. dia., etc.	
Valves:	
1 L2	**Mazda**
1 VO2	**Tungsram**

The Wireless Industry

An extremely informative, compact and well-arranged Data Book, dealing with American Raytheon valves, is issued at 2s. post free by Leonard Heys, Faraday House, Henry Street, Blackpool, Lancs. Curves, base connections and full technical data are given.

Some of the exhibits at the Scottish Empire Exhibition "speak for themselves" by means of recordings made on Duo-Trac film, produced by British Ozaphane, Ltd. This firm has devised special equipment for reproducing these explanatory talks.

An enlarged catalogue of short-wave components for reception and transmission has been issued by the Raymart Manufacturing Co., 44, Holloway Head, Birmingham, 1, from whom copies may be obtained, price 1½d.

A catalogue of Grampian Service and Public Address equipment has been received from Holiday and Hemmerdinger, Ltd., of 74/78, Hardman Street, Manchester, 3, from whom copies can be obtained.

Balance and Control at Home

Part II.—SPEAKER EFFICIENCY AND OUTPUT WATTS

By R. H. WALLACE

ONE of the chief tendencies in set design of recent years has been in the direction of increased output power. This is a natural reaction from the limitations of early types of valves and equipment, and in most cases the effect on quality of reproduction has been very beneficial. There are, however, difficulties if this increased power is provided without proper regard to the other factors involved, or full consideration of the needs of the user. One comes across many instances where the full output provided cannot be tolerated, either owing to the inability of the speaker to handle it without distortion, or to an unsatisfactory cabinet design resulting in bad resonances. It is not always recognised that outputs of eight and ten watts in a table model call for very substantial cabinet design if good quality is to be obtained.

SUGGESTIONS are made as to the necessary output power for various conditions and requirements; it is stressed that the acoustic efficiency of the loud speaker must be taken into account. The author also explains why low-note response is also an important factor.

Where a large output stage is provided it is necessary to take care that the response in the bass is commensurate with that in the middle and top registers, or the reproduction of music will be unnatural and appear to be without a "foundation." This effect is not evident at lower volume levels owing to the fact that the lower notes are near the threshold and their absence is consequently not noticeable.

Practical Considerations

A large number of listeners live in modern houses and flats where the rooms are comparatively small, and in such cases it is wasteful to install apparatus capable of filling a small hall, on the grounds that the larger the output power the better the quality; it is wise to preserve a practical outlook and realise that if the general level must be kept low the peak values will be in proportion. An engineer does not fit a five-h.p. motor to a sewing machine or a bus engine to a private saloon car, yet some enthusiasts will install a ten-watt amplifier and a PA speaker in a room twelve feet square; of course they get good reproduction, but equal results could be obtained at less cost.

The chief factors affecting the desirable maximum undistorted output are the degree of musical appreciation of the owner, the average volume level required, the size of the room and the efficiency of the speaker used. The first of these requires some explanation; it must not be forgotten that the word "undistorted" applied to radio equipment is an abbreviation and really means, "The output possible with an agreed amount of distortion." In the case of valves, and most other parts, this agreed amount is equal to the introduction of five per cent. of second or third harmonic, whichever is the most. This amount would generally be accepted by the average listener as giving perfect reproduction, but a keen musical ear might reject anything over two per cent. as imperfect, and hence demand an amplifier of greater nominal power, especially as a higher level would probably be used.

The average level of speech watts is usually grossly over-estimated and many listeners would be amazed if they saw the readings of an output meter on their own set. While the peaks on an ordinary domestic set will probably rise to three or four watts, the normal power is likely to be about 250 milliwatts on an orchestra playing moderately loudly, and a violin solo, unless raised by the balance and control department, would be accommodated within 50 milliwatts, the quietest passages of the higher notes perhaps requiring only five milliwatts.

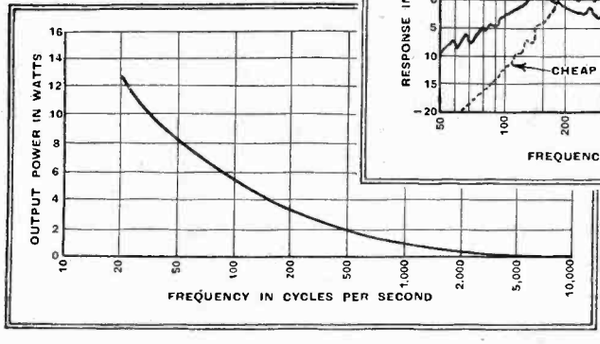


Fig. 1.—Approximate power needed at different frequencies for correct balance when the level is set at the value (comparatively high except for large rooms) of 1 watt at 1,000 c/s. A fairly efficient speaker is assumed.

Nearly all the energy is carried by the low frequencies, and a heavy drum passage or organ pedal-note will cause a rise from a normal level of 250 milliwatts to as much as four watts; speech, being put over at an artificially high level, will touch one watt under the same conditions.

From the foregoing it is evident that it is not so much normal conditions that decide the output necessary, as the amount of distortion that can be tolerated at peak values. These in turn depend somewhat on the low-note response of the set, since if this is unusually well maintained the peaks will be higher above the general level.

Recommended Output Levels

The actual figures of requisite outputs for different circumstances are necessarily not susceptible to precise delineation, but it is suggested that for rooms of ordinary character the values given in the table are a good approximation. It might appear at first that the watts should be proportional to the volume of the room, but account has been taken of the fact that as the size of the room increases the distance between the speaker and the listener does not increase to the same extent, also a larger room has generally less damping. The speaker classifications are arbitrary but largely self-explanatory, the differences lying chiefly in the greater energisation of the better types, and the

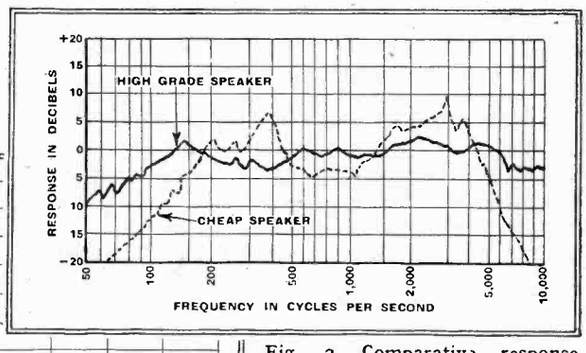
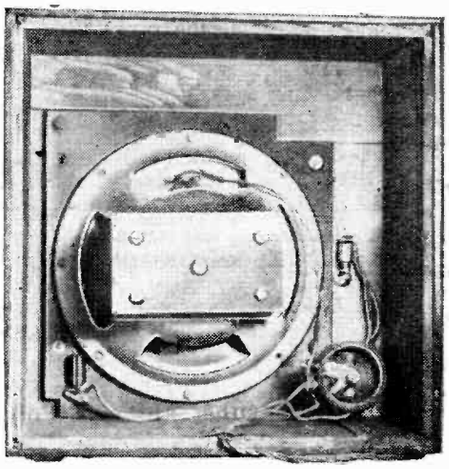


Fig. 2.—Comparative response curves of high-grade and cheap speakers. The curves do not relate to any particular type of instrument, but are typical of average characteristics.

Balance and Control at Home—

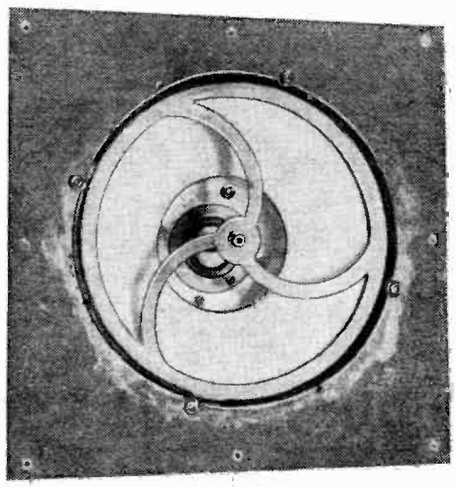
much higher electro-acoustic efficiency of a horn-loaded diaphragm; the columns headed "Special Reproduction" refer to use by a listener with good musical taste. Those few people who have no ear for music at all, and whose only interest is in the spoken word, could take values one column to the left, and those definitely hard of hearing one to the right of that indicated for normal use.

The differences between the various powers recommended for the same size of room serve to emphasise the importance of speaker efficiency in contributing to the overall sensitivity, and suggest at once a means of obtaining a bigger acoustic output without any alteration to the set. It may well be that in some cases it is cheaper to get a better speaker than to enlarge the amplifier; for instance, if the speaker in use is not of a very high quality type, then to use an output stage of higher power will only accentuate its deficiencies, while the fitting of a good speaker of higher efficiency will at the same time improve both quality and volume.



A cheap but sensitive speaker, with output mainly in the region of from 200 to 2,500 c/s.

There is need in the consideration of efficiency to avoid confusing the comparatively large output given by many cheap speakers over their resonance ranges with the true high general level available from a speaker with an even response. The reason why cheap units cannot be tolerated at really high volume is largely due to this cause, namely, that their efficiency for certain notes near the principal resonances may be as much as twenty times that at other frequencies. Output at the resonance points may become too great for the cone to handle, or the ear to tolerate, before that over the rest of the scale reaches a reasonable level. The author has, for occasional extension use, an inexpensive reproducer which has apparently the same sensitivity as the really good one in the set; yet the response of the former at 100 and 3,000 cycles is 6 decibels below that of the other, and at 5,000 cycles the drop is 15 decibels.



The author's own modified mica cone speaker. Sensitivity is about 3 db. below that of the speaker shown in the other photograph, but response is well maintained from 200 to over 9,000 c/s, the lower limit being partly due to the smallness of the cabinet.

An approximate idea of the actual differences in sensitivity may be obtained as follows: the two speakers should be worked on the same output, and on a programme of even volume—such as a dance band—and if one appears to be "appreciably quieter" than the other the drop will be about 3 decibels, while if one is "considerably less" the difference will probably be near 6 decibels. These remarks refer to a normal, unskilled ear and are necessarily only very rough guides, the 3-decibel change corresponds to an efficiency ratio of two to one, the 6-decibel to a four to one ratio.

While there have been, and will continue to be, many arguments as to the relative merits of horn and baffle loaded cones, there is no question that the horn type is considerably more efficient, and, moreover, at positions well off the axis the difference is further in its favour, since the distribution for the higher frequencies is better.

The nature of the room in which the set is used has an appreciable effect on the power needed; a very "live" room, with no "soft" furnishings needs considerably less output—possibly half that which would be acceptable in a living room with heavy curtains, carpeted floor and upholstered furniture, which would combine to give a large absorption factor.

Contrast expansion calls for undistorted outputs much greater than ordinary reception. Full expansion of a large orchestra would require quite four times the normal power; if the level remained the same the quietest passages would probably be inaudible in most rooms, as they are depressed by the expander. Six times the output would in general be necessary unless the room was unusually quiet. There is no virtue in the use of contrast expansion unless the peaks in ordinary reception are at least in the region of four watts and the hum level must be kept very low as it will be increased with the volume on loud passages.

There will probably be many parts of this article which some readers will consider unnecessarily dogmatic, since these are matters into which the personal taste of the listener enters so largely, yet it is the hope of the author that his suggestions may help to clarify the position and prove a guide to those who have not a great deal of experience in these matters.

SUGGESTED OUTPUT POWERS FOR VARIOUS CONDITIONS.

Size of Room.	Average Conditions.			Special Reproduction.	
	Poor Speaker.	Average Speaker.	Good Speaker.	Good Speaker.	Horn Speaker.
12×12 feet	5 watts.	3.5 watts.	2 watts.	5 watts.	2 watts.
16×16 feet	10 watts.	7 watts.	4 watts.	10 watts.	4 watts.
24×24 feet	15 watts.	10 watts.	6 watts.	15 watts.	6 watts.

CLUB NEWS

Eastbourne and District Radio Society

Headquarters: The Science Room, Cavendish Senior School, Eastbourne.
Hon. Sec.: Mr. T. G. Dowsett, 48, Grove Road, Eastbourne.

At the meeting held on April 25th it was decided that the construction of a 5-metre transmitter should be entrusted to Mr. E. Wingfield. Meetings will in future be held at fortnightly intervals. The immediate programme is as follows:—

May 30th.—"Short-wave Radio Reception" by a representative of Belling and Lee.
June 13th.—Tuning up of the 5-metre set by the members.

Maidstone Amateur Radio Society

Headquarters: 244, Upper Fant Road, Maidstone.
Meetings: Tuesdays at 7.45 p.m.
Hon. Sec.: Mr. P. M. S. Hedgeland, 8, Hayle Road, Maidstone.

On April 19th Mr. H. Bowen, of the Mullard Co., gave a lecture entitled "Modern Valve Developments." Last Tuesday (May 3rd) Mr. Cholot, of Lissen's, demonstrated several of his firm's receivers and also some of their "Hi-Q" components.

A general meeting will be held on May 10th to decide the Society's summer policy.

Edgware Short-Wave Society

Headquarters: Conservative Club, Edgware.
Meetings: Wednesdays at 8 p.m.
Hon. Sec.: Mr. F. Bell, 118, Colin Crescent, London, N.W.9.

On April 6th the Club held a junk sale. On April 13th a demonstration was given of the RME69 and DB20 receivers.

The Society is shortly to be affiliated to the R.S.G.B.

Future engagements include a visit to the International Telephone Exchange, a lecture by a representative of Ferranti, and a 5-metre night.

Kingston and District Amateur Radio Society

Headquarters: The Three Fishes Hotel, Richmond Road, Kingston.
Meetings: Alternate Wednesdays at 8 p.m.
Hon. Sec.: Mr. D. N. Biggs, 44, Pooley Green Road, Egham.

On March 13th Mr. Dedman, of the Quartz Crystal Co., gave a lecture entitled "Piezo-electric Crystals."

On May 11th a lecture will be given by a representative of Radio Graphic, Ltd.

The Home Laboratory

Part III.— CATHODE-RAY TUBES

By M. G. SCROGGIE, B.Sc., A.M.I.E.E.

AN explanation of the properties and uses of cathode-ray tubes, to be followed in the next instalment by a description of inexpensive cathode-ray apparatus.

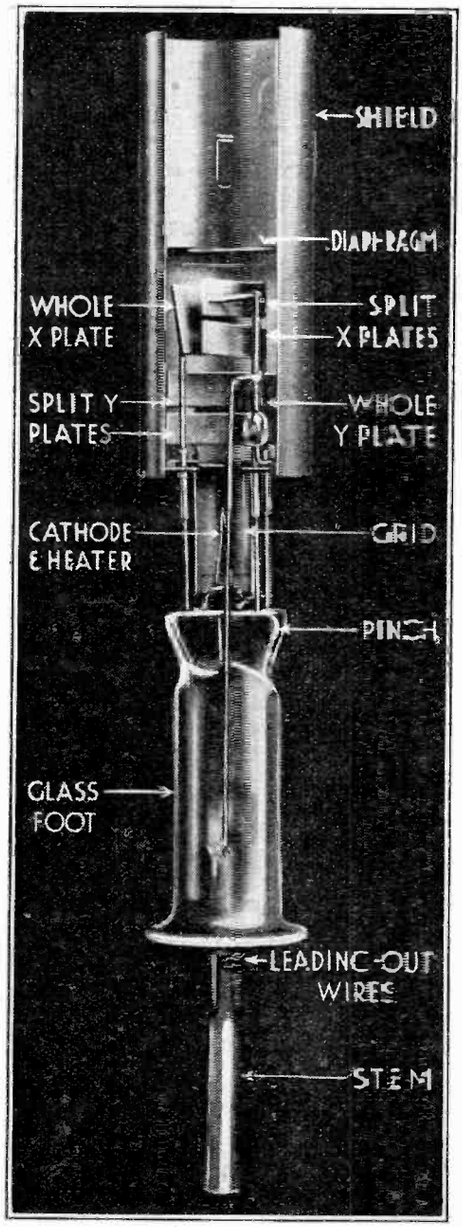
IN proclaiming the desirability of the cathode-ray tube the writer is handicapped by not being a poet, who alone could handle the subject adequately. Mere prose may convey the impression that a cathode-ray tube is just another piece of equipment, and that there is room for difference of opinion concerning whether or not it is worth having. That would be a great mistake. It is very questionable whether any establishment without a cathode-ray tube is entitled to be called a radio laboratory.

Another great mistake is to suppose that it is expensive. The idea may still survive that, first, the tube itself costs £10 to £15; secondly, that it cannot be worked without thousands of expensive and dangerous volts; and, thirdly, that even then it is not much use without one and possibly two time-base units, each with from three to six unusually high-priced valves; and perhaps sundry amplifiers, modulated oscillators, etc. While this may be true of television and certain special laboratory applications, it is certainly quite wrong so far as general laboratory work is concerned. Cathode-ray tubes can be bought for about 35s. upwards, and in the next article it will be shown that for most purposes all one needs is a power unit made from scrap receiver parts, and a "time base" costing approximately one shilling!

Some Comparisons

Now that illusions concerning the advantages and benefits of cathode-ray oscillography being beyond the amateur of moderate means have been removed, these advantages can be examined without the bitterness of envy. In the preceding articles in this series it was seen that the valve voltmeter owes most of its great utility to two things—its very high impedance causing negligible disturbance to any circuit to which it is connected, and the very wide range of frequency over which it is effective. As regards the impedance the cathode-ray tube is strictly comparable; as regards frequency range, not all types extend so far as a well-designed valve voltmeter. But whereas a cathode-ray tube can do all or most of the things a valve voltmeter does, that is only quite an insignificant part of its capabilities. Valve voltmeters, and other sorts of meters, are restricted to one dimension, such as voltage or current. A cathode-ray tube responds to two or even three dimensions simultaneously. And whereas meters give static readings and are useless for examining even quite slow movements, the cathode-ray tube traces variations at the speed of radio frequencies.

Mere statement of these two derestrictions can hardly be expected to reveal the extraordinary range of usefulness they open up. Books have been written on the subject, but they include only a selection of the possibilities. So useful are cathode-ray methods that people who work at other things, such as mechanical engineering and medicine, convert what they are studying into electrical form just in order to be able to bring the cathode-ray tube to bear on the problem. It is an under-statement to say that the cathode-ray tube occupies as important a place in the radio engineer's work as the X-ray tube does in the surgeon's.



Courtesy A. C. Cossor Ltd.

Fig. 1.—A gas-focused cathode-ray tube, showing a section of the electrode system. The split deflector plates form part of a system for avoiding origin distortion.

A meter shows merely the *magnitude* of the voltage or other quantity measured; the cathode-ray tube is capable of showing (simultaneously, if necessary) the magnitude, form, phase, and frequency of a wave, and its relationship to other quantities. And, unlike most meters, it does not matter how violently the "pointer" is treated.

Where Other Methods Fail

Suppose one has a "quality" amplifier that does not quite live up to its name. According to meter readings everything seems normal. And at low or moderate volume it sounds all right; but the output before noticeable distortion sets in is disappointing. Without a cathode-ray tube one is in the dark; with it, the amplifier can be thoroughly checked in a very short time. Perhaps spurious oscillation of the output valves takes place during a portion of the signal cycle when it exceeds a certain amplitude. Or the transformer iron may be saturating at low frequencies. Or the low frequencies may be modulating the high. All sorts of unexpected distortions come to light when an amplifier is subjected to cathode-ray tube examination. Even when tests can be done in other ways these are generally much slower or more difficult.

For a detailed account of the theory and construction of the cathode-ray tube a whole book is needed,* but before discussing the choice of tube and equipment it

*Some good books are:—*The Cathode Ray Oscillograph in Radio Research.*—Watson-Watt, Herd, & Bainbridge-Bell. (H.M. Stationery Office.)

The Low Voltage Cathode-Ray Tube.—G. Parr. (Chapman & Hall.)

The Cathode Ray Tube at Work.—John F. Rider. (For American practice.)

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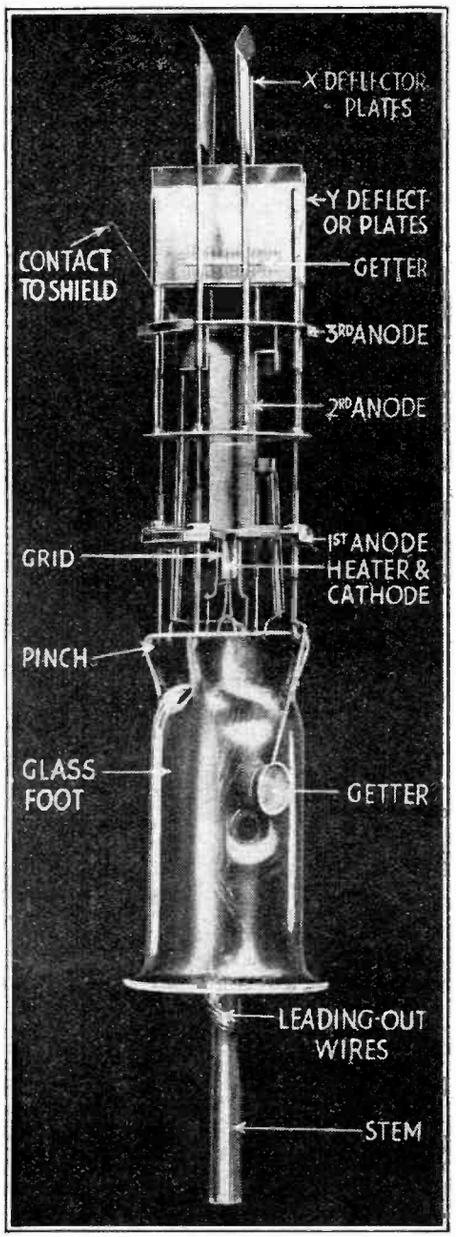
may be as well to refer very briefly to the essential features, and how they differ between one type and another. It may be thought of as a specialised form of



Courtesy A. C. Cossor Ltd.

Fig. 2.—Section of electrode system of a high-vacuum tube with electrostatic focusing and deflection

valve; there is the cathode, directly or indirectly heated, as a source of electrons; then the anode, to which a high positive voltage is applied, holds out a very powerful attraction to these electrons, but is tantalisingly kept out of their reach by means of the counterpart of a valve's grid—a cylinder which is connected to a negative bias, constraining them into a narrow stream so that they pass through a hole prepared for them in the anode, and continuing by their own momentum they strike a chemical screen at the far end of the tube with such violence as to cause a visible glow.

This narrow electron ray, after it has emerged from the anode, can be deflected from its course by either electric or magnetic fields, so causing the spot of light to move over the screen; and the magnitude, direction, and change with time of such fields made plain to see. Although all sorts of elaborate patterns or figures can be caused to appear in this way, it must be clearly realised that these are optical illusions caused by the "visual persistence" of the eye, aided to a greater or lesser extent by a similar characteristic of the screen itself. At any one instant only a single spot of the screen is being touched by the ray.

The fineness of the spot is a most important characteristic of the tube, because it determines the amount of detail that can be revealed on a screen of given size. One pays much more for a larger screen, and if the size of the spot increases in proportion there is no advantage at all except in the distance at which the results can been seen. While this is important for demonstrations, it is generally of no interest in the laboratory. Quite the contrary, in fact, for the larger screen generally necessitates a greater deflecting signal if the size of the spot is in proportion; a small screen is therefore to be preferred if the spot is correspondingly small.

Methods of Focusing

The smallness of spot is important, then, for more than one reason. To attain it, the focusing effect of the cylinder (or *grid*, if valve nomenclature is followed), is not enough. Tubes are classified principally according to the method of focusing, into gas-focused and high-vacuum types, and the latter subdivided into electrostatic and magnetic varieties. In gas-focused tubes (Fig. 1) there is only a partial vacuum; sufficient gas is present for the ray to cause a measure of ionisation along its path, which has the effect of drawing the scattering electrons into a narrow beam. This type of tube is simple to work; gives good results with low anode voltages; and is not seriously defocused by unbalanced signal circuits (one side "earthy"), but begins to lose focus when the spot velocity corresponds to a frequency of deflection exceeding some hundreds of kc/s (but oddly enough regains it at ultra-high frequencies); there is non-linearity of deflection near the central position of the spot (known as *origin distortion*); modulation of the spot's brightness (as in television) is not practicable; and only tubes with directly heated cathodes are obainable.

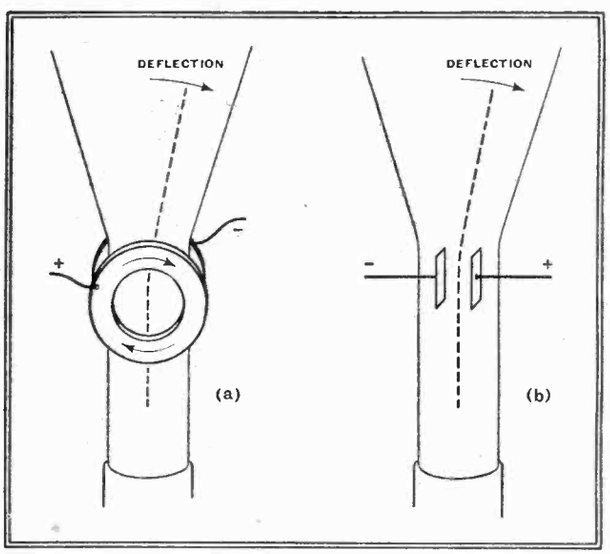


Fig. 3.—Simplified diagrams showing the action of (a) magnetic deflection and (b) electrostatic deflection of a cathode beam.

In the electrostatically focused high-vacuum tube (Fig. 2) there are two or even three anodes at various stages along the tube, and these are maintained at voltages so graduated as to make the beam converge on the screen. The system is described as an electron lens because it is in some ways analogous to an optical lens. To secure satisfactory results this rather complicated electrode system must be located with some precision; but if the beam is magnetically focused by means of steady current passing through a coil wound around the axis of the tube externally, the construction of the interior parts of the tube is simplified, and there is more scope for placing internal deflecting plates. It is also claimed that a bigger beam can be focused, giving a brighter spot. While magnetic focusing is on the increase, it is at present generally confined to television use.

A properly focused "pointer" having been obtained, the next thing is means for deflection. Unlike a meter pointer the cathode ray can be deflected in two or more directions at once, thus enabling, for example, the input and output of an amplifier to be directly compared. Nearly all tubes for laboratory purposes are provided with two pairs of electrostatic deflecting plates, distinguished as the X and Y pairs (corresponding to the X and Y axes of a graph). Magnetic deflection is possible, alternatively or additionally, by means of external coils around the neck of the tube with their axes at right angles to it. These coils are not so generally useful, because appreciable power is required to produce deflection, and their inductance is likely to cause difficulty except at low frequencies. To ensure a uniform deflecting field a pair of coils is placed as shown in Fig. 3 and deflection takes place in a direction at right angles to the common axis of the coils. Electrostatic deflection, however, is in the same plane as a line joining the plates. Whereas electrostatic deflection is inversely proportional to the anode voltage, magnetic deflection is inversely proportional to the square root of the anode voltage.

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In selecting a tube there are quite a large number of points to be considered. For audio and low radio frequencies the gas-focused type is probably the most suitable. Origin distortion can be removed, where necessary, by biasing the deflecting plates; and certain Cossor tubes are provided with split plates to enable this bias to be applied without deflecting the spot (Fig. 1). Incidentally, there is no origin distortion with *magnetic* deflection. If work at high radio frequencies—1 Mc/s and upwards—is to be done, the high-vacuum type must be used. An advantage of the vacuum tube is that if signals are applied to the control grid they vary the brightness of the spot without defocusing it, so giving a sort of additional dimension to play about with. Actually it is not so very useful outside television.

The deflection sensitivity of either gas or vacuum types is of the order of $\frac{400}{V}$ millimetres per volt, where V is the anode voltage. At this figure, if 400 volts are applied to the anode, a voltage of about 25 between the deflector plates gives a deflection of 1 inch, and a peak alternating voltage of the same amount draws a line 2 inches long. It is important to realise that the deflection sensitivities of X and Y plates are not necessarily the same; in a very short tube such as the miniature R.C.A. Type 913 the difference is quite large.

Fig. 4.—Cossor 2-in. tubular high-vacuum cathode-ray tube.

The maximum anode voltage for which the tube is rated—usually several thousands—thus requires a considerable deflecting voltage to give a reasonable-sized figure on the screen. And great care must be taken not to let the spot rest stationary on the screen, for it will quickly "burn" it and cause permanent loss of fluorescence. The life of the cathode is also reduced by high anode voltage. So there is obviously no sense in using the rated voltage unless strictly necessary; and, fortunately, it is only for special work (such as photographing transient figures or very high-frequency deflection) that it is necessary. For general use a few hundred volts gives a figure visible in a not-too-bright room, and there are the advantages of relatively high deflection sensitivity and long life.

The greater the length of tube, the greater the deflection sensitivity, obviously; but to gain the full advantage of a long tube it is necessary for the focusing to be of a correspondingly high accuracy. There is a Cossor tube 18in. long (Fig. 4), and although the screen diameter of 2in. seems small in proportion, extremely fine oscillograms can be photographed, and for a full-sized figure a peak signal of only 30 volts is needed.

An important characteristic, more especially at high frequencies, is the signal output impedance. One of the advantages of electrostatic deflection is that this impedance is so high that the effect on the signal circuit may often be neglected. The capacity of any deflector plate to all other electrodes is similar to that of a valve's control grid—about 5 to 12 mmfd.—and the resistance, even in gas-focused tubes, is almost infinite.

Screen Colours

Various types of screen are available, some being particularly suitable for visual work and others for photographic; the former generally give a green light and the latter blue, but this is not invariable.

The time taken for the fluorescence of the screen to disappear after the ray has moved from it may be anything from a fraction of a micro-second to half a minute; it is thus possible to get special screens for work involving exceptionally fast or slow deflections.

So much for cathode-ray tubes in general. In the next article it will be shown how for nearly all their most useful purposes they can be worked with extremely simple and inexpensive equipment.

A PHILIPS PORTABLE

FOR the first time a battery portable appears in the current list of Philips receivers. To be known as the Type 225B the new set will cost 8½ guineas, complete with batteries, and will have four valves in a superheterodyne circuit, with automatic volume control.

The coloured tuning scale is recessed into the top of the case and a hinged carrying handle is incorporated in the moulded escutcheon. Dimensions are 11½ × 10½ × 7¾ and the weight is 16lb.

COSSOR MODEL 394

A SUPERHETERODYNE circuit is employed in this new three-valve battery set recently introduced by A. C. Cossor, Ltd., at 6 guineas, without batteries. There is no IF amplifier, but reaction is used in the pentode detector stage which follows the pentagrid frequency-changer. A special iron-cored IF transformer is employed.

The horizontal-type cabinet, measuring 17¾in. by 11¼in. by 9¾in., contains an 8in. PM loud speaker, and there is ample accommodation for batteries. No grid bias battery is required.

PARIS RADIO SHOW

An Excursion from London

A trip to the "Salon de la TSF" is again being organised this year by Mr. S. Gould, and according to present arrangements those participating will leave Victoria Station at 8.20 p.m. on Friday, May 20th, returning early on the following Sunday morning. The cost of tickets, which must be booked before May 10th, is £2. Full particulars are obtainable from Mr. Gould at 65, Shortcrofts Road, Dagenham, Essex.

Television Programmes

An hour's special film transmission intended for the Industry only will be given from 11 a.m. to 12 noon each weekday.

Vision	Sound
45 Mc/s.	41.5 Mc/s.

THURSDAY, MAY 5th.

3, Cabaret, including Flotsam and Jetsam and Afrique. **3.25,** Gaumont-British News. **3.35,** 143rd edition of Picture Page.

9, A programme of Swing Music, directed by Eric Wild. **9.20,** British Movietonews. **9.30,** 144th edition of Picture Page. **10,** News Bulletin.

FRIDAY, MAY 6th.

3, "Tobias and the Angel," a comedy by James Bridie. Cast includes Jean Cadell and Frederick Bennett. **4.20-4.30,** Making a News Reel.

9, Paul and Grace Hartman in "Cabaret Cartoons"; cartoons by Harry Rutherford. **9.45,** Making a News Reel; O.B. from British Movietone Studios. **10.15,** Preview. **10.25,** News Bulletin.

SATURDAY, MAY 7th.

3, "In Our Garden," C. H. Middleton. **3.15,** Gaumont-British News. **3.25,** Russell Thorndike in his play "The Tragedy of Mr. Punch." The play projects the Punch and Judy Show in full size, with living figures.

9, Cabaret. **9.30,** British Movietonews. **9.40,** Judo, a demonstration of the art of self-defence. **9.55,** Cartoon Film. **10,** Comic Strip, a programme of American humour. **10.20,** News Bulletin.

SUNDAY, MAY 8th.

8.50, News Bulletin. **9.5,** Yvonne Arnaud, pianoforte. **9.10,** Gaumont-British News. **9.20,** Ballet Discussion. **9.30-10.20,** The Vic-Wells Ballet in "Checkmate."

MONDAY, MAY 9th.

3-4, "Red Peppers," the play by Noel Coward on the lives of two music-hall artistes.

9, Lyana Grani in "Starlight." **9.10,** "The Oak and the Ash." **9.25,** British Movietonews. **9.35,** "Deirdre," a play in verse by W. B. Yeats. **10.25,** News Bulletin.

TUESDAY, MAY 10th.

3, "After Dinner," Shanklin's Concert Party in a new summer show. Cast includes Tommy Trinder, Sylvia Welling and Henry Lytton, Jnr. **3.45,** "18th Century: Brief Glimpses," with Gillian and Isobel Scaife, in a scene from "The Provoked Wife," by Sir John Vanbrough.

9, Gaumont-British News. **9.10,** As on Monday at 3 p.m. **10.10,** News Bulletin.

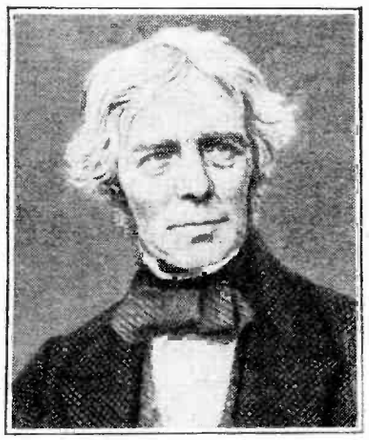
WEDNESDAY, MAY 11th.

3-4, "The Emperor Jones," the famous play by Eugene O'Neill; a macabre study of an incident in the Pacific, with Robert Adams in the name part.

9, Starlight. **9.10,** British Movietonews. **9.20,** Six Explorers will tell "Why They Leave Home." **9.50,** Cartoon Film. **9.55,** As on Tuesday at 3.45 p.m. **10.15,** News Bulletin.

Magnetism and Electricity in 1832

FARADAY AND THE PROPAGATION OF ELECTRO-MAGNETIC FORCES. — A Newly Discovered Document



1791-1867.

THE recent opening of a letter written by Michael Faraday in 1832 has resulted in the discovery of a document of considerable historic interest, in that it has added materially to our knowledge of the early history of electricity and wireless. The importance of Faraday's researches on the subject of electro-magnetism is retold in this article

By G. R. M. GARRATT, M.A.

FOR more than one hundred years an historic document, with its red seal unbroken, has lain in the safe of the Royal Society. Its existence has, of course, been known to successive Secretaries, but until very recently the directions upon its outside—"to be deposited (by permifsion) unopened for the present"—have been rigidly respected, and thus its contents have remained unknown. As the photograph of the exterior shows, it was written by Faraday on the 12th of March, 1832, and it was received from him by the Secretary of the Royal Society on the same day. A month later—on the 12th April, 1832—it was deposited in the strong box by the assistant secretary, Peter Mark Roget, whose initials appear on the outside, and it is of interest to note that the consent of the Council of the Royal Society to the receipt and custody of "a sealed packet from Mr. Faraday" is recorded in the Society's Minute Book of the period.

It was recently decided that sufficient time had elapsed to justify the examination of the contents, and it was accordingly opened by Sir William Bragg, the President of the Royal Society, in the presence of the Council. The following is the complete text of the document:—

"Royal Institution,"
March 12th, 1832.

"Certain of the results of the investigations which are embodied in the two papers entitfed, 'Experimental Researches in Electricity,' lately read to the Royal Society, and the views arising therefrom, in connexion with other views and experiments, lead me to believe that magnetic action is progrefsive, and requires time, i.e. that when a magnet acts upon a distant magnet or piece of iron, the influencing cause (which I may for the moment call magnetism) proceeds gradually from the magnetic bodies, and requires time for its transmifsion, which will probably be found to be very sensible.

I think also that I see reason for supposing that electric induction (of tension) is also performed in a similar progrefsive way.

I am inclined to compare the diffusion of magnetic forces from a magnetic pole to the vibrations upon the surface of disturbed water, or those of air in the phenomena of sound; i.e. I am inclined to think the vibratory theory will apply to these phenomena, as it does to sound, and most probably to light.

By analogy, I think it may pofsibly apply to the phenomena of induction of electricity of tension also.

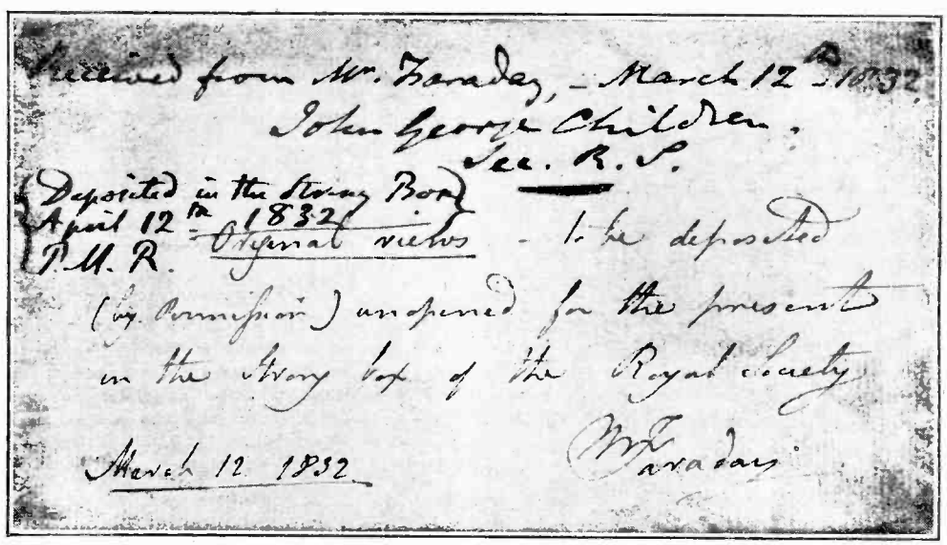
These views I wish to work out experimentally; but as much of my time is engaged in the duties of my office, and as the experiments will therefore be prolonged, and may in their course be subject to the observation of others, I wish, by depositing this paper in the care of the Royal Society, to take pofsefsion as it were of a certain date, and so have right, if they are confirmed by experiments, to claim credit for the views at that date; at which time as far as I know no one is conscious of or can claim them but myself."

Royal Institution. M. Faraday.
March 12, 1832.

To appreciate fully the contents of this letter one must recall very briefly the state of knowledge at the time the letter was written. Very little was known at all about electricity, and it had only been discovered a few years previously—in 1820—by Oersted that a current of electricity could influence a magnetic needle. In 1823 the first electro-magnet was invented by Sturgeon.

Michael Faraday, who, from humble parentage—his father was a blacksmith—had become Director of the Laboratory of the Royal Institution, argued in 1824 that since electricity can produce magnetism, it should be possible for magnetism to produce electricity. His notebooks show that between 1824 and 1831 he made no less than five attempts to solve the problem. Each, however, was doomed to failure, because, as we know now, his magnet and the wires were at rest relatively to each other.

At last, in September 1831, the answer to the problem was revealed almost by accident. Faraday was experimenting with a ring of soft iron upon which were three separate windings and he observed that upon connecting a battery to one winding there was a momentary pulse of current through a galvanometer connected to another winding. He found that a second pulse, but in the reverse direction, occurred when the battery connection was broken. Suspecting that the induced currents were caused by the magnetisation of the iron ring due to the current in the first winding, Faraday proceeded to make a series of experiments with various coils and magnets, during the course of which he discovered all the elementary facts of induction, and discovered also how to produce a continuous current of electricity by rotating a copper disc between the poles of a powerful magnet. In the course of these experiments he laid the foundations upon which the whole modern practice of electricity has been built up.



A photograph of the outside of the historic document showing Faraday's instructions regarding its safe custody.

Magnetism and Electricity in 1832—

He described the experiments in great detail in two papers[1] which he read to the Royal Society on the 24th November, 1831, and the 12th January, 1832, respectively. These two papers form the first and second of his celebrated series of "Experimental Researches."

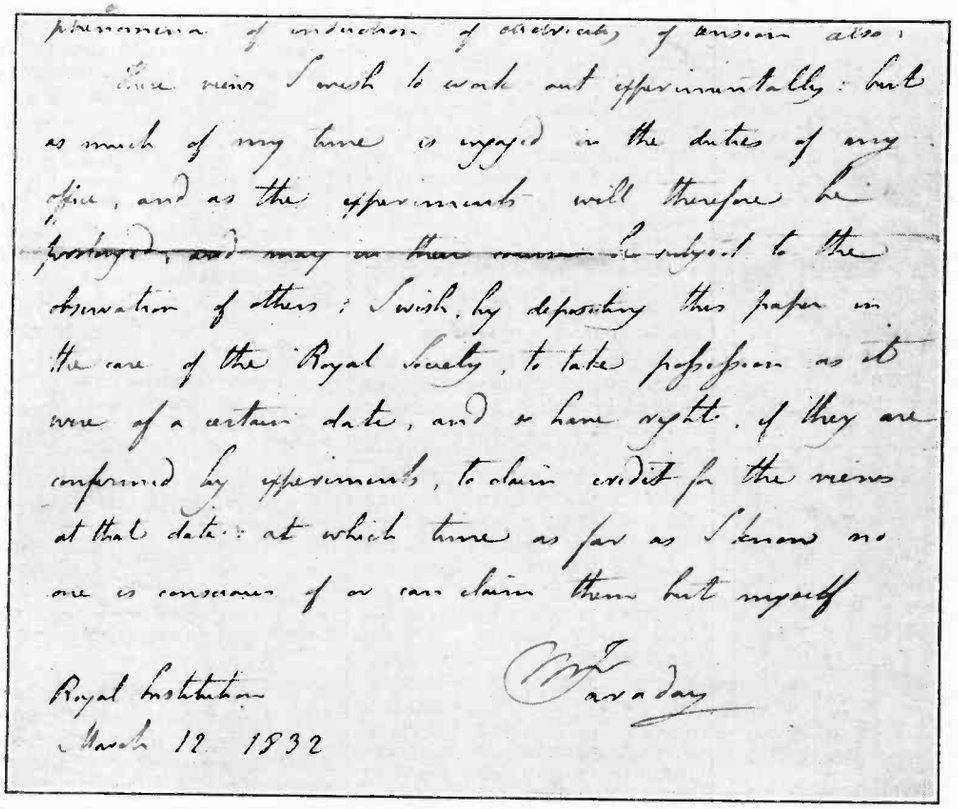
While he was making the experiments which these papers describe, it is evident from the document just unsealed that he conceived the theory that electro-magnetic forces require time for their transmission, though it is also evident that he considered that an appreciable length of time might be required, instead of the very short time which we now know to be involved. It seems quite inconceivable that Faraday could have actually detected the transmission time with the very primitive apparatus at his disposal, and, unfortunately, a careful examination of the two papers referred to has failed to disclose any clue as to the actual results which lead him to formulate his theory.

With a less eminent worker, one might be tempted to ascribe his theory to pure guess-work. Faraday, however, was one of the most brilliant experimentalists ever known to science, and, as a study of his work very quickly reveals, he was not given to guessing. On the rare occasions when he allowed free-play to his imagination he frankly admitted that he was putting forward only a tentative idea. The whole tone of the newly disclosed document, however, is one of conviction in the truth of a theory of which, however, he is lacking an immediate and positive proof.

Whatever may have been the source of his inspiration, I feel, therefore, that one must regard it, not as a fortunate guess, but as the instinctive deduction of an experienced and brilliant experimenter.

In explanation of Faraday's apparent desire to establish his claim to priority by depositing this document, it must be said that it was contrary to his principles to patent any discovery. He always insisted, however, that he should receive acknowledgment for original work, and his normal practice was to publish his results immediately. On this occasion he was not ready to publish his theory, but since his rights had been unjustly disputed on two occasions in earlier years he had grown cautious and preferred to safeguard his claim—a perfectly understandable procedure!

Faraday was no mathematician, and he relied on practical experiments to provide the proofs for all his theories. Thus it remained for Clerk Maxwell to translate Faraday's theories into mathematical terms and to deduce the equations for the propagation of electro-magnetic waves in space. It was Faraday's researches and his conception of the magnetic field as consisting of lines of force which formed the data upon which Maxwell developed his electro-magnetic theory. Maxwell proved mathematically in 1865 that electro-magnetic phenomena are propagated through space in the form of a wave motion with the velocity of light, and in so doing he laid foundations upon which wireless communication has developed.



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Royal Institution
March 12 1832

M. Faraday

The conclusion to the document reproduced from a photograph lent by the Science Museum.

As is well known, the theory, proved mathematically by Maxwell, remained unconfirmed experimentally until 1888 when Heinrich Hertz showed how to produce and detect electro-magnetic waves, and so laid the practical foundations which have developed to such an extraordinary extent in only fifty years.

To Faraday, however, must belong the honour of having put forward the first suggestion that time is required for the transmission of electro-magnetic forces. That he should have simultaneously suggested that their propagation is comparable with "waves on the surface of disturbed water" within such a brief period of his epoch-making experiments is of considerable interest and a further proof, if one were needed, of the genius of one to whom the world must ever be indebted for his many fundamental contributions to the development of electrical science.

The two photographs of the document are reproduced by courtesy of the Royal Society.

[1] Phil. Trans., Vol. CXXII, 1832, p. 125, *et seq.* "Experimental Researches in Electricity" and Phil. Trans., Vol. CXXII, 1832, p. 163, *et seq.* Bakerian Lecture, "Experimental Researches in Electricity."

Tungsram Photo-Elements

Range of Photo-Electric Cells

BARRIER-LAYER type photo-cells are now being marketed by Tungsram Electric Lamp Works, Ltd., Tungsram House, 82-84, Theobald's Road, London, W.C.1. They are available in three types: The S44 with and without housing at 50s. and 42s. 6d. respectively, the S204 without housing at 42s. 6d., and the S5 with special housing at 50s. The S44 has a circular metal base-plate with a working area of 10 sq. cm. and is intended for use in a photometer; the S204 has a rectangular plate with a working area of 4.5 sq. cm. and is advised for photographic exposure meters. The S5 is intended for use in talkie apparatus and is of tubular construction, with a slit for the admission of light; the working area is 5 sq. mm.

The open-circuit voltage generated by these cells rises rapidly with increasing illumination up to about 100 lux; thereafter, the rise is slower but saturation is not soon reached and at 1,000 lux an output of about 0.4 volt is obtained. On short-circuit the current sensitivity is 460 μA/Lumen, and the response is linear up to 1,000 lux.

With 400 lux illumination, maximum power output is obtained with a load of 1,400 ohms, the power being 27 micro-watts. Owing to the internal capacity of the cell the response is frequency dependent, and with a 0.25MΩ load the response at 10,000 c/s is about −12 db. This can, however, be corrected by the use of a compensating circuit which includes a 2-H inductance and a 0.1-MΩ resistance.

The curve depicting the colour sensitivity of the cell shows a response similar to that of the eye, but extending over a wider range. Light filters are consequently only needed for high accuracy, and for liquid filters a 0.24 per cent. solution of potassium bichromate and a 10 per cent. solution of copper sulphate, both in 5 mm. containers, are recommended.

The cells have a negligible temperature error below 45 deg. C., but at higher temperatures a change in the molecular structure of the barrier may occur. For the measurement of high temperature light sources, therefore, it is advised that the heat content of the radiation be filtered out by a transparent water trap.

THE CAIRO CONFERENCE

B.B.C. Chief Discusses Its Effect

ALTHOUGH *The Wireless World* published on April 14th a summary of the wavelength allocations proposed by the Cairo International Telecommunications Conference, no official statement had, until Monday, been made by the General Post Office or the B.B.C. On that day Sir Noel Ashbridge, Chief Engineer of the B.B.C., speaking to a gathering of Press representatives, explained some of the changes which will become operative from September 1st, 1939.

Under the Cairo regulations four ultra-short-wave bands have been allocated to television. These are 40.5-58.5, 64-70.5, 85-94 and 170-200 megacycles, the last being for broadcasting as well as television. These wavebands allow sufficient channels for the working of two, one, two and five television transmitters respectively.

It will be seen from the above ultra-short-wave allocations that the frequency of the Alexandra Palace sound transmitter (41.5 Mc/s) comes within one of the bands allocated exclusively to television. It is probable, therefore, that this may be the reason for the delay in arriving at a decision concerning the contemplated transmissions of the Toscanini concerts on this frequency, which were exclusively announced in *The Wireless World* last week.

When asked if there was any change contemplated in B.B.C. wavelengths, Sir Noel said that although no statement could be made on this point, as the U.I.R. had not started their work of preparing a new wave-plan, it is almost inevitable that certain changes would be necessary. He could not, therefore, say whether or no any B.B.C. station would be given a wavelength in the additional medium waveband from 192.3-200 metres.

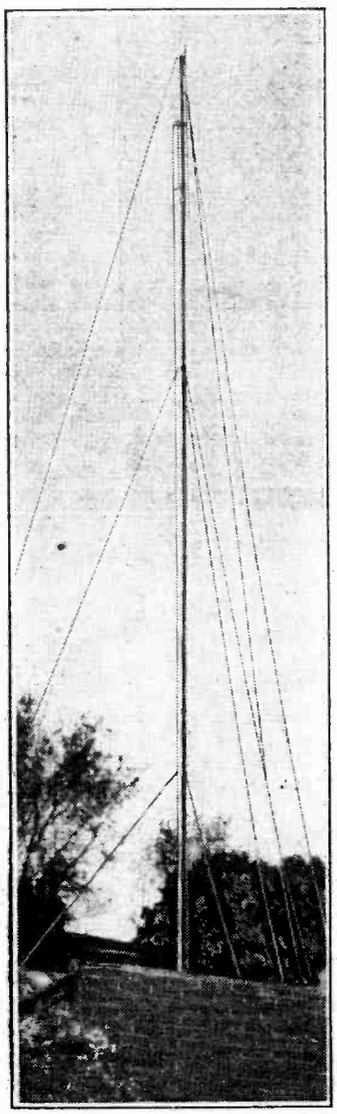
VOTING HALLS FOR LISTENERS ?

More Listener Research

CAN a mass audience, listening to the best possible reproducer, constitute a useful voting medium for broadcast programmes? This is one of the listener research problems now engaging the B.B.C. The idea has been propounded of setting up listening halls up and down the country with the latest receiving equipment and inviting local residents to sit through an evening's National or Regional programme, denoting their preferences by a show of hands.

The scheme might offer a good opportunity for local radio traders to display their products, but the two primary objections would probably be (a) that residents might not easily be persuaded to leave their firesides, and (b) that mass voting is usually unreliable for psychological reasons.

The scheme has not been abandoned, however, and with certain modifications may be carried out during the summer in a number of country districts.



AN AERIAL situated two miles from the receiver is used by the B.B.C. to receive the television transmissions from the mobile unit. This 50-ft. aerial is erected, when required, in a garage in Highgate and replaces the previous experimental aerial which was affixed to the spire of St. Michael's Church, nearby. The signals are "piped" direct to Alexandra Palace.

NEWS OF

P.O. WIRELESS COMMUNICATION

New Radio Links with America and the Continent

IT was revealed in a speech delivered by Sir Walter Womersley, Assistant Postmaster-General, at the banquet of the National Chamber of Trade in Brighton last week, that the Post Office proposes the erection of a new short-wave station to deal with transatlantic telephone calls. Apart from furthering the reliability of the transatlantic telephone service the station is in the nature of being a defensive preparation for the adverse propagation difficulties due to sun spot activities which are expected to reach a maximum within the next two years.

The principal feature of the work comprises the erection of an aerial which will extend over a distance of two miles. The site of the station is at Cooling Marshes, near Rochester, Kent.

Sir Walter, who was reading the speech that was to have been delivered by Major Tryon, the P.M.G., said that arrangements were also in hand for the provision of ultra-short-wave radio-telephone channels between England and France. These new channels are to supplement submarine circuits, and will serve as a stand-by in the event of cable interruption. Arrangements have also been made to provide telephone services to the Shetland Islands by means of ultra-short-wave links with the mainland. This system will also be used for connecting up the Hebrides and other islands where neither telegraph nor telephone communication has hitherto been available.

MILAN III

IN the old Pavilion of Nations at the Milan Fair has been installed the new 1-kW Milan III transmitter which, working on a wavelength of 209.9 metres, began transmitting on April 1st.

For the first time in Italy a mast-radiator aerial has been used. This consists of a simple drawn-steel mast, just over 150ft. high, which is set in a block of concrete. No further insulation is provided, and the mast itself oscillates electrically at a quarter wavelength on the Marconi principle, in which the maximum current is at the base. The aerial is not excited in "series," but derives its energy via a "paired" feed line.

Visitors to the Fair were able to see the transmitter at work.

PARIS TELEVISION

Time Table of Transmissions

THE Eiffel Tower television transmitter, which was recently inaugurated, is regularly transmitting vision on 46 Mc/s and sound on 42 Mc/s at a power of 25 kW, although, as previously stated, this will soon be increased to 30 kW.

The transmissions are made on a definition of 455 lines, employing positive modulation and sync pulses similar to those of the B.B.C.

A reader in Brighton having received the transmissions, it is thought that others, especially on the South Coast, who may want to try their hand at tuning in Eiffel Tower, would like to know the present schedule of transmissions, which is, in B.S.T.:—

	Sync. Signal.	Fixed Pattern.	Fixed Picture.	Actual Programme.
Sun.	2.30-2.45	2.45-3	3-3.30	3.30-5.30
Mon.	2-2.15	2.15-2.30	2.30-3.30	3.30-4.30
Tues.	No transmissions			
Wed.	No transmissions			
Thurs.	2-2.15	2.15-2.30	2.30-3.30	3.30-5
Fri.	2-2.15	2.15-2.30	2.30-3.30	3.30-4.30
Sat.	2.30-2.45	2.45-3	3-3.30	3.30-4.30

Reports on reception will be welcomed by Le Directeur du Service de la Radiodiffusion, 107, rue de Grenelle, Paris.

BROOKMANS PARK ON STRIKE

NOT often do both the London transmitters go out of action simultaneously, as happened on April 26th, when both National and Regional broke down, from different causes, with an overlap of nearly five minutes. The trouble began with the Regional, in which a flash-over at the transmitter burned out a coupling coil at 15.54 hrs. 23 seconds. Three minutes seven seconds later (such is the accuracy of the Brookmans Park log) the transmitter got going for 24 seconds, collapsing again for another 11½ minutes.

In the meantime the National engineers were tearing their hair over a valve failure which silenced their transmitter for five minutes from 3.55 p.m.

RADIO RELAYS AND THE STATE

THE conference of the National Chamber of Trade unanimously opposed the nationalisation of broadcast relay services as recommended by the Ullswater Committee and appealed to the P.M.G. to clarify the future of the services without delay. Speaking for Major Tryon, the Assistant P.M.G. said that the Post Office had not asked for the scheme. It was thrust upon them.

THE WEEK

PROGRAMME CUTS

B.B.C. Decision

MUCH heart-burning was recently caused when the Berlin Philharmonic Orchestra, during a relay from Berlin, was faded-out by the B.B.C. before the end of a symphony. Hitherto announcers and producers have lacked precise instructions as to the course to be followed when a programme overruns its scheduled time. The air has been cleared, however, by a new official dictum that, as a general rule, any programme overrunning its allotted time must be cut off. Exceptions are, however, to be made for important programmes in all categories; but, unfortunately, announcers and others must still use their own judgement as to what is important!

PROGRESS IN RADIO-TELEPHONY

American Lecturer at the I.E.E

"RESEARCHES in Radiotelephony" was the title of a paper read in London yesterday before the Institution of Electrical Engineers by Dr. Ralph Bown, of Bell Telephone Laboratories, New York. Dr. Bown pointed out that most of the technical problems encountered in the development of radiotelephony over the last twenty years have arisen in one way or another from the necessity of overcoming noise and distortion. The straightforward and obvious methods of achieving these objects consist in increasing the power of transmitters, improving receiver selectivity and the perfection of amplitude and frequency characteristics of apparatus. There are, however, technical and economic limits to possibilities in these directions, and Dr. Bown's paper was largely devoted to more subtle methods, such as directivity and single-sideband transmission, of achieving the desired objects.

VAGARIES IN VARIETY

THE broadcast scheduled to take place from the Holborn Empire on May 11th at 8 p.m. on the Regional wavelength was suddenly deleted from the advance programmes and a well-known dance band substituted. No arrangements for future broadcasts from this theatre are being contemplated at the moment.

Mr. John Watt, B.B.C. Director of Variety, in disclosing his plans for the summer, revealed that a series of relays from the principal British seaside resorts will figure largely in the programmes week by week.

Working in close touch with the Post Office, the O.B. Department will visit such places as Aberdeen, Bournemouth, Southend, Blackpool, Margate, Scarborough, Clacton, the Isle of Wight, and even the Channel Islands. In the case of the last named, use may be made of a wireless telephone link. In most of the ports of call, the new "lip" microphone will be used, so as to enable a roving commentator to interview passers by without picking up extraneous sounds and crowd noises.

NEWSPAPERS OR RADIO NEWS

FOLLOWING a questionnaire sent to five hundred people in the U.S.A. asking "from which source do you get most of your daily news—newspapers or radio news broadcasts?" the American monthly journal, *Fortune*, recently published the following results:—

Newspapers, 45.2 per cent.; radio, 23.5 per cent.; both, 28.2 per cent.; neither or undefined, 5.8 per cent.

It is interesting to note that 47.9 per cent. of those who indicated radio gave as their reasons for so doing either that they thereby received the news quicker, or that it was more easily absorbed.

FROM ALL QUARTERS

Community Listening

ON the Cayman Islands, in the West Indies, are to be erected assembly halls in which loud speakers will be fitted to diffuse the Daventry programmes. These halls, which are being paid for by the revenue of nearly £8,000 derived from the issue of special stamps at the time of the Coronation, will also serve as hurricane shelters and recreation centres.

Radio and A.R.P.

MOBILE transmitters co-operated with the Southend-on-Sea Fire Brigade during the Air Raid Precautions tests last week. It is understood that, the tests being satisfactory, the short-wave radio units will form part of the A.R.P. plan.

Closing Prices

THE Columbia Broadcasting System has commenced a Press and Stock Exchange broadcast news service which will be transmitted to Europe from W2XE each weekday at 7.30 p.m. (B.S.T.).

"Up to B.B.C. Standards"

THIS is the verdict of radio authorities on the new Lucknow transmitter, estimated to have cost Rs.200,000, which was recently inaugurated by Sir Harry Haig, Governor of the United Provinces. The transmitter, which is situated seven miles out of the city, has a carrier power of 5 kW, uses a wavelength of 293.5 metres, and employs high-power Class B modulation.

South Africa to Fill Blind Spots

SOUTH AFRICA is still troubled with "blind spots" so far as wireless reception is concerned, and the South African Broadcasting Corporation has now decided to set a consultative committee of radio experts to prepare a scheme which would ensure complete coverage of the whole country. Other technical problems, including that of electrical interference, will also be discussed.

N.R.E.A. — Suppressing Interference

ALL radio dealers and engineers in the Romford (Essex) area are invited by the National Radio Engineers' Association to a lecture on the suppression of electrical interference with radio reception which is to be given by Mr. Walters, of Belling and Lee, at 8.30 on Thursday, May 11th, at the Durham Arms, Brentwood Road, Romford.

Address Wanted

WE have a communication from America to forward to Mr. Frank R. Stringer, and should be glad to know his present address.

Cup-tie Climax To-night

THE USW sound transmission from Wembley Stadium last Saturday broke down at 2.40 p.m., but the cause of the failure was rapidly traced to a break in the land line near Alexandra Palace, and repair was effected before the teams took the field. The match was televised without a hitch, and shortly before the finish Tommy Woodrooffe, the commentator, vowed to eat his hat if a goal was scored. In accordance with this promise he will eat his hat in front of the television cameras to-night at 9.30.

Latin on the Air

WEEKLY transmissions of topical interest are to be broadcast in Latin from Cairo. This introduction of Latin as a living language shows the striking originality of the Egyptian broadcasting authorities.

Broadcast Atlas

A USEFUL atlas of broadcasting stations throughout the world was published in Italy a short time ago. Each Italian licence-holder can purchase one copy for Lire 12.50 (2s. 6d.), but additional copies cost double that amount. It includes much useful data, although this soon becomes out of date because of the continual increases in power and additional stations.

Authors' Rights and Radio

THE International Authors' Congress, which is due to take place in Stockholm from June 27th to July 2nd, will be considerably occupied with the question of authors' rights and broadcasting.

ROYAL EQUIPMENT. The Marconi wireless equipment fitted to H.M. King Gahzi's new Percival Q6 aircraft. At the bottom of the rack is the Marconi Type 77A transmitter, covering the wavebands of 35—105, and 550—1,100 metres. Three types of transmission are available, telephony, and MCW and CW telegraphy; the maximum normal working range on CW is 300 miles. On the rack above the transmitter is the receiver. A rotatable 13-inch frame aerial (the control wheel is seen in the roof of the cabin) permits of the equipment being used for either aural, homing or DF purposes. Immediately under this is the DF aural-visual c/o switch, while below is the aerial loading unit which enables the transmitter to be kept in tune when working with either trailing or fixed aerials. The total weight of the complete equipment is approximately 120 lb.

UNBIASED

By FREE GRID

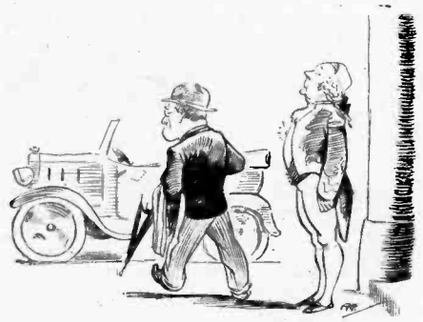
Frailties of Human Nature

LIKE certain members of the medical profession, I have always felt it incumbent upon me to place my professional skill at the disposal of my fellow-men, neither seeking nor receiving any fee or favour in return. Consequently, when I heard from a mutual friend the other day of a fellow television viewer who had so far seen nothing on the screen of his set, I prepared, like Grace Darling of old, to set forth to the rescue with my little black bag.

According to my informant, the television set which his friend had purchased was a very expensive-looking instrument which had been installed some weeks before and was the envy of the whole neighbourhood. Unfortunately, nothing had so far been seen on the screen, and this was earning television a very bad name in the district, a totally erroneous opinion gaining ground that television receivers were as unsatisfactory and unreliable as the early wireless sets.

The hauteur and frigidity with which I was received on arrival at the house came rather as a shock to me, however; after all, even if my trousers *were* somewhat baggy and my general sartorial appearance rather out of keeping with the extreme *comme il faut* atmosphere of the neighbourhood, it is not customary to look a gift horse in the mouth.

A few swift manipulations of the control knobs producing no result, I prepared to remove the back of the set in order to delve into its innards. To my surprise the owner flatly declined to allow me to do so, putting forward a somewhat lame



"With scrupulously insulting politeness."

excuse to the effect that I was not a certificated service engineer. I need scarcely tell you that such an insult was equivalent to telling a Harley Street specialist that he was not a certificated nurse, and without more ado I promptly took my hat and my leave, being seen to my car with insultingly scrupulous politeness by an attendant menial.

It was not until some time later that I learned the true explanation of this strange affair, which, had I been endowed with the extraordinary mental gifts of Inspector Hornleigh, I might have deduced as a result of my previous experience of the astonishing snobbery-complex existing in certain London suburbs. It appears that to possess a television set is one of the things that is "done" in suburbia, but unfortunately the necessary cash or credit are not always available.

However, there has never been any lack of commercial opportunists to seize any and every opportunity to batten on the frailties of human nature, and so it has been in this case. Certain unscrupulous firms of the type who find a ready market for ostentatious-looking but unseaworthy and permanently anchored yachts have been pandering to this snobbery-complex by supplying dummy television sets to certain selected persons in each suburb whose desire to do the correct thing exceeds the length of their purses.

I sincerely trust that as a result of my revelations you will all know what to do should you at any time be in a televiewer's house and are told that there has been an unfortunate technical hitch.

A Bass Attack

I SEEM to have aroused a rare old hornet's nest about my ears as a result of my recent statement that with advancing age the response of the human ear to high notes becomes attenuated. It may be remembered that I demanded to know why it was that since this was so, and since, also, statistics proved that the majority of listeners had passed their prime, the makers of certain components, more especially output transformers, continued to publish curves, proving that the frequency response of their products goes well up towards the 20,000-cycle mark. I furthermore expressed the opinion that such manufacturers must be preparing to give special concerts for dogs, who are admittedly exceptionally appreciative of ultra-high notes.

In the first place, I was assailed by an advertiser in *The Wireless World* of April 14th, who pleaded guilty to the charge I made but put forward a somewhat flimsy defence that one of these "dogs' concert" transformers of his was used in *The Wireless World* Quality Amplifier, thus trying by artful innuendo to saddle me with the responsibility of having designed this particular piece of apparatus.

In the second place, I was attacked by several people for my statement that high-note reception is lacking in elderly people. One of my correspondents alleged that the reverse was the case, there being a deficiency of bass appreciation by the elderly. Now, as all my medical readers will be aware, a deficiency of low-note appreciation is a symptom of catarrhal conditions in the auditory mechanism, and it is no

Bass appreciation by the elderly.

excuse to reply that most elderly people usually do suffer from such a condition.

One reader, in order to prove that my contentions are wrong, claims that although no longer a callow youth he can still hear the cry of the bat. Such a feat is, of course, unusual at any age, but it is not necessarily a proof of acute hearing. In some parts of the country, notably in East Anglia, such a feat is still deemed to indicate the possession of occult powers, and, as in ancient days, insane persons were considered *ipso facto* to possess occult powers, there arose the old saying about "bats in the belfry."

It must not be thought, of course, that I am intending anything personal in referring to this. Such a thing would be entirely foreign to my nature since, as a scientist, I am merely interested in recording scientific fact. In many quarters the ability to hear the cry of the bat is attributed to an excess of bass of the type that concerns the alimentary tract rather than the auditory organs.

In conclusion, I can only say that I still stick to my original statement, although I shall be pleased to bow to the opinion of the experts if and when they cease contradicting each other on the subject.

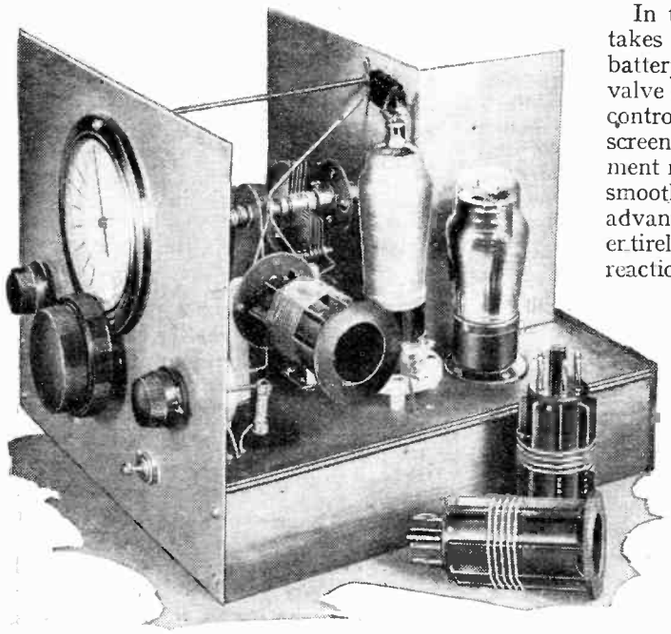
In Next Week's Issue

NOTICE is given on other pages of this issue of a Short-Wave Battery Receiver and an AC Ultra-Short-wave Converter to be described in our next number. It is also proposed to include, in addition to several special articles covering the fields of short-wave reception and transmission, a review of a number of commercial short-wave receivers and components designed to be used in short-wave sets.

Short-Wave Three

BATTERY-OPERATED RECEIVER COVERING 6.5 TO 86 METRES WITH PLUG-IN COILS

To be Fully Described in Next Week's Issue



LARGE and complicated receivers are not essential for long-distance reception on the short waves, as the simple straight set possesses sufficient sensitivity if one is prepared to use headphones. The detector is, perhaps, the most important stage in a set of this kind, since its performance relies to a large extent on regeneration.

When receiving weak signals the detector will generally be operated close to the threshold of oscillation, so that the reaction must be smooth and under perfect control at all times.

In this receiver the detector takes an unusual form for a battery set. A screen-grid valve is used, and reaction is controlled by varying the screen voltage. This arrangement not only gives the desired smooth control, but it has the advantage that the tuning is entirely unaffected by the reaction adjustment.

The receiver includes a tuned RF stage and a small power output valve giving loud speaker reproduction on some of the more powerful short-wave stations. Care has been taken to keep the efficiency of the tuned circuits as high as possible in order to provide adequate adjacent-channel selectivity.

Plug-in coils are used and the coil formers are a new type having a self-locating centre spigot. The aerial and RF coils for each range are interchangeable and winding details will be given for four sets of coils, one of which covers the television wavelengths.

By ganging the RF and detector variable condensers the handling of the set is made reasonably simple.

THE LIST OF PARTS USED

2 Variable condensers, short-wave, 0.0001 mfd. — **Premier Tro 100**

Fixed condensers:

3 0.01 mfd., tubular	T.C.C. 451
2 0.1 mfd., tubular	T.C.C. 341
1 0.002 mfd., mica	T.C.C. "M"
1 0.0001 mfd., mica	T.C.C. "M"
1 0.00005 mfd., mica	T.C.C. "M"
1 25 mfds., 25 volts, electrolytic	T.C.C. "FT"

1 Dial, full vision, dual speed — **Eddystone 1070**
1 RF Choke — **Eddystone 1010**
1 Trimmer, mica — **Eddystone 1923**

Resistances:

1 100 ohms, ½ watt	Bulgin HW37
1 150 ohms, ½ watt	Bulgin HW38
1 20,000 ohms, ½ watt,	Bulgin HW19
3 50,000 ohms, ½ watt	Bulgin HW23
1 500,000 ohms, ½ watt	Bulgin HW31
1 2 megohms, ½ watt	Bulgin HW34

1 Volume control, 25,000 ohms — **Bulgin VC46**
1 Volume control, 50,000 ohms — **Bulgin VC47**
1 Valve holder, 4-pin, chassis type — **Eddystone 1073**
1 Valve holder, 4-pin, baseboard type — **Eddystone 949**
1 Valve holder, 5-pin (without terminals) — **Clix Chassis Mounting Standard Type V1**
1 Switch, SPDT — **Bulgin S81T**
1 Switch, DP, on-off — **Bulgin S126**
2 Stand-off insulators, Midget — **Eddystone 1019**
1 Battery cable, 4-way — **Belling-Lee**
6 Terminals, LS+, LS−, P+, P−, A, E — **Belling-Lee "R"**
2 Flexible couplers — **Premier Supply Stores**
8 Coil formers, 6-pin, self-locating type — **B.T.S.**
2 Coil bases, 6-pin, chassis type — **B.T.S.**
Chassis: 10 × 10 × 2in., plywood

Miscellaneous: — **Peto-Scott**
Aluminium for front panel, 10×8½in., and screen 10¼×6½in., 5 brackets, 1 piece paxolin tube 3in. long×½in. dia., 1 length 6 BA Studding with 4 nuts and washers, 2 lengths 6 BA Studding 1½in. long with 5 nuts and washers to each, 6 6BA soldering tags, 6 lengths Systoflex, 4oz. No. 18 tinned copper wire, small quantity Nos. 20 and 22 tinned copper wire, small quantity Nos. 24 D.S.C. and 24 D.C.C. wire, etc. Ebonite for terminal strip 10in.×2¼in.×$\frac{3}{16}$in. **Screws:** (Wood) 8 ½in. 4BA R/Hd., 24 ¼in. 4BA, R/Hd., 2 ½in. 6BA, R/Hd., 3 1in. 4BA, C/Sk.; (Metal) 7 ¼in. 6BA R/Hd., with nuts.

Valves:

2 SG220	Hivac
1 KT21	Osram

Random Radiations

By "DIALLIST"

Wanted a Small Vibrator

A RECENT article in *The Wireless World* * disclosed that a great deal of attention is being given by various manufacturers to the vibratory type of high-tension current generator. These have been used for a long time in car-radio receivers, and there is at least one domestic battery set on the market, the Ekco, which operates by means of a vibrator. The vibrator is used, again, by Philips to convert their AC sets for DC mains working. A very promising field for this type of apparatus should be its use as an eliminator of the high-tension battery in existing battery sets; it should appeal, again, to the constructor who is about to build a new battery set for himself. But it seems to me that there is one big drawback to the vibrator in its present form. So far as I know there is no model available to the man-in-the-street with a maximum rated output of less than 7.5 watts. At 150 volts, which is the limit for many battery valves, this means the maximum current output is thus 50 milliamperes. Nothing like this current is required by even the largest of commercial battery sets, whose total H.T. drain seldom exceeds some 20 milliamperes.

Economy Types

One knows, of course, that the load on the accumulator supplying the vibrator varies with the output; but it does not vary in direct proportion, since the highest efficiency of the apparatus is reached on the full rated output. What I feel is wanted is a vibrator of the economy type, giving high efficiency for an output of, say, 3 to 3.5 watts. Assuming a 60 per cent. efficiency figure, this would mean a load of 5-6 watts on the accumulator. This with a 4-volt accumulator means a drain of between 1.25 and 1.5 amperes. Such a vibrator would be most useful, for a 6-volt car battery of 60 ampere-hour capacity would then suffice to supply all the current needed by a largish battery set. One cell would be used for the filaments of the valves; the other two for working the vibrator. It would not be difficult to select a valve combination whose filament current requirements were about the same as those of the vibrator so as to keep the load on all three cells substantially equal. Or, if the filament current was less than that taken by the vibrator, the output of the cells could be balanced by means of a "bleeder" resistance. It must be possible to design vibrators of the kind suggested, for the total load on a 4-volt accumulator of the Ekco B.V.78 receiver for both HT and LT is only just over one ampere.

* Vibratory H.T. Generators, *Wireless World*, March 31, 1938, page 293.

Variety First

THE popularity of variety programmes with listeners, as disclosed by every test, competition or questionnaire that has ever taken place, is not at all surprising when you come to think of it. For one thing, the variety programmes are usually put on at just the times when listeners are most likely to be in a mood to appreciate them. Saturday night, when the week's work is over, finds most people ready for something light and bright in the way of radio entertainment. And the B.B.C. very sensibly provides it in such items as "In Town To-night" and "Music Hall" or "Palace of Varieties." And, after all, when you take our wireless programmes by and large, what are they but variety on the grand scale? The National programme, for example, for the day on which this note is written, begins with a service, goes on to weather and shipping news, and then provides a household talk and organ recital, a gramophone recital, a talk on London, orchestra, more gramophone, folk songs from abroad, orchestral music from Central Europe, news, choral singing, the theatre organ, a talk on poetry, a Scrap-Book programme, news again, a talk from America, piano solos, a poetry reading, a dance band in the flesh and dance-band records. And if that isn't some fourteen hours of variety, I don't know what variety is. Add the Regional programme as well, and your variety becomes still more varied! But using the word variety with its narrower meaning of a complete shortish programme of assorted light items, two things are quite certain. The first is that the B.B.C. has reached a very high standard in its productions of this kind, and the consequence is that the public likes variety and wants a great deal of it.

A Big Improvement

At one time it seemed that B.B.C. variety shows were rather in danger of becoming vulgar and not very funny. I am all for a little hearty vulgarity in the right place and in the right atmosphere, but it just doesn't do when brought into the home by means of the loudspeaker; it's altogether too crude that way. Luckily, the B.B.C. took the matter firmly in hand, and, on the whole, comedians who appear before the microphone have solved the problem of being funny without being gratuitously vulgar. There are occasional lapses, which are to be regretted. Not so very long ago a well-known entertainer was a great deal too free with gags of double meaning, and an avalanche of protests ensued. The lesson seems to have gone home, for at a subsequent appearance he gave us a rollicking turn without using a single word which could have given offence to anyone. Anyway, the B.B.C. variety people seem now to have found the happy mean, and one hopes that they will stick to it.

New Problems

PRESS-BUTTON tuning has brought in its train many little problems of design with regard to details which either need not be considered or else present no difficulty in manually tuned sets.

For instance, it may be desirable when

Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, MAY 5th.

Nat., 6.20, Forgotten Anniversaries—The Death of Napoleon. 7.30, The Twinkle Company in "Our's is a Nice Hour Our's Is." 9.20, "Hail Variety!"—The Development of the Compère.

Reg., 6, "42nd Street"—an adaptation of the film success. 7.50, "The Mighty Adam"—a musical play by Denis Constanduros. 8.30, Carroll Gibbons and the Savoy Hotel Orpheans.

Abroad.

Hamburg, 8.10, "Gipsy Love," operetta (Lehár).

Milan Group, 9, "Aida," opera (Verdi).

FRIDAY, MAY 6th.

Nat., 6.25, The Week in Westminster, Richard Acland, M.P. 7.15, Big Bill Campbell and his Hill-Billy Round-Up. 9.35, "Cads College," devised and presented by The Western Brothers.

Reg., 7.30, "The Tyburn Brook"—a forgotten London stream. 8, Geraldo and his Concert Orchestra.

Abroad.

Vienna, 6.55, "Faust," opera (Gounod).

Leipzig, 8, "La Traviata," opera (Verdi).

SATURDAY, MAY 7th.

Nat., 3 and 5, Commentary on First Day's Play for the Davis Cup, Great Britain v. Rumania. 4.10, Commentary on Rugby League Cup Final, Salford v. Barrow. 8, Music Hall, including Wee Georgie Wood and Flotsam and Jetsam. 9.20, American Commentary. 9.35, Discussion on Medicine and the State.

Reg., 8.15, "Winning Ways," a comedy of the valleys of South Wales. 9, British Folk Music.

Abroad.

Luxembourg, 9.15, Symphony Concert with Alexander Zakin, pianoforte.

SUNDAY, MAY 8th.

Nat., 5, Mr. Lloyd George speaks from Broadcasting House and Dr. Willis Dodds from America in commemoration of Whitefield's first landing in America. 5.30, Sonata Recital by Arthur Catterall, violin, and R. J. Forbes, pianoforte. 9.35, "Mississippi Nights"—negro spirituals and plantation music, with Roland Smith (bass-baritone).

Reg., 6.45, The Menges String Quintet. 9.35, Franz André conducts B.B.C. Orchestra (D).

Abroad.

Brussels, II, 8, "The Mikado," opera (Gilbert and Sullivan).

Radio-Paris, 8.30, Joan of Arc Festival from Orléans.

MONDAY, MAY 9th.

Nat., 3, Davis Cup Commentary. 7, Monday at Seven. 8.20, Wild Life Around Us. 9.20, World Affairs.

Reg., 6.30, The Little Orchestra in a programme of English music. 8.45, Covent Garden, Richard Strauss' opera "Elektra."

Abroad.

Radio-Paris, 8.30, "The Magic Flute," opera (Mozart).

Paris, PTT, 10.45, Joan of Arc Festival in Esperanto.

TUESDAY, MAY 10th.

Nat., 8, Showmen of England: C. B. Cochran. 9.20, America Speaks (conclusion).

Reg., 8, "Westward Ho," a radio magazine, ninth edition. 8.30, Recital on the Concert Hall organ by Ralph Downs. 9, Ambrose and his Orchestra from the Empire Exhibition. 9.30, Varicty from Birmingham.

Abroad.

Kalundborg, 9, Lanner, Strauss and Lumbye dances and waltzes.

WEDNESDAY, MAY 11th.

Nat., 1.10 and 5.40, Cricket Commentaries, Middlesex v. Gloucester, and Lancashire v. Derbyshire. 7.30, "At the Pig and Whistle," a truly rural episode. 8, Covent Garden, "The Flying Dutchman," Act 1.

Reg., 7.30, "The World Goes By." 8, Jack Jackson and his Band.

Abroad.

Warsaw, 9, Chopin Recital by P. Lewiecki, pianoforte.

Leipzig, 9, Bruckner's Ninth Symphony.

any of the buttons corresponding to long-wave stations are pressed to introduce a filter to suppress whistles due to medium-wave transmitters. A neat way of making this addition automatically has been proposed: the suppressor unit consists of a coil and sliding switch assembly which has a spring-loaded bar attached to the switch movement. This bar is in contact with the extremities of the LW push-buttons which, when pressed, automatically bring into circuit the filter. When an MW station button is pressed the LW buttons return to a common position and remove pressure from the bar, thereby allowing the coil on the filter unit to be cut out of circuit.

Another desirable feature of push-button sets seems to be a mechanical device whereby it is assured that no button will remain in operation when the manual-automatic change-over switch is set at "manual." A suggestion has been made that this state of affairs might be brought about by a cam attached to the wave-change switch spindle which trips the latch on the push-button unit on all positions except the automatic, thereby preventing any stray capacity affecting calibration of the wave scale by accidental pressing of buttons when operating the receiver manually.

Mains-borne Interference

INVESTIGATIONS into the interference caused by electric motors of the commutator type, such as are often used in vacuum cleaners and other domestic apparatus, have shown that impulses radiated by them can be picked up by electric wiring in the buildings in which they are used and re-radiated by the wiring of other buildings some distance away. This would seem to explain some of those rather mysterious cases of interference which occur from time to time. Neither the owner of a house in which the typical roar of commutator-produced interference occurs nor his immediate neighbours may possess apparatus that could cause trouble; yet it occurs in unmistakable form. The cure, I suppose, is to fit disturbance suppressors close to the electric meter; but if re-radiation from a wiring is taking place complete freedom might not be secured unless one's neighbours were obliging enough to do the same. What a lot of bother a single piece of domestic or commercial electrical apparatus can cause if it is not of an interference-free type!

Caledonia Wild Again

THE Free Church Presbytery of Lewis is, I observe, demanding an apology from the B.B.C. for what it calls the public insult offered by the sound picture of the Island and its life given in one of the February programmes. I heard that programme and I can't say that I detected any insults. So far as I can remember it was an interesting programme of a perfectly innocuous kind. At any rate, I am sure that the B.B.C. had no intention of treading upon anybody's toes; they hoped, in fact, to make sure that nothing of the kind would happen by having the programme written by a native of Lewis. The B.B.C. does quite unwittingly say or do the wrong thing at times, as is the common lot of most public bodies. But I feel that the Islanders are being just a little too touchy in describing the programme in question as a public insult, as a gross caricature and a little short of blasphemous. They would be much better advised to let whatever bygones there have been be bygones.

High-Fidelity USW Adaptor

QUALITY RECEPTION ON 7-METRE WAVEBAND

THERE is a probability of the regular use of the Alexandra Palace sound transmitter on 41.5 Mc/s for the radiation of programmes at extra-high quality outside television hours. Those who are within its range will doubtless wish to avail themselves of the high quality reproduction which will be obtainable.

In Next Week's Issue

There must be many who wish to avail themselves of these transmissions but who are not attracted by the duplication of equipment involved by building a special receiver. Fortunately, this is unnecessary, for as the greater part of the distortion introduced in a modern receiver occurs before the AF amplifier, high quality can be obtained by using this part of the set in conjunction with an ultra-short-wave adaptor.

The High-Fidelity USW Adaptor to be described thus takes the form of a self-contained unit for connection to the pick-up terminals of the receiver. It consists of one RF stage with a grid detector and is AC operated. The quality obtainable will naturally be limited by the AF equipment of the receiver used, but in any case a marked improvement over that obtained on medium waves should be evident.

LIST OF PARTS TO BE USED.

1 Mains transformer, with screened primary, 200-250 volts 50 c/s; secondaries, 4 volts 1 amp., 4 volts 2 amps., 250-0-250 volts, 25 mA. **Premier Supply Stores WW/250**

1 Smoothing Choke, 25 mA., 20H., 500 ohms **Premier Supply Stores WW/C25**

Fixed condensers:

2 0.01 mfd., mica	**Dubilier 691**
1 0.0001 mfd., mica	**Dubilier 690W**
1 0.0005 mfd., mica	**Dubilier 690W**
1 0.1 mfd., tubular	**Dubilier 4603/S**
1 8-8-8 mfds., 500 volts, electrolytic	**Dubilier 312**
1 0.01—0.01 mfd., 500 volts, A.C.	**Dubilier BE328**

3 Variable condensers, 15 mmfds. **Raymart VC15X**

Resistances:

1 200 ohms, ½ watt	**Erie**
2 500 ohms, ½ watt	**Erie**
1 10,000 ohms, ½ watt	**Erie**
1 30,000 ohms, ½ watt	**Erie**
1 250,000 ohms, ½ watt	**Erie**
1 100,000 ohms, 2 watts	**Erie**

1 Potentiometer, wire-wound, 10,000 ohms, tapered **Reliance TW**

1 Valve holder, 4-pin (without terminals) **Clix Chassis Mounting Standard Type V1**

1 Valve holder, 5-pin (without terminals)

1 Valve holder, 7-pin (without terminals) **Clix SW Chassis Mounting Floating Type V5**

1 Skeleton captive screw strip, two-way "Output" **Bulgin T10**

1 Skeleton captive screw strip, three-way, A1, A2, E **Bulgin T11**

Chassis **B.T.S.**

Valves:

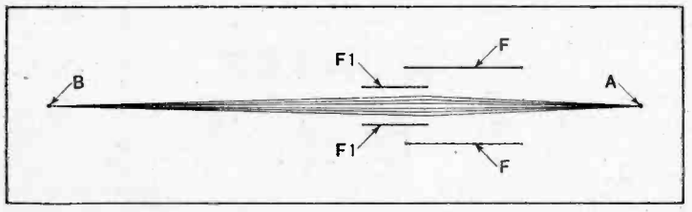
1 TSP4 (Met), 1 DW2	**Mullard**
1 MH4 (Met)	**Osram**

Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

FOCUSING THE ELECTRON STREAM

AN electron-optical lens for focusing a stream of electrons coming from a source A, such as the cathode of a cathode-ray tube, on to a point B on the fluorescent screen of the tube consists of a pair of coaxial cylindrical electrodes F, F1, the second of which is approximately half the radius of the first and carries a higher biasing-voltage. The focal length required will naturally depend upon the size of the cathode-ray tube, and the potentials applied to each of the electrodes are governed by this factor. It is stated that the arrangement produces a clear-cut spot, substantially free from spherical aberration. The method is particularly suitable for scanning the photo-sensitive mosaic screen of a television transmitter.



Focusing arrangement in CR tube to obtain a clear-cut spot on screen.

W. D. Wright and O. Klemperer. Application dates, July 30th, 1936 and May 7th, 1937. No. 480857.

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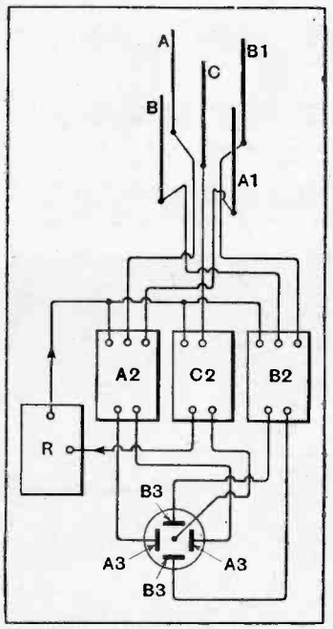
DIRECTION-FINDING

IN certain cases automatic volume control is applied to a direction-finding set, so as to keep the output constant in spite of the overall changes in field-strength, which occur, for instance, when an aeroplane flies towards or away from a beacon station. At the same time, it is essential that the ordinary directional response caused by changes of orientation should not be affected.

The drawing shows two pairs of spaced aerials A, A1 and B, B1, arranged as an Adcock aerial, to give directional results, and a fifth non-directional aerial C to supply the automatic volume control.



Direction-finding system embodying automatic volume control.

The pick-up from the directional aerials A, A1 and B, B1 is amplified at A2 and B2 respectively and applied to the two pairs of deflecting plates A3, B3 of a cathode-ray indicator. The pick-up from the aerial C is amplified at C2 and is applied to a rectifier R which provides AVC for the amplifiers A2, B2. A part of this signal voltage is also used to give the usual "sense" of direction in the cathode-ray indicator.

The Plessey Co., Ltd., and C. E. G. Bailey. Application date, August 8th, 1936. No. 479689.

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TELEVISING INVISIBLE OBJECTS

OBJECTS in the dark, or obscured by fog, are made visible through the infra-red radiation which they give off. These rays are focused on to the fluorescent screen of a cathode-ray tube, and the image so formed is intensified by regenerative feed-back from an amplifier which is coupled to the output from the cathode-ray tube and is back-coupled to the control grid of the same tube.

The moving picture produced can then be televised to any desired distant point. As the infra-red rays are focused on to the fluorescent screen the latter is simultaneously scanned by the electron stream from the cathode-ray tube, the result being that a modified form of fluorescent light is produced which is particularly suitable for the purpose of the invention.

Sturdy-Cage Projects, Inc., Convention date (U.S.A.), July 6th, 1935. No. 477775.

o o o o

CATHODE-RAY TUBES

IT is usual to focus or deflect the stream in a cathode ray tube whilst the electrons are still travelling at a relatively low speed and to accelerate them afterwards. In these circumstances it is found that the angle of deflection is reduced whilst the stream is passing through the accelerating field, so that it becomes necessary to apply an initial deflection, or to adopt some other means of compensation involving an intricate electrode system.

According to the invention, the required result is obtained more simply by producing an accelerating field in which the lines of force, instead of being plane, are curved outwards, so that they appear convex as viewed from the screen end of the tube. The effect is produced by using a long tubular anode, which is maintained at a potential equal to that of the negative end of the accelerating field. The tubular anode may be wound with a magnetic focusing-coil, and may house an electrostatic ring or lens at the end furthest from the cathode.

Fernseh Akt. Convention date (Germany) August 7th, 1935. No. 479471.

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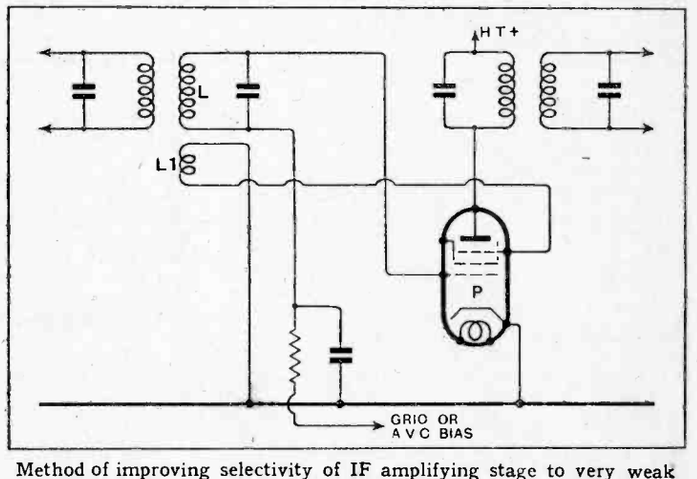
HIGH-FREQUENCY AMPLIFIERS

THE input admittance of an amplifier, such as a pentode, can be divided into two parts, one static the other dynamic. The static admittance is determined solely by the geometry or spacing of the electrodes, and is measured when the valve is idle or cold. The dynamic admittance, on the other hand, depends upon a number of factors, such as the inter-electrode capacities, the gain of the valve, and, in particular, upon the load into which the valve is working. In operation it becomes the source of unwanted reaction and of other undesirable effects.

The dynamic admittance, particularly of the IF amplifier in a superhet set, is reduced to zero, in the type of circuit shown in the Figure, by applying to the suppressor grid of the pentode P a voltage in phase-opposition with the received signal. This voltage is derived from a coil L1 coupled to the input coil L, the grid being biased so as to prevent it from drawing any substantial space current. Incidentally, the selectivity of the amplifier is made more pronounced for weak signals than for strong signals, which is a desirable feature when AVC is used.



Method of improving selectivity of IF amplifying stage to very weak signals.

Philco Radio and Television Corporation. Convention date, (U.S.A.), July 3rd, 1936. No. 480417.

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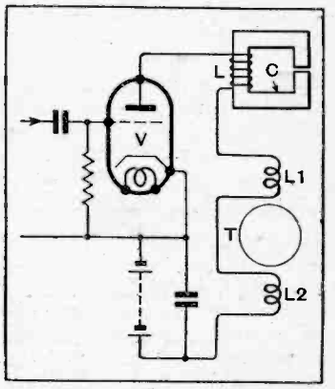
TIME-BASE CIRCUITS

A "SWEEP" circuit for producing saw-toothed oscillations, as used for scanning in television, consists of an iron-cored inductance coil L which is inserted in series with the deflecting coils L1, L2 of a cathode-ray tube T in the anode circuit of a valve V. The iron core C of the coil L has only a small air-gap, so that the magneto-motive force of the anode current is almost wholly expended in overcoming the reluctance of the core.



Time-base circuit for magnetic deflection with CR tube.

A formula is given for the design of the inductance in order to ensure a straight-line rise of current with time, when a negative synchronising-impulse is applied to the grid of the valve V. The frequency of the "sweep" oscillation is thus made wholly dependent upon that of each synchronising signal, and no oscillation occurs in the interval between.

Ferranti, Ltd. and J. C. Wilson. Application date, August 28th, 1936. No. 480754.

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Editorial Comment

Short Waves

Cairo Allocations: New High-fidelity Transmissions

BOTH short waves and the ultra-shorts are prominently in the news just at the moment. The Cairo Conference, when it came to questions of wavelength distribution, concerned itself very much with the question of carving up the short-wave bands so as to make the best and fairest use of them, and in regard to the shorter wavelengths we have the recent decision of the B.B.C. to commence a series of concert broadcasts on the sound wavelength used in conjunction with the television transmissions from Alexandra Palace.

The action taken at Cairo to endeavour to readjust short-wave band allocations was very timely, because it was generally admitted that the position was becoming difficult as the number of short-wave broadcasting and other stations continued to increase at a very rapid rate. Extensions have been approved in a number of short-wave bands to accommodate more broadcasting stations, allowing a 10-kc/s separation between stations.

The decision by the B.B.C. to put out concerts on the television sound frequency is the culmination of a long-discussed proposal. As far back as February, 1935, we alluded to the prospects of high-quality sound broadcasting as a by-product of television, while at the beginning of 1937 it was confidently expected that the B.B.C. was about to start an ultra-short-wave relay of the National programme from a transmitter located on the roof of Broadcasting House.

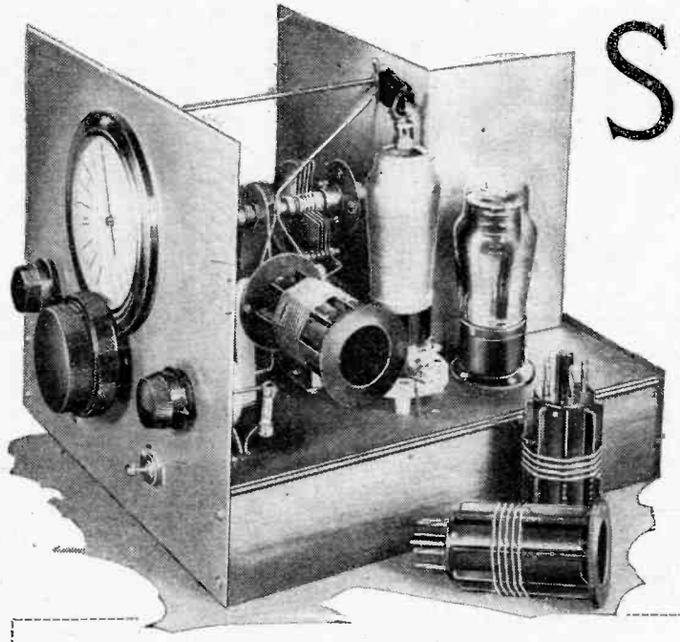
Now, a full year later, the B.B.C. has announced a definite series of programmes, and the opportunity is presented to a great many more listeners to participate in the appreciation of how excellent is the quality obtainable on this waveband.

The B.B.C. has not, we believe, committed itself to anything beyond a short series of high-quality broadcasts on this band, but it seems likely that a keen response from the public would ensure the continuance of the scheme.

Two arguments have recently been put forward against the extension by the B.B.C. of broadcasting of additional sound programmes on television wavelengths. The objections are, first, that the Cairo agreement allocates these wavelengths for television but perhaps does not permit their utilisation for sound broadcasting alone, and secondly, that popularising reception of broadcasting on wavelengths of the order of seven metres will distract the interest of the public from normal wavelength broadcasting, thus affecting the prestige of the B.B.C. service and embarrassing those radio manufacturers whose sets are not designed for reception on seven metres.

As regards the Cairo agreement, this argument seems to be nothing more than a technical "quibble," for if the wavelengths are allotted for both sound and vision accompanying it for unrestricted periods, there can surely be no complaint if at times the vision transmission is inoperative and only the sound transmitted.

As regards the status of existing transmissions, a short-wave service which is purely local to the London area at present cannot surely distract listeners' attention from the normal transmissions, nor is any unfavourable effect likely to be noticed by manufacturers, but rather there may be an increased demand for modern sets with ultra-short-wave facilities.



Short-Wave Three

GENERAL-PURPOSE RECEIVER FOR THE AMATEUR EXPERIMENTER : Waverange 6.5 to 86 Metres

A "STRAIGHT" short-wave set necessarily depends largely on reaction for its sensitivity and selectivity; this article describes the construction of a battery-fed receiver in which a novel regeneration control, free of the shortcomings of the conventional system, is employed.

By H. B. DENT

THE comparative simplicity of the straight or TRF (tuned radio frequency) set will naturally appeal to those who are thinking of building a receiver solely for the short waves. In a set of this kind the most important part is the detector, which, of course, will be of the regenerative type.

When functioning well it possesses extraordinarily high sensitivity, but the main difficulty encountered as a rule is to get the stage to behave in a rational manner at the high-frequency end of the short-wave band from, say, about 20 metres downwards.

When an ordinary triode valve is used the reaction control is inclined to be rather fierce in operation, and it is by no means easy to induce the detector to go smoothly into oscillation and, what is possibly most important of all, to come out of oscillation at the same setting of the condenser that starts it oscillating.

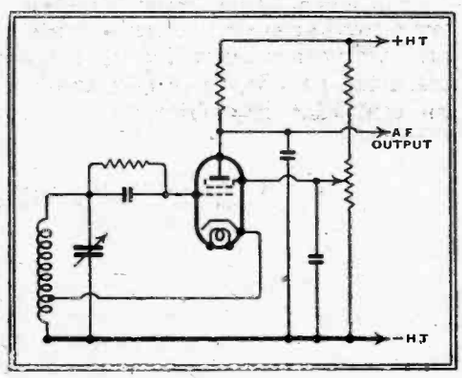


Fig. 1.—This detector circuit gives very smooth control of reaction, but it requires a valve with a separate cathode.

Often there is a considerable difference in the two positions, and this makes the set very difficult to handle in its most sensitive state, which is on the borderline of oscillation.

For receiving CW signals the valve is most sensitive when the reaction control is adjusted to the point where oscillation just commences.

One disadvantage of a triode valve is that in the non-oscillating state it heavily damps the preceding tuned circuit so that for the reception of weak broadcasting signals, or other modulated transmissions, a critical adjustment just on the threshold of oscillation has to be made.

Another matter that has to be taken into account is that of selectivity. Almost every available channel on the short waves is now occupied, which means that there is a transmission of one kind or another at about 10 kc/s intervals throughout. If it were possible to obtain the same frequency selectivity on the short-wave as on the medium-wave band the design of a TRF set would be, comparatively speaking, plain sailing, but tuned circuits of the orthodox kind are not quite so accommodating, as their response to a wanted and unwanted signal depends on the ratio of the respective frequencies.

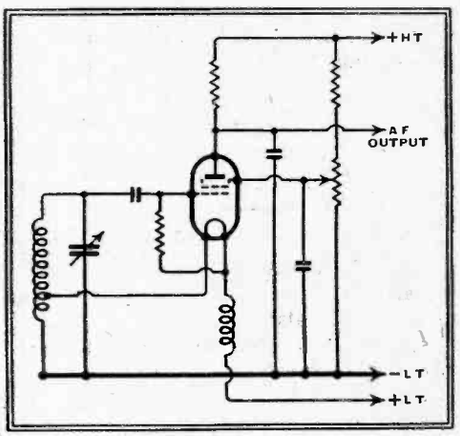
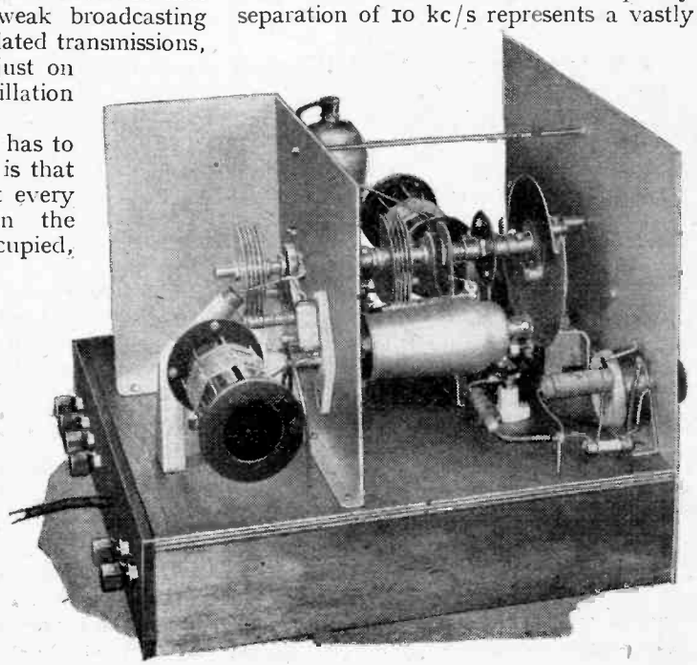


Fig. 2.—By fitting a small choke in the LT positive lead to a battery valve it becomes possible to employ a reaction circuit on the lines of Fig. 1.

It is thus obvious that a frequency separation of 10 kc/s represents a vastly



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different percentage of the working frequency on the medium- and on the short-wave bands. At 300 metres, 1,000 kc/s, it is one per cent., but at 30 metres, 10,000 kc/s, it is only 0.1 per cent. Thus, in order to achieve comparable selectivity on the short waves the tuned circuits would have to be ten times as good as those needed for medium-wave reception, and this simply cannot be done, even though the best of insulating materials be employed. Increasing the number of tuned circuits is impractical, since so many would be needed, and other ways have to be found to make the set usable on the short waves.

The easiest and simplest is to employ such weak couplings to the tuned circuits that aerial and valve damping are as small as practical considerations will allow, and also to use as much reaction as the set will stand and yet remain stable for telephony reception. Hence the need for a perfectly controllable reacting detector in all such sets.

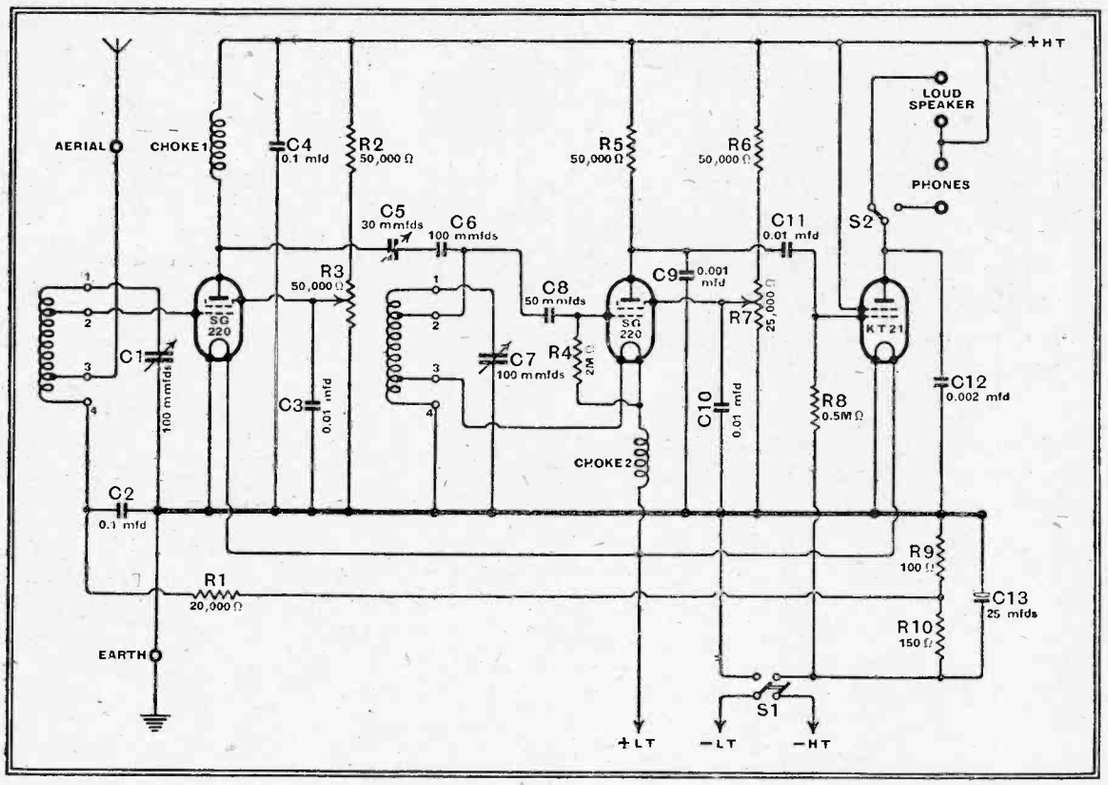


Fig. 3.—Complete theoretical circuit diagram of the receiver. Condensers C1 and C7 are ganged and plug-in coils are used.

RF Stage

Having outlined the desirable requirements, let us now see how far it is possible to go towards achieving them without adding too much to the cost of the set or making it unduly complicated. It was thought that a three-valve circuit would best suit the purpose, as an RF stage could be included as well as a small power valve, thus enabling a loud speaker to be used when receiving strong signals. On other occasions headphones would be employed.

The advantages of an RF stage are that it provides an extra tuned circuit, increases the sensitivity and, most important of all, it acts as a buffer between the aerial and the detector stage. On the short waves the impedance of the aerial varies considerably over the waveband, and it will thus produce varying degrees of damping on the tuned circuit, resulting in the reaction sometimes behaving in a very peculiar manner. If the aerial swings with the wind its capacity to earth varies and again the tuning of a circuit to which reaction is applied is also affected. An RF stage is, therefore, most desirable.

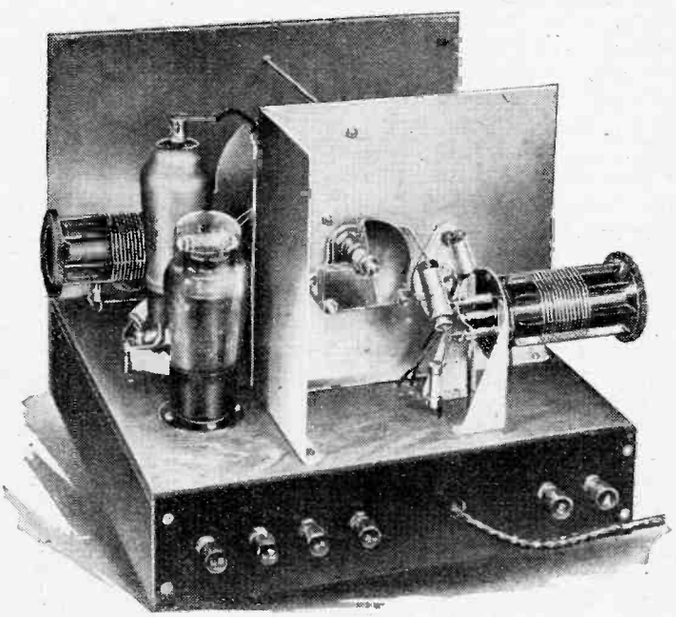
The detector stage at first presented some difficulty, since most of the orthodox arrangements, in which a reaction coil and a variable condenser figure, tend to become rather difficult to handle below about 20 metres. Reaction is often very fierce and "ploppy," while the sensitivity and selectivity are only really good on the threshold of oscillation. It is by no means easy to obtain smooth regeneration with such an unsatisfactory arrangement.

One circuit which is known to be free of most of these troubles is that shown in Fig. 1, but as will be seen it requires a valve having a separate cathode, this being tapped on to the coil. Actually, it is a variation of the well-known Hartley oscillator and the control of oscillation is effected by varying the screen potential. The advantage of this arrangement lies in the fact that the moving vanes of the tuning condenser are at earth potential.

Despite the fact that battery valves are being used in this set it was decided to employ, if possible, a detector of this kind as no other is known to be quite as simple and so easy to handle. The circuit of Fig. 2 was eventually evolved.

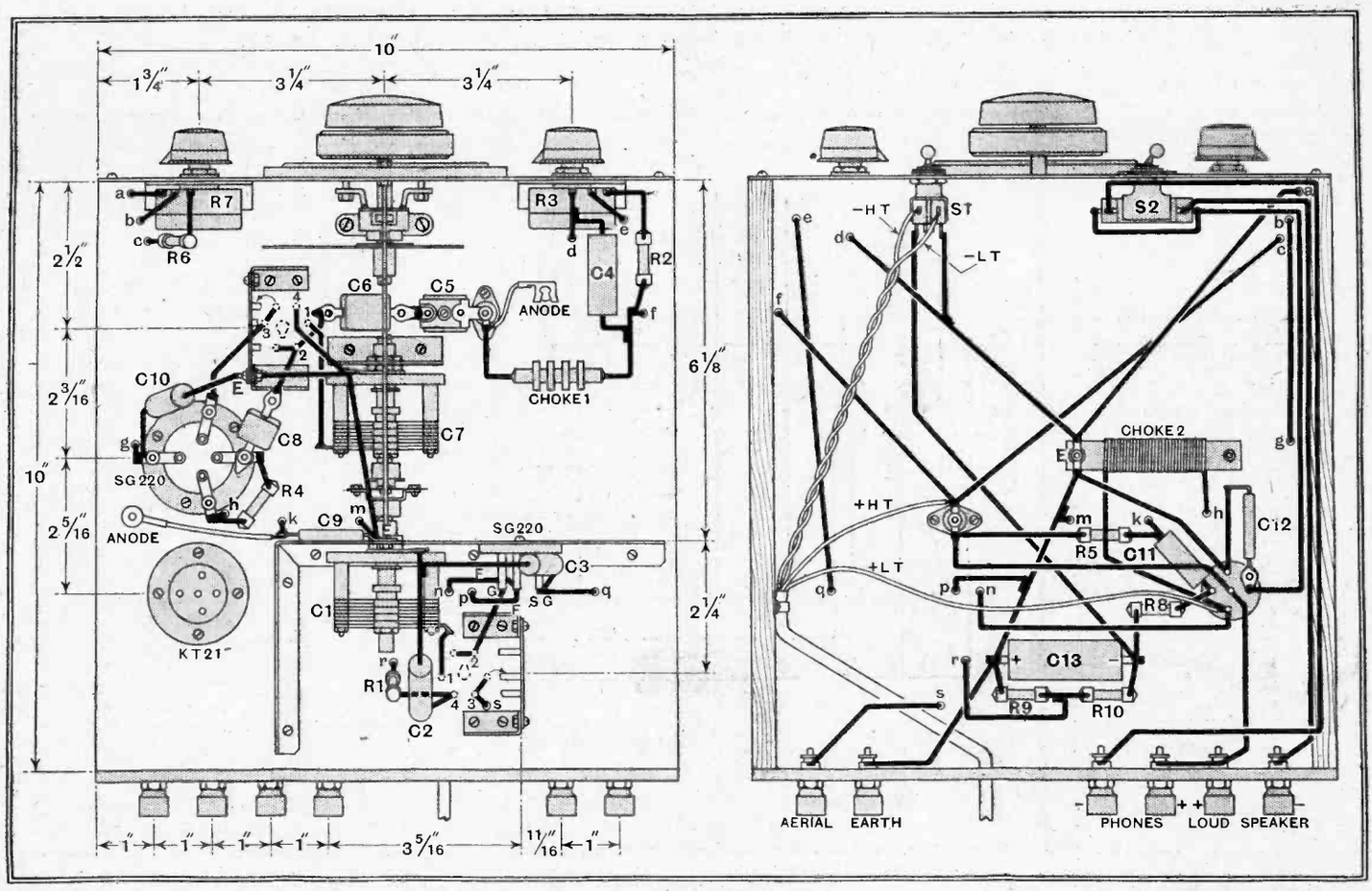
A small RF choke having a very low DC resistance is connected in the *positive* LT lead to the valve and the negative filament connection is made *via* the tapping on the coil. The impedance of the filament choke need only be high compared with that part of the tuning coil which is between the negative filament tapping and the LT negative line. As in all the coils this tapping is not more than two turns from the "earthy" end, quite a small filament choke will suffice.

In a detector of this kind the screening grid and not the usual anode appears to act as an anode when the valve oscillates, and it is therefore important to make the RF return path from this electrode as direct as possible or regeneration will not be obtainable on the ultra-short wave coil.



The arrangement of the input circuit, showing method of mounting the coil and tuning condenser.

Whilst this arrangement gives very



Layout of the components and the practical wiring plan. The coil holders are mounted vertical to the baseboard but for the purpose of showing the pin connections it has been assumed that they are horizontal with the pins uppermost. The key-way in the centre hole points towards the vertical screen in both cases.

nice control of regeneration it unfortunately has its limitations; it does not enable an unrestricted waveband to be covered. Nevertheless, it is effective over as wide a waveband as is usually wanted in a general-purpose short-wave set.

The upper frequency limit with the particular choke used is about 46 Mc/s, i.e., 6.5 metres. Several valves of the make and type specified have been tried and the highest frequency at which oscillation has been obtainable varied between 47 and 44 Mc/s. For this reason the circuit does not seem to lend itself for further extension into the ultra-high-frequency region, though it might be possible to induce it to function on the five-metre amateur band by fitting a different filament choke.

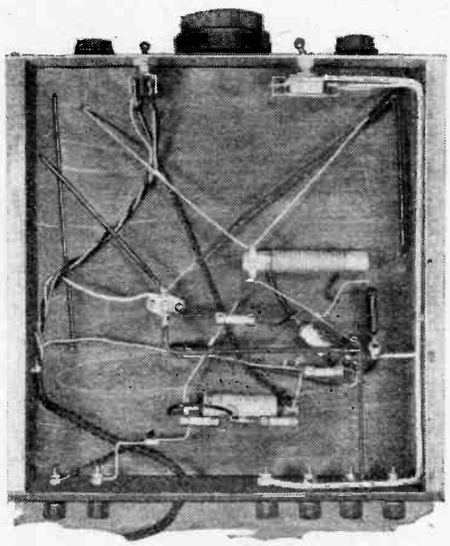
There is also a limit to its effectiveness at the low-frequency end, for at between 140 and 150 metres regeneration ceases to behave in a rational manner. This is assumed to be due to the fact that the impedance of the filament choke is then too small compared with the filament-earth portion of the tuning coil.

Increasing the size of the choke would overcome this difficulty, but then the upper frequency limit would be lowered and it was particularly desired to include the television sound wavelength.

The useful range of the set is thus 6.5 to about 140 metres. It is proposed therefore to give winding details for four sets of coils only and terminate the wave-range at 86 metres.

The RF stage does not require a detailed description as it is quite an orthodox arrangement. Referring to Fig. 3, which shows the complete circuit of the set, it will be seen that the coils for the grid circuit of the RF stage are identical with those of the detector. This has been arranged in order to avoid confusion between aerial and detector circuit coils, the windings and tapping points actually being the same for both circuits.

The RF valve is also the same type as the detector, so that they can be changed over and if one is found to function better in the detector position, oscillating a little more readily than the other on the ultra-short waveband, it should henceforth be used in this position.



Underneath the chassis is the filament choke, grid bias resistance and AF coupling components.

The output valve, an Osram KT21, was chosen as it requires a comparatively small input and as a negative bias of $-2\frac{1}{2}$ volts only is needed this is obtained in the set from a resistance joined between the negatives of the HT and LT batteries. Resistances R9 and R10 supply this bias and the junction between the two, giving about one volt, is used as a source of negative bias for the RF valve.

Automatic bias has the advantage that as the voltage of the HT battery falls the bias is regulated accordingly.

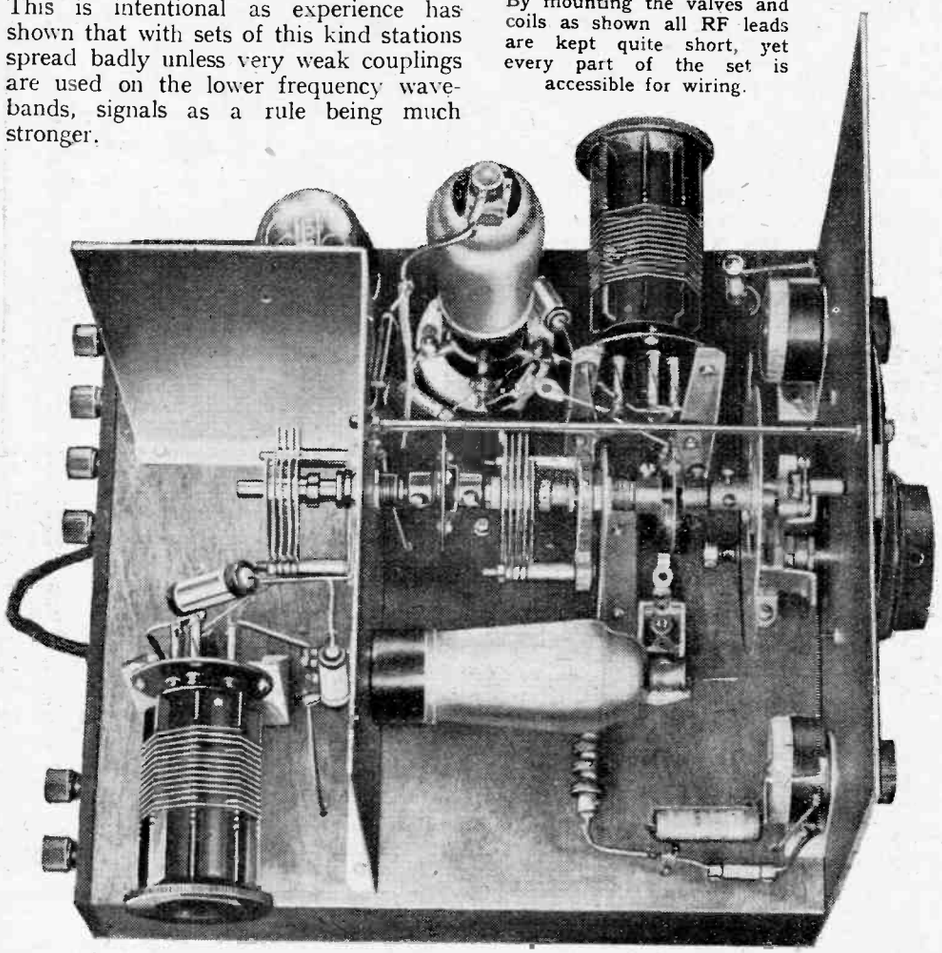
The RF stage is choke-capacity coupled to the tuned grid detector circuit, the choke CH1 having an effective range of 5 to 180 metres. The coupling condenser, C5, is a small mica-dielectric pre-set type having a maximum capacity of 30 m-mfds., but only about 10 m-mfds., or less, are actually needed to obtain good selectivity. A fixed mica condenser, C6, of 100 m-mfds. is joined in series with C5 solely as a precautionary measure and to safeguard the HT battery should C5 be short-circuited accidentally when adjusting it.

As the aerial is joined to the tapping on the coil that in the detector stage is the negative filament connection and which on none of the coils exceeds two turns

Short-Wave Three—

the aerial coupling becomes progressively weaker on the longer wavelength coils. This is intentional as experience has shown that with sets of this kind stations spread badly unless very weak couplings are used on the lower frequency wavebands, signals as a rule being much stronger.

By mounting the valves and coils as shown all RF leads are kept quite short, yet every part of the set is accessible for wiring.



Of course, the sensitivity is lowered, but as it is the only way in which reasonable selectivity can be obtained with a simple circuit of this kind the sacrifice would seem to be justified. In any case there is no alternative.

Where the need for high selectivity is not so pressing, namely, below about 20 metres, the aerial coupling is automatically made tighter by the scheme adopted.

Though the set is primarily intended for headphone reception, provision is made for using a loud speaker when signals are strong enough, and the change over is effected by the switch S2 in the anode circuit of the output valve.

The KT21 is a tetrode, so perhaps it is unwise to break its anode circuit without first switching off as otherwise the valve might come to harm.

An examination of the circuit will reveal the need for a double-pole on-off switch as it is necessary to break the HT negative separately as well as the LT circuit. If it were connected to the LT− as is customary, and only the LT+ lead broken, the HT battery would continue to discharge through the two screen grid potentiometers.

(To be concluded.)

THE LIST OF PARTS USED

2 Variable condensers, short-wave, 0.0001 mfd., **C1, C7** — **Premier Tro 100**

Fixed condensers:

- 3 0.01 mfd., tubular, **C3, C10, C11** — **T.C.C. 451**
- 2 0.1 mfd., tubular, **C2, C4** — **T.C.C. 341**
- 1 0.002 mfd., mica, **C12** — **T.C.C. "M"**
- 1 0.001 mfd., mica, **C9** — **T.C.C. "M"**
- 1 0.0001 mfd., mica, **C6** — **T.C.C. "M"**
- 1 0.00005 mfd., mica, **C8** — **T.C.C. "M"**
- 1 25 mfds., 25 volts, electrolytic, **C13** — **T.C.C. "FT"**

1 Dial, full vision, dual speed — **Eddystone 1070**

1 RF Choke — **Eddystone 1010**

1 Trimmer, mica, **C5** — **Eddystone 1923**

Resistances:

- 1 100 ohms, ½ watt, **R9** — **Bulgin HW37**
- 1 150 ohms, ½ watt, **R10** — **Bulgin HW38**
- 1 20,000 ohms, ½ watt, **R1** — **Bulgin HW19**
- 3 50,000 ohms, ½ watt, **R2, R5, R6** — **Bulgin HW23**
- 1 500,000 ohms, ½ watt, **R8** — **Bulgin HW31**
- 1 2 megohms, ½ watt, **R4** — **Bulgin HW34**

1 Volume control, 25,000 ohms, **R7** — **Bulgin VC46**

1 Volume control, 50,000 ohms, **R3** — **Bulgin VC47**

1 Valve holder, 4-pin, chassis type — **Eddystone 1073**

1 Valve holder, 4-pin, baseboard type — **Eddystone 949**

1 Valve holder, 5-pin (without terminals) — **Clix Chassis Mounting Standard Type V1**

1 Switch, SPDT, **S2** — **Bulgin S81T**

1 Switch, DP, on-off, **S1** — **Bulgin S126**

2 Stand-off insulators, Midget — **Eddystone 1019**

1 Battery cable, 4-way — **Belling-Lee**

6 Terminals, LS+, LS−, P+, P−, A, E — **Belling-Lee "R"**

2 Flexible couplers — **Premier Supply Stores**

8 Coil formers, 6-pin, self-locating type — **B.T.S.**

2 Coil bases, 6-pin, chassis type — **B.T.S.**

Chassis: 10×10×2in., plywood

Miscellaneous: — **Peto-Scott**

Aluminium for front panel, 10×8½in., and screen 10½×6½in., 5 brackets, 1 piece paxolin tube 3in. long×½in. dia., 1 length 6 BA Studding with 4 nuts and washers, 2 lengths 6 BA Studding 1½in. long with 5 nuts and washers to each, 6 6BA soldering tags, 6 lengths Systoflex, 4oz. No. 18 tinned copper wire, small quantity Nos. 20 and 22 tinned copper wire, small quantity Nos. 24 D.S.C. and 24 D.C.C. wire, etc. Ebonite for terminal strip 10in.×2½in.×⅜in. **Screws:** (Wood) 8 ½in. 4BA, R/Hd., 24 ¼in. 4BA, R/Hd., 2 ½in. 6BA, R/Hd., 3 1in. 4BA, C/Sk.; (Metal) 7 ¼in. 6BA R/Hd., with nuts.

Valves:

- 2 SG220 — **Hivac**
- 1 KT21 — **Osram**

Television Programmes

An hour's special film transmission intended for the Industry only will be given from 11 a.m. to 12 noon each week-day.

Sound	Vision
41.5 Mc/s.	45 Mc/s.

THURSDAY, MAY 12th.

3, "Comic Strip"—a programme of American humour. **3.20,** British Movietonews. **3.30,** 145th edition of Picture Page.

9, Cabaret, including George Robey. **9.25,** Gaumont-British News. **9.35,** 146th edition of Picture Page. **10.5,** News Bulletin.

FRIDAY, MAY 13th.

3, Marcel Boulestin talks about Spring Vegetables. **3.15,** Gaumont-British News. **3.25-4.10,** The Vic-Wells Ballet in "Checkmate"—a ballet in one scene with a prologue.

9, Marcel Boulestin, as at 3 p.m. **9.15,** "The Emperor Jones"—the famous play by Eugene O'Neill, a macabre study of an incident in the Pacific, with Robert Adams in the name part. **10.15,** British Movietonews. **10.25,** Preview. **10.35,** News Bulletin.

SATURDAY, MAY 14th.

3, Polo: O.B. from Hurlingham of part of the Whitney Cup Final. **3.15,** Cabaret. **3.40,** Cartoon Film. **3.45,** Polo O.B. continued.

9, "After Dinner," Shanklin's Modern Concert Party. **9.35,** Gaumont-British News. **9.45,** "Rory Aforesaid"—a West Highland comedy by John Brandane. **10.15,** News Bulletin.

SUNDAY, MAY 15th.

3-3.45, O.B. from Hurlingham of Veteran Car Gymkhana.

8.50, News Bulletin. **9.5,** Peggy Wood, the celebrated actress, with the Television Orchestra. **9.15,** Film. **9.25-10.25,** "Viceroy Sarah"—the play by Norman Ginsbury, with Marie Ney in the name part.

MONDAY, MAY 16th.

3-4.30, "So Much to Do," a play by H. R. Barbor on the life of Cecil Rhodes; it projects many of the episodes in his African pioneer work. Rhodes will be played by Arthur Young.

9, Jack Hylton and his Band. **9.35,** Gaumont-British News. **9.45,** "Three Artistes"—Pearl Argyle dances to the music of Lisa Minghetti's violin and Theyre Lee-Elliott illustrates the movements of the dancer with sketches. **10.15,** News Bulletin.

TUESDAY, MAY 17th.

3, Eric Wild's New Band. **3.15,** Cartoon Film. **3.20,** Gaumont-British News. **3.30,** "The Wife of Bath's Tale," a Pepler Masque.

9, "In Our Garden," by C. H. Middleton. **9.10,** British Movietonews. **9.20,** "So Much to Do," as on Monday at 3 p.m. **10.50,** News Bulletin.

WEDNESDAY, MAY 18th.

3, Starlight. **3.5,** Craftsmen at Work. **3.15,** British Movietonews. **3.25-4.10,** "Deidre," a play in verse by W. B. Yeats.

9, "100% Broadway." **9.40,** Gaumont-British News. **9.50,** as at 3.5 p.m. **10,** News Bulletin.

Ultra-Short-Wave Wiring

By PAUL D. TYERS

THE author describes some of the more obscure causes of interaction in receivers operating in the 5- and 7-metre regions, and in particular draws attention to the possibilities of unwanted couplings in the earth connection —usually regarded as "dead." He also describes a system of "radiated" symmetrical earth wiring.

THE design of the chassis and the arrangements of wiring and components for broadcast frequencies are comparatively simple. No special precautions are necessary and provided reasonable care is taken a perfectly stable receiver is easily produced. In the case of high radio frequencies a number of problems arise which are not met with in broadcasting practice and accordingly the experimenter should be interested in a consideration of the unusual points which occur.

Special Precautions for High Radio Frequencies

The effect of stray admittances is very great at frequencies of the order of 40 Mc/s. This is not surprising when one considers that the reactance of a capacity is an inverse function of the frequency.

In all high-frequency circuits the current distribution tends to be towards the skin of the conductor, and, obviously, this effect is greatly enhanced at higher frequency working. Whereas a few inches of wire in the form of a connecting lead can be disregarded at broadcasting frequencies, the reactance of the lead at high frequencies is quite appreciable.

While in a broadcasting receiver the chassis can be regarded as being more or less uniformly at earth potential this is far from the case at high radio frequencies.

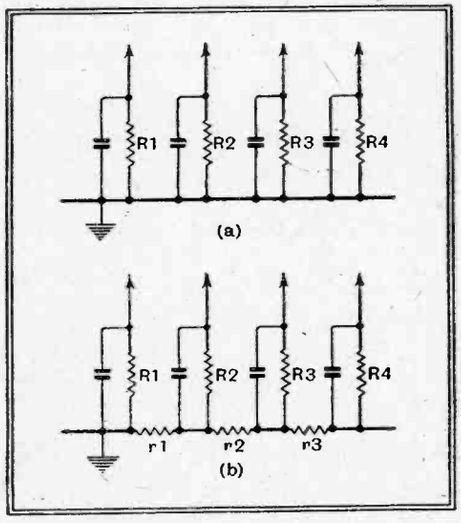


Fig. 1.—R1, R2, R3 and R4 are mutually coupled through the residual reactance of the earth line r1, r2 and r3.

This is found even in a broadcast receiver operating down to 15 metres.

It is obvious, therefore, that in designing a chassis for high-frequency work all these points must be considered. While it is practically impossible to lay down any hard and fast rules it seems desirable to consider how a chassis may be constructed so as to avoid as far as possible the various effects that have been enumerated.

The first consideration is obviously the chassis frame itself. Undoubtedly, thick copper suggests itself as being ideal. It has the advantage of low resistance and adequate screening properties. Against this, however, is the cost, which is quite considerable if the chassis is of appreciable size. In making a final decision the overall stage gain and the frequency at which the amplification is carried out are important factors. A large multi-valve amplifier with a high gain working at frequencies of the order of 40 Mc/s is quite likely to lead to trouble if ordinary steel is used in a haphazard way. On the other hand, in building a television receiver with a three- or four-stage intermediate amplifier working at 10 to 12 Mc/s, steel will give entirely satisfactory results.

The really important point, however, is that of earthing. Provided a very low resistance earth bus-bar is fitted then liberties can definitely be taken in the chassis frame itself. In fitting an earthing bus-bar to a chassis it is rarely possible to use a single bar in such a position that short leads are obtained from all the points which have to be taken to earth, and it is generally necessary to use some form of network. If this is done it is advisable to arrange it so that loop circuits, across which appreciable potential differences can build up, are not produced. Even an earth bar of very heavy sections underneath the chassis is not at the same potential throughout.

This fact makes desirable the use of a symmetrical radial system. This principle can be applied both to leads or pairs of leads and also to an earth network. Fig. 1 shows how it is easy to obtain coupling between leads taken to what is supposedly a conductor at uniform potential. The conventional representation of diagram (a) has been redrawn in diagram (b), where the earth conductor is actually shown as a resistance. Immediately, it is obvious that each lead is partly coupled to the others. Fig. 2 shows how this is avoided in a radiated wiring system. A very convenient radiated bus-bar system is shown in Fig. 3, and a system of this type has been used by the writer in a number of amplifiers, including television sets, with great success, the receivers having a very high degree of inherent stability.

A particular adaptation of the earth bus-bar system has been worked out by the writer, in which exceedingly simple decoupling is obtained because leads carrying high-frequency currents are reduced to a minimum. The system consists of placing an earth bus-bar directly below the valve bases and the transformer or coil connections. The distance is such that an ordinary standard resistance and a small tubular condenser can be connected directly between the valve or coil socket and the earth bar. Long cathode wires are responsible for more trouble in a multi-

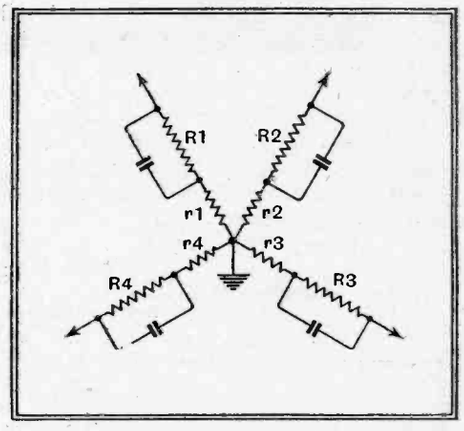


Fig. 2.—Radial system of earth connections in which the residual reactance of Fig. 1 is no longer common to several circuits.

valve high-frequency amplifier than anything else and this arrangement entirely obviates the difficulty. The photograph shows clearly the relative positions of the condensers and resistances.

Condensers used for decoupling high-frequency amplifiers play a very important part. The efficiency of the decoupling circuit depends entirely upon the relative impedance of the feed resistance and the condensers. It should be very obvious from first principles that the larger the condenser the lower will be the impedance, and, therefore, the greater the decoupling. This is perfectly correct from a theoretical point of view, but it is not the case in actual practice. Every condenser has a slightly inductive component, and,

Ultra-Short-Wave Wiring—

of course, the power factor is not zero. The larger the capacity of the condenser the greater tends to become the actual inductive reactance, and the equivalent resistance is therefore a function of the total capacity. The ideal condenser is probably a flat mica combination which has a good power factor and is substantially non-inductive. Experiment has shown, however, that the tubular type of paper condenser with a capacity of 0.01 mfd. with a swaged end connection is eminently satisfactory, and condensers of this type are relatively cheap when compared with the flat mica type. Tests on such a condenser (T.C.C. Type 451) show that the residual inductance is substantially 0.01 microhenry. Even a condenser of this type cannot be used indiscriminately, and it is very important that the outer foil is connected to the earth side. The writer has had experience of an amplifier which was not stable in which some 15 to 20 condensers of this type were employed. The instability was found to be due to a reversed connection on a cathode decoupling condenser in one of the amplifying stages. Reference is made to this occurrence simply to indicate the necessity of paying attention to very small details in high-frequency chassis work.

Inspection of the photograph shows that the only undecoupled lead of appreciable length carrying high-frequency currents is that marked A, which connects the coil to the anode pin. The provision of screens between the base of the valve sockets whereby the chassis is divided into a number of compartments effectively prevents any trouble due to stray coupling from these leads. It is not usually necessary with frequencies of the order of 10 to 15 megacycles to employ very elaborate screening, and a small partition of quite thin metal does all that is required. End-

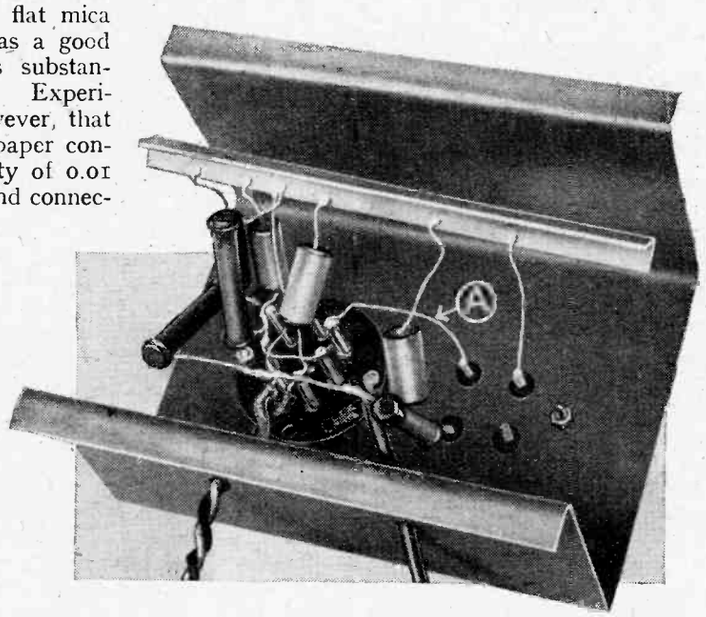


Fig. 4.—Under-chassis view illustrating the use of a heavy brass bus-bar for connection of decoupling components, etc.

less trouble, however, can arise from these partitions, particularly at the higher frequencies. It is vitally important that the whole chassis (and this, of course, includes these divisions) is completely mechanically stable and electrically continuous. The writer once investigated a chassis which was giving intermittent results, and the trouble was found to be due to nothing other than indifferent contacts between the screening compartments, the screens in question being screwed into position. When a steel chassis is used spot welding is very satisfactory, but if bolted copper or aluminium is employed locking washers should be used on the retaining bolts. In the case of a tin, iron, copper or brass chassis soldered joints can be successfully used.

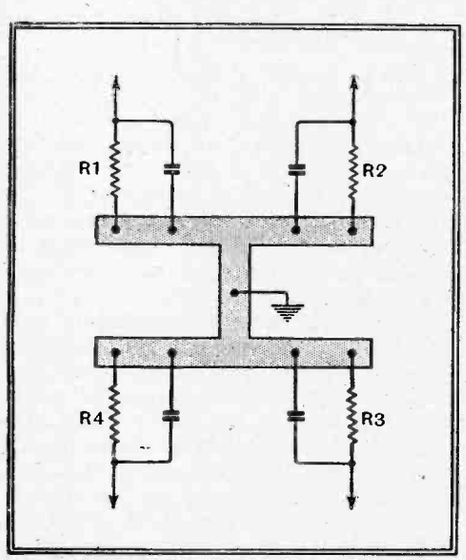


Fig. 3.—The wiring system of Fig. 2 in practical form, showing the use of a heavy earth bar.

Isolation by Screening

The remarks concerning the chassis in general obviously apply to cans or screens used on coils and transformers. An indifferent contact between the base of an open can on the top of the chassis will again cause endless trouble. If there is any possibility of this arising it is better to isolate the screen completely from the top of the chassis and simply make a positive earth connection at one point.

Closely associated with the subject of coils and transformers is that of tuning condensers. This is too important and too vast a subject to discuss here, and apart from the obvious necessity of mechanical rigidity, it is proposed to make no mention of it.

Another apparently harmless component which may give no end of trouble is the screened lead. Screened leads are of two types, those with a woven braid screening and those employing a spiral tube. Sometimes the central conductor is insulated by ceramic beads, while in other cases it is partially air spaced with some form of insulating material. Whilst a low capacity is generally desirable for high frequency work, this is by no means the most important property. Mechanical stability is of fundamental importance. If the central conductor is free to move with respect to the outer screening, the effective capacity of the lead will vary by a fraction of a micro-microfarad. Variation of this order at high frequencies is quite sufficient to cause trouble. Tests have shown that the spiral type of screening is very unsatisfactory, and quite a large potential gradient may be set up across the outer screening. As a rule screened leads are quite short, and in this case they form part of the tuned circuit in which they are connected. Where high magnification is of importance and a high dynamic resistance for the tuned circuit is necessary, the lead should obviously have the lowest possible losses and stray capacity. In vision technique, however, a high dynamic resistance for the tuned circuit is rarely necessary, and in many instances ordinary braided flexible wire with rubber insulation is a far better article than a low-loss lead with bad mechanical stability and an appreciable potential gradient along the screen.

Long screened leads are highly undesirable for very high frequency work, as apart from producing a bad L/C ratio they are prone to act in the manner of a transmission line, which is obviously incorrectly terminated, and accordingly the lead introduces marked attenuation. Provided the lead is short the resonant circuit will function satisfactorily. The final lead found most satisfactory by the writer consists either of a central conductor spaced on a Telconax spider with a heavy outer braiding or alternatively a special arrangement of ceramic beads with a heavy outer screening and a conductor with a very thin insulating layer which is a tight friction fit in the hole in the bead. This forms a mixed dielectric and the insulating material on the conductor certainly tends to increase the capacity, but the increase is not sufficient to be of any real consequence.

If careful attention is given to the various points which have been dealt with it should be possible to produce a highly satisfactory chassis for high-frequency working. Any departure from the method suggested or alternative arrangements having the same effect are more than likely to result in considerable trouble, and too much care and attention cannot be given to small points before undertaking any high-frequency design.

TELEFUNKEN PICK-UP

PYE, LTD., inform us that they are now the sole distributors in this country of the Telefunken pick-up. They can give immediate delivery of the Model TO.1001 with improved sapphire mounting and protective roller. The price remains at 5 guineas.

CHOOSING SHORT-WAVE COIL VALUES

Assessing Stray Capacities and Finding Coil Turns

SHORT-WAVE coils require so few turns that they are readily constructed and the chief difficulty encountered lies in deciding how many turns will be needed for a given tuning range. In general, it is not possible to calculate precisely the turns needed, for they depend upon many factors which are rarely known exactly. Fortunately, however, it is usually possible to estimate these factors with sufficient accuracy to enable the design of a coil to be carried out with a useful degree of precision.

IN experimental work it is often necessary to wind a coil for a given tuning range. It is explained in this article how to assess the stray circuit capacities and find the tuning condenser needed for a given coverage. The coil inductance required, and the number of turns of wire on a given former to give that inductance, can be found with little calculation.

Knowing the tuning range required in metres or kc/s, the first step is to divide the higher figure by the lower to obtain the frequency or wavelength ratio. Then square this figure; the resulting figure is the ratio of maximum to minimum capacity required. Thus if f_{min} and f_{max} are the minimum and maximum frequencies to which the circuit must tune, the frequency ratio $f_r = f_{max}/f_{min}$, and the capacity ratio $C_r = f^2_r = f^2_{max}/f^2_{min}$. Working in terms of wavelength we have similarly $C_r = \lambda^2_r = \lambda^2_{max}/\lambda^2_{min}$.

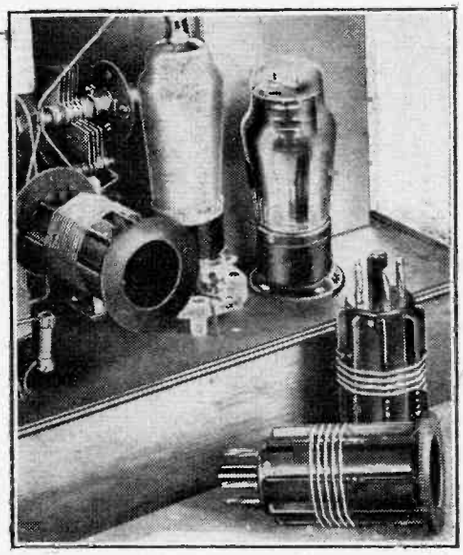
Stray Circuit Capacities

In obtaining a given waveband coverage the important factor is this ratio of maximum to minimum capacity and not the capacity of the variable condenser itself. The minimum capacity C_{min} is the sum of the circuit stray capacities C_s and the minimum capacity C_1 of the variable condenser alone. Similarly the maximum capacity C_{max} is the sum of the circuit stray capacities C_s and the maximum capacity C_2 of the variable condenser alone. That is, $C_{min} = C_s + C_1$ and $C_{max} = C_s + C_2$. From this data we find

$$C_2 = C_s(C_r - 1) + C_rC_1 = C_rC_{min} - C_s.$$

The values which are usually unknown are C_s and C_1 and it is necessary to estimate these. Now C_s is the total of the circuit stray capacities and depends on the circuit used, the layout of components and wiring, the valves employed, and the type of winding of the coils. The estimation of capacities, however, is less difficult than it sounds. The valve capacities can be obtained from the makers or from *The Wireless World* Valve Data Supplement. The coil capacity with a single-layer winding is usually around 5 $\mu\mu$F., and with a good layout the wiring capacities will come to about the same figure. With plug-in coils having well-spaced pins another 2–5 $\mu\mu$F. should be added for the base and with switching some 5–15 $\mu\mu$F. according to the type of switch and the length of wiring which will be adopted. If a trimmer is used, at least 3 $\mu\mu$F. should be allowed for its minimum capacity.

As an example, suppose we are building a coil for use with a tuned anode coupling between a KTW63



valve used as an RF stage and a KTZ63 detector. We estimate the capacities as shown in the following table:

Output capacity of RF valve	KTW63		10.4
Input capacity of Detector	KTZ63		5.1
Coil capacity	say		5.0
Coil base capacity ...	say		3.0
Wiring	say		5.0
			28.5 $\mu\mu$F.

Say 30 $\mu\mu$F. total.

We thus take $C_s = 30$ $\mu\mu$F. Now if we want to cover 15–30 metres, we have $C_r = (30/15)^2 = 4$ and consequently $C_2 = 30(4-1) + 4C_1 = 90 + 4C_1$. The value of C_1 depends on the construction of the variable condenser and in general increases with the maximum capacity C_2. Thus a 0.0005 μF. condenser of the ganged type may have $C_1 = 15$–25 $\mu\mu$F., whereas an ultra-short-wave condenser of maximum capacity 40 $\mu\mu$F. may have $C_1 = 3$–6 $\mu\mu$F. A typical figure for a condenser of 100–160 $\mu\mu$F. maximum capacity is around 6–10 $\mu\mu$F. Taking $C_1 = 7$ $\mu\mu$F. we have

$$C_2 = 90 + 28 = 118 \ \mu\mu\text{F}.$$

A condenser with a maximum capacity of 120 $\mu\mu$F. would be suitable.

Taking this figure we have

$$C_{min} = 30 + 7 = 37 \ \mu\mu\text{F}.$$

and $C_{max} = 30 + 120 = 150$ $\mu\mu$F., so that the new value of C_r is

$$150/37 = 4.05 \text{ and } f_r = \lambda_r = 2.015.$$

We shall thus cover 15–30.2 metres.

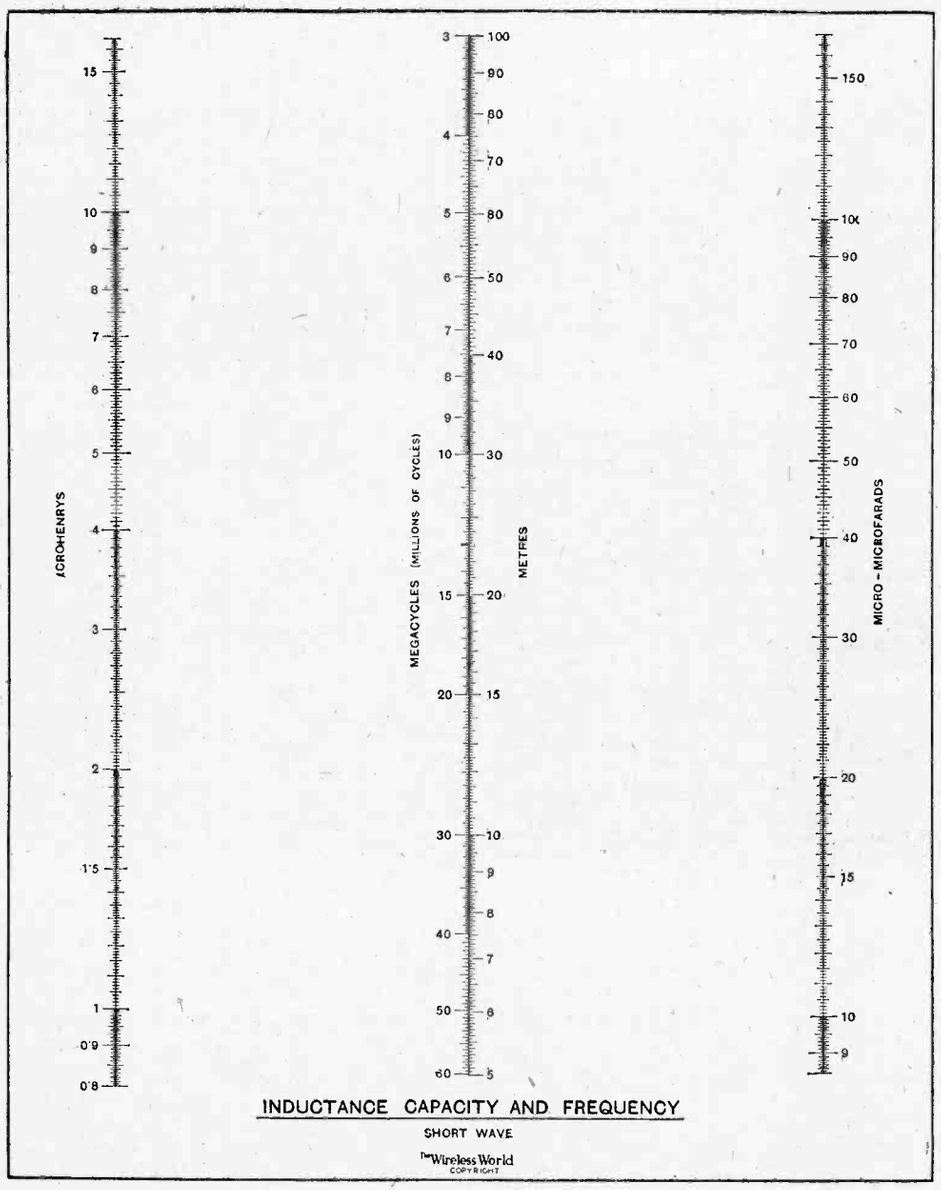
Calculating Coil Inductance

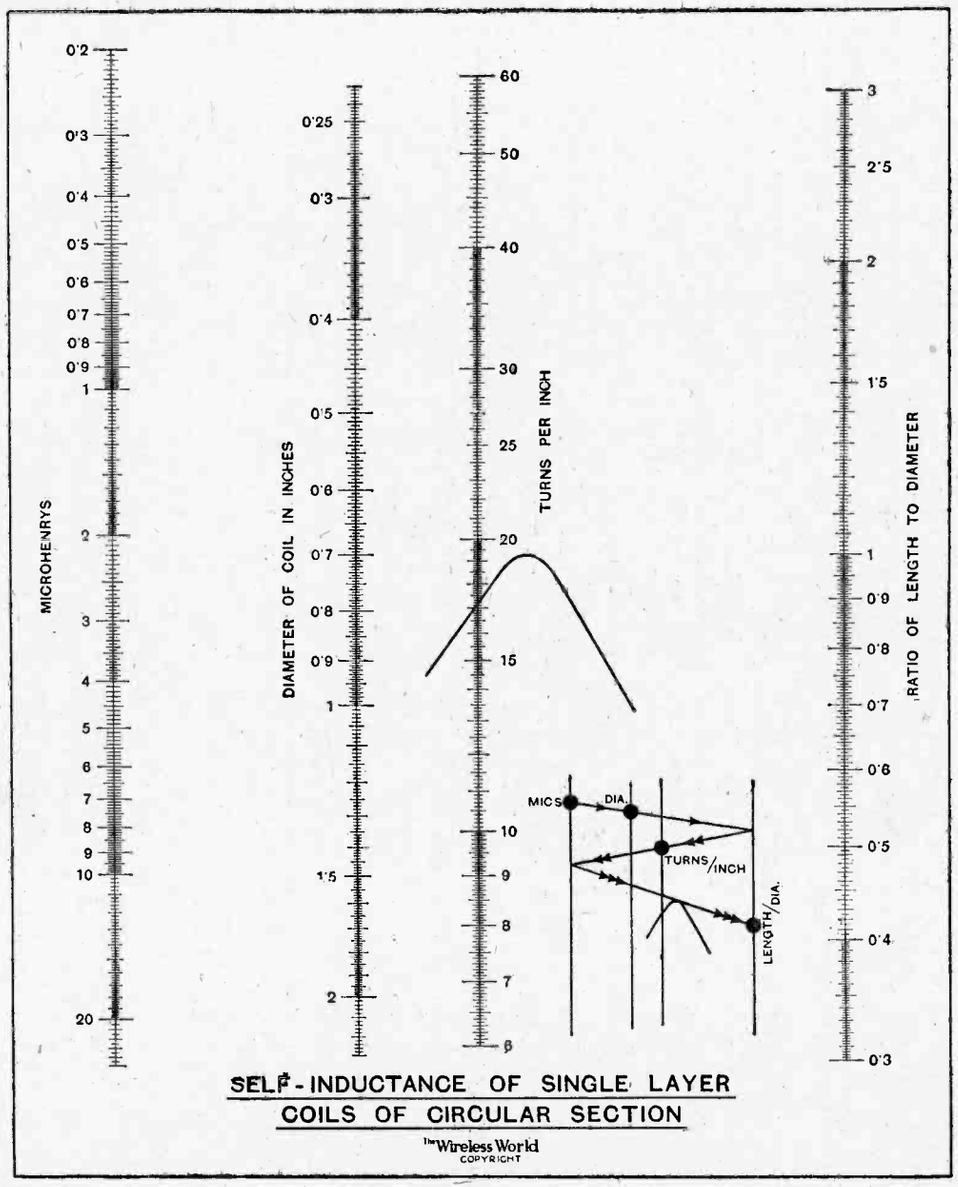
The inductance of the coil needed can be found without calculation from the Abac connecting inductance, capacity, and frequency (or wavelength) by placing a straight-edge across the three scales. We connect 37 $\mu\mu$F. on the right-hand scale with 15 metres on the centre scale and read off the inductance on the left-hand scale. For this case it is 1.7 μH.

The next step is to design a coil of this inductance and for this we use the second Abac. The inductance depends on the number of turns, the mean diameter, and the winding length. It is usual to start with the inductance required, the diameter of the former, and the wire which will be used. Where thin wire is used the mean diameter of a single-layer coil can be taken as the diameter of the former, but it is actually the diameter of the former plus the diameter of the wire. With heavy gauge wire and a small diameter of former this must be taken into account. If the former is grooved for the wire, however, its actual diameter at the winding points is less than its overall diameter by the depth of the groove. It is usual to let this compensate for the wire diameter and take the mean diameter as the overall former diameter.

Let us suppose that we are using such a former with a diameter of 0.75 in. and that we choose 16 turns per inch for winding, since this is a standard pitch for grooved formers. Starting with 1.7 μH. on the inductance scale and 0.75 in. on the diameter scale, we place a straight-edge across the Abac to intersect the length/diam. scale at 0.62. This figure means nothing in itself, but this point on the scale is used for the next step, which is to join this point through the appropriate point on the Turns per Inch scale (in this case 16) back to the inductance scale. This turns out at 1.78. We again use this as a turning point and go back to the Length/Diameter scale, this time placing the straight-edge so that it makes a tangent to the curve on the Abac. In this case it falls across the peak of the curve and we now read off 0.922 as the ratio of length to diameter. As the diameter is 0.75 in. the length is 0.691 in.

ABACS SHOWING THE RELATION OF INDUCTANCE, CAPACITY AND FREQUENCY AND THE INDUCTANCE AND PHYSICAL CONSTANTS OF A COIL.





The correlation between inductance, capacity and frequency is obtained by placing a straight-edge across the three lines of the left-hand Abac; if any two quantities are known the third can immediately be read off. The right-hand Abac enables the ratio of length to diameter of a coil to be determined and, as diameter and turns per inch are known, the number of turns. In use the straight-edge is placed across the Abac three times as shown in the explanatory diagram. The Abacs are reproduced (on a reduced scale) from " Radio Data Charts " by R. T. Beatty, M.A., D.Sc., issued from *The Wireless World* Office.

Choosing Short-Wave Coil Values—

and at 16 t/in. this gives 11.08 = 11 turns.

If we are designing a set of coils to cover a wide range, we shall have roughly the same capacity ratio on all bands, for the only variation will lie in the coil capacities. We can thus quickly tabulate a list of inductance values from Abac 1 to cover our various bands and then design the coils themselves from Abac 2 in the manner just described. It will often be found necessary to change the diameter and turns-per-inch in such a series, for if an attempt is made to keep them constant through a whole series of coils of widely varying inductance some of the coils will come out absurdly long and others very short. A 0.75 in. former and 16 t/in. usually gives a reasonable coil for inductances of 1–5 μH., but for lower inductance coils it is wise to change to a 0.5 in. former, or, better, to 8 t/in. For larger coils one should use a 1 in. former, if possible, and eventually closer winding.

On the Short Waves

NOTES FROM A LISTENER'S LOG

I CONSIDER one of the most important of recent short-wave "developments" to be the production by the Ediswan valve works of a low-priced transmitting triode especially for amateur use.

One refers, of course, to the new E.S.W.20, and to judge from the details already published, this valve is likely to be very popular.

Of perhaps even greater interest, however, is the implication associated with the production of this valve, that of a rapidly growing *official* interest in amateur affairs.

The contribution of the amateurs to the radio art has been by no means negligible, and of recent years, especially in America, considerable achievements in maintaining communication in emergencies have been made.

In the U.S.A. the opportunity for amateur public service has more often than not arisen out of the breakdown of normal telephone and telegraph facilities as a result of floods and similar natural disturbances.

Widespread havoc of the type unfortunately all too common in America is an extremely rare occurrence in this country, so that here, so far, the amateur has had to confine his attentions to strictly scientific or pseudo-scientific studies.

This may not always be so, however, in view of the rather delicately poised political state of Europe, and, indeed, the world at the moment.

It does not need to be emphasised, I feel, that in the event of this country being involved in a European war, and that in repeated air attacks, dislocation of communications on a large scale would follow.

One suggests, therefore, that the time has now arrived for better direction of amateur communication facilities, according to some plan, which might well be centralised with the licence issuing authorities.

It has been suggested that the Post Office Radio Section might establish a bureau with powers to issue literature summarising recent developments in the radio art, special attention being given to the amateur aspect.

In a few years it should be possible to build up quite a useful emergency network, based on direct-ray 56 Mc/s transmission. This frequency has the advantage, of course, that it would not produce audible signals outside of the country except under very abnormal conditions.

If any sort of encouragement were offered, perhaps, under A.R.P. schemes, no doubt quite a few amateurs would willingly produce small petrol-electric sets and the like, in order to ensure continuance of communication should power supplies fail.

In this connection, one is pleased to record that the number of signals on 56 Mc/s audible in Epsom is rapidly increasing, and most evenings at least one or two 'phone signals of the crystal-controlled variety are to be heard. Activity is greatest generally after 10 p.m. B.S.T.

One interesting station on this band is "old-timer" G2OD at Ascot, Berks.

The two strongest signals to me, however, are G5MA, Ashtead, and G2LH, of Surbiton.

I am not certain what the most popular 56 Mc/s transmitting aerial is at the present time, but my experiences favour a $3/2\lambda$ horizontal wire, fed in the centre with an open wire feeder, the length of the feeder being adjusted until it presents a low impedance to the transmitter. A single-turn coil is then used to couple it to the transmitter output tank circuit.

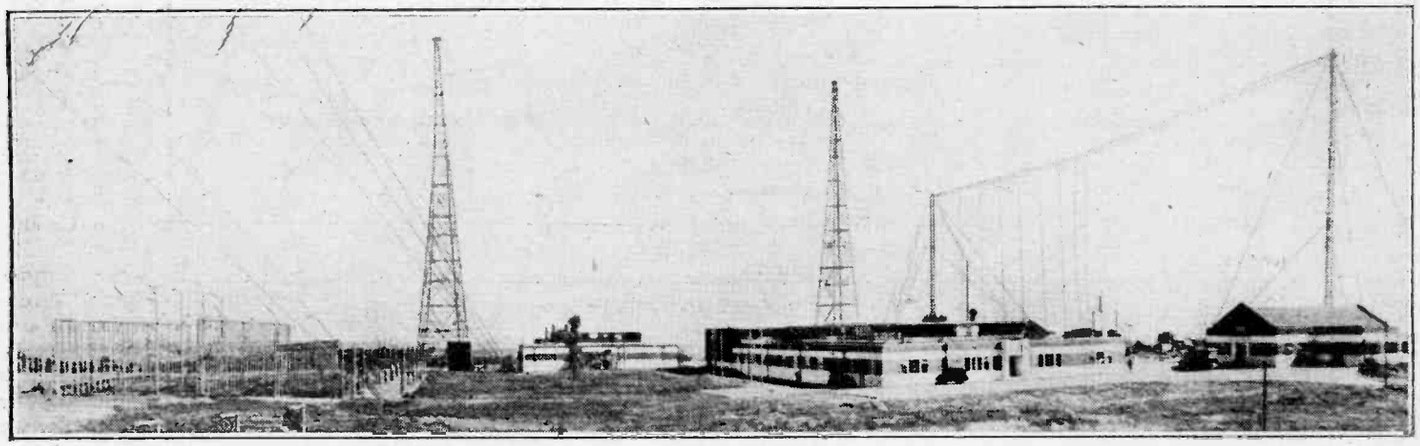
In practice this means that the line will be approximately an even number of quarter-waves long.

The horizontal diagram of such an aerial is substantially circular, and the energy is considerably concentrated at low angles, especially if the wire is erected at a wavelength or greater above earth.

The balanced loading of the feeder line makes this type of aerial superior to the same length of wire fed in the so-called Zeppelin manner, although, neglecting feeder-line radiation, the horizontal diagram will be the same in both cases.

Ideally, of course, the particular aerial will radiate and respond only to horizontally polarised waves, and this point should be borne in mind when arranging tests with portable stations.

ETHACOMBER.



THE EMPIRE LINK. A recent view of the Empire short-wave station at Daventry showing some of the twelve masts, which, varying in height from 150 ft. to 500 ft., support the 25 aerial arrays. On the left is the HF feeder distribution and switching frame, whilst right centre is the new transmitter building which is now being extended to cover almost double its size to provide accommodation for the two recently-ordered transmitters and a further two which may become necessary later. The halyards taking the strain of each complete array are fixed by balance weights at ground level so that the tension on them does not exceed a safe value during heavy winds or ice loading.

Three New Murphy Sets

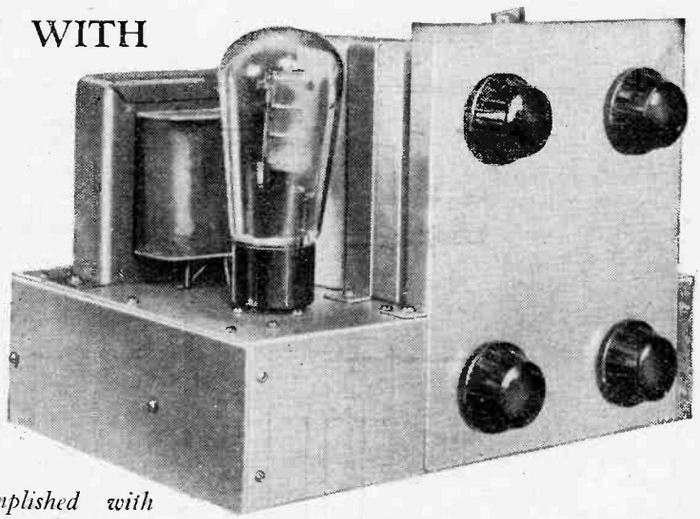
A BATTERY-OPERATED console and two new table models have now been added to the Murphy range. The console has the same circuit as the B47 table model, but a special loud speaker of high sensitivity is employed, having more than twice the weight and efficiency of the smaller unit. Average HT consumption at 120 volts is 8.5 mA on medium and long waves and 12.5 mA on the 16.7-50-metre range. The price is £14 5s., less batteries.

The two type "50" sets for AC and DC operation have provision for 7-metre television sound and are superheterodynes in which the RF stage may be permanently cut out by the dealer on medium and long waves to avoid overloading the frequency changer when the customer is near a strong station. On short waves the improved image rejection and signal-to-noise ratio given by an RF stage are retained. The A50 costs £16 and the D50 £16 5s.

Ultra-Short-Wave High-Fidelity Adaptor

HIGH-QUALITY REPRODUCTION WITH THE BROADCAST SET

By
W. T. COCKING

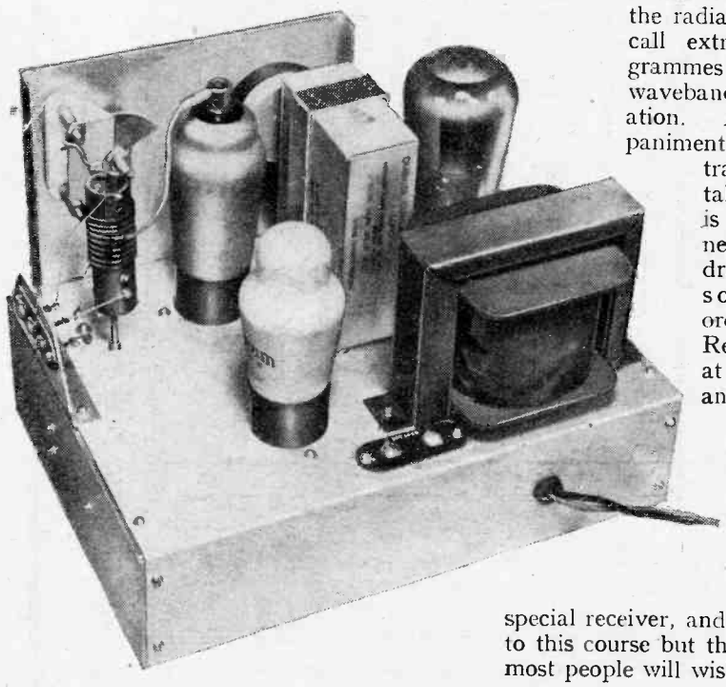


WHEN the aim is high-quality reproduction, reception on the ultra-short wavelengths is most easily accomplished with an adaptor consisting of a small straight set which feeds into the pick-up terminals of the standard broadcast receiver. In this article an adaptor of this nature is described and it gives a good performance in the reception of the television sound programmes.

THE quality of reproduction obtainable on the medium waveband is limited by several factors. In the first place the close frequency spacing of stations necessitates the use of fairly selective receivers if interference is to be avoided. Such sets inevitably reduce the upper audible frequencies, with the result that the reproduction is adversely affected. At very short distances from a transmitter, of course, the signal, by its sheer strength, overrides interference and high selectivity is unnecessary. It is then possible to reproduce the upper musical frequencies without any limit at the receiver.

The frequency range broadcast at the transmitter, however, does not as a rule extend much beyond 10,000 c/s, for several good reasons. In the first place, an extension of the range of modulation frequencies would, on the medium waveband, involve an appreciable increase in the cost of the transmitter; secondly, it would tend to cause more interference with other stations; and thirdly, very few would gain any advantage because of their need of selectivity for the avoidance of interference.

When we come to the ultra-short wavelengths, however, these considerations do not apply and modulation frequencies up to the limit of audibility can be used. The extension of the range causes less difficulty at the transmitter than would be the case on the medium waveband and there is no need to limit the quality in the receiver, for high selectivity is not wanted.



In view of this it is not surprising that the radiation of what we may call extra-high-fidelity programmes on the ultra-short waveband is under consideration. As the sound accompaniment to television such transmissions do in fact take place now, but it is probable that in the near future the Alexandra Palace will radiate some parts of the ordinary National or Regional programmes at extra-high fidelity and outside the ordinary hours of television transmission. Such transmissions are on 41.5 Mc/s or 7.23 metres.

For their reception the obvious thing to do is to build a special receiver, and there is no objection to this course but that of cost. Probably most people will wish to press their existing receiver into service. Most sets, however, cannot readily be altered for ultra-short-wave reception, but can be used in conjunction with an external converter unit. This course is the more convenient, and there are two ways of doing it.

One method is to use a superheterodyne-type converter and change the frequency of the incoming signal to one within the tuning range of the set, say 1,500 kc/s. The other is to use a small straight or superheterodyne receiver built for the ultra-short waves and to feed its output into the pick-up terminals of the broadcast set.

Converter v. Adaptor

The first method seems the better at first sight, but becomes less attractive as one considers the details. The greatest objection is that the quality of reproduction will be limited by the broadcast set. As in the majority of cases this will be too selective to do full justice to the quality of medium-wave transmissions, there is likely to be little, if any, benefit on the ultra-short waves. Even those sets which are up to the standard of the medium-wave transmissions, by virtue of their possessing a good system of variable selectivity, are not likely to have an overall frequency response extending beyond 10,000 c/s.

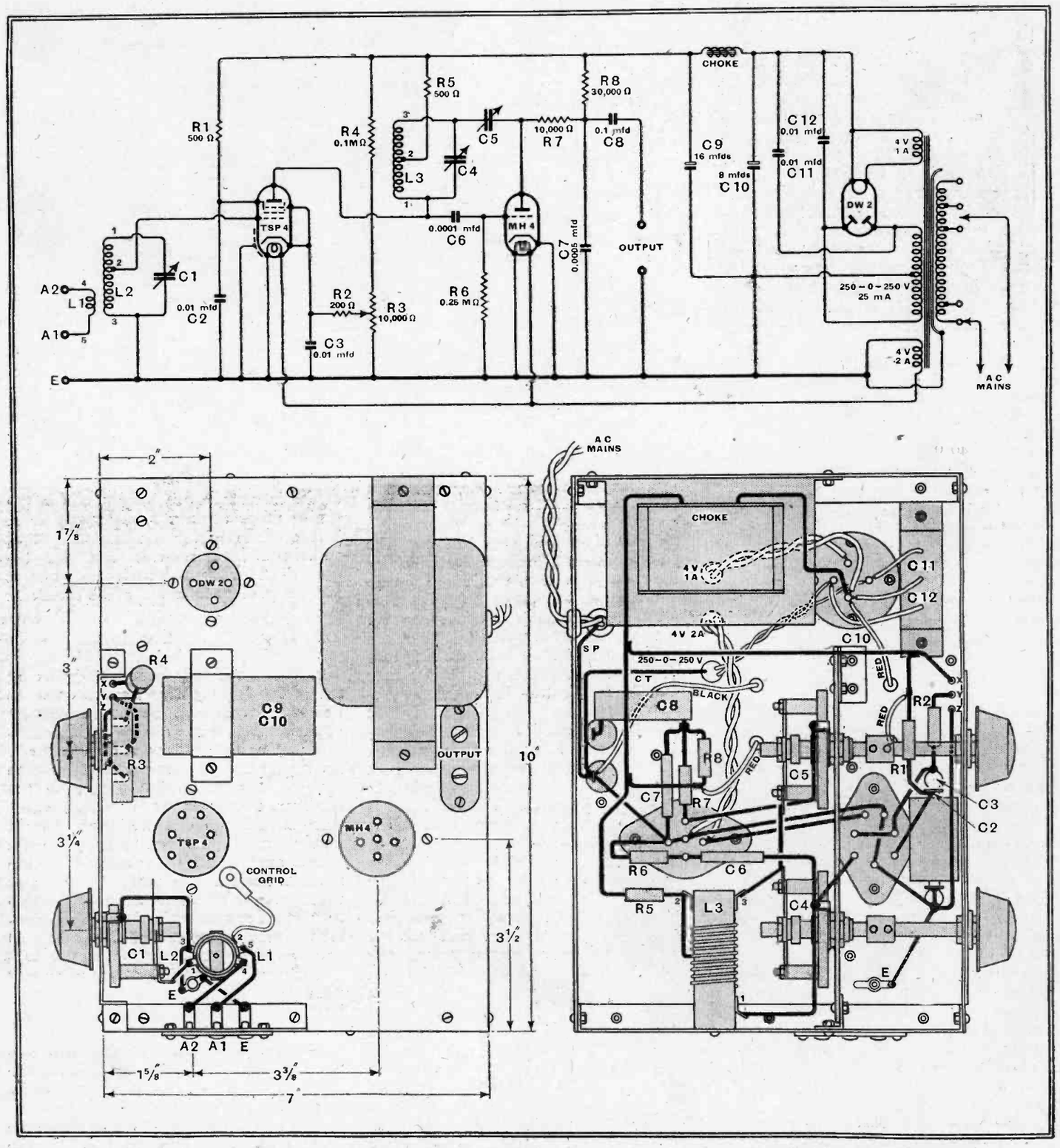
The use of a superheterodyne converter with an ordinary broadcast set is thus likely to lead to a negligible improvement in the reproduction. Moreover, owing to the selectivity of the receiver the avoidance of microphony and tuning drift are likely to present serious problems.

Turning now to our alternative course—the use of a small receiver feeding into the pick-up terminals—the position is quite different. The frequency response of the

Ultra-Short-Wave High-Fidelity Adaptor—

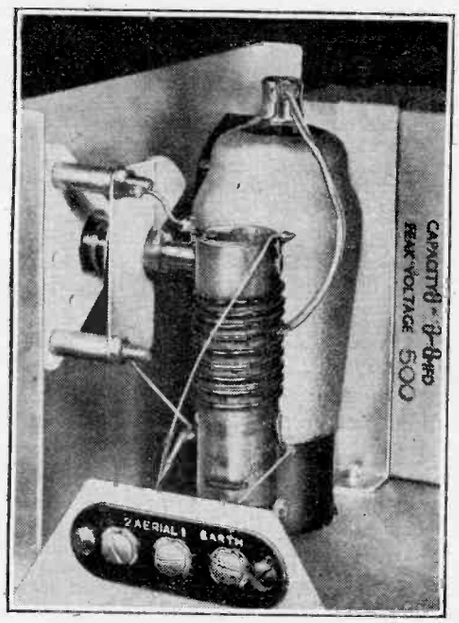
AF side of the average receiver is much better than that of its pre-detector circuits and the USW receiver can be designed to introduce negligible distortion. The precise results obtained will naturally depend on the characteristics of the AF side of the broadcast set and full advantage of the USW transmissions will not be obtained unless the response extends up to some 20,000 c/s. On the other hand, if the normal response of the whole set is only up to some 5,000 c/s and the AF amplifier alone extends to 8,000-10,000 c/s, as is often the case, USW reception will afford a big improvement even although the improvement is not as great as it might be if the AF amplifier were better. Actually, a bigger audible improvement will be found by extending the response in this way from 5,000 c/s to 10,000 c/s than if one already has a limit of 10,000 c/s and extends it to 20,000 c/s.

Experience shows that one of the most suitable types of receiver for our purpose is a simple RF-detector set with reaction. Unless it is pressed to the extreme limit, reaction need cause no loss of quality on the ultra-short waves because the highest modulation frequency involved is such a small fraction of the carrier frequency that it would need an incredibly sharp resonance curve to attenuate the side-bands appreciably. Its use is almost essential in a straight set because a circuit of high dynamic resistance cannot be obtained at a frequency of 41.5 Mc/s. The dynamic resistance of a circuit depends not only upon the RF resistance of the



Circuit diagram of the adaptor together with full details for the assembly of components and wiring connections.

circuit but upon the L/C ratio. By taking care in design it is possible to make the capacity about one-fifth to one-twentieth that normally found on the medium waveband, but the inductance cannot be greater



The aerial tuned circuit is mounted alongside the RF valve.

than 1/150-1/200 of that on medium waves. The L/C ratio is likely to be 1/7.5-1/40 of the medium-wave value.

Now although it is possible by care in coil and condenser design to obtain an extremely low value of RF resistance in these components, it is an unfortunate fact that valves have quite a low input resistance at these frequencies. The precise value depends upon the valve construction and it varies with frequency; it is, however, of the order of 2,000 ohms to 10,000 ohms only for efficient RF pentodes of normal design.

The Aerial Circuit

The result is that the dynamic resistance obtainable in practice is severely limited, for it is the effective dynamic resistance, including the effects of all associated components and valves, which counts. By the application of reaction this unwanted damping can in large measure be removed and its use must be considered essential in a USW straight set.

The arrangement adopted can be seen from the circuit diagram, and it will be noticed that one RF stage is used with a valve of high mutual conductance. A single tuned circuit precedes it and the grid connection is tapped down for two reasons —one is to relieve the tuned circuit in some degree from the load imposed by the input resistance of the valve, and the other is to reduce the stray capacity thrown on to the tuned circuit by the valve.

The aerial is coupled to the tuning coil by a separate winding which consists of two turns only interwound at the earthy end of the main winding. This last has nine turns space wound to eight turns per inch on a ¾in. former and is tapped at the fifth turn for the grid connection. Full details are given in one of the drawings accompanying this article.

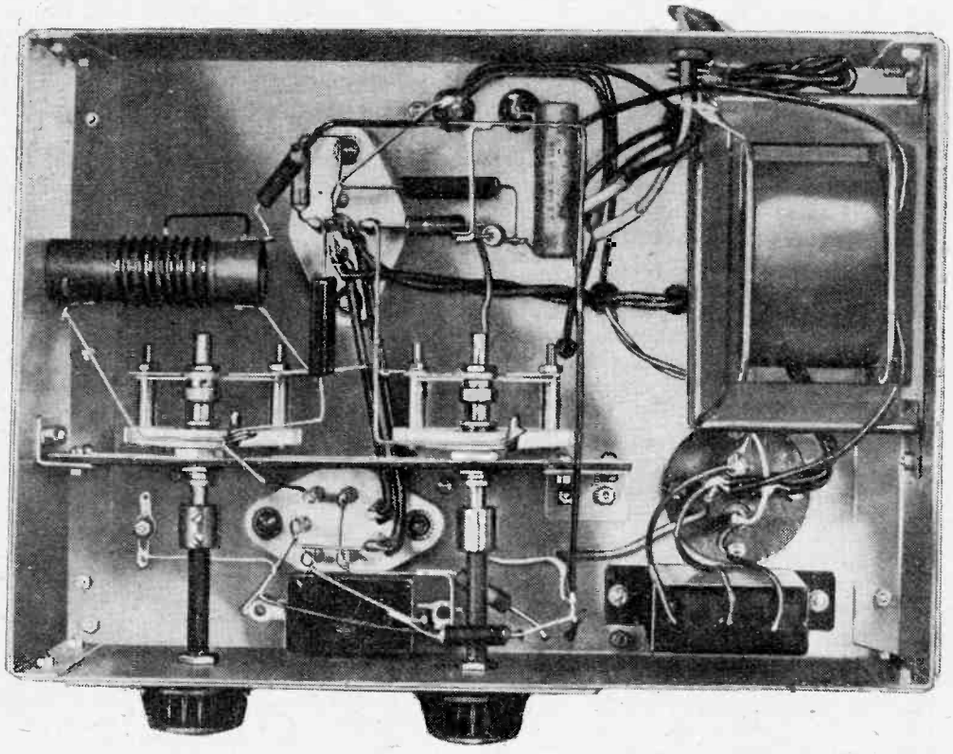
The intervalve circuit may look a little peculiar at first, but is really quite simple, being a form of tapped tuned anode coupling and modified Colpitt's reaction circuit. The tuned circuit L3 and C4 is connected between the grid and anode of the triode detector, the usual grid condenser C6 and reaction condenser C5 being interposed. The centre-point of the coil is connected to positive HT through a 500-ohm resistance R5.

If a condenser were connected to the detector cathode from this centre-tap, the circuit would take the form of the Hartley oscillator. As often as not, however, this arrangement refuses to oscillate at very high frequencies and better results are secured with a floating tap on the coil. By this is meant the arrangement shown, with which the tapping point is not maintained at earth potential to RF voltages. This circuit is really the modified Colpitt's oscillator and the necessary cathode-tap is secured by a capacity potentiometer across the circuit. The capacities involved are actually the grid-cathode and anode-cathode interelectrode capacities of the detector valve, and so do not appear on the circuit diagram. In practice, of course, other stray capacities appear in parallel with them.

LIST OF PARTS USED

1 Mains transformer, with screened primary, 200-250 volts 50 c/s; secondaries, 4 volts 1 amp., 4 volts 2 amps., 250-0-250 volts, 25 mA. **Premier Supply Stores WW/250**
1 Smoothing Choke, 25 mA., 20H., 500 ohms **Premier Supply Stores WW/C25**
Fixed condensers:
2 0.01 mfd., mica, C2, C3 **Dubilier 691**
1 0.0001 mfd., mica, C6 **Dubilier 690W**
1 0.0005 mfd., mica, C7 **Dubilier 690W**
1 0.1 mfd., tubular, C8 **Dubilier 4603/S**
1 8-8-8 mfds., 500 volts, electrolytic, C9, C10 **Dubilier 312**
1 0.01—0.01 mfd., 500 volts, AC, C11, C12 **Dubilier BE328**
3 Variable condensers, 15 mmfds., C1, C4, C5 **Raymart VC15X**
2 Coils **B.T.S.**
(See text for constructional details.)
Resistances:
1 200 ohms, ½ watt, R2 **Erie**
2 500 ohms, ½ watt, R1, R5 **Erie**
1 10,000 ohms, ½ watt, R7 **Erie**
1 30,000 ohms, ½ watt, R8 **Erie**
1 250,000 ohms, ½ watt, R6 **Erie**
1 100,000 ohms, 2 watts, R4 **Erie**
1 Potentiometer, wire-wound, 10,000 ohms, tapered, R3 **Reliance TW**
1 Valve holder, 4-pin (without terminals) **Clix Chassis Mounting Standard Type V1**
1 Valve holder, 5-pin (without terminals)
1 Valve holder, 7-pin (without terminals) **Clix SW Chassis Mounting Floating Type V5**
1 Skeleton captive screw strip, two-way, "Output" **Bulgin T10**
1 Skeleton captive screw strip, three-way, A1, A2, E **Bulgin T11**
Chassis **B.T.S.**
Valves:
1 TSP4 (Met), 1-DW2 **Mullard**
1 MH4 (Met) **Osram**

however, we are not so much interested in obtaining the maximum sensitivity as

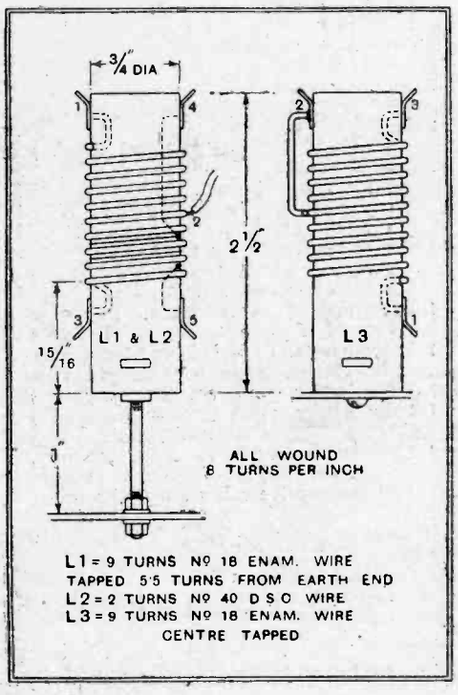


The choice of this circuit has been dictated largely by the use of a triode detector. From the points of view of reaction and sensitivity, better results could be obtained from a tetrode or pentode detector with screen voltage variation for the control of reaction. In this case, in getting the best quality. From this point of view the triode is the better valve for it is much less likely to introduce distortion.

The detector output is taken through a straightforward resistance-capacity coupling to the output terminals, which must

tra-Short-Wave High-Fidelity Adaptor—

be connected to the pick-up terminals of the broadcast set. The adaptor contains its own mains equipment, comprising transformer, rectifier, smoothing choke, and smoothing condenser. These last comprise a triple 8-mfd. block, one section of which is used for the reservoir condenser C10 and the other two are parallel



Full details of the coils are given in this drawing.

to form a 16-mfd. smoothing condenser C9.

No attempt has been made to gang the two tuning condensers, and they are not even provided with tuning scales. Such refinements are quite unnecessary, since the apparatus is intended as a single-station receiver. Tuning is carried out once and for all and normally need not be varied afterwards.

Similarly, the volume and reaction controls are intended to be pre-set. All four controls can be adjusted initially when the gear is set up and thereafter, in most cases, the volume control of the broadcast set will be employed for varying the volume.

When setting up the apparatus connect the two output terminals with the pick-up terminals of the receiver. If a dipole aerial is used, connect its feeder to the two aerial terminals and join the earth lead to the earth terminal. With a plain wire aerial, connect it to A2 and join A1 to the earth terminal.

Set the two tuning condensers about half-way, the volume control at maximum, and advance the reaction control from minimum. At one point a slight plop should be heard, indicating the commencement of oscillation. If it is not, try reversing the leads to the pick-up terminals. It is important that the "earthy" output terminal on the adaptor be joined to the "earthy" pick-up terminal on the receiver. If the receiver connections can be traced out and the correct terminal identified no doubt need arise as to the correct connections, but if it cannot, then they must be determined by trial and error.

Keeping the reaction close to the oscillation point, tune in the signal and adjust the controls for the best results. It will be found that reaction appreciably affects the tuning of the inter-valve circuit and no more reaction than is necessary should be used. Once the controls are correctly set, a process which need take no more than a few minutes, they need not be touched again, for volume can normally be adjusted by the receiver volume control.

It is recommended that a separate aerial be used for the adaptor in order to avoid having to change it over from receiver to adaptor and vice versa when a change of station is needed. For distances up to ten or fifteen miles a small outdoor inverted-L aerial can be used, and at shorter ranges an indoor aerial is likely to be satisfactory. At greater distances, or where interference is exceptionally bad, a vertical centre-fed dipole is recommended, and at extreme range a reflector should be added.

Tested at some six miles from Alexandra Palace, very good signals were received with about two feet of wire attached to the aerial terminal and using the adaptor in conjunction with a standard commercial broadcast set. Tuning was, however, quite critical, and a better aerial system is to be recommended. With the standard inverted-L aerial very strong signals were obtained and still stronger with the dipole. At this distance, of course, the latter was quite unnecessary.

Provided that a small degree of reaction is used, the selectivity is adequate for the avoidance of interference from the vision signal in television sound reception. The adaptor consequently provides one of the cheapest means of obtaining the television sound in conjunction with the broadcast set.

The Wireless Industry

WE understand that the business of Epoch Reproducers, Ltd., has now been taken over by Amerad (Great Britain), Ltd. (temporary address : 1, Lancelot Avenue, Wembley, Middlesex). This firm is in a position to handle repairs to Epoch speakers and microphones, and can supply complete units.

Cyldon Electric Chimes, providing an alternative to the unpleasant harshness of the conventional bell or buzzer call device, are described in a leaflet issued by Sydney S. Bird and Sons, Ltd., Cambridge Arterial Road, Enfield, Middlesex.

The Motorola Company, 38, Hugh Street, Eccleston Square, London, S.W.1, have issued a booklet dealing with the problems of fitting car radio sets. Entitled "Major Points on Car Radio Installation," this publication costs 2s.

Philips Radio is maintaining a specially equipped school for imparting instruction in the installation of Motoradio car receivers.

The Discavox, an interesting portable dictation recorder, is described in a pamphlet issued by Discavox Dictating Machine Co., 32, Victoria Street, London, S.W.1. The recording blanks are little thicker than paper, so the user, when travelling, can post a number of them to his headquarters for transcription.

News from the Clubs

Southend and District Radio and Scientific Society

Hon. Sec.: Mr. J. M. S. Watson, 23, Eastwood Boulevard, Westcliff-on-Sea.

The Society, which is now in its eighteenth year, concluded the winter season with a dinner and dance.

Six open-air meetings, comprising 1.7 Mc/s and 56 Mc/s DF tests, have been arranged. The dates of the first two are May 15th and June 26th.

East Dorset and West Hants Radio Club

Headquarters: Lintlaw Lodge, Wimborne Road, Poole.
Meetings: Alternate Wednesday evenings.
Hon. Sec.: Mr. D. M. Williams, Amberley, Cornwell Road, Poole.

The following programme has been arranged:—

May 18th.—Demonstration by a representative of Lissen, Ltd.
June 1st.—Discussion on the DX Contest.
June 15th.—A visit to Dorchester beam station.

West Sussex Short Wave and Television Club

Headquarters: Tangmere, Sussex.
Meetings: Wednesdays at 8 p.m.
Hon. Sec.: Mr. C. J. Rockall, Aubretia, Seafield Road, Rustington, Sussex.

On April 13th a lecture and demonstration of their "Hi-Q" components was given by Lissen, Ltd. On April 28th the Automatic Coil Winder Co. gave a lecture and demonstrated the "Avo" range of instruments.

London Transmitting Society

Headquarters: 40, Raeburn Road, Edgware.
Meetings: Thursdays at 8 p.m.
Hon. Sec.: Mr. G. Yale, 40, Raeburn Road, Edgware.

At a recent lecture by the Secretary on aerials it was explained that all designs of antennæ were derivatives of three main types, the "Marconi," the "Hertz," and the "Terminated" aerial. The Society has offered its services as A.R.P. wardens.

Dollis Hill Radio Communication Society

Headquarters: Braincroft Schools, Warren Road, London, N.W.2.
Meetings: Alternate Tuesdays at 8 p.m.
Hon. Sec.: Mr. E. Eldridge, 79, Oxgate Gardens, London, N.W.2.

On April 26th a talk was given by Mr. Bradley entitled "The Development and Growth of G8KZ." Great interest was taken in the 5-metre crystal-controlled transmitter and the 15-valve all-wave receiver which were on view.

Radio, Physical and Television Society

Headquarters: 72a, North End Road, London, W.14.
Meetings: Fridays at 8.15 p.m.
Hon. Sec.: Mr. C. W. Edmans, 72a, North End Road, London, W.14.

On April 29th Mr. E. R. Corbett, of Thomson, Alston and Co., delivered a lecture entitled "The Organisation of the Rubber Plantation Industry."

Leicester Amateur Radio Society

Headquarters: Winn's Café, Granby Street, Leicester.
Hon. Sec.: Mr. T. Cribb, 55, Knighton Drive, Leicester.

The following arrangements have been made for the Field Day on June 19th. The first transmission will be at 11 a.m., and then for the first five minutes of every half-hour until 5 p.m., except for the luncheon break from 1-2 p.m. Sealed envelopes containing the location of the transmitter will be provided for the unsuccessful searchers in order to enable them to get to the tea rendezvous which will be near the transmitter site.

Wirral Amateur Transmitting and Short-Wave Club

Headquarters: Beechcroft Settlement, Whetsone Lane, Birkenhead.
Meetings: Last Wednesday in the month at 7.30 p.m.
Hon. Sec.: Mr. J. R. Williamson, 13, Harrow Grove, Bromborough, Birkenhead.

At the last meeting Mr. R. Cumberlidge gave a talk entitled "Antennæ."

The Club is to produce its own monthly bulletin, which is to be circulated to members free of charge. Transmitters and other members are asked to supply articles.

NEWS OF THE WEEK

HIGH FIDELITY TRANSMISSIONS

Toscanini Concerts on Ultra-short Waves

THE difficulties which delayed the ultimate settlement of the proposed relays on the Alexandra Palace sound frequency (41.5 Mc/s) of part of the forthcoming series of Toscanini concerts, which are to be held at the Queen's Hall, have now been overcome, and the first transmission will be given on Wednesday next.

In the official announcement made by the B.B.C., it states "... that for the convenience of viewers special and exceptional arrangements have been made. ..." There will doubtless be many readers who, as yet, are not the proud possessors of television receivers who will, if their sets tune down to 7 metres, take the opportunity of hearing these really high-fidelity transmissions.

The complete schedule of the forthcoming relays is:—

Thursday, May 19th.
8.18.—God Save the King.
8.19-8.25.—Overture, "The Magic Flute" (Mozart).
8.27-9.0.—Symphony No. 4 in B flat (Beethoven).
Monday, May 23rd.
8.18-8.31.—Brandenburg Concerto No. 2 in F (Bach).
8.33-9.4.—Symphony No. 5 in C minor (Beethoven).
Friday, May 27th.
8.18-8.40.—Te Deum (Verdi).
Monday, May 30th.
8.18-8.40.—Te Deum (Verdi).
Friday, June 3rd.
8.18-8.48.—Symphony No. 41 in C ("Jupiter"), K.551 (Mozart).
Friday, June 10th.
8.18.—God Save the King.
8.19-8.25.—Overture, "La Scala di Seta" (Rossini).
8.27-9.7.—Symphony No. 2 in D (Sibelius).

SCHOOL RADIO SUBSIDISED

South African Scheme

UNDER a new scheme recently launched in South Africa every school in the Union will be able to avail itself of the School Broadcasts, where hitherto the use of radio in schools has been mainly confined to Cape Colony.

The new arrangement stipulates that each province of the Union shall contribute to a general fund proportionately to the number of schools in the province. This fund will be used to finance educational broadcasts and to grant subsidies to the schools for the purchase of wireless equipment.

Forty-five minutes daily will be devoted to school broadcasts, which, for the time being, will be supervised by the Educational Office.

It is, perhaps, regrettable that such a national scheme does not exist in England, where there are very few areas in which every school is radio-equipped. One such area, however, is the Isle of Man, where Philips recently installed receivers in every school.

THE VOICE OF SCANDINAVIA

A JOINT Scandinavian Committee, appointed some time ago to enquire into the situation of short-wave broadcasting, has recommended the erection of a short-wave transmitter on a central site near Gothenburg. This station, with an output of 20 kilowatts, would be operated jointly by the broadcasting authorities of Denmark, Norway, Sweden and Finland, and therefore might well be called "The Voice of Scandinavia." The new station would not, however, affect the short-wave broadcasting schemes of the individual countries.

SIR AMBROSE FLEMING, the G.O.M. of radio, who is to give a broadcast talk on his personal reminiscences of the early days of wireless, in the Regional programme at 9.20 on Wednesday next, is here seen hoisting the aerial at the 80-foot mast of the Calmore Wireless College, near Southampton, when he recently opened the summer term. The reminiscences of Sir Ambrose, who is in his 89th year, will be specially interesting to "Wireless World" readers.

MARCONI'S SON, Giulio (right), photographed at Radio City, New York, where he has been working in the experimental television laboratory of the N.B.C. He arrived in London last week on his way back to Rome where he is to help in organising a national television service.

CRITERIA OF GOOD RECEPTION

Baffles or Cabinets?

A SCHOOL loud speaker should be placed centrally in front of the class between three and six feet from the floor, according to the Central Council for School Broadcasting, which gives hints to school teachers in a "Broadcasts to Schools" pamphlet to be issued in June.

Exact tuning is strongly urged, and one of the criteria of good reception, in the opinion of the Council, is that *all* initial and final consonants, even in isolated words, should be clearly distinguishable. Here is a useful test for the ordinary listener's set!

The over-accentuation of certain bass notes makes speech sound "boomy" and is particularly irritating to children, whose powers of concentration are easily upset. The best way to avoid it, says the Council, is to mount the speaker on a flat baffle-board rather than in a cabinet.

Advisory engineers have been placed by the B.B.C. at the disposal of the Central Council, and technical advice is thus available to school authorities free of cost.

STUDIO CONSTRUCTION

REVERBERATION chambers of varying sizes are now being used for acoustic tests at the B.B.C. Research Heaquarters in Nightingale Square, Balham, to decide, among other things, whether wood panelling can be employed for studio construction. A new method of changing the reverberation periods rapidly is to use moveable tile linings.

N.B.C. TELEVISION

Regular Transmissions

STATION W2XBS in the Empire State tower in New York is now engaged on a special four-week period of experimental transmissions, ending on May 17th, with five full-hour broadcasts a week.

Good reception, according to Mr. O. B. Hanson, chief engineer of the company, is limited to the area north of the station, the experimental aerial array being situated on that side of the tower. Steel and masonry on the tower itself screens the radiations southwards, and the only signals received in this direction are those reflected by tall buildings to the north, resulting in multiple images. When the work of redesigning the aerial and transmission plant is completed, it is expected that the service range of fifty miles in all directions will be restored.

Only two of each week's programmes include living talent and selected films, and these are radiated on Tuesdays and Thursdays between 8 and 9 p.m. Afternoon transmissions, on Tuesdays, Wednesdays and Thursdays, consist of test charts and still pictures.

The N.B.C. transmits pictures of 441 lines at 30 frames a second. The vision frequency is 46.5 megacycles and the sound 49.75 megacycles.

NEW TRANSMITTERS FOR BOUND BROOK

TWO new 25-kW short-wave transmitters using the latest type of aerials directional to Europe are to be installed at W3XAL, the N.B.C. international station at Bound Brook, New Jersey. Four directional

News of the Week—

and two non-directional aerials will be installed on the 24-acre field which has been described as "America's Daventry."

According to a statement by the chief engineer and vice-president of the N.B.C., the new transmitters should yield higher quality than their predecessors.

A VANTAGE POINT is secured for French commentators when using this reporting car. As can be seen, the roof of the observation cabin is hinged allowing an uninterrupted view for the commentator.

The output stage of each transmitter consists of two water-cooled valves delivering a maximum of 12.5 kW each to any one of the aerial systems. These valves are fed by two other HF valves newly developed for the purpose, each doing the work previously done by six valves.

Transmissions from Bound Brook are now carried out for sixteen hours a day in six languages, the station being designed, in the words of the N.B.C., "to answer the challenge of elaborate and powerful short-wave systems operated by European Governments."

NOTHING FOR SOMETHING

MOST British listeners realise that their licence fees are paid as a tax to the Government and not as a payment to the B.B.C. for value received. If there were no B.B.C. programmes the fees would still be payable, though whether they would be paid is another matter.

The question has cropped up in British Guiana, where, according to the *Daily Argosy*, many listeners are protesting against the tax on radio receivers. The burden of complaint is that, whereas in Great Britain taxpayers receive something in return for their money, their brothers in British Guiana get nothing. The answer would seem to be a broadcasting station.

FRENCH REPORTING CARS

IT is announced that the French Broadcasting Department is to acquire ten small reporting cars which will be planned on the lines of the large one which has been in use for some time. This car is equipped with recording apparatus as well as short- and ultra-short-wave transmitters and receivers.

The car has an observation cabin which is elevated above the roof thereby giving a clear view to the commentators.

Power for the complete apparatus, at 110 volts 50 cycles, is obtained from a 24-volt battery through a rotary converter. Sound pick-up apparatus, including microphone and recording amplifiers, is mounted on a rotatable chassis giving easy access through the rear to internal connections.

Apparatus enabling the mixing of the output of six outside microphone circuits, each of which is provided with its own drum of cable, is housed beneath the reporter's cabin. The vehicle is equipped for two-way communication on 160 and 5 metres. An extra 5-metre transmitter-receiver is provided for the reporter on whose back it is easily carried. On the longer wavelength an effective range of up to 120 miles is possible thus enabling long-distance contact to be made with the parent station.

SCANDINAVIAN SHORT-WAVE BROADCASTING

SWEDEN has now three short-wave transmitters, all of which are radiating the National programme in full or in part. SM5SX, operating on 19.8 metres, is radiating the National programme from 3.30 p.m. G.M.T., while SBP, Motala, is working daily until 7.30 p.m. on 25.63 metres. From 7.30 p.m. onwards the national programme is being radiated by SBO Motala on 49.46 metres.

The new Norwegian short-wave 5-kW station at Oslo has been completed. In addition to the wavelengths 31.48 and 48.94 metres, which it is to share with the 1-kW Jeloy station, the new transmitter is also designed for operation on 25.56, 19.78 and 16.9 metres.

The Danish short-wave station Skamlebaek, operating on a wavelength of 31.51 metres, has increased its power to 6 kW and changed its call sign from OXY to OZF.

The Finnish experimental short-wave station at Lahti is now transmitting on a wavelength of 31.58 metres and is being fitted with a new aerial array, the direction of which may easily be changed at short notice.

FROM ALL QUARTERS

New Zealand Records

RECEIVING conditions are not sufficiently reliable to justify the B.B.C. relaying from New Zealand the special programme, "New Zealand Panorama," which will be heard Nationally on Empire Day. Recordings by the Dominion's broadcasting authorities have therefore been made and are now on the high seas on their way to the Mother Country.

Ultra-shorts from Sweden

EVERY day throughout the rest of this year, except for a probable break from June 25th to July 18th, an ultra-short-wave transmitter, SM5SN, will send out continuously a short text, including its call-sign, from 8.30 a.m. to 3 p.m. (B.S.T.) on frequencies from 56 to 57.5 Mc/s. Reports of reception will be welcomed by Mr. G. Siljeholm, Aktiebolaget Hammarbylampan, Stockholm 20, Sweden.

Regulated Radio in Switzerland

As the result of the Swiss Government's decree that a licence must be obtained before a trader may sell wireless apparatus, the number of radio dealers in the country has fallen from 3,000 to 850.

Cycle Radio

THE Danish radio monthly, *Radio Ekko*, has published details of a two-valve cycle receiver measuring 18 × 14 × 8 centimetres and weighing less than 3 lb. complete with batteries and headphones. A frame aerial measuring 18 × 24 centimetres secures satisfactory results at considerable range. This set should be well received in Denmark where there are about one million cyclists.

New Singapore Stations

THE Malayan Broadcasting Corporation is putting two new short-wave stations into service. They are ZHP and ZHD, transmitting on 31.58 and 49.9 metres respectively.

Police Wireless in Sweden

As the result of the successful establishment of police wireless in the Swedish town of Gothenburg, a comprehensive system is to be introduced into the capital, Stockholm. Further installations are scheduled for a number of other large cities.

Swedish Commercial Radio

THE commercial wireless centre of Sweden is to be moved from Gothenburg to Stockholm, where new transmitters and receivers have been installed.

Poor Beccles

EAST ANGLIA, with its poor signal strength, is notoriously cut off from British broadcasting. Further proof of this arrived at Broadcasting House last week in the shape of a letter from Beccles, Suffolk, addressed to the British Broadcasting Company, Marconi House, Strand, London, W.C.2. The B.B. *Company* moved from the Strand in 1923.

The Artful Law

How many of those who drive to the music of a car radio remember to turn it off when driving through the Royal parks where unauthorised music is not allowed?—asks a writer in *The Times*.

Down in the Forest

A QUIET copse in Suffolk is to figure in the programmes four times next week when a microphone amongst the trees will, it is hoped, pick up the song of the feathered noctua. The nightingale broadcasts are scheduled to take place at specified periods between 11 and 11.30 p.m. on Monday, Tuesday and Wednesday, and a preliminary relay of popular bird songs will be given at 6.35 on Sunday evening. It is understood that Carroll Levis is taking no active interest in the proceedings.

CAMBRIDGE UNIVERSITY O.T.C., were last week inspected by H.R.H. The Duke of Gloucester, who is Honorary Colonel-in-Chief. During the visit he saw this undergraduate using an ultra-short-wave portable transmitter-receiver with which he kept in touch with a nearby field station.

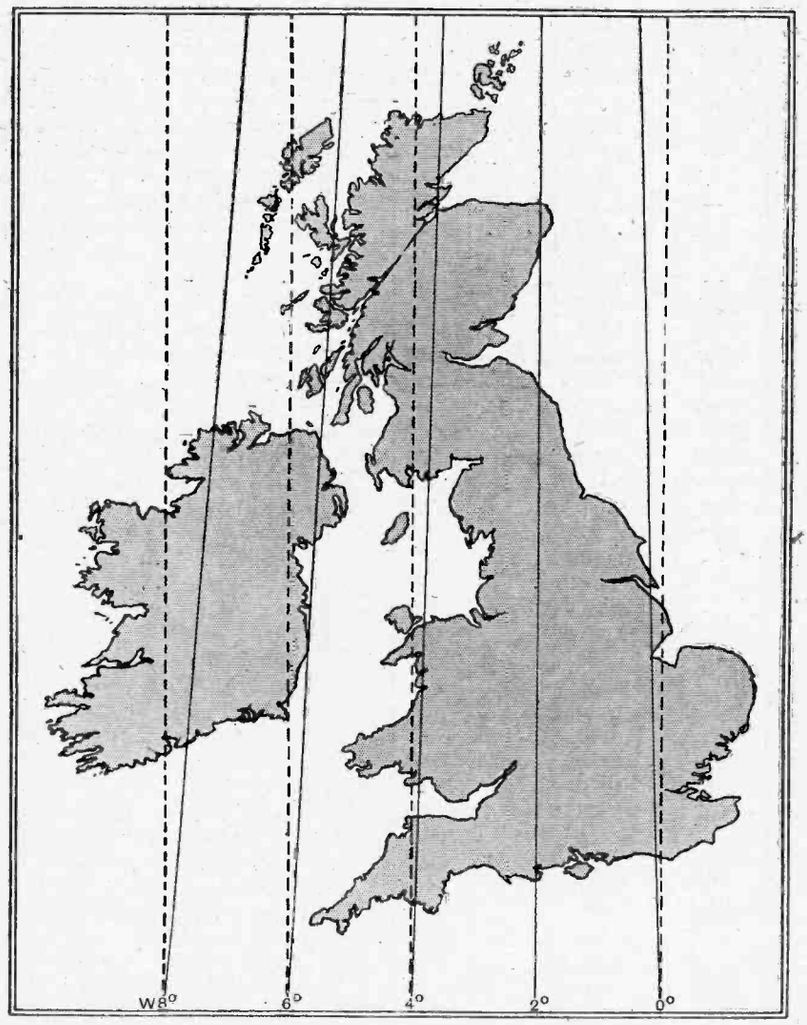
Laying Off DF Bearings

THE USE OF ORDNANCE SURVEY MAPS

By D. A. BELL, B.A., B.Sc.

IT seems to be almost universally believed that on Ordnance Survey maps the right- and left-hand margins of the map run true north and south, and so do the corresponding lines forming the squared divisions. This is what one would hope for, of course, from a well-behaved map, but in fact it is only true of Ordnance maps if one lives somewhere near 2° West longitude; the nearest towns to this line are Poole, Marlborough, Cheltenham, Birmingham, Halifax, Darlington, and Berwick-on-Tweed. In any other district there is an angle between the squares on the map and the true north and south line; the size of the angle depends upon the distance of the place from the "origin of projection" of the maps, which for Fifth Edition Ordnance Survey maps is stated to be 2° W. longitude, 49° N. latitude, i.e. just south of the Channel Islands.

This complication is just another example of the difficulty of representing the surface of a spherical world on flat sheets of paper. (The corrections necessary in laying off long-distance bearings according to great circle tracks on a Mercator chart were explained in "Navigation by Wireless," *The Wireless World*, February 3rd, 1938; that was also a "curved world *versus* flat map" problem.) First we must remember that the line running due north through any point must run direct to the North Pole; consequently lines through various points which are all running due north (*e.g.* lines of longitude) are *not parallel*, but are converging to the North Pole. Thus lines 0° and 1° W. longitude, for example, are about 43¾ miles apart in the English Channel, but only about 37¾ miles apart on a level with Edinburgh. The lines ruled on the Ordnance Survey maps, on the other hand, *are* parallel; they remain the same distance apart all over the country: 2 miles on the older 1in. maps and 5,000 yards on the Fifth Edition 1in. maps. Consequently it is only on the one longitude, 2° W., which is the centre-line of the map system, that the lines on the map are running in the same direction as the lines of longitude, i.e. are true north and south lines. The effect is illustrated in the accompanying sketch map, where the full lines are lines of longitude and the dotted lines are parallel with the lines to be found ruled on the Ordnance Survey maps.



Showing how the vertical lines and margins of Ordnance Survey maps (shown in dotted lines) diverge from the meridians of longitude (shown in full lines). On the meridian of 2 degrees West, however, there is no divergence, and the lines and margins lie true North and South.

Extent of the Error: How to Find True North

In the south of England, the angle is roughly 0.9° per degree of longitude away from 2° W.; thus at 1° E. longitude, about 5 miles east of Colchester, the angle as measured on the map is 2.85°; in London the error will be nearly 2°.

It is easy to remember that when one is east of the datum line of 2° W. longitude the squares on the map point east of north, but when one is west of the datum line they point west of north. Fortunately, minutes of latitude and longitude are marked on the borders of Ordnance Survey maps, so the simplest plan is to rule in a few of the true north-south lines by joining corresponding divisions of longitude at the top and bottom of the map. Alternatively, one can make a correction to the bearing so that it can be plotted in terms of the printed squares; on Fifth Edition maps the angle between the central vertical line of the map and true north is indicated on the right-hand margin of the map, together with the magnetic variation at date of publication. Incidentally, the magnetic variation is not a constant quantity; do not forget that the correction for this which is marked on the map (and occasionally on the compass) may be a degree or more out by now. The change in magnetic variation over the last 15 years is 2½° to 3°.

NEW FERRANTI SUPERHETS

A FIVE-VALVE (including rectifier) superheterodyne all-wave chassis suitable for AC or DC mains is used in the 512AM and 513AM receivers just released by Ferranti, Ltd. The latter, at 13½ guineas, is housed in a walnut cabinet and is fitted with a tone control and a large output transformer of new design giving improved bass response. The Model 512AM is similar in circuit specification, but has no tone control. Housed in a moulded cabinet, the price is 12 guineas.

THE LONDON RADIO COLLEGE

WE have received a copy of the prospectus issued by the London Radio College, of 43, Grove Park Road, Chiswick, London, W.4. This institution trains students for the Marine service as well as for engineering positions in the industry. The course for would-be marine operators covers the full syllabus of the first-class certificate issued by the Postmaster-General, while the engineering course is based on the examination syllabus of the City and Guilds Institute and the Institution of Radio Engineers.

SHORT-WAVE STATIONS O

(Stations with an Aerial Power of 20 kW. and above are shown in heavy type)

Station.	Call Sign.	kc/s.	Tuning Positions.	Metres.	kW.
Soerabaja (Dutch East Indies)...	YDB7	1,530	.....	196.08	0.15
Soekaboemi (Dutch East Indies)	YDA4	1,550	.....	193.55	0.025
Malang (Dutch East Indies) ...	YDB6	1,570	.....	191.08	0.025
Batavia (Dutch East Indies) ...	YDD3	1,585	.....	189.27	0.05
Solo (Dutch East Indies) ...	YDB5	1,595	.....	188.09	0.025
Tjepoe (Dutch East Indies) ...	YDB4	1,615	.....	185.76	0.015
Buitenzorg (Dutch East Indies)...	YDA3	1,640	.....	182.93	0.025
Djokja (Dutch East Indies) ...	YDB3	1,660	.....	180.72	0.025
Amateurs	—	1,715–2,000	.....	174.63–150.00	—
Liepaja (Latvia)	—	1,734	.....	173.00	0.1
Small craft, including Yachts, Trawlers, Lifeboats and Lifeships	—	1,837.10	.....	163.30	—
Djokja (Dutch East Indies) ...	YDE5	2,350	.....	127.66	0.025
Batavia (Dutch East Indies) ...	YDA2	2,385	.....	125.79	0.15
Bandoeng (Dutch East Indies)...	YDA5	2,415	.....	124.22	0.15
Semarang (Dutch East Indies)...	YDE3	2,450	.....	122.45	0.15
Cheribon (Dutch East Indies) ...	YDA6	2,870	.....	104.53	0.025
Bandoeng (Dutch East Indies)...	YDD2	2,910	.....	103.09	0.1
Batavia (Dutch East Indies) ...	YDA	3,040	.....	98.68	10
Soerabaja (Dutch East Indies)...	YDE4	3,150	.....	95.24	0.15
Pekalongan (Dutch East Indies)	YDA7	3,270	.....	91.74	0.015
Bombay (India)	VUB2	3,300	.....	90.77	10
Amateurs	—	3,500–4,000	.....	85.71–75.00	—
Aeronautical Communications ...	—	4,000–18,750.00	.....	75.00–16.00	—
Delhi No. 2 (India)	VUD2	4,990	.....	60.06	10
Bandoeng (Java)	PMY	5,150	.....	58.30	1
Caracas (Venezuela)	YV5RC	5,800	.....	51.72	1
Vatican City (Vatican State) ...	HVJ	5,976	.....	50.26	15
Moscow (U.S.S.R.)	**VZSPS**	6,000	.....	50.00	20
Mexico City (Mexico)	XEBT	6,000	.....	50.00	1
Montreal (Canada)	CFCX	6,005	.....	49.96	6
Pretoria (South Africa)	ZRH	6,006	.....	49.94	5
Havana (Cuba)	COCO	6,010	.....	49.92	0.3
Prague (Podebrady) (Czechoslovakia)	**OLR2A**	6,010	.....	49.92	30
Sydney (Canada)	CJCX	6,010	.....	49.92	1
Zeesen (Germany)	**DJC**	6,020	.....	49.83	5–40
Prague (Podebrady) (Czechoslovakia)	**OLR2B**	6,030	.....	49.75	30
Boston (U.S.A.)	**W1XAL**	6,040	.....	49.67	20
Miami (U.S.A.)	W4XB	6,040	.....	49.67	5
Daventry (Great Britain) ...	**GSA**	6,050	.....	49.59	10–50
Philadelphia (U.S.A.)	W3XAU	6,060	.....	49.50	10
Cincinnati (U.S.A.)	W8XAL	6,060	.....	49.50	10
Motala (Sweden)	SBO	6,065	.....	49.46	0.75
Georgetown (British Guiana) ...	VP3MR	6,070	.....	49.42	0.2
Chicago (U.S.A.)	W9XAA	6,080	.....	49.34	0.5
Nairobi (Kenya)	VQ7LO	6,082	.....	49.33	0.5
Lima (Peru)	OAX4Z	6,082	.....	49.33	15
Toronto (Canada)	CFRX	6,090	.....	49.28	0.5
Hong Kong (China)	ZBW2	6,090	.....	49.26	2.5
Cape Town (South Africa) ...	ZRK	6,100	.....	49.20	5
Johannesburg (South Africa) ...	ZRJ	6,100	.....	49.20	5
Chicago (U.S.A.)	W9XF	6,105	.....	49.18	10
Bound Brook (U.S.A.)	**W3XAL**	6,105	.....	49.18	15–35
Belgrade (Yugoslavia)	YUA	6,105	.....	49.18	1
Daventry (Great Britain) ...	**GSL**	6,110	.....	49.10	10–50
Calcutta (India)	VUC	6,110	.....	49.10	0.5
Wayne (U.S.A.)	W2XE	6,120	.....	49.02	10
Jeloy (Norway)	LKJ	6,120	.....	49.02	1
Havana (Cuba)	COCD	6,130	.....	48.92	1
Halifax (Canada)...	CJHX	6,135	.....	48.90	0.5
Pittsburgh (U.S.A.)	**W8XK**	6,140	.....	48.83	30
Durban (South Africa)	ZRD	6,150	.....	48.80	
Winnipeg (Canada)	CJRO	6,155	.....	48.78	
San Jose (Costa Rica)	TIPG	6,410	.....	46.80	
Riobamba (Ecuador)	PRADO	6,610	.....	45.31	
Radio Nations (Switzerland) ...	**HBQ**	6,670	.....	44.94	20
Amateurs	—	7,000–7,300	.....	42.85–41.09	
Barcelona (Spain)	EAJ1	7,030	.....	42.70	
Salamanca (Spain)	EA1BO	7,070	.....	42.43	
Tokio (Japan)	**JVP**	7,510	.....	39.95	50
Moscow (U.S.S.R.)	**RKI**	7,540	.....	39.79	25
Radio Nations (Switzerland) ...	**HBP**	7,797	.....	38.48	20
Budapest (Hungary)	HAT4	9,120	.....	32.88	6
Havana (Cuba)	COCH	9,435	.....	31.80	10
Madrid (Spain)	EAR	9,480	.....	31.63	10
Rio de Janeiro (Brazil)	PRF5	9,500	.....	31.58	12
Melbourne (Australia)	VK3ME	9,500	.....	31.58	2
Bangkok (Siam)	HS8PJ	9,500	.....	31.58	5
Daventry (Great Britain) ...	**GSB**	9,510	.....	31.55	10
Skamlebaek (Denmark)	OZF	9,520	.....	31.51	6
Pretoria (South Africa)	ZRH	9,522	.....	31.50	5
Hong Kong (China)	ZBW3	9,525	.....	31.49	2
Jeloy (Norway)	LKC	9,530	.....	31.48	1
Schenectady (U.S.A.)	**W2XAF**	9,530	.....	31.48	25
Suva (Fiji)	VPD2	9,535	.....	31.47	0
Tokio (Japan)	**JZI**	9,540	.....	31.46	50
Zeesen (Germany)	**DJN**	9,545	.....	31.45	5
Prague (Podebrady) (Czechoslovakia)	**OLR3A**	9,550	.....	31.41	30
Bombay (India)	VUB2	9,550	.....	31.41	4
Schenectady (U.S.A.)	W2XAD	9,550	.....	31.41	
Soerabaja (Dutch East Indies)...	Y2B	9,555	.....	31.40	1
Zeesen (Germany)	**DJA**	9,560	.....	31.38	5
Lima (Peru)	OAX4T	9,565	.....	31.37	10
Millis (U.S.A.)	W1XK	9,570	.....	31.35	10
Paris (Radio-Mondial) (France)...	**TPB11**	9,570	.....	31.35	25
Manila (Philippine Islands) ...	KZRM	9,570	.....	31.35	1
Lyndhurst (Australia)	VLR	9,580	.....	31.32	1
Daventry (Great Britain) ...	**GSC**	9,580	.....	31.32	10
Sydney (Australia)	**VK2ME**	9,590	.....	31.28	20
Perth (Australia)	VK6ME	9,590	.....	31.28	2
Delhi No. 2 (India)	VUD2	9,590	.....	31.28	10
Huizen (Holland)	**PCJ**	9,590	.....	31.28	60
Moscow (U.S.S.R.)	**RW96**	9,600	.....	31.25	20
Cape Town (South Africa) ...	ZRK	9,605	.....	31.23	5
Soerabaja (Dutch East Indies) ...	YDB	9,610	.....	31.20	1
Rome (Italy)	**I2RO3**	9,635	.....	31.12	25
Lisbon (Portugal)	CS2WA	9,650	.....	31.09	2
Buenos Aires (Argentina) ...	LRX	9,660	.....	31.06	10
Havana (Cuba)	COCQ	9,740	.....	30.80	1
Madrid (Spain)	EAQ1	9,830	.....	30.52	10
Havana (Cuba)	COCM	9,835	.....	30.51	
Lisbon (Portugal)	CSW	9,940	.....	30.18	5
Marapicu (Brazil)	PSH	10,220	.....	29.35	
Bandoeng (Dutch East Indies)...	PMN	10,260	.....	29.24	1
Ruysselede (Belgium)	ORK	10,330	.....	29.04	10
Buenos Aires (Argentina) ...	LSX	10,350	.....	28.99	12
Bandoeng (Dutch East Indies)...	PLP	11,000	.....	27.27	1
Lisbon (Portugal)	CSW2	11,040	.....	27.17	5
Radio Nations (Switzerland) ...	**HBO**	11,400	.....	26.31	20
Havana (Cuba)	COCX	11,490	.....	26.11	1
Warsaw (Poland)	**SPD**	11,530	.....	26.01	20
Motala (Sweden)	SBP	11,705	.....	25.65	0
Santiago (Chile)	CB1170	11,700	.....	25.65	
Paris (Radio Mondial) (France)...	TPA4	11,720	.....	25.60	12
Winnipeg (Canada)	CJRX	11,720	.....	25.60	2
Huizen (Holland)	**PH1**	11,730	.....	25.57	25

THE WORLD

Arranged in Order of Frequency and Wavelength

Station.	Call Sign.	kc/s.	Tuning Positions.	Metres.	kW.
Boston (U.S.A.)	W1XAL	11,730	.....	25.57	—
Daventry (Great Britain) ...	GSD	11,750	.....	25.53	10–50
Zeesen (Germany)	DJD	11,770	.....	25.49	5–40
Boston (U.S.A.)	W1XAL	11,790	.....	25.45	20
Zeesen (Germany)	DJO	11,800	.....	25.42	5–40
Vienna (Austria)	OER3	11,800	.....	25.42	1.5
Tokio (Japan)	JZJ	11,800	.....	25.42	50
Rome (Italy)	I2RO4	11,810	.....	25.40	25
Daventry (Great Britain) ...	GSN	11,820	.....	25.38	10–50
Wayne (U.S.A.)	W2XE	11,830	.....	25.36	10
Lisbon (Portugal)	CSW4	11,840	.....	25.34	5
Zeesen (Germany)	DJP	11,855	.....	25.31	5–40
Daventry (Great Britain) ...	GSE	11,860	.....	25.29	10–50
Pittsburgh (U.S.A.)	W8XK	11,870	.....	25.26	25
Paris (Radio Mondial) (France)	TPB7	11,885	.....	25.24	25
Paris (Radio Mondial) (France)...	TPA3	11,885	.....	25.24	12
Reykjavik (Iceland)	TFJ	12,235	.....	24.52	7.5
Moscow (U.S.S.R.)	VZSPS	12,000	.....	25.00	20
Warsaw (Poland)	SPW	13,635	.....	22.00	2
Amateurs	—	14,000–14,400	.....	21.42–20.83	—
Barcelona (Spain)	EAJ1	14,060	.....	21.35	—
Radio Nations (Switzerland) ...	HBJ	14,530	.....	20.64	20
Sofia (Bulgaria)	LZA	14,920	.....	20.11	1.5
Moscow (U.S.S.R.)	RW96	15,040	.....	19.95	25
Zeesen (Germany)	DJL	15,110	.....	19.85	5–40
Vatican City (Vatican State) ...	HVJ	15,120	.....	19.84	25
Paris (Radio Mondial) (France)...	TPB6	15,130	.....	19.83	25
Boston (U.S.A.)	W1XAL	15,130	.....	19.83	20
Daventry (Great Britain) ...	GSF	15,140	.....	19.82	10–50
Bandoeng (Dutch East Indies)...	YDC	15,150	.....	19.80	1.5
Batavia (Dutch East Indies) ...	—	15,150	.....	19.80	3
Daventry (Great Britain) ...	GSO	15,180	.....	19.76	10–50
Hong Kong (China)	ZBW4	15,190	.....	19.75	2.5
Zeesen (Germany)	DJB	15,200	.....	19.74	5–40
Pittsburgh (U.S.A.)	W8XK	15,210	.....	19.72	20
Huizen (Holland)	PCJ	15,220	.....	19.71	60
Prague (Podebrady) (Czechoslovakia)	OLR5A	15,230	.....	19.70	30
Paris (Radio Mondial) (France)...	TPA2	15,240	.....	19.69	12
Boston (U.S.A.)	W1XAL	15,250	.....	19.67	20
Daventry (Great Britain) ...	GSI	15,260	.....	19.66	10–50
Wayne (U.S.A.)	W2XE	15,270	.....	19.65	10
Zeesen (Germany)	DJQ	15,280	.....	19.63	5–40
Buenos Aires (Argentina) ...	LRU	15,290	.....	19.62	7
Daventry (Great Britain) ...	GSP	15,310	.....	19.60	10–50
Prague (Podebrady) (Czechoslovakia)	OLR5B	15,320	.....	19.58	30
Schenectady (U.S.A.)	W2XAD	15,330	.....	19.57	20
Zeesen (Germany)	DJR	15,340	.....	19.56	5–40
Budapest (Hungary)	HAS3	15,370	.....	19.52	6
Hicksville (U.S.A.)	W2XGB	17,310	.....	17.33	5
Hong Kong (China)	ZBW5	17,750	.....	16.90	2.5
Zeesen (Germany)	DJE	17,760	.....	16.89	5–40
Wayne (U.S.A.)	W2XE	17,760	.....	16.89	10
Paris (Radio Mondial) (France)...	TPB3	17,765	.....	16.88	25
Huizen (Holland)	PHI	17,765	.....	16.88	25
Bound Brook (U.S.A.)	W3XAL	17,780	.....	16.87	15–35
Daventry (Great Britain) ...	GSG	17,790	.....	16.86	10–50
Buenos Aires (Argentina) ...	LSY3	18,110	.....	16.56	5
Radio Nations (Switzerland) ...	HBH	18,480	.....	16.25	20
Bangkok (Siam)	HS8PJ	19,020	.....	15.77	5
Zeesen (Germany)	DJS	21,450	.....	13.99	5–40
Daventry (Great Britain) ...	GSH	21,470	.....	13.97	10–50
Schenectady (U.S.A.)	W2XAD	21,500	.....	13.95	—
Wayne (U.S.A.)	W2XE	21,520	.....	13.94	10
Daventry (Great Britain) ...	GSJ	21,530	.....	13.93	10–50
Pittsburgh (U.S.A.)	W8XK	21,530	.....	13.93	6
Daventry (Great Britain) ...	GST	21,550	.....	13.92	10–50
Amateurs	—	28,000–30,000	.....	10.71–10.00	—
Alexandra Palace, Sound ...	—	41,500	.....	7.23	3
Alexandra Palace, Vision ...	—	45,000	.....	6.67	17
Amateurs	—	56,000–60,000	.....	5.35–5.00	—

Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, MAY 12th.

Nat., 7, A Quick-Fire Rhythm Exchange between Otto Dobrindt and his Band (in Germany) and Debroy Somers and his Band (in England). 7.40, "Eight Bells"—a naval visit to Sydney, Australia. 8.40, Sir Ralph Wedgwood talks on Railways.

Reg., 6, Showmen of England—C. B. Cochran. 8.15, Folk and Traditional Music. 8.40, "Marriage is no Joke"—a play by James Bridie.

Abroad.

Hilversum II, 11.10 a.m., Christening of H.R.H. Princess Beatrix of Holland relayed from The Hague. Recordings will be broadcast at 8.55 p.m.

FRIDAY, MAY 13th.

Nat., 6.40, Benny Frankel and his Orchestra. 7.25, Pianoforte Recital by Solomon. 8, A Flying Visit to Paris.

Reg., 6.40, "Under London," II; Talk on London's Tubes, by F. L. Stevens. 7.30, The Arcadian Follies from Burnley. 9, The Old Music Halls.

Abroad.

Deutschlandsender, 8, Berlin Philharmonic, conducted by Latoszewski.

Warsaw, 8, "The Grand Duchess," opera (Offenbach).

SATURDAY, MAY 14th.

Nat., 1.15 and 5.45, Cricket Commentaries, M.C.C. *v.* The Australians. 9.20, American Commentary. 9.35, Songs and Duets from famous operas.

Reg., 6.50, Stop Dancing—Tunes Old and New. 8, Laurance Turner conducts the B.B.C. Orchestra (E). 8.45, Poetry Reading from Paris by Berthe Bovy.

Abroad.

Milan, 9, "Aida," opera (Verdi). Cast includes Gigli and Gina Cigna.

SUNDAY, MAY 15th.

Nat., 12.45, London Palladium Orchestra. 3.15, Band of H.M. Coldstream Guards. 5.50–7.50, Godfrey Tearle in "King Lear." 9.5, British Soldiers' Songs.

Reg., 6.35, Bird Songs from a copse in Suffolk. 6.50, "Maritana," the English opera by Vincent Wallace. 10, Chopin Recital by Iso Elinson.

Abroad.

Königsberg, 8, "Boccaccio," operetta (Suppé).

MONDAY, MAY 16th.

Nat., 7, Gracie Fields in "Monday at Seven." 9.20, World Affairs. 9.35, "Hail Variety."

Reg., 7.30, Musical Biography of Franz Haydn. 8.20, Sydney Lipton and his Band. 9.40, A Visit to the working face of the new flood control tunnel under Derby.

Abroad.

Lille, P.T.T., 8.30, Rosenthal conducts Paris Symphony Concert.

Leipzig, 9, Sibelius Concert.

TUESDAY, MAY 17th.

Nat., 6.25, B.B.C. Theatre Organ. 9.20, "My Best Story" No. I—Talk by Tom Clarke. 9.40, Joseph Lewis conducts B.B.C. Orchestra (E) with Leslie England, pianoforte.

Reg., 7.30, Fats Waller and his Rhythm relayed from New York. 8, Organ Recital by W. H. Harris. 8.25, "Fidelio," Act I of Beethoven's opera from Covent Garden.

Abroad.

Poste Parisien, 9, Maurice Chevalier in "La-Haut," operetta (Yvain).

WEDNESDAY, MAY 18th.

Nat., 8, Geraldo and his Concert Orchestra. 9.20, Sir Ambrose Fleming talks on the Early Days of Wireless. 10.5, "Das Rheingold," Scene IV of Wagner's opera from Covent Garden.

Reg., 7.30, The World Goes By. 8, From the Empire Exhibition—B.B.C. Scottish Orchestra augmented by players from the Glasgow String Orchestra. 9, Dance Cabaret from Bournemouth. 9.35, Speeches from the British Legion Dinner.

Abroad.

Brussels II, 8, "Great Masters," concert by the I.N.R. Symphony Orchestra.

Specialised Short-wave Equipment

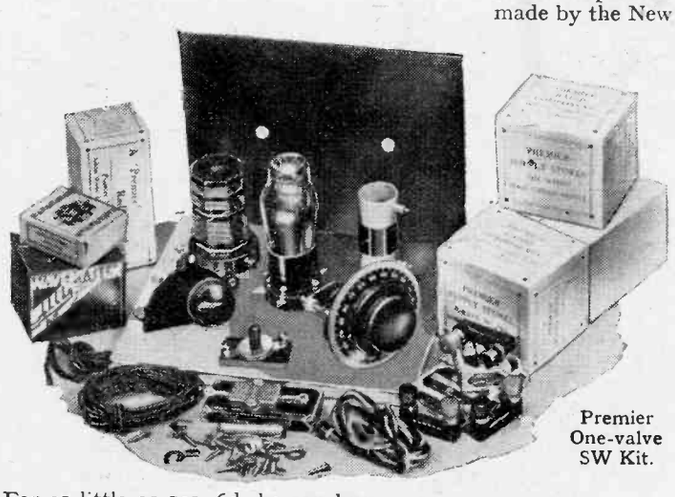
COMPONENTS AND COMPLETE INSTALLATIONS

A Review of Types and Sources of Supply

IN spite of recent improvements in the performance of "all-wave" broadcast receiving sets the design must, of necessity, be something of a compromise, and the enthusiast whose first interest is long-distance reception of amateur and commercial short-wave stations rightly demands a receiver which has been specifically designed for that purpose. He is fortunate in having much greater freedom of choice than the man who favours a conventional broadcast receiver, for whereas the "all-wave" broadcast set nowadays conforms more or less to a pattern, the specialised short-wave receiver ranges in type from the single-valve reacting detector to the professional "communication" receiver and in price from a few shillings to hundreds of pounds.

British Short-Wave Receivers

The newcomer to short waves who does not wish financially to commit himself too deeply until he has gained some experience is well served by the British manufacturer.



Premier One-valve SW Kit.

For as little as 12s. 6d. he can buy a complete set of parts to build a one-valve short-wave converter-receiver which will igve him familiarity with short-wave conditions and serve as an hors d'œuvre for a more substantial installation later on.

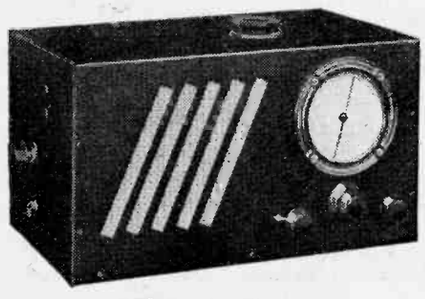
The Premier Supply Stores list a kit of parts at this price which includes a 2-volt valve and has a tapped tuning coil giving a range of 18-87 metres. A similar outfit on a metal chassis with four coils covering 13-170 metres costs 17s. 6d., and from a well-graded range of more ambitious kits the SG3, at £2 18s. 6d. complete with valves, may be selected as being typical of the value obtainable. This set has an RF-det.-output circuit with automatic bias, a metal chassis, and covers 14-178 metres in four ranges.

The Peto Scott Co., Ltd., also make a speciality of kits for the short-wave experimenter with circuits ranging from one to four valves. For £4 8s. it is possible to buy a kit of parts from which no fewer than eight short-wave sets can be built.

New Times Sales DX AC4.

For those who would prefer to start with a mains-operated set there is the DX AC4, made by the New Times Sales Co., and costing in kit form 75s., including valves. The wavelength range is 12-49 metres, and the RF-det.-output circuit with bandspread auxiliary condenser is for assembly in a drilled metal chassis. A single-valve "3-in-1" converter-receiver kit, and components for a two-valve bandspread receiver, are also available at 25s. and 32s. 6d. respectively, less valves.

Those who prefer to come straight to the business of handling the controls without the preliminaries of construction will gain valuable experience with receivers such as



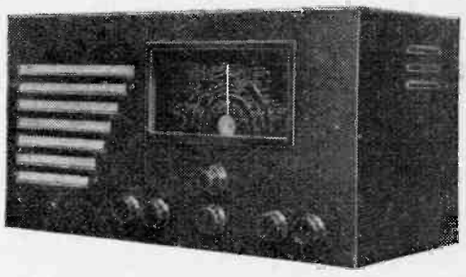
BTS Trophy Three.

Eddystone "All World Eight."

the Eddystone (Stratton) "All World Two" at £3 17s. 6d., complete with valves, coils and calibration charts, or the BTS "Trophy 3" at 6 guineas for AC mains and £5 15s. for battery operation.

British short-wave sets of the more advanced type generally known as "communication" receivers are as yet few in number, for although much work has been done on multiple tuning units, these have for the most part been developed for "all-wave" broadcast sets. The Eddystone "All World Eight," however, can claim to be a thoroughbred short-wave receiver, for it has a die-cast chassis with integral screening compartments, ceramic insulation and interchangeable coil units housed in cast aluminium screening boxes. The circuit arrangement is RF—mixer—osc.—two IF—2nd det., AVC, 1st AF—push-pull output. Coils are available to cover 9.5-2,000 metres with a gap for the intermediate frequency. The price with coils for the more popular wavebands is £25.

The DP Communication Receiver, at 11½ guineas, just released by Peto Scott, has many of the features found usually only in more expensive sets. AVC is optional, there is a beat-frequency oscillator for CW reception, and—a point which will appeal to



Peto Scott DP Communication Receiver.

transmitting amateurs—the HT current is interrupted by a switch combined with the RF gain control, while the main switch is incorporated as usual with the AF volume control. The loud speaker is built into the metal cabinet, and there is provision for headphones. The circuit is RF—frequency-changer—IF—beat oscillator—double-diode-pentode 2nd det. AVC and output valve. The whole of the RF tuning unit is rubber-mounted, and the scales are calibrated against a crystal standard.

Specialised Short-Wave Equipment—

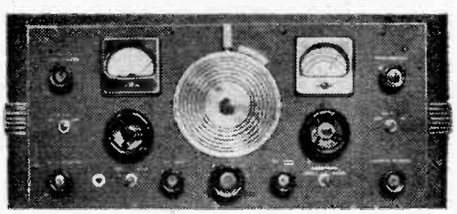
Another specialised short-wave set of British origin, the SW6/M8, made by the Union Radio Co., Ltd., is of interest for the fact that the principle of double frequency-changing is employed. The first IF amplifier is tunable over a range of 2.5 Mc/s and feeds into a second frequency changer and IF amplifier operating at 465 kc/s. In this way the waverange of the receiver (15-40 metres) is spread over six bands.

Before leaving the British sets mention should be made of the G.E.C. Commercial SW receiver. This has been designed for relaying Empire programmes in the colonies, and is already being used on the Gold Coast. It is a rack-mounted installation, and the basic circuit is a 7-valve superhet with an AVC system capable of reducing 65 db fluctuations of signal strength to 4 db at the second detector. The SW coverage is 13-100 metres, and the IF is tunable from 200-550 metres, giving scope for a suitable compromise between selectivity and fidelity, and also permitting the reception of medium-wave stations as a straight circuit. There is an intermediate AF amplifier panel and the output stage uses two DA100 valves in push-pull to deliver 90 watts undistorted. The whole equipment is built on engineering lines and as a communication receiver is the "real thing."

American "Communication" Receivers

In the United States the widespread amateur relay organisation has created a market for communication-type receivers of a very advanced type. These are now finding favour with experimenters in this country and are readily obtainable from the many enterprising firms who cater for the needs of the short-wave fraternity.

Most of these receivers are superheterodynes with a sensitivity better than "one micro-volt." They are equipped with electrical or mechanical "bandspread" tuning to expand small sections of the tuning range to the full width of the dial, and a calibrated "R" meter giving a quantitative measure of the received signal strength. Many make use of a crystal filter to secure the highest possible selectivity, and a beat-frequency oscillator for CW reception is more or less standard. A change-over switch for AVC or manual volume control is general as is the provision for headphones as an alternative to the loud speaker.



Hallicrafter Super Sky Rider.

Apart from these features in common the American sets show a refreshing diversity of treatment in detail, as the following brief descriptions of some of the leading makes will show.

HALLICRAFTER

1938 Super Sky Rider. *545 kc/s-62 Mc/s in 6 ranges. Eleven valves. RF—mixer—osc.—two IF—beat osc.—signal indicator ampl.—2nd det., AVC, 1st AF—push-pull output. Rectifier.*

It will be seen that this receiver covers the 5-metre band. The tuning dial has 338-degree scales with vernier and is directly calibrated. Band spread is by means of a special composite tuning condenser with two rotors and a single stator, thus eliminating parallel insulator losses. Selectivity is variable and the receiver may be obtained with or without a crystal filter.

Average price in this country, £31

Sky Challenger. *435 kc/s-38 Mc/s in 5 ranges. Nine valves. RF—mixer—osc.—two IF—beat osc.—2nd det., AVC, 1st AF—single output. Rectifier.*

This has the same 338-degree dial with direct calibrations as the Super Sky Rider, but band spread tuning is by means of a parallel condenser.

Average price in this country, £23; or £25 with crystal filter.

Sky Chief. *540 kc/s-17.6 Mc/s in three bands. Seven valves. RF—mixer—osc.—IF—beat osc.—2nd det., AVC, 1st AF—single output. Rectifier.*

A circular illuminated dial carries pointers for main and band spread tuning and the loud speaker is built into the chassis.

Average price in this country, £12 10s.

Sky Buddy. *541 kc/s-18 Mc/s in 3 bands. Five valves. Frequency changer—IF—beat osc.—2nd det., AVC, AF—single output. Rectifier.*

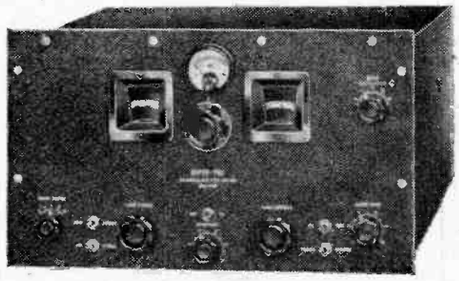
Similar in scope to the Sky Chief this receiver has an illuminated dial and built-in loud speaker. The band spread ratio is 36 : 1.

Average price in this country, £9.

HAMMARLUND

Super-Pro. *7½–240 metres. 15–560 metres or 15–2,000 metres in 5 ranges. Sixteen valves. Two RF—mixer—osc.—three IF—beat osc.—2nd det., 1st AF—driver—push-pull output. Two rectifiers.*

This receiver is obtainable with either continuously variable selectivity giving band widths from 3 to 16 kc/s or with a crystal



Hammarlund Super-Pro.

filter in the IF amplifier. The system of band spread tuning involves a 12-gang trimming condenser on the IF transformers. The switch mechanism is of the cam-operated knife-edged type with silver contacts. A calibration accuracy of ½ per cent. is guaranteed.

Average price in this country, £70.

NATIONAL

Standard HRO. *1.7–30 Mc/s in 4 ranges. Ten valves. Two RF—mixer—osc.—two IF—beat osc.—2nd det., AVC, 1st AF—single output. Rectifier.*

An elaborate worm drive through epicyclic gearing gives an effective scale length of 12 feet for the main tuning condenser. The scale makes ten revolutions in traversing the full range of the condenser and index numbers are automatically changed at each revolution. Wave changing is by means of plug-in coil units, each provided with its own calibration curves. By means of switching in the coil boxes each amateur band may be expanded to 400 out of 500 divisions available on the main tuning scale. The IF amplifier makes use of a crystal filter and a calibration curve is provided for converting the metre R scale to micro-volts.

Average price in this country, £50.

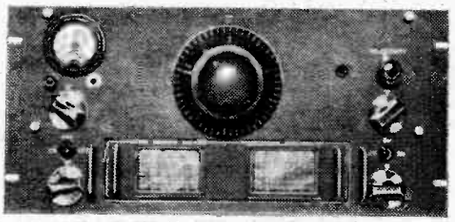
Junior HRO. *Tuning range 14–30 Mc/s. Circuit as above but without crystal filter and super band spread.*

Average price in this country, £30.

One-ten. *1–10 metres in 6 bands. Four valves RF—self-quenching super-regenerative det.—1st AF—single output.*

Two acorn and two metal valves are used in this super-regenerative circuit, and special attention has been given to the shortness of wiring. Actually the acorn valve-holders are built into the shields between the condenser sections. The rotors of the gang condenser are individually insulated and have a low capacity to earth. The receiver is primarily for battery-operation, but a power supply unit is available.

Average price in this country, £21 10s.



National HRO.

NC80X. *550 kc/s–30 Mc/s in 4 ranges. Ten valves. Mixer—osc.—three IF—beat osc.—linear 2nd det., AVC ampl.—single output. Rectifier.*

This receiver has the unusually high intermediate frequency of 1,560 kc/s. A crystal filter is employed in a circuit which is also arranged to give variable selectivity with a band width of 400 c/s to 5 kc/s. The instrument is for AC/DC operation and is provided with a horizontal type scale with a mirror to overcome parallax errors. A similar model, NC81X, is available for the amateur bands only.

Average price in this country, £26.

NC100. *540 kc/s–30 Mc/s in 5 ranges. Twelve valves. RF—mixer—osc.—two IF—beat osc.—tuning ind.—2nd det., AVC ampl.—push-pull output. Rectifier.*

A special feature of this receiver is the mechanical plug-in wave changing device. The coils are separately screened in a cast aluminium box which is moved bodily until the appropriate coils are over the circuit contacts. In this way all dead-end losses and absorption resonances are eliminated.

Average price in this country, £35; or £37 with crystal filter and coils for the amateur bands.

PATTERSON

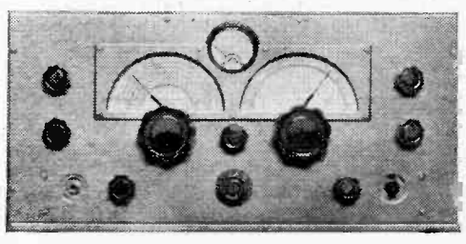
PR15. *575 kc/s–40 Mc/s in 5 ranges. Fifteen valves. Two RF—mixer—osc.—IF—IF and noise silencer injector—2nd det., AVC, 1st AF—NS ampl.—NS rec.—automatic threshold valve—interstation noise suppressor—beat osc.—push-pull output. Rectifier.*

A noise silencing circuit involving three valves is used in addition to a normal interstation noise suppressor. The crystal filter in the IF amplifier can be connected either in the usual series-parallel circuit or to give a band pass response curve for better quality of reproduction on telephony.

Average price in this country, £32 10s.

R.M.E.69. *550 kc/s–32 Mc/s in 6 ranges. Nine valves. RF—mixer—osc.—two IF—beat osc.—2nd det., AVC, 1st AF—single output. Rectifier.*

This well-known communication receiver is



R.M.E. 69.

Specialised Short-Wave Equipment—

fitted with a crystal filter as standard. The band spread tuning dial is equal in diameter to the main scale which is calibrated on all bands directly in megacycles. The "R" meter is also calibrated in decibels. A pre-selector unit with two RF stages giving an average gain of 20 to 25 db. is also available. It is fitted with its own power supply and has an image rejection ratio of 20,000 : 1.

Average price in this country, £38; or with Lamb noise silencer, £41 10s. Pre-selector unit, £12 10s.

We give below some of the leading firms in this country from whom the above and other American receivers are obtainable.

A.C.S. Radio, 52-54, Widmore Road, Bromley, Kent.

Supply receivers by Hallicrafters, Hammarlund, National, Patterson, R.M.E., Tobe Deutschmann, etc. A series of information sheets dealing with technical features of these sets is issued from time to time, and includes particulars of the firm's own transmitting gear and of reconditioned short-wave receivers by the leading makers. The technical director is Mr. H. Miles (G2NK).

The Premier Supply Stores, Jubilee Works, 167, Lower Clapton Road, London, E.5.

Handle receivers by Hallicrafters, R.M.E., etc., in addition to their own make of short-wave receiver kits. Transmitting gear components and complete installations are also included in the recently expanded short-wave activities of the firm. This section is under the direction of Mr. J. F. Lucas (G2HK), and visitors will be welcomed at the "Ham Shack" at the Jubilee Works, where the latest communication apparatus may be seen and problems discussed.

The Quartz Crystal Co., Ltd., 63-71, Kingston Road, New Malden, Surrey.

This firm, which specialises in all types of quartz crystal elements and their associated equipment is also one of the principal distributors for the National Co., Inc., Malden, Mass., and holds stocks not only of all the National receivers, but most of the components made by this American firm.

Radiomart: G5NI (B'ham) Ltd., 44, Holloway Head, Birmingham, 1.

A very useful manual, freely illustrated with circuit diagrams of practical short-wave transmitters and receivers is issued by this active Midland firm, who are agents for Hallicrafters, National, R.M.E., Radio Silver, Tobe Deutschmann, etc. The R.M.E. 510X frequency expander for ultra short wave reception in conjunction with the R.M.E.69 is obtainable from this firm and also the DB20 two-RF pre-amplifier and image rejector.

Radiographic, Ltd., 2, 3 & 4, Dean Street, London, W.1.

Have a New York office and are official distributors for Hallicrafters, Meissner, National, R.M.E., etc. The Meissner communication receiver has a range of 5 to 555 metres, and the 14-valve circuit includes crystal filter, variable selectivity, noise suppression, and amplified AVC.

Rocke International, Ltd., 11, Gt. Marlborough Street, London, W.1.

Distributing representatives for the Hammarlund Super Pro receiver and Hammarlund transmitting and receiving coils and condensers.

Webb's Radio, 14, Soho Street, Oxford Street, London, W.1.

Readers of this journal require no introduction to this firm, which makes a point of being in a position to give immediate delivery of any of the leading English and American receivers, valves and components. The new Hallicrafters "Champion," with RF amplifier, beat frequency oscillator, separate band spread dial, is now obtainable through this firm. The wavelength range is 6.8 to 550 metres and the price £15. Also the latest Hallicrafters Sky Buddy at £9, which is fitted with a separate band spread dial and accurately calibrated main scales.

Two new Meissner products obtainable through this firm are worthy of special note. One is a beat frequency oscillator unit with self-contained power pack, and the other a Lamb noise silencer, also with its own power supply for use with any superheterodyne receiver.

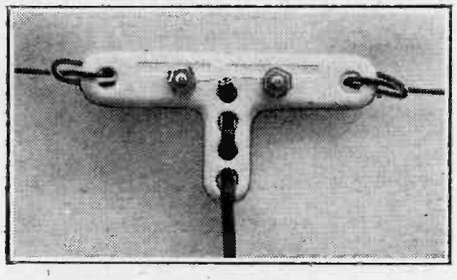
Full details will be given in the comprehensive illustrated catalogue of the Webb stock to be issued in the course of the next few days.

Components

THE basic requirements of the short-wave constructor in the matter of special condensers, coils, etc., have been catered for fairly comprehensively, and many of the components which were introduced two or three years ago require no revision in the light of subsequent developments. It would be quite impossible in the space at our disposal to give a balanced survey of the complete stock carried by each firm, and we propose therefore to deal only with those items which are of outstanding interest or have been introduced in recent months.

Although the main business of **A.C.S. Radio** is with complete receiving and transmitting installations a number of useful components are stocked, including the RCA Spiderweb all-wave antenna with 5-metre attachment at £2 10s., Crowe transmitting dials with vernier at 7s. 6d., and Insuline and Insulex transmitting coil formers, acorn and wafer valve holders. Another item of interest to the beginner is the Instructograph Morse transmitter with six tapes at 6 guineas. These instruments with three tapes may be hired at 7s. 6d. per week.

Stand-off low-loss insulators are among the **Belling-Lee** components which are of direct interest to short-wave enthusiasts. For aerial equipment there is a neat "T" strain insulator at 1s. 6d. designed to take



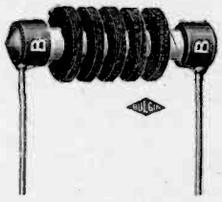
Belling and Lee "T" strain insulator.

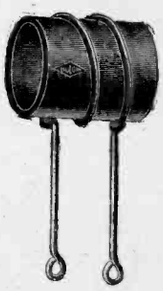
the feed from the centre of a half-wave aerial. Non-hygroscopic twin feeder cable is also available at 6s. 9d. per 65ft. The characteristic impedance is 75 ohms at 45 Mc/s, and the loss per 100ft. at that frequency is only 1.4 db.

Sensitivity in headphones is of first importance for long-distance working, and the **S. G. Brown** Type "A" earpieces with adjustable reeds are ideal for this purpose. A lightweight type with flat diaphragm is also available.

British Television Supplies, Ltd., have recently introduced an ultra-short-wave tuning condenser suitable for ganging at 5s. 9d., and a series of "One-shot" plug-in coils with self-locating 6-pin bases. Prices range from 2s. 6d. to 3s. 3d.

The range of short-wave components made by **A. F. Bulgin and Co., Ltd.,** is so wide that it is difficult to make a selection in any way representative, but the special sectionalised short-wave chokes for both transmission and reception are worthy of mention, and also the ultra-short-wave oscillator coil at 1s. 9d. with a coverage from 5-8 metres. This is representative of the value offered in all types of short-wave tuning inductances specially designed for the constructor. Kits of parts for short-wave and television aerial systems are available at prices ranging from 7s. 6d. to 30s.





Bulgin section-wound SW choke and (right) USW coil.

In receivers with a number of preselection circuits associated with one or more RF stages the problem of switching is a difficult one. **Burne Jones and Co., Ltd.,** have introduced for this purpose a special version of their multi-contact switches with double spacing and silver contacts. This type is available with from 2 to 12 pairs of contacts at prices ranging from 2s. 9d. to 7s.

Many short-wave receivers have to function under adverse climatic conditions, and even in more temperate zones attention to the possible effects of humidity will be well repaid from the point of view of efficiency. The type 690W **Dubilier** mica condensers is ideal for this purpose. These have a

low power factor, and are completely sealed with 20 SWG connecting leads enabling the condensers to be suspended in the wiring of a receiver. Condensers of the ceramic type are nowadays much in demand for short-wave work, and the Dubilier range is made in three shapes, namely, disc, cup and tube, depending upon the capacity required. In all cases, connections are made by means of 22 SWG wire, and they are rendered moisture-proof by a coating of high-grade synthetic enamel. On account of their ex-

tremely low power factor they find their most useful applications at frequencies of 50 kc/s and upwards.

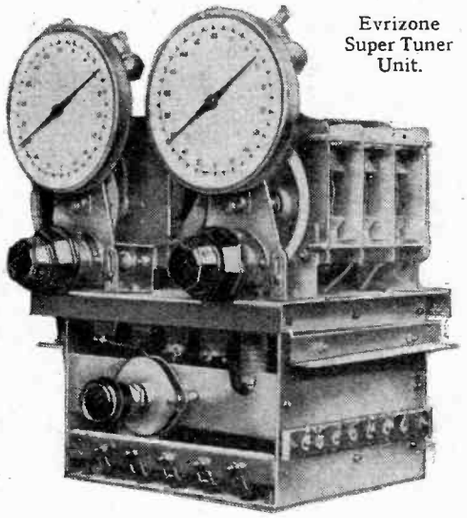
The Edison Swan Electric Co., Ltd., make a comfortable pair of lightweight headphones at 15s., and some of their transmitting valves are of special interest to the amateur. The ESW20, for instance, works well up to 56 Mc/s, and is rated for 20 watts dissipation. It can be supplied with either the American or British 4-pin base, and is a triode with top anode connection.

Ericsson headphones, which are of the flat diaphragm type, are eminently suitable for experimenters who are interested primarily in telephony, for the quality of speech and music is above the average, and these phones are, in fact, used by the B.B.C. and other

Specialised Short-Wave Equipment—

services for monitoring purposes. With 6ft. cords the price is 15s., resistances of 120, 2,000 and 4,000 ohms are available, and spare parts are obtainable at reasonable prices.

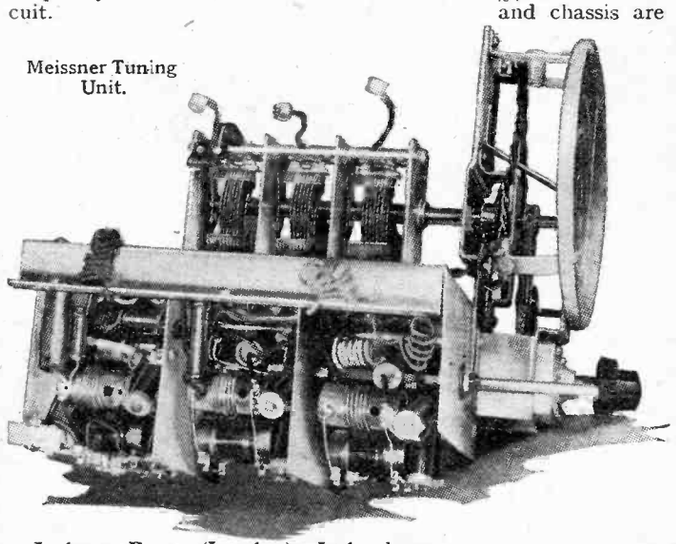
A new superheterodyne tuner unit covering 5 to 190 metres in five ranges has been introduced by **Evrizone Radio and Television Co., Ltd.** The circuit is designed for an RF, separate oscillator and mixer stages,



Evrizone Super Tuner Unit.

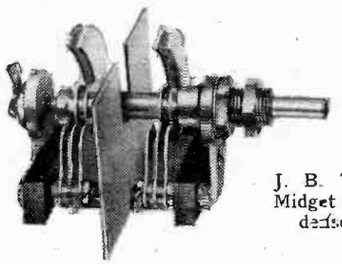
and the IF is 465 kc/s. A special wave-range switch is employed with contact capacities of only 1.9 mmfd., and there are two triple-gang condensers with separate clock-face dials for main and band spread tuning. Only seven connections taken from an accessible terminal panel are required. The price is £4 10s., which includes a blue print circuit for a 12-valve communication type receiver with crystal filter.

The Meissner tuning unit obtainable from **Anglo-American Radio (and Motors), Ltd.,** is made in two types one of which, the Model 7512, is suitable for constructors of communication type receivers. It covers 5-555 metres in five ranges, and is wired for RF, oscillator and mixer valves. The range of Meissner self-powered adaptor units supplied by this firm includes a remote tuning control, modulated gramophone oscillator, beat-frequency oscillator, and noise silencer circuit.



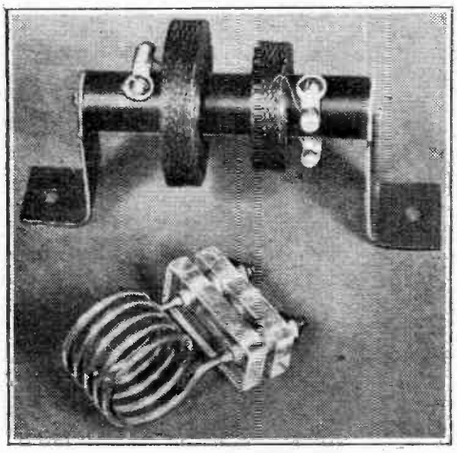
Meissner Tuning Unit.

Jackson Bros. (London), Ltd., have a number of tuning condensers specially designed for the ultra-short waves with maximum capacities of 15, 30 and 45 mmfd. These are useful for reaction, band spreading, etc., and the rotors have specially shaped vanes to give a low minimum. The twin condenser illustrated costs 5s.



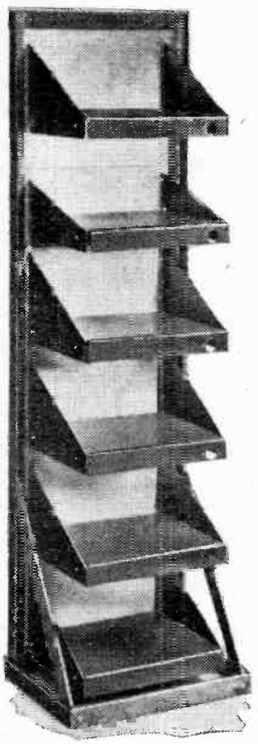
J. B. Twin Midget condenser.

It is evident from the catalogue of **The Premier Supply Stores** that they have a thorough appreciation of modern requirements of both the receiving and transmitting short-wave enthusiasts. From a very complete and varied list we would select for special mention their plug-in SW coils and



Premier quench coils and SW coil with Trolitul base.

bases with Trolitul insulation, quench coils for use in super-regenerative receivers, and the standard relay rack assembly. The latter uses panels 19 inches wide, and the rack alone costs 30s., and a complete 67-inch rack with five 10½in. panels, one 7in. panel, one 3in. meter panel, six chassis with brackets sells for £4 10s. Panels and chassis are available separately.

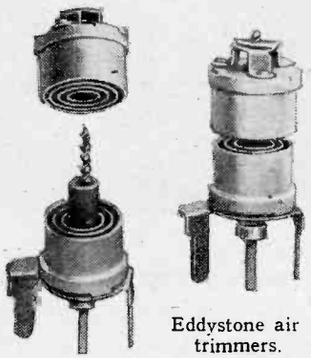


Premier standard six panel rack.

Specialised Short-Wave Equipment—

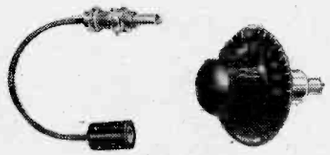
The experienced amateur would be hard pressed to think of any possible requirement in the way of components or materials which the **Raymart Manufacturing Co.** does not supply. Their micro-variable condensers for transmitting and reception are particularly interesting as they use a ceramic material known as "RMX" with a power factor comparable with quartz. Prices are reasonable, and a 40 mmfd. transmitting tuning condenser costs only 3s. 6d. Short-wave coils and formers using RD_4 low loss dielectric are available at prices averaging 2s. 9d. and 1s. 9d. respectively

Stratton and Co., Ltd., need no introduction as manufacturers of "Eddystone" short-wave components. High-grade transmitting variables with "DL9" and "Frequentite" insulation for peak voltages up to 3,500 include models with split stators for



Eddystone air trimmers.

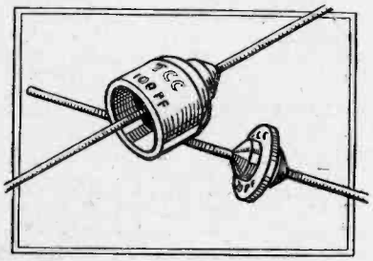
USW work. The capacity range of the latter in series is 1 to 10.5 mmfd., and the price is 15s. There is also a high-voltage "microdenser," capacity 3-18 mmfd. with spindle extended for ganging at 3s. 9d. Low-loss "Frequentite" formers and bases with spiral grooves moulded for coils up to 26 turns of 12 SW9 are supplied at 4s. with winding data for the amateur bands. On the receiving side the new air trimmers with spiral rotor adjustment at 1s. 3d. are of



Eddystone Flexible Coupler.

particular interest, and the flexible cable coupling shaft will solve many problems of layout arising from the conflicting claims of electrical and mechanical symmetry in short-wave circuits.

For all the auxiliary AF and power supply circuits of a short-wave receiver a **T.C.C.** condenser of suitable capacity and rating will be found, and on the RF side the small



T.C.C. disc and cup ceramic condensers.

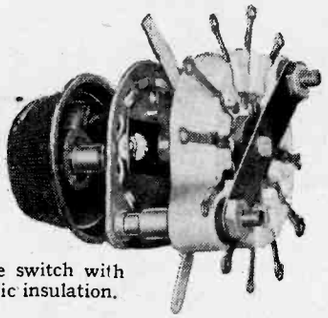
physical dimensions and good power factor commend the ceramic disc and cup types which have a small "earth" capacity, and are readily suspended in the wiring.

The "Wavemaster" Type 90/EX short-wave tuning condensers recently produced by **The Webb Condenser Co., Ltd.,** are provided with triangular ceramic ends and extension spindles for ganging. They are available in five sizes with maximum capacities from 15 to 160 mmfd., and cost from 3s. 6d. to 5s. Constructed on similar lines the Type 97 reaction condenser incorporates a 10: 1 slow-motion drive.

Ward and Goldstone, Ltd., are well known for aerial equipment, and have a wide selection of insulators, wires and cables, including "Telestat" twin low-impedance feeder for dipole aerials at 2s. 9d. for 50ft. They also market a wide variety of SW components of which their ceramic valveholders and transmitting copper tube inductances are representative.

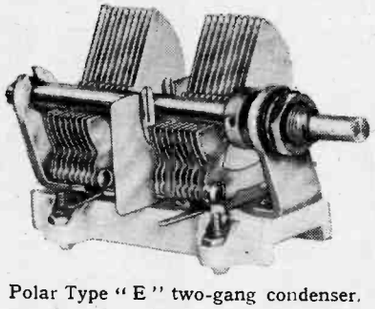
The **Whiteley Electrical Radio Co., Ltd.,** include a ceramic octal valve holder in their list, and many experienced amateurs regard the Stentorian loud speakers as particularly suitable for short-wave reception since they do not give prominence to excessive high note "squelch."

The plate-type wafer switch with ceramic insulation made by **Wright and Weaire, Ltd.,** are pre-eminently suitable for multi-range circuits on short waves. A wide variety of switch combinations is possible, and any number of wafers may be ganged. A single unit with locator plate and knob costs 5s., and additional wafers cost 3s. each.



Wearite switch with ceramic insulation.

Of the "Polar" range of **Wingrove and Rogers'** condensers the Type E single and two-gang variables on "Steatite" bases are probably the most popular with constructors on account of the precautions which have been taken to ensure electrical silence in



Polar Type "E" two-gang condenser.

operation. The maximum capacity of each element is 160 mmfd., and the price 5s. for the single and 10s. 6d. for the two-gang with electrostatic shield.

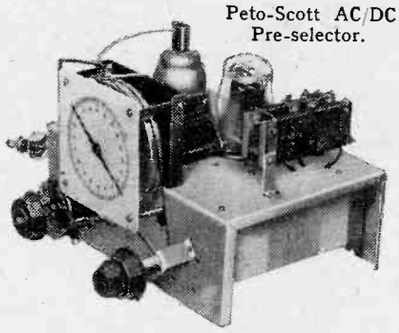
Converters

Those who already have a broadcast receiver for the medium and long waves can easily adapt them for short-wave reception by connecting a converter unit to the aerial and earth terminals. Units of this type are virtually short-wave frequency changers, and the receiver acts as an IF amplifier at the frequency to which it happens to be tuned.

Well-known examples of this useful accessory are the "Antinodal" converter made by **Aeronautical and General Instruments, Ltd.,** with a range of 12-80 metres, and the two-valve "Eelex M_2" model with two waveranges, 15-30 and 28-55 metres, made by **J. J. Eastick and Sons,** 118, Bunhill Row, London, E.C.1. Single-valve models are also available from this firm.

A very neat converter unit with valve mounted inside the tuning coil is made by **Stonehouse Radio Supplies** and costs 21s. with valve. It can be conveniently mounted inside the broadcast receiver cabinet.

In the **Peto-Scott** short-wave AC/DC preselector a heptode valve is used for frequency changing instead of the more usual



Peto-Scott AC/DC Pre-selector.

self-oscillating triode. The range of the converter is 15-70 metres and it works equally well on AC or DC mains from 200 to 250 volts. The price, including cabinet, is £4 17s. 6d.

Transmitters

In addition to the many firms catering for the transmitting amateur who builds his own installation there are several firms who undertake the construction of complete stations or can supply sections such as modulators already wired and tested.

ACS Radio make a 20-watt transmitter with crystal control for use on any band between 1.7 Mc/s and 28 Mc/s which is supplied either in open rack or closed metal cabinet form for £25. A two-stage CW or phone transmitter with double-triode crystal oscillator and frequency doubler and triode power amplifier is also available for the 20- and 40-metre bands at 19 guineas. A kit of parts for CW only costs 12 guineas.

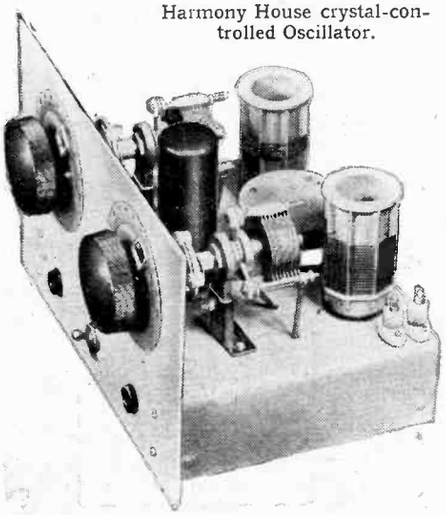
The T20/40 transmitter designed by the **Fox Radio Co.** is entirely self-contained with mercury rectifier, crystal controlled harmonic oscillator, power amplifier, first AF stage and Class AB modulator. The latter gives full modulation up to 25 watts. With Weston moving-coil milliammeter, high-grade carbon microphone, and coils for 7 and 14 Mc/s the cabinet model costs £21; with rack mounting the price is £20. The Model M60 by the same firm is a 4-stage unit with a push-pull output rated at 60 watts. Suitable for crystal as well as carbon microphone inputs, it is built up in two standard chassis and costs £21.

Harmony House Sound and Service specialise in the construction of mobile field transmitters, and also market a range of fixed station transmitters. The nucleus of most of these installations is a crystal-controlled oscillator using the 6L6 metal beam power valve and suitable for all amateur bands between 10 and 160 metres.

The Meissner "Signal Shifter," obtainable from **Anglo-American Radio (and Motors), Ltd.,** is an electron-coupled exciter unit designed to facilitate rapid change of

Specialised Short-Wave Equipment—

frequency within the 10, 20, 40, 80 and 160 metre bands, to avoid temporary jamming. The full scale is occupied by each of these



Harmony House crystal-controlled Oscillator.

bands and the price of the unit with self-contained power supply is £12 10s. A set of coils for any given band costs 14s. 6d.

A 10-watt crystal-controlled CW transmitter for the 7 Mc/s band, completely wired and "air-tested," is obtainable from the **Premier Supply Stores** for 4 guineas. It is for AC or DC operation and incorporates a barretter. "Trolitul" insulation is used in the tuning condenser and the equipment includes a key and anode current milliammeter. Rack mounted 10- and 25-watt phone and CW transmitters are also available at £15 and £21 respectively.

Radiomart (G5NI, B'ham), Ltd., are agents for the American Collins transmitting equipment and also market a very complete 60-watt 12-valve transmitter kit, including crystal-controlled oscillator amplifier, modulator and power pack, crystal microphone, four moving-coil meters, etc., for £36.

RANDOM RADIATIONS

By "DIALLIST"

Canned Peals

THERE'S trouble, I see, over the gramophone records and PA equipment which have been used instead of bells at St. John's Church, Weymouth. You can't install things in churches without previously obtaining what is known as a faculty. Most faculties are granted without much fuss, but in this instance the whole question may have to be considered by a Consistory Court sitting in Salisbury Cathedral, for the Dorset Guild of Bell Ringers have made strong protests. There are various queer laws, I believe, about the use of church bells, and now that the question has been raised it turns out to be a moot point whether or not it is legal to used "canned bells" instead of real bells. Myself, I should be very sorry if bells were supplanted, for bells and bell ringing are fine old British institutions. But there are places where the bells can't be rung, either because the hanging arrangements have become too shaky with the passage of time or because no ringers are available. Gramophone records and PA loudspeakers are certainly better than no bells at all.

The Luxembourg Effect

WRITING from Ambleside, a reader asks me how it is that he receives the National programme as a background to the Welsh Regional. "Is this," he asks, "another harmonic or is the trouble due to Post Office telephone lines?" This is very clearly an instance of the "Luxembourg Effect," for Ambleside, Droitwich and Washford Cross are near enough to being in a straight line to cause it. A bee-line, joining the Welsh Regional transmitter and Ambleside, passes within about 45 miles of Droitwich, so that the three places stand at the angles of a narrow isosceles triangle. In such circumstances it is quite usual for a powerful long-wave station to be heard as a background to a medium-wave transmission, and there is, unfortunately, nothing that the listener could do about it. He can rest assured that it is due to no fault of any kind in his receiving set, and he is as likely to suffer from the Droitwich background whether he pays £5 or £50 for his apparatus.

A Real Novelty

WIRELESS manufacturers, I know, are racking their brains to find genuine novelties to incorporate in the sets which will constitute their new ranges. To my mind, by far the weakest point of 90 per cent. of the sets on the market is to be found in their tuning arrangements on the short-wave range. If wavelengths from, say, 13 to 50 metres are covered in one range, the scale is hopelessly cramped, and whole wave-bands, such as the 19-metre, the 25-metre and the 31-metre, each containing a large number of stations, may be represented by a fraction of an inch of pointer-travel. Even where there are two short-wave ranges, tuning is still many times more difficult than it is on the medium and the long waves. I am sure that a receiving set with adequate band-spreading on the short-wave range would make a big appeal. It is by no means difficult to produce it, and I know from experience what an enormous difference proper band-spreading makes to one's results in short-wave reception. Well, there's a suggestion. It remains to be seen whether set manufacturers will realise its value.

Good 'Vision

THE televising of the Cup Final at the Wembley Stadium was a great piece of work. It must have been one of the longest continuous programmes that the Alexandra Palace staff has yet undertaken, for the match itself ran to two full hours with the extra time that was played, and the television cameras came into action some time before the actual kick-off. It was a pity that the game itself was so dull except for its last 30 seconds.

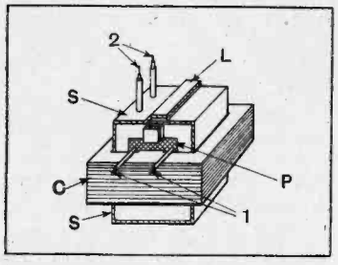
The King came out splendidly during his inspection of the players before the game. King George V was, I believe, the first King to broadcast, and King George VI is certainly the first to be televised. He must be getting quite used now to the Emitron cameras at functions in or near London.

Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

"STATIC" ELIMINATORS

THE Figure shows the construction of a supply transformer designed to prevent the transfer of any high-frequency disturbing voltages from the mains to a wireless set. The inductive coupling for such frequencies is, of course, practically nil, but leakage is likely to occur across the shunt capacity of the windings. One at least of the windings is accordingly arranged inside a substantially closed screen, which is connected to the chassis of the set.



Electrostatic screening for mains transformer.

The primary coil P is wound around a shell-type coil C. The screening cage S surrounds both the primary and secondary windings (the latter not being shown), and its ends are lapped over at L so as to exclude any high-frequency disturbing voltages. The supply leads are shown at 1 and the secondary terminals at 2.

E. Huber. Convention date (Switzerland), March 23rd, 1936. No. 481001.

o o o o

HIGH-FREQUENCY COUPLINGS

A RADIO-FREQUENCY amplifier V is coupled to the frequency-changing stage V1 of a superhet receiver through a primary winding L, which is fitted with a trimming condenser C1 and shunted by the main tuning condenser C. The primary circuit is sharply selective over a band of frequencies. The secondary winding L1, though not definitely tuned, is made broadly resonant at or below the lowest frequency to which the primary is tunable. Loading coils such as L2, L3 can also be brought into circuit by a wave-change switch S, provided the same conditions hold.

The arrangement is stated to give uniform gain over a wide range of frequencies, and a relatively constant degree of selectivity over that range, whilst avoiding the use of a directly tuned input to the frequency-changing valve.

B. J. Banfield. Application date, July 25th, 1936. No. 480680.

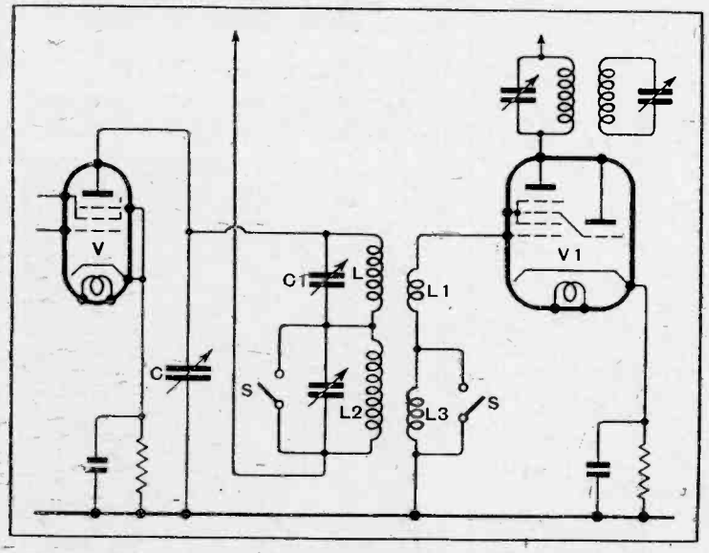
o o o o

AUTOMATIC TUNING CONTROL

THE mutual conductance existing between the signal-input grid and the oscillator-anode of a frequency-changing valve, preferably of the heptode type, is used as a means for automatically correcting the tuning of the set. Two discriminating circuits, one tuned above and the other below the correct intermediate frequency, serve in the ordinary way to develop a biasing voltage, the strength and polarity of which depend upon the out-of-tune conditions.

The oscillator anode of the frequency-changing valve is back-coupled to the signal-input grid, and this causes the effective reactance of the oscillator anode-cathode space of the valve (which is in shunt with the tuned oscillator circuit) to vary in accordance with the bias applied to the input grid from the discriminating circuits. This in turn automatically adjusts the oscillator frequency until the effect of the original mistuning is offset.

R. I. Kinross. Application date, August 15th, 1936. No. 480017.



RF coupling giving relatively constant amplification over a wide range of frequencies.

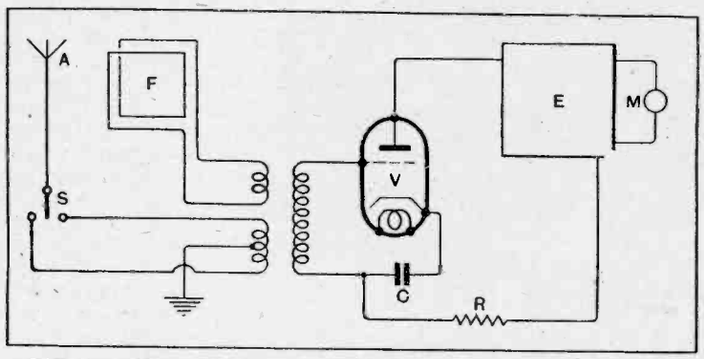
o o o o

DIRECTION-FINDING

IT is necessary in direction-finding to get rid of "false" indications produced by signal waves reflected down at an angle from the Heaviside layer. One recognised remedy is to transmit signals in short pulses, and to provide means at the receiver for accepting those pulses which arrive as earthbound waves whilst rejecting the corresponding "echo impulses" which come down from the Layer.

The invention relates to systems of this kind and provides a simple way of eliminating the undesired space-wave or "echo" signals. The Figure shows a directional receiving system in which a frame aerial F is combined through a rapid change-over switch S with a vertical aerial A, the combined pick-up indicating the bearings of a distant transmitter in the usual way. A biasing voltage is fed back from one of the output stages E through a resistance R to the grid of the first valve V, and serves to "paralyse" that valve for a sufficient period of time (determined by the resistance R and condenser C) to prevent the "echo" of impulse from passing through and affecting the "bearings" indicator M.

Telefunken Ges. fur Drahtlose Telegraphie m.b.h. Convention date (Germany), June 20th, 1936. No. 480572.



Direction-finding system in which space-wave is cancelled out by mechanical switching

o o o o

SUPERHET SETS ...

IN order to stabilise the frequency of the local oscillator of an all-wave superhet set, the type of circuit used to produce the local oscillations is automatically altered as the wave-band switch is operated. The well-known Hartley type of circuit is used, say, for the medium waves, and is changed to another form of back-coupling for the long waves, whilst a single wire forms the feed-back inductance on the shortest waves.

The arrangement also helps to reduce undesirable reaction between the oscillator and signal input circuits, and gives a relatively high output from the first detector, thus improving the signal-to-noise ratio.

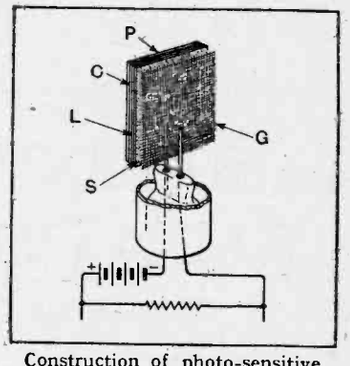
Marconi's Wireless Telegraph Co., Ltd. Convention date (U.S.A.) August 31st, 1935. No. 481020.

o o o o

PHOTO-SENSITIVE SCREENS

A PICTURE is projected on to a photo-sensitive screen which reacts by developing variations in its transverse resistance, that is, in the resistance as measured from back to front of the screen through the thickness of the material. The reverse side of the screen is then scanned by a moving ray of light, or by an electron stream, to develop the signal currents.

The construction of the screen (which is normally enclosed in an evacuated glass bulb) is shown in the Figure. The image to be televised is thrown on to a glass plate P, which is covered with a coating C of silver carrying a thin layer L of high-resistance material, the conductivity of which is increased by the action of light. This, in turn, is covered by a very thin film S of a photo-emissive metal, such as potassium. The whole is backed by a wire-gauze grid G, which allows the passage of the scanning ray and collects the electrons released by its action.



Construction of photo-sensitive screen for use in television apparatus.

Electrical Research Products Inc. Convention date (U.S.A.), March 4th, 1936. No. 480996.

The Wireless World

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EDITORIAL COMMENT

The Radio Show

Important Changes Announced

THE Radio Manufacturers' Association, the organisers of the annual Radio Exhibition at Olympia, are to be congratulated on several decisions which they have recently announced in regard to arrangements for the next Show, which is to be held from August 24th to September 3rd.

In our view, the most welcome change of all is the decision to discontinue the variety theatre, which year after year has been held and has, in our opinion, detracted considerably from the Radio Exhibition itself. In the very early days of broadcasting there was some justification for indicating to the public what they were missing if they did not own a wireless set, but, later on, when the public generally became thoroughly familiar with broadcasting and its possibilities, we repeatedly urged that there remained no justification for a variety theatre in conjunction with the Radio Exhibition. We have always felt that the variety theatre drew people away from the actual show and that the performance was really only a rival to the Radio Exhibition alongside.

Television Studio

The theatre will be replaced this year by a television studio with glass sides so that visitors will be able to walk round and watch television transmissions in actual progress in the studio ; there will be no need to take seats and it is expected that there will be ample opportunity for everyone attending the Exhibition to inspect the television studio without loss of time or the necessity to book in advance.

Television receivers will be on view on many more stands than previously, and arrangements have been made for actual demonstrations to be given, the television programmes being fed to individual stands. In addition, arrangements are being made for sound receivers to be demonstrated on stands, each stand being supplied with a radio-frequency input, this input to be of the same programme but in two forms to demonstrate the performance of receivers on local reception and under conditions corresponding to the reception of a distant transmitter.

It is a courageous decision on the part of the R.M.A. to supply stands with television and with broadcast programmes at radio-frequency for the purpose of demonstration, and we wish every success to the technical arrangements which are being placed in the hands of a special committee.

Points to Remember

Whilst television will be the centre of attraction at this year's Show, we hope that it will be borne in mind that television is, for the present, of local appeal only, so far as practical results are concerned. The Exhibition should be designed to interest all broadcast listeners and we should remember that probably for a long while to come viewers will remain a minority of the wireless public.

The disappearance of the variety theatre may, and probably will, result in an apparent falling-off in the attendance at the Radio Exhibition this year. We say "apparent" falling-off deliberately because we believe that in past years a large proportion of those who have gone to the Exhibition have really gone to the variety theatre, with little interest in the Exhibition itself. A falling-off in attendance, therefore, if it occurs, must not be regarded as any indication that the Exhibition is less successful. It will mean that the Show will only draw visitors who are seriously interested in a radio exhibition.

The Home Laboratory

By M. G. SCROGGIE, B.Sc., A.M.I.E.E.

Part IV.— INEXPENSIVE CATHODE-RAY OSCILLOGRAPHY

IT was shown in the last instalment that a cathode-ray tube is necessary to anyone who wants to find out how audio and radio apparatus is really working, and that there is nothing to be frightened about either as regards cost or difficulty. Some guidance was then given on the choice of a tube.

SIMPLE cathode-ray gear, most of which can be improvised from receiver components, is described in this instalment. The practical uses of the apparatus are also discussed.

Whatever sort of tube is selected, *some* auxiliary equipment is necessary, but it need not be nearly so elaborate as is generally supposed. It is well to begin by pointing out that it is eminently practicable to run a cathode-ray tube from batteries. In fact, except for convenience, batteries are definitely to be preferred. In gas-focused tubes the cathode temperature is one of the two focusing adjustments, and as the cathodes are directly heated the focusing is not quite so sharp when AC is used. All the gas-focused tube heaters run at a low voltage—less than 1—so a single 2-volt cell with suitable resistance control is required. In high-vacuum tubes the cathode temperature is not critical, and most of them follow ordinary AC valve practice with 4-volt indirectly heated cathodes. Though, of course, they can be run by battery, most people naturally prefer to use AC when it is available.

As has already been suggested, the rated anode voltages—generally at least 3,000—need not be taken too seriously for laboratory purposes, as most tubes are useful at a tenth of that figure. So the cost of dry batteries is not at all unreasonable, particularly as the current taken is almost

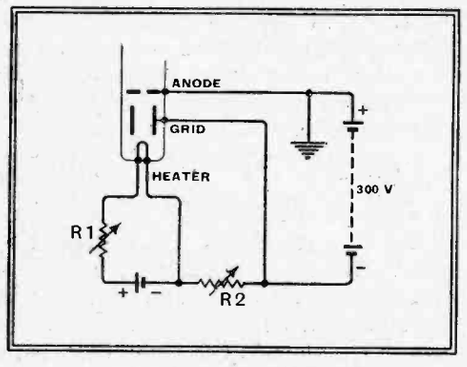

Fig. 1.—Circuit of a gas-focused CR tube.

negligible—of the order of 0.05 mA. In view of this they should be selected for good "shelf life" rather than heavy current capacity. The circuit for a gas-focused tube is simple enough; see Fig. 1. Actually R1, the filament rheostat, should be elaborated somewhat, as will be described later, to restrict the range of control. The other focusing control is R2, which supplies auto-bias to the grid. Normally, the bias is about a tenth of the anode voltage, and R2 may be half a megohm.

Years of experience with radio receivers accustoms one to regard "−HT" and "earth" as much the same thing, and similarly "+HT" and "live" (or "hot"). It is necessary to reverse this way of thinking when handling cathode-ray tubes, because it is the anode, or +HT, that is earthed, and the filament and its battery are "live." The latter should be well insulated and rendered inaccessible during use.

Batteries are good from the tube's point of view, but have to be replaced at intervals, and are heavy and bulky, especially if the voltage is much greater than the bare minimum. So an AC power unit will now be described.

It fits the Cossor gas-focused tube type 3232, which was almost the only one obtainable some years ago. It costs £7 10s., and is now available at no extra charge with split deflector plates for eliminating origin distortion, and the screen diameter is 5in. There is now a slightly smaller Cossor tube, also gas-focused, at £4 15s.; the Mullard E40-G3, with a 3in. screen, at £3 10s.; the Dumont 24-XH 2in. tube at £2 17s. 6d.; and the RCA 913 1in. tube, costing £1 17s. 6d.[1] The last three are all of the high-vacuum type, and require a lower voltage tapping for the second anode. This modification is very easily introduced by substituting a potentiometer for one of the 1-megohm resistors in Fig. 2, which shows the circuit of the power unit.

This unit is made up of ordinary receiver parts, including a typical mains transformer. Two anode voltages—300 and 600—are available by a change-over switch: 600 volts gives a bright enough trace for visual use in artificial light or moderate daylight. With 300 volts it is necessary to draw the curtains when the day is bright; but the sensitivity is double, and as an example quite a useful figure ½in. long is given by only 5 volts peak.

The smoothing circuits are simple and cheap because the current drawn by the tube is only a matter of microamps. For the same reason the rectified output voltage is very nearly the *peak* input, and an ordinary 250-0-250-volt receiver transformer (so rated at a much heavier current) gives 600 volts DC when connected as shown, even after allowing for the drop in the smoothing resistor. If somewhat higher voltages—about 450 and 900—are wanted, a 350-volt transformer can be substituted. The rectifier is not important so long as it will stand the high back-voltage. The Dario SW1 is very suitable. Obviously, single 0.5-mfd. condensers may be substituted for the pairs of 1 mfd., but they would have to be specially ordered for the full voltage. The 1-megohm leaks serve to prevent the condensers from holding a charge after use and to stabilise the output voltage. The 0.5-megohm variable resistance, used for grid bias, is an ordinary receiver volume control. The other focusing adjustment, the filament rheostat, is arranged to give fine control and to avoid the possi-

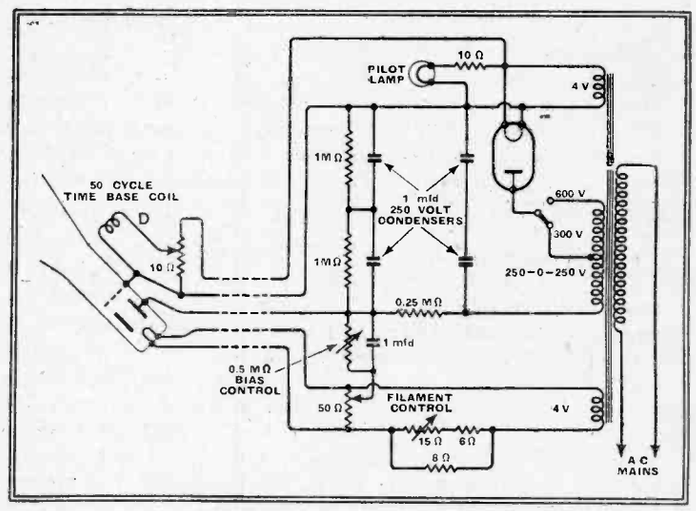

Fig. 2.—The circuit of the power supply unit.

[1] A 1½in. G.E.C. tube has been introduced since this was written.—Ed.

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bility of current being passed in excess of the rated maximum for the filament. The values specified are for a tube requiring about 0.75 amp. at 0.6 volt, and are designed to make use of a rheostat of higher resistance than would give a gradual enough adjustment if entirely in series. Although DC filament heating is somewhat preferable for gas-focused tubes, AC has been found quite satisfactory and much more convenient, though the focusing adjustments may be rather critical.

The power unit should be made up in a box that can be kept not less than about 5ft. away from the tube, to which it is linked by an adequately insulated multiway cable, so that there is no chance of the spot being drawn out into a line by unwanted magnetic deflection due to the power transformer (Fig. 3). When working one must remember to make sure that no other transformer—possibly in the apparatus being investigated—is causing any such deflection. Even the earth's magnetic field produces a perceptible deflection at low anode voltages, but as it is a steady one it does not matter much. If transformers must be close to the tube it is necessary to protect it by a mumetal shield which, however, is fairly expensive.

Mounting the Tube

Although complete oscillographs or oscilloscopes, as sold, usually comprise a cathode-ray tube built into a box along with all the auxiliary apparatus, which, of course, is conveniently portable, there is not only the problem of stray fields, but also it may not be easy to get the deflector plates connected straight to the desired circuit points with a minimum of connecting leads as is required to prevent stray capacity and interaction effects. For bench use, therefore, it is preferable to mount the tube in a retort clamp (Fig. 3), sold quite cheaply by chemical dealers such as Griffin and Tatlock, so that the base can be placed where it is wanted, and the screen set at a convenient angle for observation. The diverging part of the tube can be painted black, and a cylindrical hood placed around the screen to keep out room light. A ruled square millimetre scale for measuring screen figures is obtainable from Cossor for 1s.

Sometimes the power source includes potentiometers for shifting the spot over the screen along either X or Y axes to counterbalance any voltage bias from the signal circuit that would otherwise decentre the figure. There is a limit to the bias that may be used, in any type of tube, before defocusing results. Generally, however, such "X-shift" and "Y-shift" controls form part of a time-base unit.

When using the equipment so far described, the anode terminal must be regarded as "earth," and *there must be a conducting path from it to all deflector plates.* If the apparatus to which the plates are connected does not provide one, a "leak" of about 1 megohm must be used, blocked off from the apparatus by a condenser if necessary in exactly the same way as the indirect connection to a valve voltmeter. The grid and filament terminals should be kept out of touch by insulating caps or covers; and the deflector plate terminals are of the double-decker type to facilitate connections of leaks, etc. Ideally the input to each pair of deflector plates should be in push-pull, with the centre tap joined to anode; but when this is impossible or troublesome (as it usually is) one plate is shorted to anode and regarded as the earthy input terminal and its opposite number used on the high-potential side.

For instance, Fig. 4 is the conventional diagram representing two signal sources connected to a cathode-ray tube. If only one pair of plates is being used, the resulting figure is merely a straight line which indicates the double-amplitude or swing of the signal, but not much else. If a signal of the same frequency and phase is applied to the other pair of plates, the straight line becomes diagonal, the angle indicating the relative amplitudes; or if there is a phase difference between them the line opens out into an eclipse or circle from which it is possible to deduce the phase angle. If the signal sources A and B are actually the input and output of an amplifier being tested, it is possible to compare amplitude, phase, and also waveform; for electrical distortion is shown as a visible distortion of the figure. Again, if two independent signals are applied, their frequencies can be compared with great accuracy. In this case one of the signals will generally be the "unknown" and the other from a laboratory oscillator or other calibrated source.

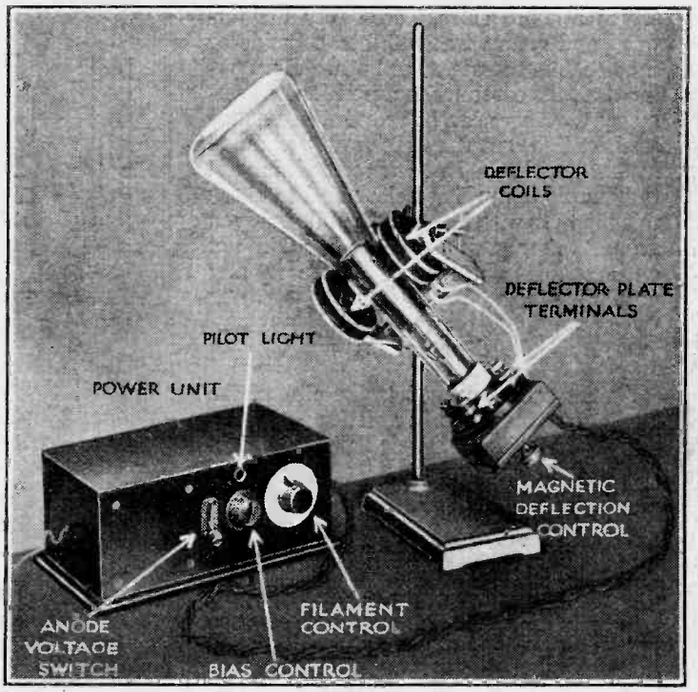

Fig. 3.—The source of power supply and the tube should be mounted as separate units. A retort stand is used as a tube support.

Time Bases

Personally, the writer favours methods of test in which the signal supplies its own "base," as just described; but it is sometimes useful to adopt the more commonly specified method of showing how the signal varies with time by projecting it on a base that is uniform with respect to time. This is where the so-called time-base or sweep circuit is used. It is an oscillator having a saw-tooth waveform, so that the spot is drawn across the screen at the desired rate, and then returned as nearly instantaneously as possible to repeat the process. If the frequency of the time base is equal to the frequency of a continuously repeated signal wave or group of waves, the separate pictures of these always coincide and form a stationary figure which can be observed or photographed at leisure.

The numerous possible time base circuits are not to be described here because there is room only for the less often emphasised features, and every book on cathode-ray tubes is full of time base circuits. Although they are useful adjuncts, the writer considers that they are not so indispensable as is sometimes made out.

Very often it is possible to substitute a sinusoidal for a linear base; i.e., one produced by an ordinary sine wave instead of the saw-tooth variety. This is the object of the coil D in Fig. 2, which consists of about 200 turns of 30-gauge wire, about 2½in. diameter, and can be clipped across one of the 4-volt AC supplies, preferably the rectifier supply for safety. The coil can be hung on the horizontal part of an inverted L-shaped piece of stiff wire which can be swung round to give a line of any length or angle.

It is used at the start for focusing purposes. Not only is a stationary spot bad for the screen, but focusing done on it may have to be revised when signals are on. The line gives a better idea of visibility, too, and shows if things are working properly. Then it constitutes a 50-c/s frequency standard of good accuracy (on time-controlled mains), which may be used for calibrating other sources of this frequency and many others of a simple ratio to 50. It can be used as a time base whenever a strictly linear law is not essential.

The disadvantage of a single coil is that it does not give a uniform deflecting field. A pair of suitable coils is very satisfactory in this respect, however, and can be seen

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fitted to the neck of the tube in Fig. 3. The amplitude of deflection is controlled electrically as shown in Fig. 2; the potentiometer is mounted conveniently at the base of the tube. Dimensions of a suitable pair of coils are given in Fig. 5, but there is no necessity to adhere strictly to these. To arrive at the adjustment of position the tube is switched on, with all deflector plates joined to anode, and the magnetic deflection turned to maximum, which should bring the beam well off the screen at both sides. Probably the forward and return traces fail to coincide or the line is not straight, or both. By moving the coils carefully to a position of symmetry the figure can be reduced to a single straight line and the coils firmly clamped in that position. In this process it is vital to have no disturbing fields; and to check this the tube with its coils should be moved around to make sure that the line does not open out into a narrow ellipse in any position.

Adjustments

As the coils are fixed to the clamp, the angle of magnetic deflection can be adjusted relative to the electrostatic deflections by twisting the tube around in its clamp.

The sinusoidal base can sometimes be used even when linear deflection is wanted because the "middle cut" of an extended sine-wave trace is quite a reasonably good approximation to it. It is necessary merely to increase the size of the base-line so that the ends are well off the screen, and then to arrange that the Y-plate signal, which is to be observed, occurs near the centre. In this manner waves of the order of 1,000 c/s can be examined on a 50-c/s base. An anode voltage

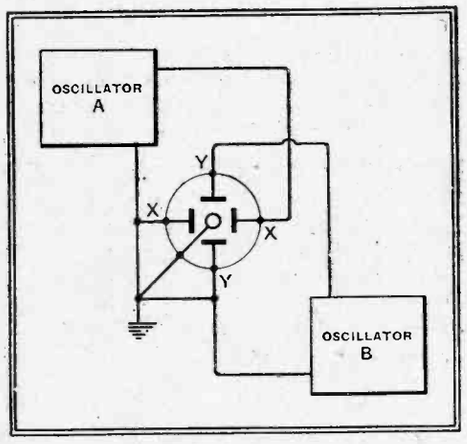


Fig. 4.—Illustrating the connection of two signal sources to a CR tube.

higher than usual is needed because the high writing speed results in less brilliance.

For many purposes, particularly service and maintenance work (e.g., lining up IF amplifiers), a frequency base is needed, whereby the resonance curve or other frequency characteristic of an amplifier or system can be displayed on the screen. This is usually worked by means of a test oscillator, whose frequency can be varied over a certain band by means of an alternating voltage. This voltage is applied to one pair of plates and constitutes the frequency base; the output of the apparatus under test, due to the signal provided by the oscillator, is applied to the other pair

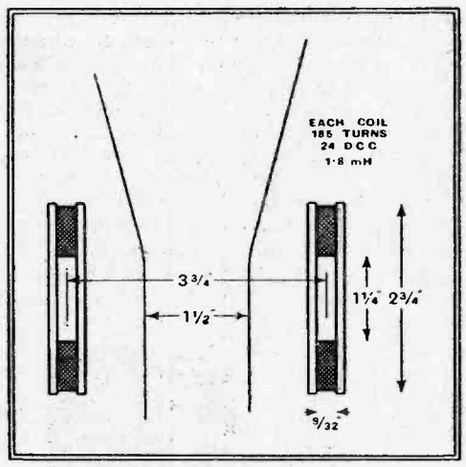


Fig. 5.—Winding details of time base coils.

of plates. This really is most valuable, and particulars should be sought in one of the detailed publications on the subject, such as the forthcoming volume by the present writer.

It may often happen, more especially when the tube anode voltage is high, that a signal under investigation is too weak to give a useful deflection. This is rather inconvenient, and is one of the best reasons for keeping the voltage to a minimum. The inconvenience is not only that amplifiers represent so much extra gear to provide, but also so much more to think about when considering the circumstances of the experiment. It is futile to look for distortion due to the apparatus under test if deflection amplifiers cannot be regarded as blameless. A simple resistance-coupled amplifier is usually adopted with a view to keeping the amplification constant over a wide range of frequency and avoiding phase shift. Most oscilloscopes and oscillographs have one or more such amplifiers built in.

Comparing Input and Output

For testing an amplifier or component for distortion one is usually instructed to apply an undistorted oscillation of appropriate frequency and examine the output on a time base. When the frequency of the time base is adjusted to a submultiple of the oscillator frequency the output waveform is held steady on the screen. The writer diverges from this advice for four reasons:—

(a) An accurate linear time-base generator is necessary.

(b) One cannot tell by looking at the wave picture whether it is distorted or not unless the distortion is very gross or a pure sine wave is accurately imprinted on the mind's eye for comparison.

(c) Unless the waveform of the test oscillator is perfect there is no means of knowing how much of the observed distortion is due to the apparatus under test. Generators of pure waves (distortion less than about 1 per cent.) are very expensive.

(d) Phase shift is not shown.

A much simpler method is to make a direct comparison between input and output signals by applying them respectively to the X and Y plates. If there is much difference in their amplitudes something should be done to bring them approximately equal, either by amplifying the one or potential-dividing the other. Distortion in the test signal does not matter, except in so far as it is desired to carry out the test at one particular frequency, which the presence of substantial harmonics would frustrate.

As already mentioned, absence of distortion and phase shift is shown by a diagonal straight line. Phase shift opens the line out into a circle or ellipse, and distortion shows up as a distortion of the figure. Obviously, it is much easier to detect when there is no phase shift. If possible, therefore, the test should be done at a frequency where the phase shift is nil (or a multiple of 180 deg.); alternatively, it may be possible to introduce a non-distorting phase shifter, such as a resistance and condenser in series or parallel. Anything more than slight distortion can easily be *detected* even when there is phase shift, but if there is none it can be *measured*.

The following method of doing so is adapted from that described by J. A. Hutcheson,[1] who demonstrates it for all

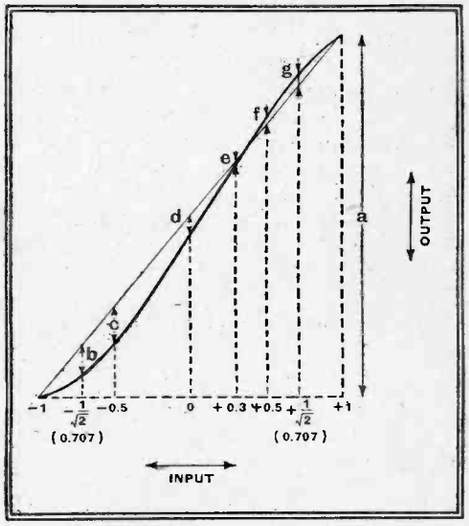


Fig. 6.—Illustrating how data for measuring distortion may be derived from the cathode-ray figure.

harmonics up to and including the seventh; and it involves only simple arithmetic. Fig. 6 shows how the requisite data are derived from the cathode-ray figure. The total output swing, *a*, is measured, as it conveniently can be by cutting off the input (horizontal) deflection. The other qualities, *b* to *g*, are the distances, measured *vertically* (in the direction of the output deflection) from a straight line drawn between the ends of the curve to selected points on the curve. The relative horizontal locations of these points are shown. Distances measured *downwards* from the straight line are called *negative*; those upwards are posi-

[1] *Electronics*, Jan. 1936, p. 16.

The Home Laboratory—

tive. These signs must be carefully observed throughout the calculation, but the signs of the final answers are of no great significance. The distances need not be measured in volts; the Cossor "graph paper" scale mentioned earlier enables them to be read off in millimetres.

If the amplitudes of the various harmonics are denoted by V2, V3, etc., they are given by

$$V_2 = \frac{f+c}{3} + \frac{d-b-g}{4}$$

$$V_3 = \frac{f-c}{3}$$

$$V_4 = \frac{d-b-g}{4}$$

$$V_5 = \frac{f-c}{3} + \frac{b-g}{2.828}$$

$$V_6 = \frac{d}{2} - V_2$$

$$V_7 = \frac{e - 1.82V_2 - 1.092V_3 + 0.655V_4 - 0.699V_5 - 0.751V_6}{1.146}$$

The seventh is the only one that takes more than a moment or two to work out, and it can often be omitted.

The amplitude of the fundamental, V1, differs from the amplitude of deflection only by the odd harmonics:—

$$V_1 = \frac{a}{2} + V_3 - V_5 + V_7$$

The percentage of any harmonic is $\frac{100V_n}{V_1}$

and the percentage total harmonics is

$$\frac{100}{V_1}\sqrt{V_2^2 + V_3^2 + V_4^2 + \ldots}$$

It is essential to measure the figure accurately and to avoid distortion of it, for unless the electrical distortion is very bad the harmonics are relatively small. Also because they are calculated as differences between probably larger quantities the working must be done to at least one more significant figure than is expected in the answers.

As an example, suppose that in Fig 6

$a = 120$ $\quad e = -2$
$b = -10$ $\quad f = 2$
$c = -12$ $\quad g = 3$
$d = -7$

Then $V_2 = \frac{2-12}{3} + \frac{-7+10-3}{4} = -3.33.$

$$V_3 = \frac{14}{3} = 4.67.$$

$$V_4 = 0$$

$$V_5 = 4.67 + \frac{-10-3}{2.828} = 0.07.$$

$$V_6 = -\frac{7}{2} + 3.33 = -0.17.$$

$$V_7 = \frac{-2 + (1.82 \times 3.33) - (1.092 \times 4.67) - (0.699 \times 0.07) + (0.751 \times 0.17)}{1.146} = -0.83$$

$$V_1 = 60 + 4.67 - 0.07 - 0.83 = 63.77$$

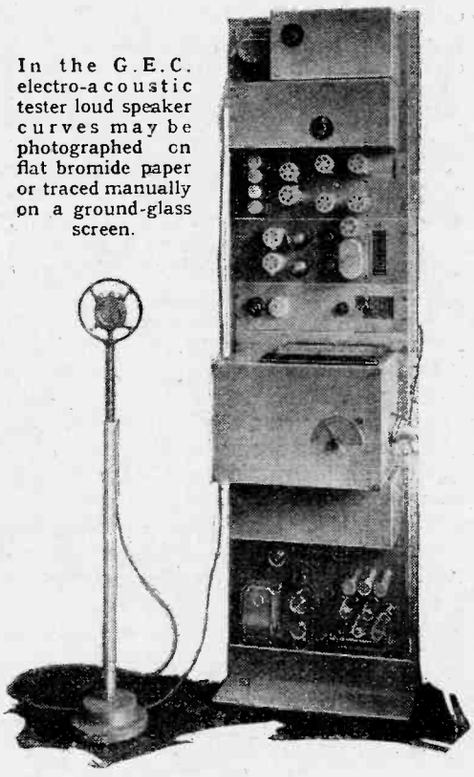
Percentage 2nd harmonic = 5.2
" 3rd " = 7.3
" 4th " = 0
" 5th " = 0.1
" 6th " = 0.3
" 7th " = 1.3
" Total " = 9.1

An Electro-Acoustic Tester

Apparatus Developed for Testing Loud Speakers at the G.E.C. Works

CURVES showing the response at various frequencies within the audible range are extremely useful to the loud speaker designer, and the ability to take such curves quickly and easily justifies the cost of development of special recording apparatus. Such apparatus has been developed by the General Electric Co., Ltd., and has been in use for some time at their Telephone and Radio Works at Coventry.

Briefly, the principle of operation of the "electro-acoustic tester" is as follows: A variable-frequency oscillator feeds the loud speaker under test. The sound output from the loud speaker is picked up by a condenser microphone placed at a suitable distance; the output from the microphone is passed through a microphone amplifier, and thence to the recording apparatus. The latter contains a mirror-galvanometer, and the record appears on a ground-glass screen as a moving spot of light, which may be traced by hand on log paper or may be recorded photographically on bromide paper.



In the G.E.C. electro-acoustic tester loud speaker curves may be photographed on flat bromide paper or traced manually on a ground-glass screen.

The output of the oscillator is continuously varied in frequency from zero to 11 kc/s by means of a slowly revolving tuning condenser, driven from a small electric motor. The same drive rotates a cam to tilt a mirror, moving the spot of light horizontally across the screen, in synchronism with the increasing frequency of the oscillator. Movement of the light-spot along the vertical axis is controlled by the response of the mirror-galvanometer to the output received from the microphone amplifier.

Results have shown that, although accurate response curves may be obtained by using a steadily increasing frequency—provided the test is conducted in a properly padded, non-reverberant room—test curves obtained in the average room, which is by no means non-reverberant, are very much affected by room effects such as echoes, reflection, etc. One way of overcoming the inaccuracies introduced by such effects is to supply the loud speaker not with a pure sine-wave but with a "warble" tone—that is, a sine-wave on which a ripple is imposed.

This ripple is introduced by revolving a small variable condenser, shunted across the main tuning condenser at about 240 r.p.m.

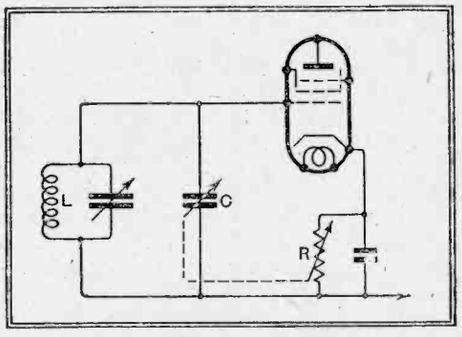
Since the impedance of the loud speaker coil varies considerably over the frequency range, it is necessary to keep either the voltage across the coil or the current through it constant throughout the test. The output from the oscillator is therefore passed through current- or voltage-control apparatus before being supplied to the loud speaker.

Automatic Correction

Compensation for De-tuning

THE inter-electrode capacity of a short-wave amplifying valve forms a considerable proportion of the total shunt capacity across any tuned circuit to which it may be connected. If then the grid bias on the valve is deliberately altered, say, for the purpose of automatic or manual volume control, the resulting change in valve capacity, due to Miller effect, is likely to mistune the set as a whole.

This is prevented by the arrangement shown in the accompanying drawing (Patent 477906). A small trimming condenser C is shunted across the main tuned circuit L, and is ganged to the volume-control resistance R. The arrangement is such that if the control R is turned to increase the amplification of the valve, and therefore the Miller effect, the condenser C is automatically reduced in value, and vice versa.



Tuning errors due to alteration of the volume control R are automatically corrected by the ganged trimmer C.

The circuit comprising L may be the local oscillator of a superhet, which is thus kept accurately aligned with the signal frequency in spite of manual adjustments of the output volume. In the case of AVC, the necessary correction can be applied by an electrical method, similar to that used for automatic tuning control.

Debunking Harmonic Distortion

By "CATHODE RAY"

ABOUT a year ago an article was published in *The Wireless Engineer*, written by J. H. O. Harries. After it appeared I waited for the bang. Of course, I may have been out of earshot, but up to the present I haven't heard it.

A few months ago, on the assumption that *The Wireless World* reaches a more responsive constituency, I made a mild attempt to stir up trouble myself. Nothing happened. Perhaps the title, "Intermodulation," looked too highbrow to encourage closer attention. So I am having another shot, hoping that the above title, and what follows, will draw some fire. I should, however, acknowledge right away my indebtedness to Mr. Harries, whose article mentioned above is thought-provoking.

Intermodulation is the Real Culprit

For at least eight years I have felt that the quality of reproduction obtainable with a pentode is worse than it is made out to be on paper. The valve research departments have kept on producing very elaborate curve sheets and data showing exactly the harmonics introduced when pentodes are used under various conditions, and the power output obtainable for a given percentage distortion. But compared with a triode giving, apparently, similar results, the pentode sounds bad. Of course I am not talking about the *very* bad results obtained when a pentode is *mis*used, but the best that can possibly be done, when everything is according to Cocking.

Harmonics and Musical Theory

An attempt has been made to explain this by saying that a pentode as normally used generates chiefly third harmonic, whereas second is the most prominent in a triode's output; and third harmonic sounds worse than second. For reasons that will soon follow, it is difficult or perhaps even impossible to prove definitely whether this is so or not. But there is good reason to believe that it is, if for no other reason than that the introduced frequency (three times the fundamental) is only the second nearest sort of musical concord, whereas the second harmonic (twice the fundamental frequency) is that most perfect order of concord, amounting almost to identity, known as the octave. The same applies to other harmonics, and to allow for this it has been proposed to estimate total harmonic distortion by combining the percentages of each harmonic *after multiplying it by the order of the harmonic*. According to this, 12 per cent. second harmonic would contribute as much as 8 per cent. third harmonic, or 6 per cent. fourth, or 4 per cent. sixth, etc. Personally I think one ought to be guided more by musical theory, according to which one would expect the eighth harmonic, which is three octaves above the fundamental, to sound much less conspicuous than the seventh harmonic, which (musicians please correct me if I'm wrong) corresponds to the remoter concord of a minor sixth.

But I don't intend to spend any more time discussing the relative obnoxiousness of harmonics, because—and this is where the fun may start—I think harmonic distortion is not really very important.

Consider the history of distortion-hunting. When it began—not much more than a dozen years ago—the only sort of distortion one ever heard about was frequency distortion. The sole aim in life was to produce a transformer, amplifier, loud speaker, etc., with a frequency characteristic indistinguishable from a perfectly horizontal straight line, from 20 to 10,000 cycles. When that aim was achieved, the thing was "distortionless."

Exactly ten years ago I wrote a heretical article (like this one) questioning this implicit trust in straight lines, pointing out that if, for example, one's listening room absorbs the higher frequencies excessively, the ideal characteristic would not be the horizontal line, but a rising curve at the high-frequency end. Moreover, one loud speaker might show a much better frequency characteristic than another, and yet be relatively intolerable to listen to, owing to a loose turn of wire on the speech coil. And the most critical listener cannot unfailingly distinguish between reproduction via a perfect amplifier and that resulting when the level characteristic is altered into quite alarming-looking waves with at least 5 db between crests and hollows.

Don't run away with the idea that I am regarding frequency distortion as of no account. Gross frequency distortion, such as that illustrated by Fig. 1 (c) and (d), upsetting the whole balance of tone, can

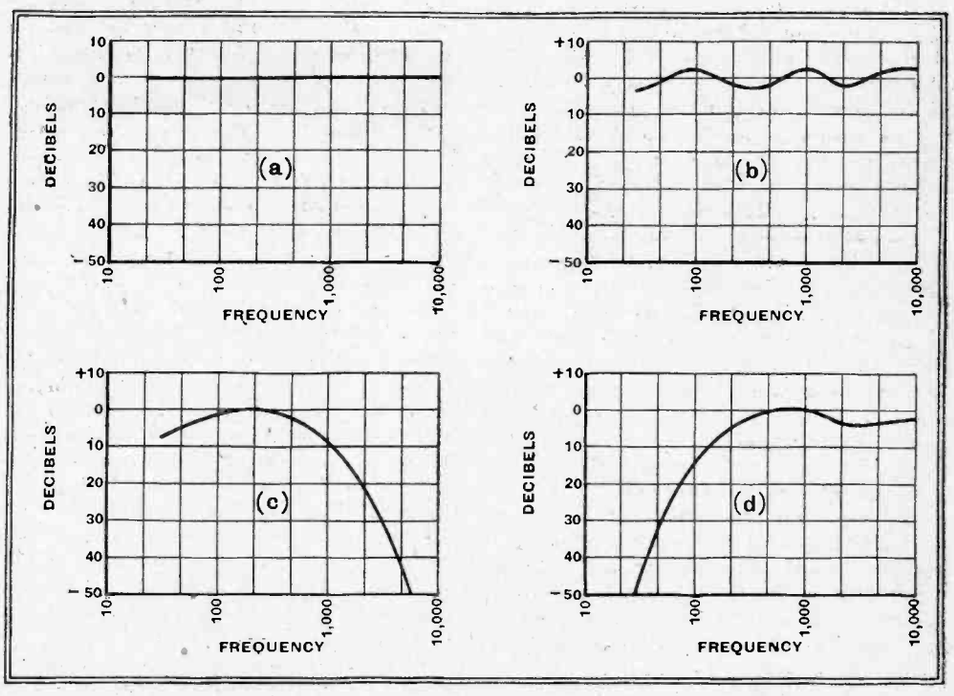
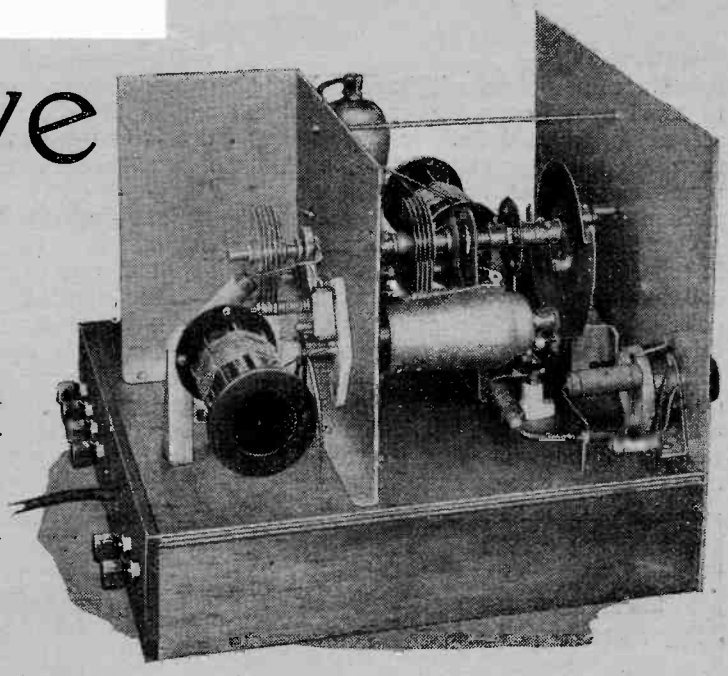


Fig. 1. Although the frequency characteristic curve (b) looks very bad compared with the perfect one (a), nobody could tell with certainty which was which on listening to the products of amplifiers having these characteristics. But a serious disturbance of the balance of tone, as shown by (c) and (d), is a different matter. The latter shows the effect of reproducing (with perfect equipment) at somewhat less than the original round intensity.

Short-Wave Three

Concluded from page 413 of last week's issue



BATTERY RECEIVER FOR WAVELENGTHS OF 6.5 TO 86 METRES

THE circuit of this receiver and the reasons for the adoption of certain features were discussed last week. In this, the concluding part, the construction is described and full winding details of the coils are given.

By H. B. DENT

THE construction of the set is, on the whole, quite straightforward and can be undertaken by anyone possessing the usual assortment of tools found in the amateur's workshop.

Even the simplest type of circuit when translated into practical form can lose much of its simplicity if care is not taken in the layout, so unnecessary complications have been avoided wherever possible in this set, yet simplification has not been carried to the extreme where the performance is likely to suffer.

Technical considerations have been the prime factors in planning the layout of the set. The layout of the components above and below the boxboard, together with the necessary dimensions for assembly, were given in last week's instalment.

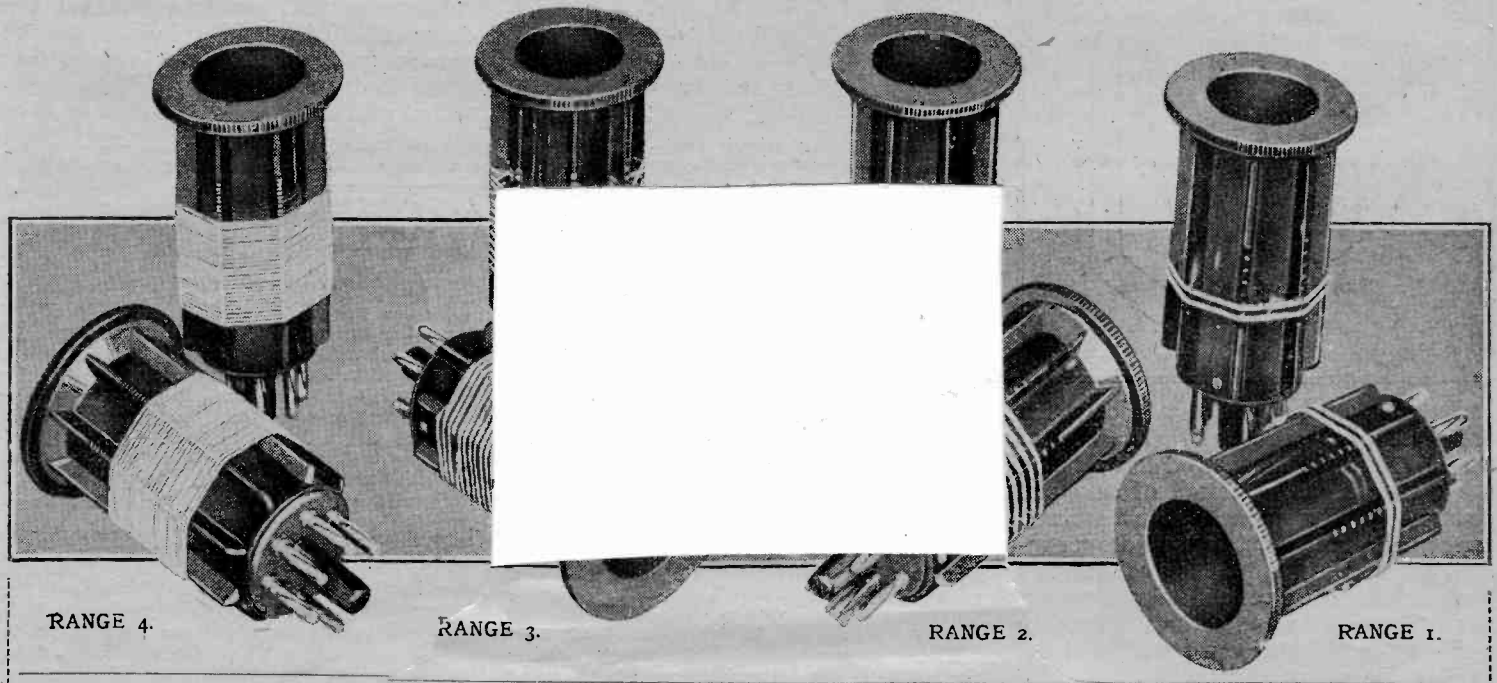
The baseboard is made of ¼in. thick plywood which, with two wooden side pieces, forms a chassis measuring 10in. by 10in. by 2in. deep. The side members can be made of ⅜in. plywood or of ½in. thick battens, whichever happens to be the more convenient.

There is an aluminium front panel measuring 10in. by 8½in., metal being chosen in this case in order to provide some screening between the operator and the receiver and thus preventing hand- or body-capacity affecting the tuning.

Screening is also used between the grid circuit of the RF valve and the detector, this being the bent vertical screen on which the RF valveholder and input circuit tuning condenser, C1, are mounted.

This screen is 6in. high and is bent at right angles as will be seen from the illustration at the top of this page. That portion which is parallel to the front panel measures 6¾in.

When assembling the two tuning condensers C1 and C7, these being ganged by a flexible coupler, their distances above the baseboard will be determined by the framework of the slow-motion dial, which with the Eddystone model, comes to exactly 3in. Incidentally, the small



RANGE 4. RANGE 3. RANGE 2. RANGE 1.

Range.	Wavelength.	Turns.	Winding.	Wire.	Tappings.
1	6.5 to 13.3 metres	2	8 turns per inch ...	No. 18 SWG	½ turn from earth end.
2	10.2 to 21.8 metres	4⅜	8 turns per inch ...	No. 18 SWG	⅝ turn from earth end.
3	19.4 to 45 metres	12¾	12 turns per inch ...	No. 22 SWG	1⅝ and 9⅜ turns from earth end.
4	37 to 86 metres	25	22 turns per inch ...	No. 24 SWG DSC ...	2 and 18 turns from earth end.

Short-Wave Three—

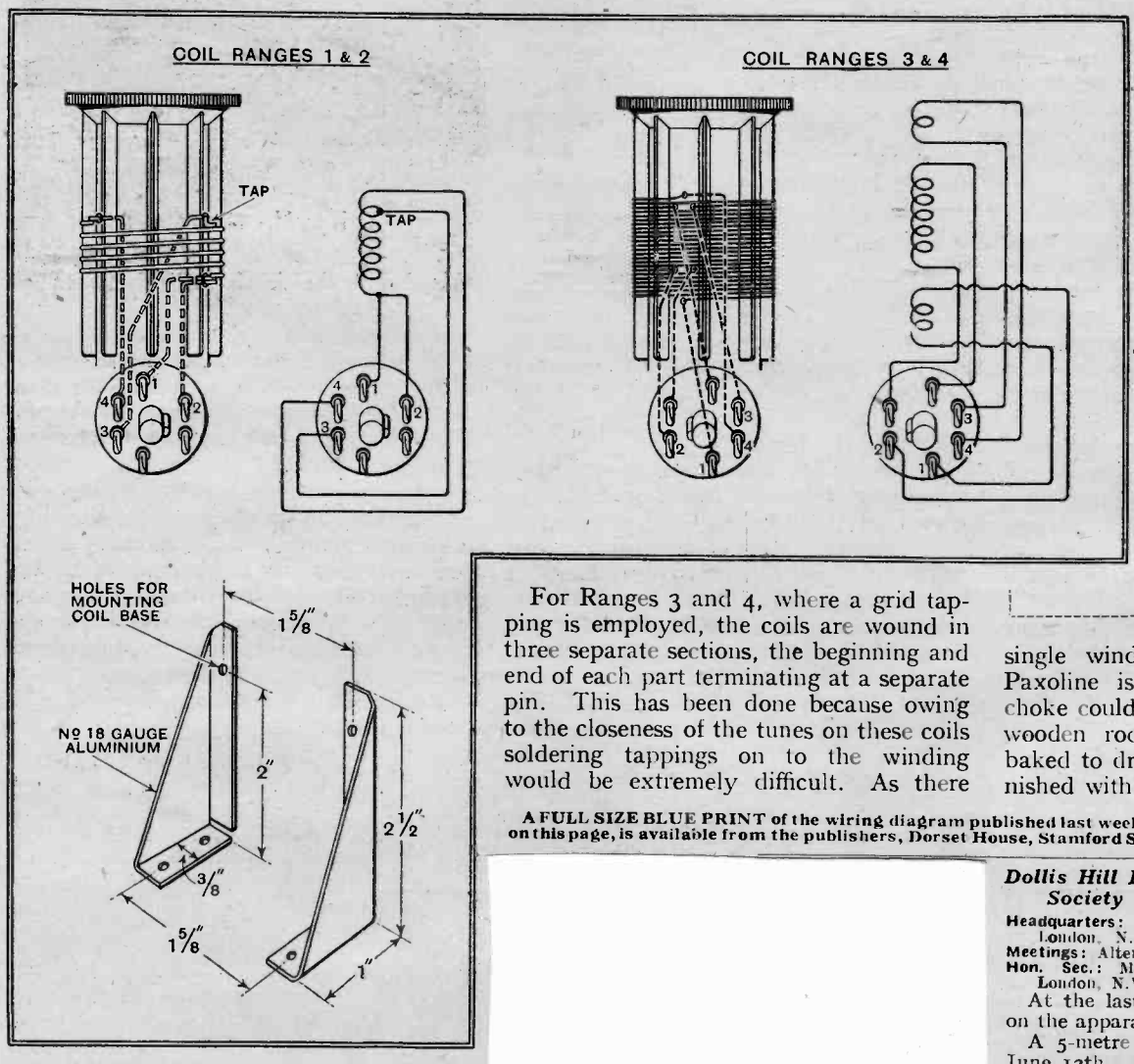
spindle on the pointer will have to be cut to the length required after the dial is assembled, as the spindle is made longer than is actually necessary for a thin metal panel in order that it can be fitted on the thicker front panel of a wood cabinet.

One departure from customary practice in this set is the method of mounting the coil holders. They are placed so that the coils lie horizontal. By mounting them in this manner the connections between the coil-base, condenser and valveholder are quite short, whereas if the coils were assembled in any other way the connections would be longer than is really desirable. The coil holders are supported by two aluminium brackets details of which are given in the drawings. The tops of the coils have been arranged to overhang the chassis so as to permit of easy coil changing if the set is enclosed in a cabinet. Large holes can be cut in the sides for inserting the coils, and as the coil-formers have self-locating centre spigots correct alignment of pins and sockets is quickly found by turning the coil round until the key on the spigot engages with the slot in the centre hole in the coil base.

A metal cabinet would probably be the best kind for this set for as much shielding as possible is desirable in the case of a short-wave receiver.

As with the coils in position the end of the winding near the top of the former will be comparatively close to the metal cabinet, it has been made the "earthy" end of the coil, though the usual practice is to regard the end of the winding nearer the pins on a coil former as the "earthy" end.

Four sets of coils, eight in all, are required, but as the aerial and RF coils are identical only four different windings are actually needed. Coils for Ranges 1 and 2 consist of a single winding with one tapping. The grid tapping shown in the theoretical circuit, Fig. 3 (last week's issue) and marked "2" is not used on these two ranges. Connection No. 2 is joined to connection No. 1 on the coil former.



On the left in the above drawing is shown the method of winding the coils for Ranges 1 and 2, while on the right are the connections adopted for Ranges 3 and 4 coils. Details are given also of the small brackets made of aluminium that support the coil holders.

For Ranges 3 and 4, where a grid tapping is employed, the coils are wound in three separate sections, the beginning and end of each part terminating at a separate pin. This has been done because owing to the closeness of the tunes on these coils soldering tappings on to the winding would be extremely difficult. As there are six pins on the coil former and only four contacts are needed the idle pins can be usefully employed in this way. This is why on the coil base two adjacent sockets in two cases are joined together and given one reference number only for the common pairs.

Winding data for the coils are given in the table on the preceding page.

Unless otherwise stated the wire used is tinned copper wire. If difficulty is experienced in winding coils for Ranges 1 and 2 with No. 18 SWG a smaller size, i.e., No. 20 SWG, may be used.

The RF choke in the positive filament lead of the detector valve is wound on a 3in. length of ½in. diameter Paxoline tube. It is wound with thirty turns of No. 24 DCC, or DSC if preferred, since this wire is required for Range 4 coil, the turns being spaced by the diameter of the wire. This is done by winding on simultaneously two wires, then giving the coil a thin coat of shellac. When nearly dry one winding is removed, leaving a single winding with spaced tunes. If Paxoline is not readily obtainable the choke could be wound on a ½in. diameter wooden rod, provided this rod is first baked to dry it thoroughly and then varnished with shellac.

A FULL SIZE BLUE PRINT of the wiring diagram published last week, together with the coil details shown on this page, is available from the publishers, Dorset House, Stamford St., London, S.E.1. Price 1/6 post free.

London Transmitting Society

Headquarters: 40, Raeburn Road, Edgware.
Meetings: Thursdays at 8 p.m.
Hon. Sec.: Mr. G. Yale, 40, Raeburn Road, Edgware.

Two challenge cups are being presented by the Society. One is for full licence-holders and will be awarded for the best modulated 'phone signals received at headquarters during June. The other is restricted to holders of Artificial Aerial licences and will be given for the best home-constructed crystal-controlled transmitting gear. The competition is open to all holders of transmitting licences in Great Britain, who must send their QSL cards to the Secretary by May 21st.

Dollis Hill Radio Communication Society

Headquarters: Braintcroft Schools, Warren Road, London, N.W.2.
Meetings: Alternate Tuesdays at 8.15 p.m.
Hon. Sec.: Mr. E. Eldridge, 79, Oxgate Gardens, London, N.W.2.

At the last meeting agreement was reached on the apparatus to be built for the laboratory.

A 5-metre field day has been arranged for June 12th. On May 22nd the Society will be taking part in a DF hunt organised by the Golder's Green Radio Society.

North Manchester Radio Society

Headquarters: 14, Fairfax Road, Prestwich, nr. Manchester.
Hon. Sec.: Mr. R. Lawton, 10, Dalton Avenue, Thatch Leach Lane, Whitefield, nr. Manchester.

The Society is about to be re-formed, and new headquarters have been obtained. The subscription is to be 2s. 6d. per year. It is proposed to arrange a series of visits to places of interest such as Broadcasting House, telephone exchanges and air ports, and arrangements will also be made for lectures to be given by representatives of various radio manufacturers. The Society offers its services to commercial, broadcast of amateur stations requiring a signal survey of their transmissions.

The first meeting will be held at 3.30 p.m. on Sunday, May 29th, at the new headquarters, which are only two minutes walk from the Prestwich Railway Station.

NEWS OF THE WEEK

WHAT LISTENERS THINK

A Survey of the North of England

THE B.B.C. has just applied the Listener Research microscope to a section of the North Country, which, unfortunately, cannot be named, as it is the rule that all such inquiries, in order to achieve their purpose, must be carried out with a certain degree of privacy.

An official has spent a fortnight in a large area, rubbing shoulders with every class of the community, extracting a wealth of valuable information on reception problems and the general reaction to B.B.C. programmes.

Reception reports are interesting. In one town, for example, it is alleged that the mercury arc rectification of the mains supply causes interference. Northern Ireland apparently gives the best all-round results, and is more reliable than Droitwich. During the tour transmissions were listened to on sets in the homes of the people with varying results! It was obvious in some cases that poor reception was due to the set, or faulty aerial erection, rather than deficiencies in the transmitter.

An intriguing case occurred in a town where reception was found to be better on one side of the street than on the other. This was attributed to the proximity of a high-power cable.

One outstanding fact is the popularity of the Athlone station, which is relied upon when the B.B.C. transmission falls short of the desired standard. An official of the station recently stated that, according to correspondence, Athlone has a listening public of some 2,000,000 in England and Scotland which is more than in its own country.

This survey may be a prelude to similar investigations in other parts of England and Wales.

LEARNING HOW TO BROADCAST. Franklin D. Roosevelt, Jnr. (right), son of the U.S. President, photographed when he made his début as a sports commentator for C.B.S. during the race between the U.S. Navy and Columbia Varsity crews. He himself was an oarsman at Harvard University.

P.A. IN FACTORIES

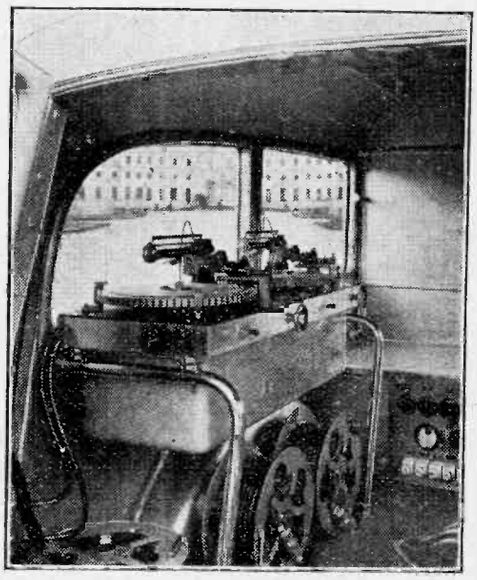
A.R.P. Warning Scheme

WORKING to music has recently been the subject of prolonged discussion, but the primary advantages of sound amplification facilities in places of work tend to have been generally overlooked. That these ignored qualities can play an important part in the handling of a modern factory is aptly illustrated in the large London premises of Crosse and Blackwell.

Over fifteen hundred employees distributed throughout buildings which cover an area of five acres, are served by the public address equipment which was recently installed by Philips. The system affords a means of giving immediate warning, instruction and information to every part of the buildings. Combining as it does warning with information, it is particularly useful for A.R.P. purposes. The installation comprises over one hundred loud-speaker units fed from a single 300-watt amplifier. An auto-radiogram unit provides for the relay of records or wireless, and, by means of a microphone at her elbow, a telephone operator can instantly locate any member of the staff. During certain periods of the day a programme of music is radiated, and this is said to have resulted in increased production, lessened fatigue, and a general improvement in the morale of the workpeople.

INDIAN BROADCASTING DEVELOPMENT

FOUR new stations, at Lucknow (MW), Delhi (SW) Lahore (MW) and Bombay (SW), having been opened by All-India Radio within fourteen weeks—something of a record in broadcasting development—A.I.R. are now preparing for the inauguration of a second SW station at Delhi. This will have a power of 5 kW, and is intended for long-distance work, with a service area beyond a 500-mile radius from Delhi, using a shorter wavelength, probably 19 metres for day working, and 31 metres at night.



TWO METHODS of recording, disc and steel tape, are employed in the latest recording car of E.I.A.R., the Italian broadcasting organisation. Part of the disc recording gear is shown in the photograph which is reproduced by courtesy of "Radiocorriere." Although pure wax discs are the ideal for quality reproduction they are not suitable for immediate playback, as they are so easily damaged, and a special type of aluminium disc with a coating of cellulose material is, therefore, used.

'PHONES v. LOUD SPEAKERS

THE commencement of the Toscanini concerts—the first is to-day (Thursday)—has raised anew among musical purists the question whether loud speakers or headphones give more faithful reproduction. At least one London music critic insists on using 'phones, and recent letters to the B.B.C. have revealed that many listeners still stick to the older method of reception. Incidentally, correspondence shows that crystal sets still have a vogue in country areas and in districts close to a transmitter.

POWER CONSUMPTION BY RECEIVERS

ACCORDING to recently published data on the consumption of electricity by receivers in Germany, the average listener, using his receiver for 920 hours per annum, uses 36 kWH per annum. The author of the book, which includes this data, states that 6 per cent. of the total power output of Germany in 1937 was consumed by radio receivers. This is approximately 267,000,000 kWH, and to this figure must be added 5,800,000 kWH consumed by transmitters.

PHYSICAL FITNESS

CONSIDERATION has been given to various schemes for the broadcasting by the B.B.C. of physical exercises, since it was mooted some time ago by the National Council for Physical Fitness. Another scheme has now been devised by the Council which will be considered by the B.B.C. Board of Governors some time before the end of this month. If, as is probable, this is adopted, it will, however, be some months before it is put into operation.

NEW B.B.C TRANSMITTER

NOW that Nottingham has its own studio (*sic*), it is understood that the B.B.C. is turning its attention to the erection of a 5-kW transmitter to serve Notts, Lincolnshire and East Anglia generally.

The original intention was to erect a relay station at Norwich, but the projected station will probably be further inland. Search for a suitable site may begin in the autumn, and by the summer of 1939 work should have begun on the station.

"VOCOLOGY!"

A NUMBER of people were recently picked at random by the Finnish broadcasting authorities and invited to read suitably prepared manuscripts aloud before the microphone. Listeners were then asked to submit any deductions which they might have made with regard to sex, age, education and social status of each of the anonymous speakers. More than six thousand "vocal analyses" were submitted by listeners, and the material is now being studied

News of the Week—

and compiled with a view to forming the basis of a scientific report.

A scheme similar to this is being considered by the B.B.C. Variety Department, and may be included in the autumn feature programme "Puzzle Corner."

MORNING TELEVISION

THE forerunner of a number of morning television transmissions, apart from the usual demonstration films, is to be given on Tuesday at 11 a.m. It is the third O.B. from the Chelsea Flower Show, and, as on the two previous occasions, the cameras are to be accompanied by C. H. Middleton, F. H. Grisewood and Elizabeth Cowell.

INDUCTIVE HEARING AID

A NEW method of aiding deaf cinema patrons was demonstrated at the Gaumont Palace Cinema, Camden Town, London, last Tuesday, May 17th. An invitation was extended to us by G.B. Equipments, on whose behalf the apparatus has been installed by Multitone Electric.

A compact box with volume control and earphone is lent by the management, and no matter what seat is occupied the instrument can be used without any connecting wires. There being no microphone in the instrument no extraneous noises are picked up. Wires are placed under all the floor coverings, and the apparatus works on the principle of induction. The radiations, being in a vertical direction, do not tend to pass beyond the confines of the building.

The box is placed on the knees and the volume adjusted to a convenient level.

FROM ALL QUARTERS

Radio Is Good for Them

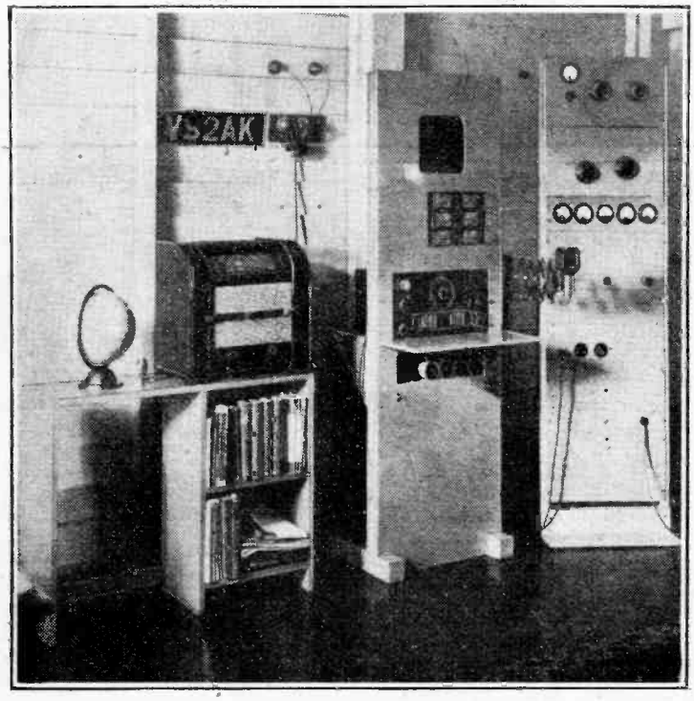
HERR HITLER, determined to increase the number of registered listeners in Austria (now standing at 600,000), has ordered that all listeners whose income is below a certain level shall be exempt from radio taxation.

Palace of Inventions

THE Palace of Inventions, which was a feature of the Paris International Exhibition of 1937, is to be reopened and a television transmitter designed for public demonstration purposes will be included.

Ultra-shorts from Sweden

SINCE publishing the note in these pages last week on the USW transmissions from the Swedish station, SM5SN, we learn that these will continue until 5 p.m. (B.S.T.) and not 3 p.m., as previously stated.



IN THE TROPICS. Station VS2AK, Kuala Lumpur, F.M.S., owned by Mr. T. A. Dineen, local Resident Engineer of the G.E.C., generally operates on 10 or 20 metres phone. The transmitter, built in a telephone-type steel rack, is on the extreme right; next to it is the operating rack, with receiver, microphone and monitor.

Sweet Are the Uses . . .

EMBARRASSMENT was caused at Sydney's B-class station the other day after Mr. Lyons had delivered his speech on Australia's new defence policy. The announcer, not understanding its import and following the usual formula, said: "You have just been listening to an advertisement paid for by the United Australian Party. It does not represent the views of this station."

Do You Hear Japan?

THE following revised time-table (G.M.T.) of short-wave transmissions has just been issued by the Japanese broadcasting authorities: 19.30-21.00 for Europe and 21.30-22.30 for South America on 25.42 or 31.46 metres; 23.00-23.30 for Eastern districts, 5.30-6.30 for Pacific Coast of North America, and 13.00-14.30 for South Seas on 25.42 metres.

R.C.A. Profits

THE statement of income of the Radio Corporation of America and its subsidiaries for the first quarter of this year shows a net profit of $1,437,800, as compared with $2,243,057 for the corresponding quarter last year.

Meritorious Service

THE Hiram Percy Maxim Memorial Award, which is given annually in memory of the distinguished scientist and inventor, who was co-founder of the American Radio Relay League, to the amateur under twenty-one years of age who has the most meritorious record of radio accomplishment for the year, is awarded for 1937 to Oscar L. Short, 20, who operates W9RSO at Webb City, Mo. The award consists of a replica of the Wouff Hong, traditional symbol of amateur radio, and a sum of money.

Child Psychology and Radio

THE effect of the cinema and wireless on the life of the school child will, according to the preliminary programme, be debated jointly by educationalists and psychologists during the British Association meeting at Cambridge in August.

Amateur Handbook in Spanish

A SPANISH edition of the well-known American short-wave manual, The Radio Amateurs' Handbook, is now available. Produced by the publishers of the South American radio journal, *Revista Telegrafica*, of Buenos Aires, it is in identical format with its prototype.

Radio and A.R.P.

DURING a recent A.R.P. black-out at Slough, Bucks, three radio transmitters were used. Highly satisfactory results were obtained with this equipment which was supplied by the Slough Radio Service Company.

At the instigation of the Northampton Wireless Relay Company, A.R.P. officials have carried out experiments with two syrens mounted on the roof of the Borough Fire Station. The syrens are actuated electrically through the Relay Company's existing wire network.

Working to Wireless

IT is stated by the Chairman of the Union Lamp and Lighting Company that the installation of wireless in their factory at Wembley has increased production by 10 per cent.

In Honolulu Tonight

SINCEREST form of flattery for B.B.C. Variety Department comes from Station KER, Honolulu, where "In Town To-night" is announced as a new regular feature.

The First Hundred Licences

A WEEK'S free holiday and free rail travel to and from Berlin, to celebrate the fifteenth German Radio Exhibition in August, is offered to the first hundred German listening licence-holders. The Reich Chamber of Broadcasting has requested likely recipients to fill in a questionnaire giving details as to their political organisation, the date of their first licence, and, if they have not had a licence continuously, the reason for not listening.

Stations for Early Inauguration

FOREIGN stations which are expected to be put into service at an early date include Ankara, Turkey, 1,639.6 metres, 120 kW (to be opened by Kemel Ataturk on July 22nd); Ankara, Turkey, 19.74 and 31.7 metres, 20 kW; Belgrade, Yugoslavia, short waves 10 kW (to open this summer); Zagreb, Yugoslavia, 276.2 metres, 20 kW; Split, Yugoslavia, 5-kW relay station; Oslo, Norway, 16.9 and 48.94 metres, 5 kW; and Baronowieze, Poland, 711 metres, 50 kW.

Colonial Chronicle

AT the request of M. Georges Mandel, French Colonial Minister, the private stations, Poste Parisien, Radio Cité, Radio-37, and Radio Normandie, are to broadcast a weekly Colonial chronicle. M. Mandel was Minister of P.T.T. in a recent Government and obviously realises the potential value of these stations for spreading Colonial propaganda.

Communal Listening

IT was recently announced in Scotland by a B.B.C. official that a new school for the establishment of radio clubs is under consideration by the Corporation. The function of these clubs would be to combine group listening and communal listening to *all* types of broadcasts.

Foire de Paris

THIS year's Foire de Paris, which takes place from Saturday next, May 21st to June 6th, will occupy an area of over 400,000 square metres and include more than 8,000 exhibitors representative of France and her Colonies and thirty-four foreign countries. Items of interest in the radio section will be dealt with in a future issue.

Co-ordination in Benevolence

THE Electrical Industries Benevolent Association has received £742 from the Radio Manufacturers' Association, it being the major portion of the nucleus of a fund which was collected at a time when the R.M.A. was considering the inauguration of a benevolent fund for the radio trade as a whole.

Big Scale Interference Suppression

WITH the object of getting to the bottom of electrical interference caused by tramcars, the Swedish Post Office is co-operating with the town of Jönköping. The whole of the tramcars in the town will be fitted with suppressors. The cost is expected to run into a thousand kronen for each car. It will take about a year to carry through the complete test.

How a Receiver is Designed.—XII

Battery Quality Amplifier

PROBLEMS OF HT SUPPLY

IN the last part of this series the question of the choice of output stage for battery operation was discussed in some detail, and for the particular conditions laid down it was shown that a triode output valve of the 6A3 type was most suitable. Such a stage requires an HT supply of 295 volts at 60 mA. for the anode and grid bias, and a signal input of some 45 volts peak for full output. For economy the preceding stage, or stages, must consume a very low anode current, and the heater current should also be low. Since it is possible to obtain a stage gain of about sixty times from a single valve with resistance coupling, it would seem that such a stage would meet our requirements, for with a gain of this order the input to the preceding stage would have to be about 0.75 volt peak only, or about 0.53 volt RMS, and this is a satisfactory value of input for the majority of present-day pick-ups.

A suitable valve is the 6F5 type, and, with the output stage, the circuit takes the form shown in Fig. 1. It is unnecessary to go into the details of the working out of the values for the circuit, since this has already been generally treated in earlier articles in this series. One point of difference arises, however, in respect of the bias circuit for the output valve. As we have a common supply and the output valve is directly heated, the bias resistance R7 carries the total anode current of the whole amplifier and not merely the current taken by the output valve. The value of R7, therefore, must be calculated on the basis of the total current, and, in general, it will be of lower value than that which would be normally used for this output valve.

In this particular case, however, we have only one additional stage, taking an anode current of about 0.5 mA. This is negligibly small in comparison with the current of 60 mA. taken by the output valve itself. As a result, the error introduced by ignoring it is very small, and is actually less than the normal variations in resistances. In this particular case, therefore, we need make no change in the value of R7, but it should not be forgotten that if any additional current is drawn from the HT supply for any further stages, then R7 must be appropriately changed. The amplifier shown in Fig. 1 requires two supplies for its operation, some 60 mA. at 300 volts for HT, and 1.3 amps. at 6.3 volts for LT.

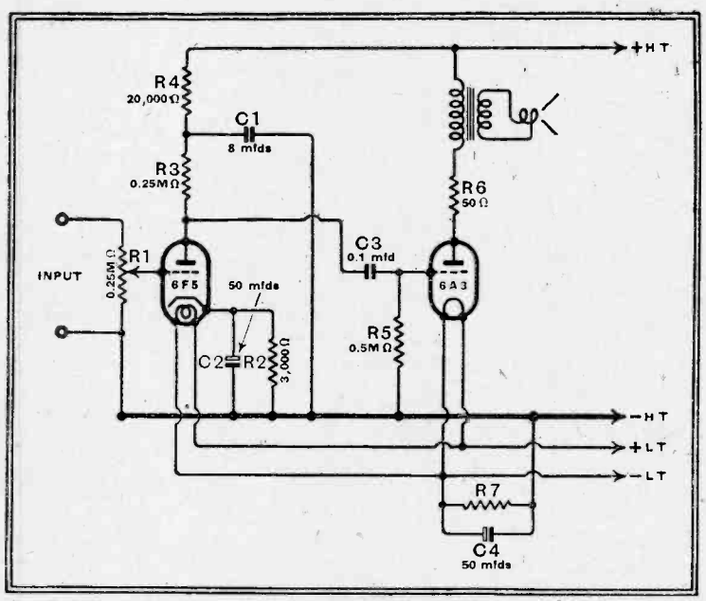


Fig. 1.—The basic circuit diagram of the amplifier is shown here. As explained in the text, it is necessary to use a different point of connection for the bias circuit in order to avoid hum.

We have now to consider the method of obtaining the HT supply. In the first place, we notice that negative HT is not at the same potential as either of the LT terminals, but is 45 volts negative with respect to LT, on account of the bias for the output valve. This rules out the possibility of using any vibrator in which negative HT and LT are necessarily common—that is, most self-rectifying or synchronous vibrators. There is another reason why such vibrators are at a disadvantage as compared with non-synchronous, and that is that they are liable to generate more interference, owing to the contacts in the high-voltage circuit.

To obtain the separation of HT and LT and a minimum of interference we shall have to use a non-synchronous vibrator with a separate rectifier. The general circuit in this portion of the equipment then takes the form shown in Fig. 2, and the 6X5 is a suitable type of rectifier to use, for it must, of course, be indirectly heated. The heater consumes 0.6 amp. and this brings up the total heater current to 1.9 amps.

DETAILS of the output stage were discussed in an earlier article in this series, and the first stage is now dealt with as well as the HT supply equipment. Problems connected with the use of a directly heated output valve are also considered.

The rectifier circuit itself is straightforward and is almost the same as that employed in an AC set, the chief difference being the use of a condenser across the HT secondary of the transformer. The purpose of this condenser is to reduce the high peak voltages which would otherwise occur, and it must be rated for working at a considerable voltage. The primary side of the transformer derives its current from the LT battery through a vibrator. This portion of the circuit is entirely straightforward, and the current taken on the primary side depends not only upon the HT output but upon the efficiency of the transformer, vibrator, and rectifier. With good components a fairly high efficiency is possible, and the measured total current consumption, including valve heaters, proved to be 5.2 amps. at a battery voltage of 5.8. With a fully charged battery giving 6.3 volts the current would be 5.6 amps.

Grid Bias

Now if we join up Figs. 1 and 2 and put the apparatus into operation, we shall not obtain very satisfactory results, for the bias on the output valve will be incorrect and we are likely to find mains hum. Consider the question of bias first. The circuit shows the bias resistance connected between negative HT and negative LT. If the valve filament were run off AC the resistance would be taken to the mid-point of the filament supply, and the ends of the filament would be swinging positive and negative with respect to this point. To allow for this it is the normal practice to give a valve operated from an AC supply additional grid bias equal in value to one-half the filament voltage.

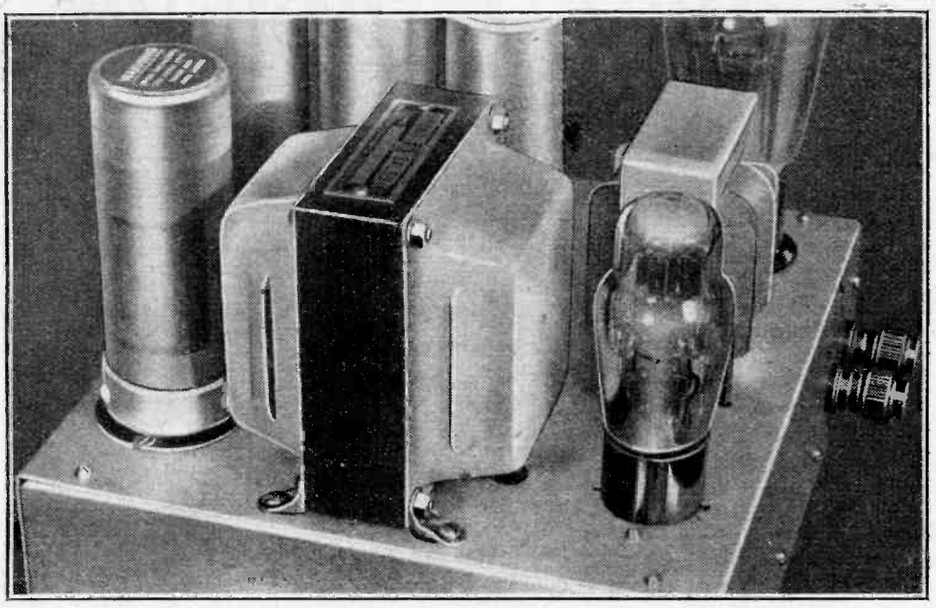
The normal figure for the 6A3 is quoted for AC working, however, and with a bat-

Battery Quality Amplifier—

tery supply we have to reduce the bias by one-half the filament voltage, or some 3 volts. The correct bias for battery working is thus 42 volts and not 45. This can, of course, be done by changing the value of R7. We have, however, first to consider the question of hum. The vibrator gives an AC output of some 100 c/s, and the main hum is removed by the smoothing circuit in the usual way. The opening and closing of the vibrator contacts, however, causes a very rapid change in current, and consequently a magnetic field is produced around the wiring which is changing very rapidly. This is the same as saying that it contains components of very high frequency; hum voltages are consequently easily picked up by the wiring or early circuits. Careful screening is, therefore, necessary, but even when all this has been done it will be found that a serious amount of hum remains, and this hum comes from the filament supply to the output valve. Owing to the resistance of the battery leads, even if these are short and are made of heavy conductors, there is still some voltage drop across the leads.

The battery current is made up of two parts, a steady current drawn by the valve heaters and a pulsating current taken by the vibrator. The total current, therefore, can be considered as direct, but with a superimposed ripple. This ripple sets up a voltage drop across the resistance of the wiring and is communicated to the 6A3 and introduces hum. Fortunately, the difficulty is easily got over and in exactly the same way as in an AC set, where AC filament heating will cause serious hum if the grid circuit is returned to one end of the filament. In an AC set the difficulty is got over by returning the grid circuit which, in effect, means the bias resistance, to the centre point of the filament instead of to one end. We can do this quite easily in our battery amplifier by connecting a resistance across the valve filament and joining R7 and C4 to the centre point of this resistance. The hum will then disappear.

Furthermore, since the LT supply is mainly direct current, we are returning the bias resistance to a point 3 volts positive with respect to its usual point; consequently, we have 3 volts less grid bias, but we have already seen that we require 3 volts less grid bias for DC operation. Consequently, we shall have to make no change in the value of R7, for although 45 volts will be developed across this resistance, it will be reduced to 42 volts, as far as grid bias is concerned, by the 3 volts between the centre point of the filament and negative LT.



A view of the complete amplifier. The vibrator is on the left and the rectifier on the right.

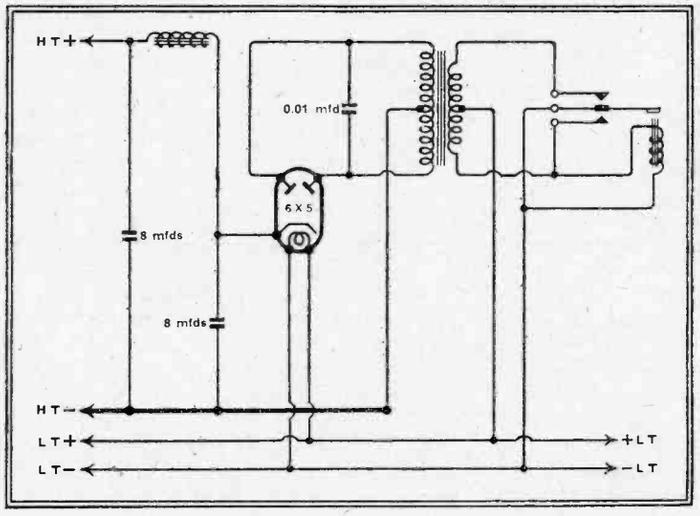


Fig. 2.—In this diagram is shown the circuit of the HT supply system.

Television Programmes

An hour's special film transmission intended for the industry only will be given from 11 a.m. to 12 noon each weekday, except Tuesday.

Sound	Vision
41.5 Mc/s.	45 Mc/s.

THURSDAY, MAY 19th.

3, Demonstration of National Dances of Hungary, Poland and Russia. **3.20,** Gaumont-British News. **3.30,** 147th edition of Picture Page.

8.15 (sound only), London Music Festival at Queen's Hall: Toscanini conducting the B.B.C. Symphony Orchestra. **9.5,** Cabaret. **9.30,** British Movietonews. **9.40,** 148th edition of Picture Page. **10,** News Bulletin.

FRIDAY MAY 20th.

3-4, "Viceroy Sarah," the play by Norman Ginsbury, with Marie Ney in the name part.

9, Starlight. **9.10,** Gaumont-British News. **9.20,** "Charles and Mary"—excerpts from the play by Joan Temple. Cast includes Peter Ridgeway, Joan Temple and Patricia Hayes. **10.30,** News Bulletin.

SATURDAY, MAY 21st.

3, Jack Hylton and his Band. **3.35,** Gaumont-British News. **3.45,** In Our Garden, C. H. Middleton.

9, "Sweet and Hot," a little show with Eric Wild and his Band. **9.30,** British Movietonews. **9.40,** "They're Off"—a melodrama of the Turf. Cast includes Queenie Leonard, Eric Fawcett and Charles Wade. **10.15,** News Bulletin.

SUNDAY, MAY 22nd.

3-3.30, O.B. from Chelsea Flower Show. Mr. C. H. Middleton, Mr. Freddie Grisewood and Miss Elizabeth Cowell will accompany the cameras during this and the remaining two transmissions.

8.50, News Bulletin. **9.5,** Egon Petri, pianoforte. **9.15,** Film. **9.25-10.30,** "Pride and Prejudice," an adaptation of Jane Austen's famous novel.

MONDAY, MAY 23rd.

3, "Broadway"—one of the first American gangster stories. The play was written by Philip Dunning and George Abbott. **4.15-4.30,** O.B. from Chelsea Flower Show.

8.15 (sound only), Relay from Queen's Hall of part of the Symphony Concert, conducted by Toscanini. **9.5,** Cabaret. **9.40,** British Movietonews. **9.50,** Flower Decoration—talk by Constance Spry. **10.5,** Music Makers: Jean Norris. **10.15,** News Bulletin.

TUESDAY, MAY 24th.

11-11.30 a.m., O.B. from Chelsea Flower Show. **3,** Intimate Cabaret. **3.20,** British Movietonews. **3.30,** The Ballets Jooss in "Seven Heroes."

9, Speaking Personally. **9.10,** Yvette Guilbert, the French actress. **9.25,** Catch-as-Catch-Can Wrestling. **9.40,** Gaumont-British News. **9.50,** Starlight. **10,** News Bulletin.

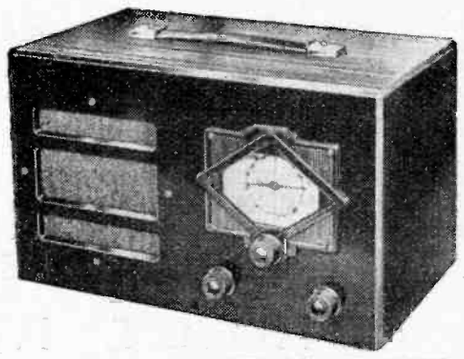
WEDNESDAY, MAY 25th.

3, Forecast of Fashion. **3.15,** Gaumont-British News. **3.25,** "They're Off," as on Saturday at 9.40 p.m.

9, As at 3 p.m. **9.15,** An account of his search for rare birds in Greenland, by Reynold Bray. **9.30,** British Movietonews. **9.40,** "The Wife of Bath's Tale," a Pepler masque. **10.10,** News Bulletin.

Stentorian JUNIOR PORTABLE

Full-sized Batteries in a Compact Three-Valve Receiver



FEATURES. ***Waveranges.***—*(1) 200-550 metres. (2) 800-2,000 metres.* ***Circuit.***—*Pentode RF amplifier—pentode grid detector with reaction—pentode output valve. Automatic bias.* ***Controls.***—*(1) Tuning. (2) Reaction. (3) Waverange and on-off switch.* ***Price.***—*6 guineas.* ***Makers.***—*Whiteley Electrical Radio Co., Ltd., Victoria Street, Mansfield, Notts.*

THE catalogue illustration of this receiver hardly does justice to the compactness of the design. Perhaps it is that the arrangement of tuning dial, controls and loud speaker grille suggest the "horizontal" type of table model and leads one to expect a set of similar volume. At all events the smallness of the instrument when first unpacked came as something of a surprise

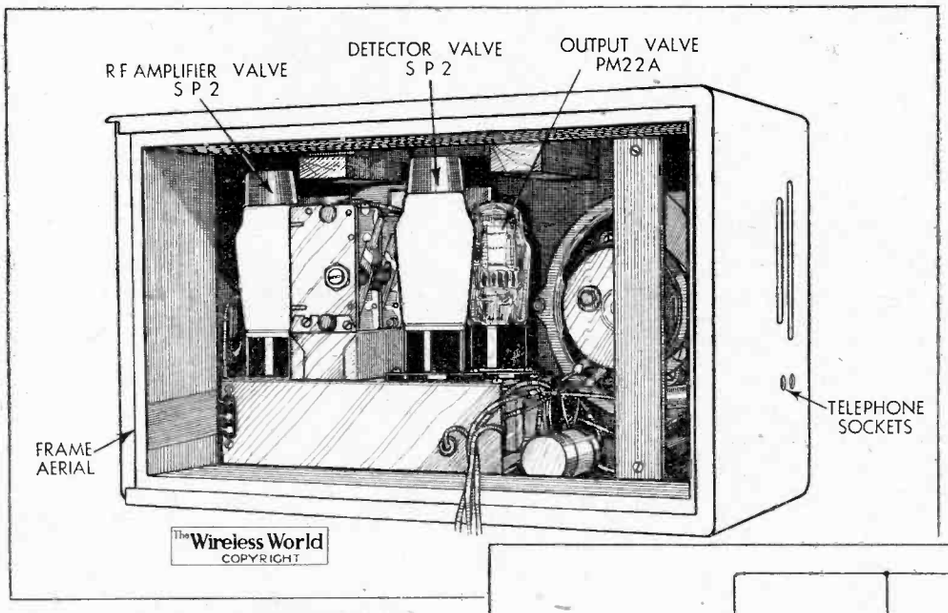
Dimensions are given in the catalogue (13in. x 8in. x 7in.) but the size is better visualised from the drawing of the interior in which the standard valves form a basis for comparison. When the batteries are in position there is very little unoccupied space in the cabinet to form cavity resonances. The 120-volt HT battery is of standard size and capacity and the LT accumulator is rated at 23 ampere-hours. The latter is of the unspillable type but free acid and not a jelly electrolite is employed. In the receiver tested HT and LT currents were 7.3 mA and 0.45 amp. respectively with a new dry battery and fully charged accumulator.

Four stations are named on the long-wave and six on the medium-wave scale which is only 2 inches in diameter. Many more than these will be receivable after dark for the amplification provided by the three pentode valves makes good use of the pick up from the small self-contained frame aerials. The capacity to earth of the chassis is increased by a foil electrode lining in the base of the cabinet, but there does not appear to be any very great increase of "vertical" pick up, and a good minimum is obtainable when using the directional properties of the frame to reduce interference from a near-by station; the cabinet stands on a plywood turntable but the friction between the baize covering and a polished table is less than that of the pivot under the weight of the set.

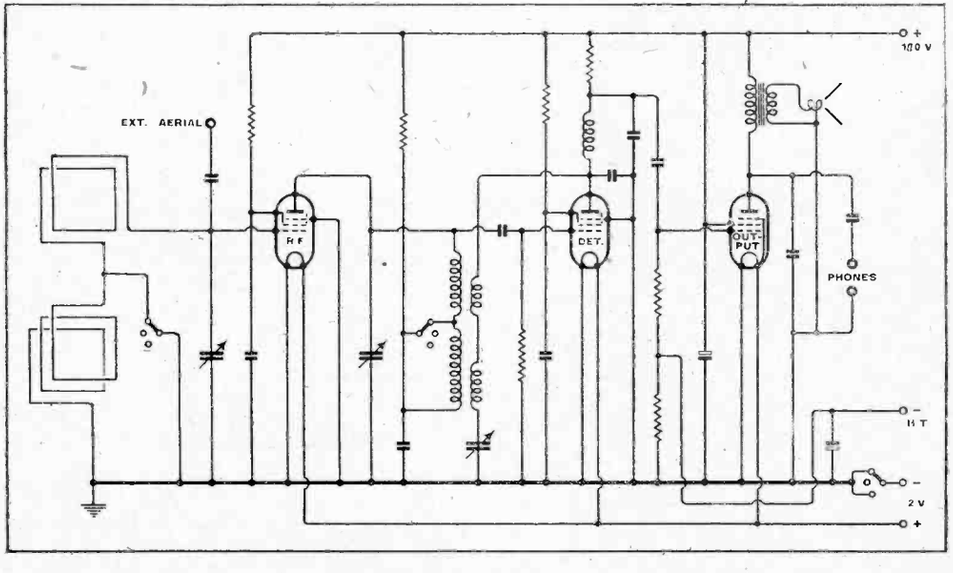
As in the majority of portables a socket is provided for the addition of an outdoor aerial, but this will not be of any advantage except in remote parts of the country, and if used the set should be realigned to obtain the full benefit of the increased input. Unless this is done a short aerial reduces output by misganging by more than the increased input and with a full-sized outdoor aerial the greater signal strength is accompanied by serious loss of selectivity.

It will be seen from the circuit diagram that the external aerial is connected through a series condenser to the high-potential end of the frame aerials. Tuned anode coupling with iron-cored inductances is employed between the RF pentode and the grid detector and resistance coupling between the latter and the pentode output valve. The bias is derived from a resistance in the common HT negative lead and only the connections to the HT battery are necessary.

The loud speaker permanent magnet is very nearly the same diameter as the diaphragm so that the efficiency is good in the region of frequencies favoured by speech and the majority of the written notes of music. What it lacks in bass it makes up in brightness and clarity, which



The standard valves give a clue to the compact proportions of chassis and loud speaker. A full-sized 120-volt HT battery and 23 AH accumulator fit neatly into the remaining space.



Iron-cored inductances are employed in the tuned anode coupling between the first two valves. The earth symbol represents a metal counterpoise in the base of the cabinet.

Stentorian Junior Portable—

is of greater importance in a general purpose portable.

Headphones or an extension loud speaker may be connected to flush fitting sockets in the left hand side of the cabinet. The extension circuit is filter-fed from the anode of the output valve.

The cabinet finish is much above the average and the sliding back panel is both solid and well fitting. If the HT battery is inserted in accordance with the instructions there is little chance of the connecting plugs coming adrift. The connections to these plugs, incidentally, are soldered.

This is a soundly made little set with a generous reserve of battery power and a performance made all the more impressive by the modest dimensions of the cabinet.

DIRECT RECORDING BLANKS

In the March 19th, 1937, issue of *The Wireless World* a table of direct play-back blanks for sound recording was published, which was compiled by Donald W. Aldous. We present below a revised table by the same writer of blanks readily obtainable in this country.

Details of foreign blanks have been omitted from this new table, but a list of the names and addresses of the principal foreign blank manufacturers is appended.

SS = Single-sided. DS = Double-sided.

Name.	Type.			Diameter.	Prices. Each.	Manufacturer.
	Base.	Surface Coating.	Processing.			
Decileth	Unbacked, i.e., flexible.	Non-inflammable material — not cellulose.	Polishing fluid only	8in. (DS) 10in. ,, 12in. ,,	2s. 0d. 2s. 6d. 4s. 0d.	Will Day, Ltd., 19, Lisle Street, W.C.2.
Electradix	Aluminium alloy.	—	Before cutting, a lubricant may be applied, e.g., paraffin oil, olive oil, or petroleum jelly ("Vaseline").	6in. (DS) 10in ,,	4s. (doz.) 7s. (doz.)	Electradix Radios, 218, Upper Thames Street, E.C.4.
G.C. Master	Zinc	Cellulose acetate.	None	10in. (DS) 12in. ,,	2s. 6d. 4s. 6d.	G.C. Electrical Recording Co., Ltd., 181, Wardour Street, W.1.
M.E.	Full details not yet announced, but it is understood this new blank has a cellulose-acetate finish.			10in.	6d.	Microphone Equipment, Ltd., 8, Charing Cross Road, W.C.2.
M.S.S.	Metal	Cellulose-acetate	Chemical treatment, i.e., hardened and polished by fluid, so-called hardening "dope"—acetic acid.	6in. (SS) 7in. ,, 8in. ,, 10in. ,, 12in. ,, 13in. ,, 16in. ,, 6in. (DS) 7in. ,, 8in. ,, 10in. ,, 12in. ,, 13in. ,, 16in. ,,	11d. 1s. 0d. 1s. 3d. 1s. 9d. 2s. 0d. 3s. 0d. 6s. 0d. 1s. 3d. 1s. 6d. 1s. 9d. 2s. 6d. 3s. 0d. 4s. 3d. 10s. 0d.	M.S.S. Recording Co., Ltd., 83, The Green, Kew, Surrey.
Phono-Disc	Aluminium	Non-fluid chemical lubricant impregnated in surface of aluminium.	None	6in. (DS) 10in. ,, 12in. ,,	5s. (doz.) 10s. (doz.) 12s. (doz.) Smaller quantities are not supplied at proportionate prices.	Phono-Disc, Ltd., Imperial House, 84, Regent Street, W.1.
Pyral	Zinc and/or aluminium.	Cellulose compound, plus black varnish.	None, although a hardening or polishing fluid may be used if desired.	8in. (DS) 10in. ,, 12in. ,,	1s. 6d. 2s. 0d. 3s. 0d.	Makers' Agents, Ltd., High Holborn House, High Holborn, W.C.1.
Simplat	Unbacked, i.e., flexible.	Gelatinous composition (non-flam.).	Chemical treatment, i.e., hardened and polished by fluids containing formaldehyde and waxy oils, respectively.	7in. (DS)	1s. 0d.	V.G. Manufacturing Co., Ltd., Gorst Road, Park Royal, N.W.10.
Simplat	Glass	,,	,,	7in. (DS) 10in. ,, 12in. ,, 14in. ,, 16in. ,,	2s. 0d. 3s. 0d. 4s. 0d. 6s. 0d. 8s. 0d.	,,
Supercut	Aluminium	Cellulose-acetate (black coloured).	Chemical treatment, and light oil applied after cutting will prolong useful playing life.	10in. (DS) 12in. ,, 13in. ,,	3s. 6d. 4s. 6d. 5s. 6d.	M.S.S. Recording Co., Ltd., 83, The Green, Kew, Surrey.
Truvoice	Zinc	Cellulose compound, plus a wax.	None	10in. (DS)	1s. 9d.	Henri Selmer & Co., Ltd., 114-116, Charing Cross Road, W.C.2.
W.D.	Metal	Cellulose-acetate	Polishing fluid only	8in. (DS) 10in. ,, 12in. ,,	2s. 0d. 3s. 0d. 4s. 6d.	Will Day, Ltd., 19, Lisle Street, W.C.2.

FOREIGN BLANK MAKERS.

(1) Presto Recording Corporation, 143-5-7, West 19th Street, N.Y.C., U.S.A.
(2) Sound Apparatus Co., 150, West 46th Street, N.Y.C., U.S.A.
(3) Allied Recording Products Co., 126, West 46th Street, N.Y.C., U.S.A.
(4) Mirror Record Corporation, 58, West 25th Street, N.Y.C., U.S.A.
(5) Universal Microphone Co., Ltd., Recording Division, Inglewood, California, U.S.A.
(6) Rangertone, Inc., 201, Verona Avenue, Newark, New Jersey, U.S.A.
(7) Wiener Gelatinewaren Industrie, XVII/3, Hernalser Haupstrasse, 130, Vienna.

THE WIRELESS INDUSTRY

THE many applications of bakelite in industry, including its uses in radio manufacture, are shown on the stand of Bakelite, Ltd., at the Scottish Empire Exhibition.

◇ ◇ ◇

The National Union Radio Corporation of New York informs us that in future all its activities (including those of the Export Department) will be concentrated at the factory, 57, State Street, Newark, New Jersey, U.S.A.

◇ ◇ ◇

Stocks of Tungsram valves are now being maintained by Hobday Bros. at their branches in London, Manchester, Sheffield and Wolverhampton.

◇ ◇ ◇

The new Ferranti all-wave receivers, Models 512AM and 513AM, recently announced in our pages, are described in a leaflet just issued by Ferranti, Ltd., Moston, Manchester, 10.

"Unirad" Short-Wave Receiver

IN describing the circuit of this double superheterodyne receiver on page 429 of our last issue the wavelength range was given as 15-40 metres. Actually, the full coverage is 13.4-60 metres in six ranges.

Television Topics

SQUEGGING OSCILLATOR TIME-BASES

MANY types of single-valve time-base are available in addition to those recently described and one of the most useful is based on the squegging oscillator. Everyone who has used an RF oscillator must have been troubled at some time with squegging, that is, the regular starting and stopping of oscillations at a frequency determined by the grid leak and condenser.

A conventional oscillator is shown in Fig. 1 and it generates RF oscillations of more or less sine waveform at a frequency determined largely by L1 and C1. Now, if the anode voltage is high, L2 is large and tightly coupled to L1, and particularly if C and R are large, the valve will start and stop oscillating regularly at a frequency dependent chiefly on C and R.

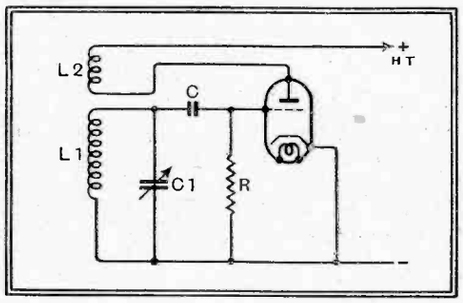


Fig. 1.—The ordinary grid-leak oscillator will develop a saw-tooth waveform across the grid condenser under suitable conditions.

What happens is this. The valve oscillates and generates a large amplitude of oscillation because of the high anode voltage and tight reaction coupling. The voltage developed on the grid is rectified by normal grid detector action, and a heavy grid current flows into the condenser C, thus driving the grid negatively. The grid is driven so far negative, in fact, that the valve stops oscillating. The charge on the condenser then leaks away through R until the grid potential becomes such that oscillation can start again. The cycle then recommences.

The change of voltage across C is of the nature we require for a time-base, and by rearranging the circuit as shown in Fig. 2 (a) we can make use of it. The condenser C1 is now omitted because we do not want to vary the main oscillator frequency and better squegging is obtained without it. Instead, R is made variable to control the squegging frequency.

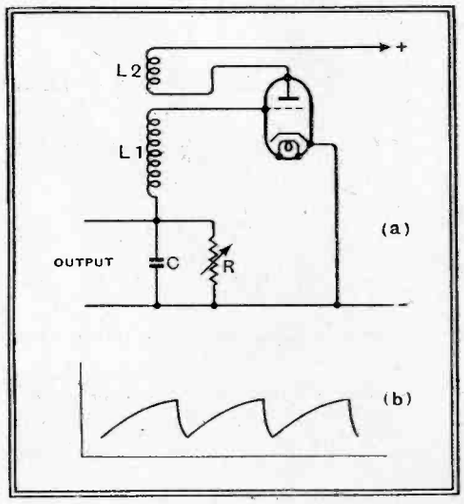


Fig. 2.—A rearrangement of the circuit of Fig. 1 is shown here which enables the saw-tooth voltage on the grid condenser to be readily employed.

As it stands this circuit is unsuitable for television scanning because the change of voltage across C is not linear, but exponential. The waveform is shown in Fig. 2 (b) and would obviously cause severe distortion of the picture.

This defect can be overcome by returning the grid leak to positive HT, for then the voltage acting to discharge the condenser is much greater, and, although the discharge is still exponential, if we only use a small part of it this part will be nearly linear. Also, if we use a tetrode or pentode for the valve we can use the screen-grid for the injection of sync pulses—a particularly convenient arrangement.

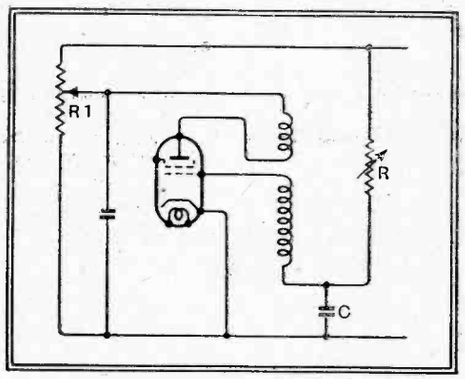


Fig. 3.—This circuit shows a further modification which enables a nearly linear saw-tooth waveform to be secured.

The circuit then becomes as shown in Fig. 3. The saw-tooth frequency is determined by C and R, and the amplitude by varying the anode voltage by R1. The sync pulses can be injected into the screen-grid circuit by an ordinary RC coupling, but the mean potential of the screen will depend upon the valve and circuit constants. In general, the screen potential should be low, and with most output pentodes a zero screen potential is satisfactory. With an RF pentode, up to 20 volts may be needed.

A Synchronising Difficulty

The circuit will produce a good saw-tooth waveform with almost any coils, and the writer has used a standard superhet oscillator coil with good results. Very reliable oscillation is obtained, but there is one defect which the writer has not so far succeeded in overcoming. This is in connection with the synchronising.

Good synchronising is obtained in the sense that the picture as a whole locks into position stably, but there are minor irregularities which affect the definition. In the case of the line time-base the irregularities result in slight wandering of the lines relative to one another, causing a ragged edge to vertical lines, and in the frame time-base it results in a tendency to a vertical wobble.

The cause of the trouble is rather obscure and until it is found it is hardly possible to devise a remedy.

In current consumption the circuit is exceedingly economical, for with a 250-volt HT supply, the anode current is of the order of 0.5 mA. only. The condenser charging current is also small since it does not normally exceed 0.5 mA., and is usually considerably less. This, however, is common to all time-base circuits, for it is the invariable practice to charge the condenser through a high resistance which limits the maximum possible current.

Now, all the hard-valve time-bases which we have so far discussed have one defect—there is an impedance additional to the valve in the discharge circuit. With the two-valve arrangements this impedance is a resistance and with the single-valve circuit it is an inductive reactance. Referring to Fig. 3, it is clear that when the grid circuit of the valve is conductive the condenser C discharges through the grid coil of the transformer in series with the grid-cathode resistance of the valve.

This impedance lengthens the fly-back time somewhat and if it is too great may have a serious effect upon the performance. More positive action is usually secured from time-base circuits in which coils are used if they are of fairly high inductance. The presence of the coil in the discharge path, however, places a limit to the inductance which can be used for a given fly-back time. Compromise is accordingly necessary between these conflicting requirements.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

Future of Wireless

YOU are doing excellent work in the pages of *The Wireless World* by opposing the threatened Post Office Relay scheme.

It is, of course, true that industries which in course of time become redundant or archaic must be allowed to go their way along the road to extinction; such industries and trades cannot be supported by the country just for the sake of sentiment, or even to keep people in useless employment. The hardships which ensue are in the natural and resistless course of evolution. But this is quite different from the deliberate abolition of a vast industry, employing thousands of men and women, in favour of a State-controlled and less efficient system, such as would necessarily occur if a relay scheme were put into operation on a national scale.

That a Post Office relay of radio programmes would be less satisfactory in the long run to the average listener, as well as less efficient, has, I think, been effectively proved in the pages of this journal. Even from the point of view of sound broadcasting alone it is obvious that the choice of programmes would be restricted. Gone, too, would be the joy of individual ownership of radio receivers, with the excitement of choosing new types from time to time. There is something peculiarly thrilling in the possession of one's own radio apparatus which years of familiarity with broadcasting has not lessened. But more important from the practical point of view, other things being equal, the quality of a programme received direct via the ether is superior to that which the listener experiences with even the best relay over a landline, and as for interference, I have heard plenty during the latter type of programme! Also, interference will, one presumes, one day be the object of legislation (which I pray will be *retrospective*—that is, will affect *existing* electrical apparatus).

Finally, the practicability of television relays has surely been disproved in the April 7th issue of *The Wireless World*.

T. J. E. WARBURTON.

St. Leonards-on-Sea.

Fading

IN the article "Sunset and Fading," by Cathode Ray, in your issue of April 14th, you published a graph showing the particularly weak field obtained from Leipzig and Toulouse on March 22nd. Commenting on this, your contributor says, "If any violent change in the weather had intervened one might have blamed it for the extraordinary difference in reception. But both days were included in a period of exceptionally settled and tranquil weather."

I would like to suggest that your contributor need not think of blaming the weather for these weak fields, for on this day there was an occurrence of much greater significance to wave propagation than any change of the weather. I refer to an ionosphere storm which took place on March 22nd, and which, while admittedly not of the severest kind, was of rather sudden incidence, and was severe enough to cause a very marked deterioration in short-wave propagation—about the only case of its kind to occur during the whole of March.

On the day in question reception of the American short-wave stations, which had been uniformly good for a long time, became very poor in the late afternoon. For instance, W3XAL on 17 Mc/s was a very poor signal at 6 p.m., and had disappeared entirely by 7 p.m. At 9 p.m. even the 15 Mc/s band had faded entirely out, no Americans being audible, whilst stations which were audible on lower frequencies suffered badly from flutter fading. All this in the midst of a period of exceptionally good reception; for the next evening, while not quite normal, conditions were certainly much better, and by March 24th were back to normal.

On March 21st there appeared on the sun's east limb, in solar latitude about 60° N., two medium-sized but very active sunspots. It seems quite possible that the ionosphere storm which interrupted the short-wave circuits was caused by corpuscular emission from these. Could it be that the weak medium-wave fields referred to were produced by some excessive lower layer absorption phenomenon brought about by radiation from these sunspots? L. H.

I WAS very interested to read the article on "Sunset and Fading" in a recent issue of *The Wireless World*.

I was unable to use my radio on March 22nd, but in view of the fact that both the author of that article and "Diallist" (in an earlier issue) remark on the peculiarities of reception on that night, the following may be of interest to both parties.

On March 22nd I was returning with some friends from Lancaster to Fleetwood. It was somewhere about 11.30 p.m. when we left Lancaster, but we all remarked on the exceptional brightness of the sky on that night. However, until we got about halfway to Fleetwood, we were unable to see beyond the heavy blanket of clouds. About midnight, however, the clouds dispersed sufficiently for us to see a clear display of what appeared to be the Aurora Borealis. It was well to the north of us. However, we saw no mention of it in the papers, and I forgot about it until I read your article. It may interest you to know that the display (on January 27th, if I recollect rightly) had its apparent centre to the east of Fleetwood, but almost directly overhead when observed at about midnight. Rays appeared to radiate in all directions from a ring.

Perhaps one of the many stations recording these phenomena electrically may have some record for that night (March 22nd).

WM. H. JARVIS.

Fleetwood.

IF any deduction can be made from "Cathode Ray's" measurements of the effect of sunset on signal strength, surely it is that the predominant factor in this case was the condition at the receiving station; for the strength of both stations changed together to a remarkable extent.

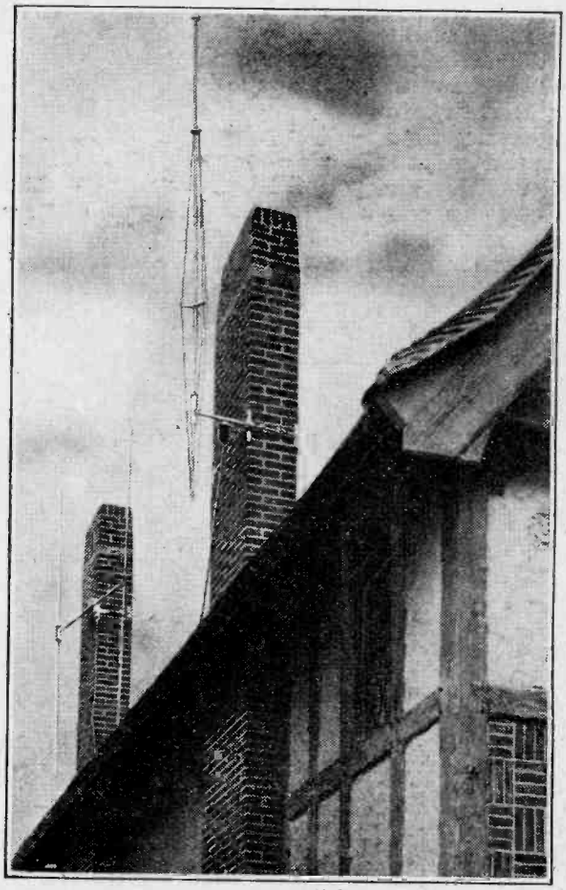
A plausible hypothesis is that signal-strength of the sky wave depends upon three factors: (a) Absorption between transmitter and ionosphere; (b) interference phenomena in the ionosphere, causing periodic fluctuations; (c) absorption between the ionosphere and the receiving aerial. It appears that until sunset at the receiving end, factor (c) is sufficient to cause complete extinction of the sky wave, thus masking factors (a) and (b).

Since it is difficult to find a transmitter west of London to reverse the rôles of (a) and (c), I suggest that "Cathode Ray" might observe effects at sunrise, and see whether the eastern station declines in strength as daylight reaches it, before the southern station, due to factor (a).

Chelmsford. D. A. BELL.

Export Wireless

I HAVE read your Leader on the conditions of the export market, and heartily endorse the comments you print



ANCIENT AND MODERN. This photograph of Belling-Lee "Spike" and television reflector aerials, as fitted on a "period" house, was taken at the recent Ideal Home Exhibition. Consideration of space prevented the aerials from being mounted in their logical positions—at the tops of the chimneys.

from a firm in South Africa. I have had experience of conditions in the British West Indies and they may be quoted as parallel.

The manufacturer over here either will not or cannot realise the conditions required. The Americans have them beaten on efficiency, price, and service every time. Many sets exported will not stand up to the climatic conditions.

You cannot expect any individual to be patriotic to the extent of his pocket and ultimate results. I have heard and examined sets in Jamaica which hailed from the U.S.A., and there was no equivalent set made in England. It must be multi-tube, of high selectivity, robust construction, and proof against extreme heat, both dry and damp, also rot and vermin proof.

I feel sure that if you publish this letter, you will receive confirmation from the B.W.I.

J. P. J. CHAPMAN.

Bournemouth.

British Sets in Malta

IN your "News of the Week" columns in the issue of March 24th, you referred to a statement attributed to the *Malta Chronicle* that Malta is "flooded with cheap Japanese receivers."

As this statement merely formed an extract from a speech made in England and reported in the journal referred to, it cannot be regarded as a statement *by* the *Malta Chronicle*. Furthermore, the speaker was referring to conditions there some *two years ago*.

I have no knowledge of the type of receiver in use here at that time, but I can assure you no receivers of the type mentioned are to be bought here to-day.

During the nine months I have been here as service engineer to the leading retail radio concern, I have *not seen one* Japanese receiver, although I have handled British, American, French, Italian, Dutch and Swedish sets.

The receivers in general use here are fully representative of modern practice, while the proportion of really large instruments of 10 to 18 valves is far higher than in England. A six-valve receiver is definitely in the *small* class, while all-wave working is regarded as essential, the Empire Transmitter being looked upon almost as the "local."

One could wish to see a larger proportion of English sets in use, especially as the leading makes give a very good account of themselves under local conditions. Once again it is a case of the more effective sales methods of our American cousins getting away with the market.

L. P. D.

Malta.

Report of Fade-out Observed on April 15th, 1938

UNFORTUNATELY, except for a check on conditions at 06.15, practically no listening was done prior to 08.35. At 06.15 signals were audible up to 31 Mc/s, indicating that conditions were somewhat better than on the previous few days, when nothing could be heard over about 22 Mc/s at this time. I cannot, however, say that conditions were definitely normal before the observed time of the fade-out, and it will be interesting to have the reports of others in this connection.

At 08.40, whilst listening on 28 Mc/s, the "hissing phenomenon" was observed to start, quickly building up to R9. The receiver was changed to the 12-22 Mc/s range, just in time to hear one or two commercial signals in the act of vanishing! The "hiss" lasted until 08.45, and was not audible below 18 Mc/s, being strongest around 30 Mc/s. At 08.45, listening from 12-32 Mc/s, the only signals that could be heard were a few weak 14 Mc/s European amateurs, such as D, OK, etc., IBX (16 Mc/s, R7, OLF, and a few commercial ground waves from G, PA, ON, etc. The peak fade-out time appeared to be at 08.50, when from 3.5-10 Mc/s was completely dead; so dead, in fact, that I checked the receiver several times to make sure it was working! There was no sign even of any amateurs on the 7 Mc/s band, nor of those usually R9 plus Zeesens on 10 Mc/s, who were absolutely inaudible. From 10 to 25 Mc/s the only signals were Zeesen, 15 Mc/s, R4/2, and a few commercial ground waves. RWG on 30 Mc/s was audible throughout the fade-out, but *not* audible on its fundamental frequency! The first signals to reappear were HBE, 15 Mc/s, R.6, at 08.55; then at 09.05, IBC, 19 Mc/s, IEM, 21 Mc/s, and FYQ, 15 Mc/s; at 09.10, IBX, R4; and at 09.15 the following could be heard: SPW, 13 Mc/s, R3/4; EAN, 14 Mc/s, R4; FYQ, R9/7; Zeesen, 15 Mc/s, R9/7; IBX, R6, IBC, R9, CUW, R6.

Compare the above with conditions on a normal day, when at this time there are very few channels without an R9 commercial signal from all directions and distances. It is interesting to note that those commercials that could be heard were mostly sending "ZAN" (absolutely nothing).

The DX signals were the last to reappear, RWG, 15 Mc/s, RKC, RUO, etc., etc., coming back about 09.40, and JNN, 19 Mc/s, at 09.50. By 09-50 a few very weak local Europeans could be heard below 10 Mc/s, but conditions were nothing like normal on these lower frequencies until about 12.00. At 10.00 the harmonics on FXD (31 Mc/s), FXG (33 Mc/s), RIS (27.5 Mc/s), etc., could be heard, but they were *inaudible* on their fundamental frequencies, and did not appear on the latter until about 11.00. JNJ, 14 Mc/s, came back about 11.15, and by about 11.30 conditions were nearly normal over 10 Mc/s. Signals from North America were not audible on any frequency, and were not heard until the late afternoon, when they were very poor and receivable over a limited frequency range. At 17.30 no "W" signals could be heard on any frequency, but they improved after 18.30, although they were very much below normal signal strengths.

Summarising, it may be said that long-distance signals (over 1,000 miles) were most affected by the fade-out, being the first to go and the last to come back. The effect of the fade-out was progressively greater the *lower* the frequency (at least to 4 Mc/s, no listening was done lower than this). Signals from all directions were affected. The lower frequencies remained dead for a much longer period than the higher ones.

D. W. HEIGHTMAN (G6DH).

Clacton, Essex.

Explanation Wanted

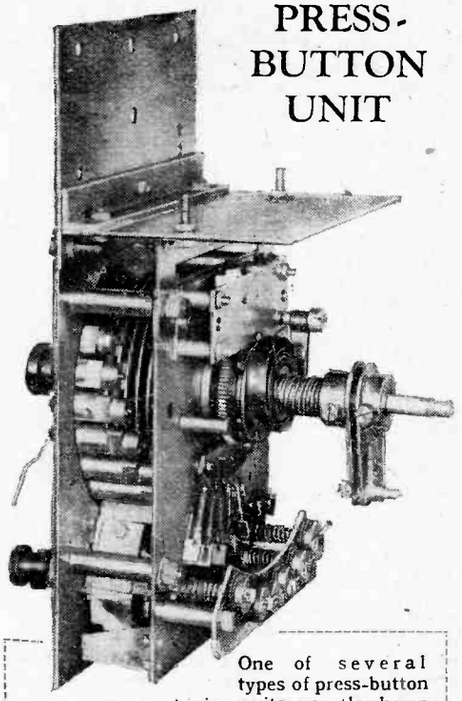
AN unusual occurrence took place here on the evening of April 5th. The receiving set was tuned to London National and was behaving quite normally. On turning on the water tap in the adjoining room the volume of the received station dropped and London Regional could be heard at almost the same strength that the London National was now being received. On switching on the lights in another room the receiver returned to normal. On investigating, I found that by moving the water tap the condition could be brought on or removed at will. The water pipe to the tap is of copper. The receiver is a 2H.F. Philips and is by no means unselective. The condition has appeared since and on the last occasion could not be removed by moving the water tap, but disappeared later suddenly.

I wonder if any other reader has had similar experiences or can offer an explanation?

B. H. GROSE.

Edgware.

PRESS-BUTTON UNIT



One of several types of press-button tuning units recently shown to radio manufacturers in London by M. Yardeny, of 210, Rue Lecourbe, Paris (15e). With this particular model a coil spring which is compressed by rotation of the selector takes the place of the more elaborate and expensive arrangement where an electric drive is employed.

Fibre Needles

In reply to Mr. F. H. Walker's query re the use of fibre needles, I think that he will find results unsatisfactory with any pick-up not specially designed for use with these needles.

Tone correction will, of course, restore some of the upper frequencies, and in this connection it is worth noting that Voigt Patents, Ltd., Silverdale, Sydenham, London, S.E.26, can supply a suitable correcting circuit for use with piezo pick-ups.

If Mr. Walker is really keen on high quality reproduction, however, I suggest that he should purchase either a Meltrope pick-up from Amplifiers, Ltd., Billet Road, London, E.17, or, if he feels disposed to spend a little more money for an even better article, a Davey pick-up from E.M.G. Hand-Made Gramophones, Ltd., 11, Grape Street, London, W.C.2.

Both these pick-ups, together with the W.W. Quality Amplifier, give splendid results with a beautiful, clean, "stringy" upper register and a full, deep bass.

I have records seven and eight years old which are as good as new, due to the use of fibre needles.

I may mention that I have no connection whatever with any of the firms mentioned above.

ARTHUR D. HILL.

Worthing.

RANDOM RADIATIONS

By "Diallist"

A Real Radio Exhibition

THE great news about this year's Wireless Exhibition, which is to open on August 24th at Olympia, is that, for the first time for many years it is to be a wireless exhibition! In other words, there will be no theatre, music-hall or fun-fair of any kind. Those who pass through the turnstiles will do so in order to see and hear wireless sets and the bits and pieces that go to make them up. It will be very interesting to see whether or not there is any great falling-off in the attendance this year. There's no question that during the years in which a theatre featuring broadcasting stars was part and parcel of Radiolympia, a considerable proportion of those who planked down their money to go in had no great interest in the wares displayed on the stands of exhibitors. A long while ago I urged in these notes that the money spent on the theatre would be far better laid out on first-rate side-shows concerned with the methods of transmission and reception of both sound and vision by wireless.

A Welcome Move

There will be plenty of attractions at Radiolympia and they will be of the right sort. Instead of the theatre with its variety shows we are to have a fully equipped television studio. The performances in this will be pretty well continuous. You can go in or go out as you like and people won't remain glued to their seats for a couple of hours at a time, as they did when watching the variety shows, for the very good reason that there won't be any seats. Nor will there be any necessity to queue up for the television demonstrations, for televisors will be at work on the stands themselves. In past years you couldn't form any idea of the quality of reproduction of different makes of wireless sets because a "ready-made" standard audio-frequency signal was fed to all stands from a central plant and it was only the loud speakers that were at work. Some time ago a manufacturer suggested in *The Wireless World* that the supply to the stands should be at radio frequency with a RMS value of 1 volt.

Hearing What Sets Can Do

That was an excellent idea and this year something still better has found favour with the authorities. Every stand will receive not one but two radio-frequency inputs. The programme conveyed by both will be the same, but there will be this difference between them. One is to be similar to what the aerial brings to the average receiving set from the local station; the other will represent the sort of input to be expected from a foreign station. In this way visitors to the stands will be given a real chance of estimating the performance of different sets. The receivers themselves will be working in all their stages and there will be some opportunity of discovering the different ways in which they deal with a good or a medium signal. Perhaps in future years the idea may be expanded. Twin transmissions, for instance, with a 9-kilocycle carrier separation would give some idea of the selectivity; or a signal with deliberate fading of various depths could be used to demonstrate the effectiveness or otherwise of the AVC arrangements. But that, perhaps, is looking rather far ahead. We can be thankful, anyhow, that the organisers of the Exhibition are already making not one but several steps in the right direction.

What Happened at Cairo?

NO one, I suppose, expected that the recent Cairo Conference would succeed in solving all the knotty problems which formed part of its agenda. The worst of these conferences nowadays is that they have become so huge: there were 700 delegates at Cairo. My own experience of conferences, committees and the like is that the bigger they are the less you get done in a given time. Much, though, depends on the chairman, who can, if he be of the right sort, restrain those who wander from the point and introduce side issues. At Cairo there were a good many chairmen, for the Conference split up into a multitude of committees, and they seem to have done their jobs well, since a surprisingly large amount of good work was carried out. Nothing could be done about the long-wave broadcasting band, and the only hope is that conditions upon it won't grow any worse in the near future. Efforts were made to secure increased width for the medium-wave band, since, with the coming of more and more new stations, an increasing stream of quarts is being poured into that pint pot. The only concession that could be obtained was for the extension downwards of the band by 7.7 metres to 192.3 metres. This adds an extra 60 kilocycles, which should mean that about six new stations can be accommodated. Or rather, perhaps, one should say that six new groups of stations can be accommodated, for it seems likely that the channels will be assigned to batches of synchronised stations.

Other Innovations

One interesting innovation decided upon at Cairo is the use of wavelengths between 120 and 130.4 metres (2,500 to 2,300 kilocycles) for broadcasting. These wavelengths will be assigned to tropical countries only, the idea probably being that they are likely to be of the greatest use in parts of the world where atmospherics are poisonous on the longer waves. Coming to

Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, MAY 19th.

Nat., 7.30, "A Formby Do"—George Formby presides. 8.15 and 9.25, The first concert of the London 1938 Music Festival, from the Queen's Hall; Toscanini conducts the B.B.C. Symphony Orchestra.

Reg., 6, "Overture and Beginners, Please." 7.30, Manxmen—Customs and Characters from the Isle of Man. 8.40, Transport: J. S. Nicholl talks on Road Haulage. 9.30, "Sands of Suez."

Abroad.

Luxembourg, 8.15, Yvonne Printemps.

FRIDAY, MAY 20th.

Nat., 7.30, New York to Hollywood by Air—a sound picture produced by Lawrence Gilliam from New York. 8, The Two Leslies present "Radio Pie." 9.20, Eddie Carroll and his Orchestra. 10.5, Lady Astor takes part in a discussion on "Drink and the Community."

Reg., 6.45, "Travelling Showmen." 8.45, The Oxford Repertory Company in "Night Must Fall"—the thriller by Emlyn Williams.

Abroad.

Budapest, 7.20, "Don Giovanni," opera (Mozart).

Sottens, 8.30, "Der Freischutz," opera (Weber).

SATURDAY, MAY 21st.

Nat., 7, "Melodies, Cheerful and Gay"—a relay of part of a German variety from Berlin. 8, Music Hall, including Peter Dawson, Sandy Powell and Vic Oliver. 9.20, American Commentary. 9.35, Alfred Piccaver sings with the Theatre Orchestra.

Reg., 3, "Radio Pie." 8.30, "Fish to Fry," a sound impression of the North-East Coast Fishing Industry. 9, The Western Brothers present "Cads' College."

Abroad.

Milan Group, 9, The 125th anniversary Wagner celebrations.

SUNDAY, MAY 22nd.

Nat., 1, Harry Davidson and his Orchestra. 5.20, Orchestre Raymonde. 7.20, B.B.C. Theatre Organ. 9.5, The Empire Sings: Pot-pourri of tunes from all parts of the Empire.

Reg., 5, Students' Songs. 5.30, "Ghosts," a spelling game. Parents *v.* Children; A. J. Alan as the master. 6.55, Franz Haydn, Musical Biography, 1761-1770.

Abroad.

Leipzig, and Radio-Paris, 5.30, "The Mastersingers," opera (Wagner)

Munich, 7.5, "The Flying Dutchman," opera (Wagner).

MONDAY, MAY 23rd.

Nat., 7, Monday at Seven, with Beatrice Lillie. 9.20, The Home Secretary speaks on Air Raid Precautions. 9.35, Jack Harris and his Band.

Reg., 6, The Empire Sings. 7.30, Fourth Centenary of Leland's Midland Tour for Henry VIII. 8.15 and 9.25, Toscanini conducts the B.C.C. Symphony Orchestra.

Abroad.

Brussels II, 8, "Frederica," operetta (Lehár).

TUESDAY, MAY 24th.

Nat., 6.25, "I Was There"—the first team from Australia in 1868. Reminiscences by Frank Gerald. 8.30 and 9.35, From the Empire Day Royal Command Concert at the Royal Albert Hall.

Reg., 6.30, Light Music from Czechoslovakia. 8, "New Zealand Panorama." 8.30, The Royal Tournament relayed from Olympia. 8.45, Wesley Commemoration. 9, Carroll Levis. 9.40, My Best News Story—Valentine Williams.

Abroad.

Berlin, 8, "The Barber of Seville," opera (Rossini).

Brussels II, 8, Hawaiian Guitar Ensemble and songs in English.

WEDNESDAY, MAY 25th.

Nat., 8, "Mercenary Mary," musical comedy with the Midland Revue Chorus and Orchestra. 9.20, Old Time Music Hall.

Reg., 6, Debroy Somers and his Band. 7.30, "Lonesome Like," a Lancashire play. 8, "The World Goes By." 8.30, "Lohengrin," Act II, of the opera from Covent Garden.

Abroad.

Leipzig, 9, Sibelius Concert.

Warsaw, 9, Chopin Recital by Drzewiecki.

the short waves we find several changes foreshadowed. There is a broadcast allocation between 85.7 and 90.9 metres (3,500 to 3,300 kilocycles), which may become popular as we proceed towards the next sunspot minimum. Actually a certain amount of use was made a good many years ago of wavelengths of this order. If I remember aright, KDKA, the first American short-wave station to be regularly received in this country, operated for a long time on a wavelength between 80 and 90 metres. Bombay is using 90.8 metres nowadays, and so comes just inside the upper limit. Other changes include additional broadcast belts in various parts of the short-wave bands, including one 100 kilocycles in width on the 41-metre band, which may not be very warmly welcomed by amateur transmitters.

Many Months to Go

The changes won't as a matter of fact come into force until September next year, and before they can do so a European Broadcasting Conference must be held to draw up a fresh wavelength plan. It is to be convened not later than February 1st next year, and it will have a formidable task. Amongst European countries the "Haves" want to keep all that they have now got in the way of channels, whilst the "Have Nots" are just as determined that they shan't do so. If, however, the forthcoming conference tackles its job as successfully as did the Lucerne Conference there won't be much cause for complaint. The Lucerne Plan, though its end is now in sight, has stood the test of time remarkably well.

Sorting Out the Short Waves

What will have to be done before so very much longer is the preparation of some kind of plan for short-wave channel allocations. And that is going to be a job, if you like, for the whole world is concerned and every civilised country will have to send delegates. It was difficult enough to obtain anything like complete agreement amongst just European countries at Lucerne, and one's imagination rather boggles at picturing the struggles of a World Conference engaged in the task of drawing up a short-wave plan.

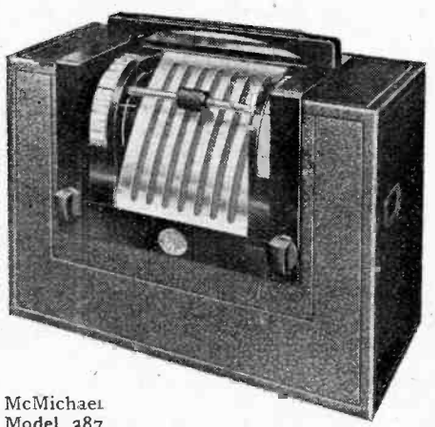
Short-wave Pranks

DURING the last few weeks I've felt more than once that those who conduct the complaints departments of set manufacturing firms must have been having a rather thin time. I am thinking of the letters likely to come their way from those who, having purchased "all-wave" receivers, write sometimes more in sorrow than in anger, and sometimes, again, more in anger than in sorrow, that there must be something wrong with their sets, since they can get hardly anything on the short waves. And, really, if you tried out the short-wave range of the best of sets on some recent days and nights you might have thought, had you not been versed in the queer ways of short-wave transmissions, that performance was none too good. It has been an astonishing period. At times reception on various short-wave bands has been almost phenomenally good, stations came roaring in with little or no fading and with beautiful clarity. At other times—and these were much more frequent—short-wave stations normally as easy to receive as Cologne or Hilversum on the medium waves might not be there at all, or they might be mere whispers or afflicted by flutter and other horrid things. Short-wave reception is a queer business even to those who have been at it for years; and it must seem something more than queer to those who take it up at a time when conditions are changing so rapidly and so violently.

Towards Valve Standardisation

AT the meeting of the International Standardisation Conference, convened by the International Electro-Technical Commission, which begins on June 22nd at Torquay, at least a day and probably more will be devoted to discussing the problems and the possibilities of radio valve standardisation. One hopes fervently that something may come of these deliberations, for if there is one thing upon which wireless manufacturers, dealers and listeners are agreed it is that we have far too many different kinds of valves. A hopeful sign is that Mr. T. E. Goldup, of the Mullard Company, has been appointed as British Radio Valve delegate. Mr. Goldup has already shown himself to be all in favour of standardisation. In the course of a recent lecture he made this clear and expressed the belief that something could be done towards attaining it if the problem were energetically tackled. The best of luck to him at Torquay and may he tackle the problem there with all the energy at his command!

McMichael Bijou Portable



McMichael Model 387 with the new "Rotabar" tuning system.

AN ingenious system of tuning is employed in the new McMichael Model 387 battery portable. Separate curved scales for medium and long waves situated on each side of the metal loud speaker grille are connected by a metal bar provided with a knurled grip. When this is rotated the bar travels in slots at each side and carries with it the tuning pointers.

The four-valve straight circuit comprises a pentode RF amplifier, triode detector, triode first AF amplifier and output pentode delivering 250 mW. A useful feature is the illuminated LT indicator in the lower edge of the black moulded dial and loud speaker surround.

The finish is in dark blue leatherette with chromium-plated metal fittings, and the price is 8 guineas complete with batteries.

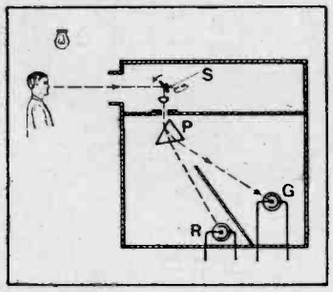
A turntable is fitted to the base of the cabinet which measures 14in. × 9¾in. × 6in., and the total weight is 16 lb.

Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

TELEVISION IN COLOURS

REFLECTED light from the object to be televised is projected on to a vibrating-mirror or other scanning device S, and is then focused on to a glass prism P, which forms a dispersed colour-spectrum in the ordinary way. The separated primary colours are fed to different photo-electric cells, the cell R, for instance, responding to the red end of the spectrum, while the cell G handles the blue-green rays. The output



Schematic arrangement of colour television system.

from each cell, after amplification, is applied to modulate its own carrier wave.

At the receiver, each set of signals is applied to control a separate source of light, these being fitted with appropriate colour filters. The output from each lamp is passed first through a "combining prism," and then through a scanning device, which projects the coloured picture on to a viewing screen.

W. H. Priess. Convention date (New Zealand), July 13th, 1935. No. 480944.

o o o o

CATHODE-RAY RECEIVERS

AN adjustable resistance is inserted in one or both of the leads from the timing-circuit to the deflecting-plates of a cathode-ray tube, in order (a) to control the size of the picture and (b) to centre it correctly on the fluorescent screen. As compared with the known method of varying the operating voltage, or alternately of using parallel resistances, the new method is said to prevent reaction on the oscillation-generator such as would tend to distort the saw-toothed waveform.

When resistances are used in both leads, they are ganged together so as to maintain the standard ratio between the height and width of the picture. For centring purposes, the arrangement is such that as one resistance is increased the other decreases, and vice versa.

E. Michaelis. Application date, September 23rd, 1936. No. 479149.

o o o o

"FLYWHEEL" TUNING

WHEN reduction-gearing is used between the control knob of a set and the main tuning condenser so as to allow of fine adjustment, the slow movement becomes rather tedious when it is desired to cover comparatively large distances over the tuning dial. For this reason, it has already been proposed to use a "flywheel" which is rotated by the control-knob and serves to speed-up the subsequent movement of the indicator needle. Usually the flywheel is mounted on the same shaft as the tuning knob and is driven directly by it.

According to the invention the flywheel is mounted on a shaft separate from, but parallel with, the shaft of the tuning knob, and is geared to the latter through a speed-increasing train of wheels. This allows the flywheel to be started up at a much higher speed than the rotation applied to the control knob.

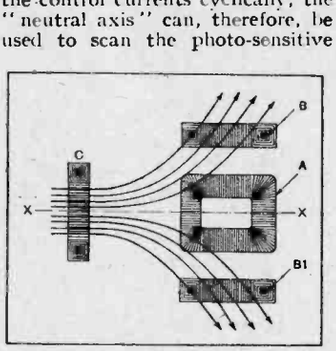
E. Czobor and M. Czobor. Convention date (France) August 22nd, 1935. No. 479938.

o o o o

SCANNING SYSTEMS

TWO pairs of magnetic coils, A, A1 and B, B1, are arranged at right angles to each other (the coil A1 being omitted from the Figure for the sake of clearness), and a fifth coil C is set across the common axis. The resulting magnetic field is indicated by the arrows, and will disperse a stream of electrons passing through the open coil C, all except those which happen to be travelling along the neutral axis XX, shown in dotted lines. These electrons will continue to travel in a straight line.

When equal currents are passing through the coils A, A1 and B, B1, the neutral axis will be along the centre of the system, but it can be made to shift to-and-fro and up-and-down according as the currents in the coils are varied, tending always to move in the direction of the weakest current. By varying the control currents cyclically, the "neutral axis" can, therefore, be used to scan the photo-sensitive



Electro-magnetic system of scanning for television apparatus.

cathode of a television transmitter, line by line. A similar arrangement of electrostatic deflecting plates can be used to scan the fluorescent screen at the receiving end.

Soc. Anon. Franco-Belge D'Electricité. Application date, May 28th, 1936. No. 480859.

o o o o

HIGH-FLYING EQUIPMENT

A BUTTON microphone for the radio-telephony set is fitted in the nose-piece of the oxygen-mask worn by a pilot when flying at very high altitudes. In order to shut out engine noise as far as possible, the mouthpiece is extended inwards to as to come quite close to the lips of the pilot. The extension piece is made of spongy rubber or other resilient material, so as to minimise the risk of injury should the pilot be suddenly thrown forward.

Marconi's Wireless Telegraph Co., Ltd., and J. Stewart. Application date August 27th, 1936. No. 480710.

o o o o

SINGLE-SIDE-BAND SIGNALS

TO relieve congestion in the ether, it has already been proposed to suppress both the carrier-wave and one of the two side-bands of the normally modulated signal, so as to reduce the frequency band occupied in transmission. To receive such a signal, it is necessary to reintroduce a local oscillation, identical in frequency with the suppressed carrier-wave, and for this purpose it has been proposed to transmit with the outgoing signal a synchronising impulse (which may be the incompletely suppressed carrier itself) in order to stabilise the local-oscillator used at the receiver.

This has not proved altogether satisfactory in practice, and the present suggestion is to modulate the transmitted signal (before the carrier is suppressed) with two low-frequency impulses which have a fixed ratio to each other. These impulses reappear in the receiver, and are applied across a phase-measuring bridge circuit to synchronise the local frequency with that of the suppressed carrier-wave.

Telefunken Ges fur drahtlose Telegraphie m.b.h. Convention date (Germany), July 20th, 1936. No. 480847.

o o o o

PIEZO-ELECTRIC CRYSTALS

A PIEZO-ELECTRIC crystal, particularly for use in a microphone or gramophone pick-up, is enclosed in a flexible wrapper, such as a piece of fish-skin, the intervening spaces being filled in with a fluid or semi-fluid substance, such as wax or paraffin.

This method of mounting improves the response of the crystal by damping-out the sharper mechanical vibrations. It also prevents any deterioration from atmospheric conditions, to which Rochelle salt is particularly susceptible.

H. Ando. Convention date (Japan), February 27th, 1936. No. 481543.

o o o o

REDUCING "MICROPHONIC" NOISE

MODERN high-frequency circuits are extremely sensitive to mechanical shocks, particularly if the set is carried on a moving vehicle, and the amplified effects may be unpleasantly pronounced. In order to reduce them, the tuning condenser is supported from a base-member which contains, or is closely adjacent to, the centre of gravity of the entire assembly.

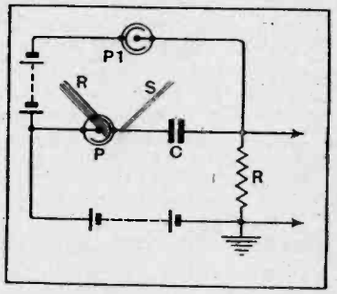
Any vibrations which may be transmitted through the supports then tend to move the rotor and stator plates of the condenser together, so that they are not mutually displaced. They, therefore, produce little or no capacity changes likely to affect the tuning and lead to microphonic noise.

Marconi's Wireless Telegraph Co., Ltd. Convention date (U.S.A.), August 31st, 1935. No. 480724.

o o o o

TELEVISION TRANSMITTERS

RELATES to means for transmitting with the signals proper a low-frequency component which represents slow variations in the overall illumination of the scene to be televised. The reason why this effect is usually masked, in a television transmitter of the type



Circuit showing connection of compensating photo-electric cell mentioned in the text.

using a photo-electric screen built up of a mosaic of small cells, is explained as follows: Taking the cell P as a typical unit of the mosaic screen, the effect of an incident ray of light R is to produce an emission of electrons which gradually charges-up the condenser C, and in doing so gives rise to a slowly varying current in the resistance R.

Immediately afterwards the scanning stream S from the "gun" of the cathode-ray tube discharges the condenser, and so sends a signalling current through the resistance R. The first-mentioned charging current, however, serves to mask any slow changes of average illumination which may form part of the signalling current.

According to the invention, a second photo-electric cell P1 is used to produce equal but opposite "charging" currents across the common resistance R, leaving the latter free to respond not only to rapid picture-point variations, but also to the low-frequency currents required to control changes of background illumination. The compensating cell P1 is, in practice, combined with or incorporated in the cathode-ray tube used for scanning the picture.

Standard Telephones and Cables, Ltd. (assignees of Le Material Téléphonique Soc. Anon). Convention date (France), September 17th, 1936. No. 480646.

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CONTENTS

EDITORIAL COMMENT

B.B.C. Complacency

Why Not Competitive Programmes?

IT has always seemed to us a pity that the B.B.C. monopoly is so comprehensive that it effectively rules out any competition even on the programme side. If it had been feasible for such an arrangement to be made, there is no doubt that two programme authorities in competition with one another would have had a very stimulating influence. As it is, there is always a danger of complacency on the part of those whose business it is to provide the programme fare. But if it were possible to devise a scheme such as has been suggested more than once in the past, a scheme where two separate programme organisations were set up within the B.B.C. itself, with independent programme directors in active competition, much might be done to engender a healthier condition and, incidentally, relieve the B.B.C. of much criticism.

If such a scheme were inaugurated the two directors would have independently staffed departments, and the funds available for programme preparation would have to be divided equally between the two departments. It would mean a slight increase, no doubt, in personnel, but this would probably be amply justified by the results and improvement in the entertainment value of the programmes provided. The B.B.C. would, of course, continue to exercise, as at present, the general control and censorship over all broadcast matter, and it would have to be understood that both the programme boards would include in their time a proportion of educational matter and special broadcasts which the present general policy of the B.B.C. requires should be put out.

To make such a scheme really effective it would be desirable that the listening public should be made aware of the origin of the programme listened to, and it would therefore probably be necessary to identify these programmes, say, as "Programme No. 1" and "Programme No. 2," and the public would be encouraged to report their preferences. This could perhaps be organised on the lines of voting for one programme or another, so providing for the respective programme directors a suitable encouragement or rebuke, according to how far the programme fare provided was meeting the tastes of the public.

Local Colour

In the early days of broadcasting, before the present facilities for connecting up one station with another by efficient land-lines, each station did actually transmit independent programmes, and those who had sets capable of picking up the various B.B.C. transmissions other than their local very soon tended to settle down to regular listening to the station whose programmes appealed most. It is in many ways a pity that the improvement of Post Office lines between stations has brought about the replacement of independent local programme compilation in favour of the present centralised system.

The B.B.C. is again encouraging the introduction of more local colour in the programmes, but we believe that it is well worth while considering whether it is not possible to introduce a strong element of competition into the programme arrangements, rather than allow the position to drift on with no particular incentive to programme autocrats to try to improve upon present standards.

Interference from

ITS CAUSE AND CURE

THE actual mechanism whereby RF oscillations are produced in a neon tube circuit has hitherto been somewhat obscure. The author of this article shows that the necessary conditions for oscillation exist in a typical neon sign and its associated wiring; he goes on to discuss means of preventing the radiation of interference.

By F. R. W. STRAFFORD (*Research Dept., Belling and Lee, Ltd.*)

IT is well known that neon signs in operation generally produce severe interference with radio reception, particularly on the long-wave broadcasting band. The medium- and short-wave bands are also affected, but usually to a lesser extent. The interference is characterised by a hundred-cycle fundamental tone rich in harmonics, and can be described as sounding like a deep buzz.

A fruitless search amongst the relevant technical literature, instituted in the hope of finding some reference to the mechanism involved in producing interference from cold-cathode gas discharge tubes, of which neon signs are an example, forced the writer to investigate the problem from scratch, as it were.

The result was illuminating, and has provided the necessary information whereby the fundamental cause and cure of this pernicious effect can be established.

It would be as well in the first place to explain briefly the general physical principles whereby neon signs operate. Essentially, the sign consists of an evacuated tube of cylindrical bore wherein is sealed approximately 1-70th of an atmosphere of neon gas. An electrode is sealed into either end of the tube, and a source of high voltage is applied across these electrodes. At a certain critical voltage the gas is ionised and becomes illuminant in the red portion of the colour spectrum. The voltage at which the gas de-ionises and the illumination is extinguished is below that required for ionisation. Hence the appearance of expressions such as "striking" and "extinguishing" voltage respectively.

How the transformers, etc., are mounted in the housing of a hanging sign.

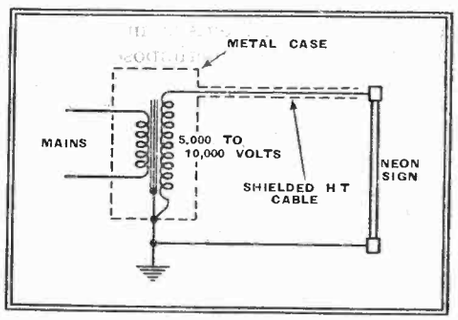


Fig. 1.—Circuit arrangement of a typical neon sign.

It is this difference in relative magnitude between the striking and extinguishing voltages which forms part of the basic mechanism whereby the interference is created. This property will be fully described in due course.

A typical circuit for a neon sign installation is depicted in Fig. 1. It will be noted that the high-voltage connections to the sign electrodes are encased in an earthed shield, thereby serving as a safety precaution against electric shock in addition to minimising corona effects by increasing the dielectric strength of the insulating barrier between the electrode wires and earth.

High-voltage Insulation

If ordinary bare wire were used for these connections, the dielectric barrier is air, and this would break down far more readily than the rubber insulation provided between the inner and outer conductors comprising the shielded cable.

The voltage supplied by the high-tension transformer varies between 5,000 and 10,000 RMS on the average installation. On larger installations, when more than 10,000 volts are required, it is usual to employ separate circuits involving one transformer per circuit. These transformers are wound in such a manner that the leakage inductance is very high, thus providing extremely bad regulation. This is necessary, since at the instant of striking there is a very large drop in voltage across the electrodes accompanied by an increase in current through the sign. This is hardly in accordance with ohms law, but it is a unique property of gas-discharge circuits.

When this typical system was installed in the laboratory for the writer's experimental work, no precautions were taken regarding the high-voltage connections; hence the shielded cable was at first omitted.

By means of a suitable field strength measuring equipment it was noticed with some surprise that no measurable level of interference could be detected. The sign appeared to be working quite normally at its rated current, so that the only departure from correct working conditions appeared to lie in the omission of the recommended shielded cable.

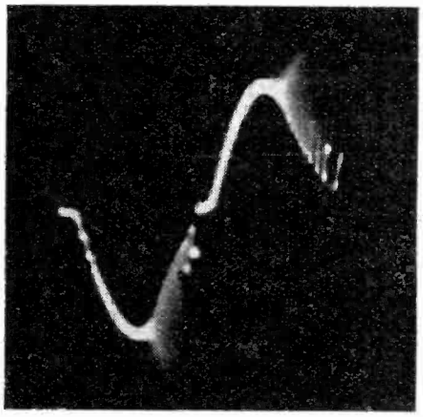


Fig. 2.—Oscillogram showing the production of RF oscillation.

A quantity of this cable was obtained and its measured capacity was found to be 40 mmfds. per foot. About 25ft. was used in the installation, providing a total capacity of 0.001 mfd. The shields were correctly bonded, and the installation was to all intents professional and in accordance with the makers' instructions and the wiring regulations.

Very severe interference was generated by this arrangement when it was obvious that the capacity of the shielded cable had brought about the effect. An oscillogram of the current waveform through the sign, shown in Fig. 2, indicates fierce oscillation occurring near the zero current level (near maximum voltage) of the 50-cycle current waveform through the sign.

Neon Signs

A little consideration soon provided the explanation of the effect, for the equivalent circuit of the sign is merely an elaboration of the relaxation oscillation gas-discharge circuit used in television and oscillograph time bases.

Fig. 3 shows a simple time-base circuit

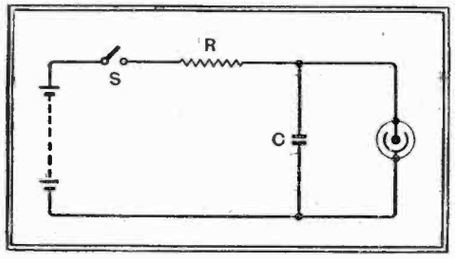


Fig. 3.—Simple circuit for producing relaxation oscillations from a neon lamp.

capable of providing oscillation of saw-toothed wave form.

The principle of oscillation is as follows. Upon closing the switch S, the condenser C charges exponentially through R until the voltage across C reaches the striking potential of the gas in the tube. As soon as this strikes the condenser is discharged, and at a certain level the neon extinguishes. The process then recommences and repeats at a time interval governed by the following equation:—

$$t = CR \log_e \frac{V - a}{V - b}$$

where t = time in seconds, V = applied voltage, a = extinction voltage, b = striking voltage, C = capacity in farads, R = resistance in ohms.

The periodicity of the waveform may be controlled by CR as a first-order effect, and by a and b as a second-order effect. As a and b are made equal the equation is no longer valid, and oscillations cease since their periodicity attains a limiting frequency at which a and b automatically tend to equalise on account of the time of recombination of the ions within the gas. In general, then, there is a limit to the lowest value of C which can produce oscillation, and in practice the amplitude decreases as the frequency increases.

Oscillation with AC Supply

Now replace the DC voltage supply of Fig. 3 by an alternating source of 50 c/s periodicity. Providing R and C are adjusted so that an oscillation of fairly high frequency is normally produced with the DC source, it is quite obvious that the oscillation will appear at certain parts of the wave of alternating applied voltage. Hence the oscillation appears in little trains over those time-periods corresponding to sufficient striking voltage from the applied alternating source.

Now the equivalent circuit of the neon sign is practically identical with the time-base circuit of Fig. 3, under alternating supply voltage conditions. Actually, the leakage inductance of the transformer must be included in R as it is in series therewith, where R is the resistance of the secondary winding and C, of course, is the capacity of the cable.

The trains of oscillations as seen in the oscillograph are actually saw-toothed in shape, and must therefore be resolved into an appropriate Fourier series to obtain their amplitude and frequency distribution. Such an analysis will reveal components of frequencies lying over the broadcast bands. The amplitude of these components gradually diminishes as the frequency becomes higher; hence the interference level on long waves is likely to be greater than on medium waves. This fact is substantiated by measurement in which the interference level at 300 metres was 16 decibels below that produced at 1,500 metres.

Superimposed AC Hum

As each train of oscillation occurs twice per cycle a characteristic modulation of 100 c/s would be superimposed upon the resultant, and it is this which is mainly emitted from the loud speaker after the normal rectification processes in the receiver.

The foregoing explanation of the cause of neon interference is fundamental, and precludes many minor effects which are incidental and would render cumbersome and non-lucid the general exposition of the subject.

In certain large installations the amount of high voltage shielded cable employed raises the parallel capacity to an extent which slows down the period of the relaxation oscillation to a low frequency, whereupon the harmonic components in the broadcast range are considerably reduced in amplitude and the resultant interference is often negligibly small. It appears that the smaller signs employing about 30ft. of cable are the worst offenders, but qualitative evidence is lacking in this respect. The period of oscillation could be slowed down by adding fixed condensers across C or increasing R or L.

The first expedient would be very expensive in that the condenser would have to be designed for continuous working at 10,000 volts RMS. Both expedients reduce the available voltage supply to the

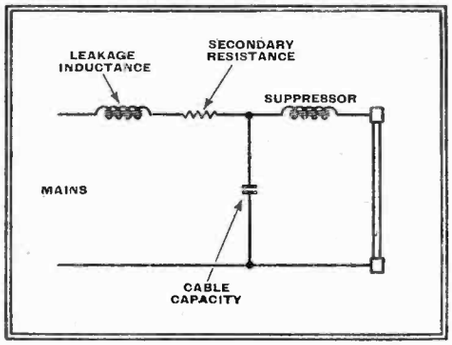
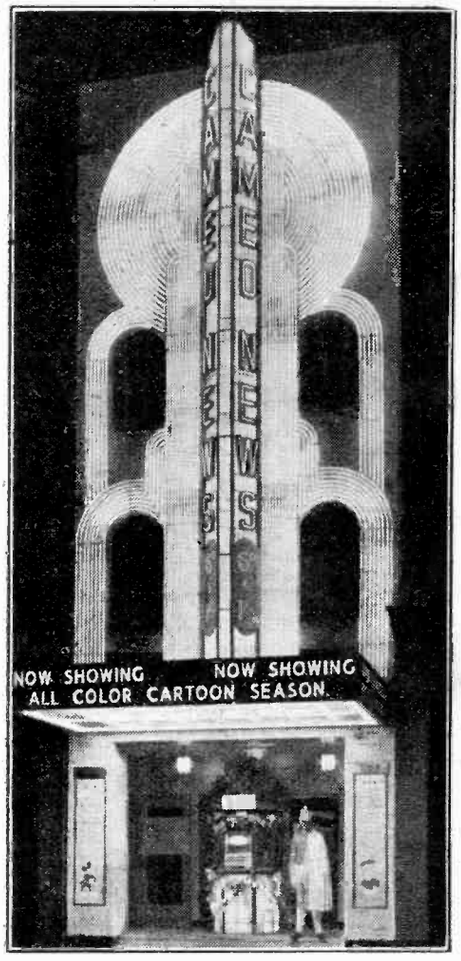


Fig. 4.—Equivalent circuit showing the use of an iron-cored choke as a suppressor.



sign and require the use of over-rated or specially wound transformers to make good the loss.

The most successful suppressor consists of a high-inductance choke connected in series with the sign electrode in such a manner that the equivalent circuit can be represented by Fig. 4.

It would appear that a value of 50 henrys is necessary to procure adequate suppression over the long-wave band, and of course this is obviously sufficient for the lower amplitude interference level on medium waves. The British Post Office have recommended a value of 50 henrys for some time and the accompanying table of results confirms this recommendation.

Effect of Choke Inductance on Interference Suppression

Inductance of Suppressor.	230 kc/s Interference.	1,000 kc/s Interference.
0 Henrys	70 db.	54 db.
5.0 ,,	41 ,,	11 ,,
50.0 ,,	24 ,,	11 ,,

This choke has to be specially designed to withstand the very high peak voltages which are developed across it, and it is usual to enclose it in a suitably insulated cover.

The effect of the choke upon the waveform of the current through the sign is very clearly depicted in Fig. 5, and shows that although the oscillations are still present their periodicity has been slowed

Interference from Neon Signs—

down very considerably, thereby diminishing to a negligible magnitude the amplitude of the higher harmonics lying in the broadcast wave bands.

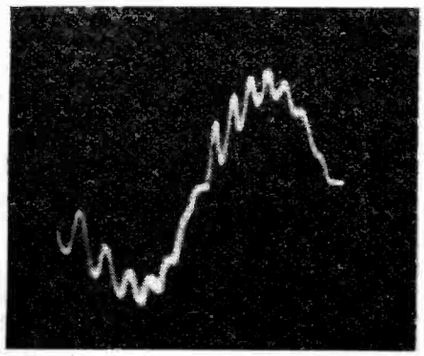


Fig. 5.—How the insertion of a suppressor choke prevents the generation of RF oscillations : compare this oscillogram with Fig. 2.

Fig. 6 shows a practical installation, complete with suppression choke, and Fig. 7 represents another arrangement where both ends of the sign are at high potential to earth.

It is sometimes found that the inclusion of the 50-henry suppressor choke in an interfering sign does not produce the desired degree of suppression. It is almost certain that this is due to (a) a badly aged sign ; (b) faulty insulation and material.

In the course of time some of the neon gas is absorbed into the electrodes, with a subsequent reduction in the gas pressure within the sign. As a result of this the applied voltage must be increased in order to strike and maintain the gas in illumination. As the sign ages a condition eventually arises in which the applied voltage is just capable of striking the gas at the peak values of the wave, and this gives rise to a distorted current waveform, high-frequency harmonic components of which are of sufficient amplitude to produce interference effects in the long- and medium-wave broadcast ranges. The cure for this type of interference obviously involves the replacement of the sign, or the installation of a transformer capable of giving a higher voltage than that originally used. The latter expedient would, however, contravene certain regulations, and so is to be deprecated.

Other causes of interference due to bad insulation and faulty material may be classified as follows :—

1. Deposits of carbon and dirt along the sign, resulting in sparking and subsequent interference arising from spark discharges.

2. Sparking from the sign electrodes to metal clips securing the sign in position when the latter is covered with a deposit of carbon and dirt.

3. Corona, due to faulty sealing of the high-voltage cable at the connections to the sign electrodes and transformer terminals respectively.

4. Faulty bonding, resulting in sparking and bad connections.

5. Faulty high-tension transformer, causing sparking between windings or between windings and laminations.

It is therefore essential to ensure that the foregoing faults are rectified before any attempt to suppress the fundamental interference is made.

A further point in connection with the wiring of the 50-henry suppressor choke is the necessity for locating it at the points shown in Figs. 6 and 7. Little or no suppression will result if the choke is placed in series with the outgoing leads from the high-tension transformer secondary winding, since this places the choke before and not after the capacity of the shielded high-voltage cable ; reference to Fig. 4 will further elucidate this point.

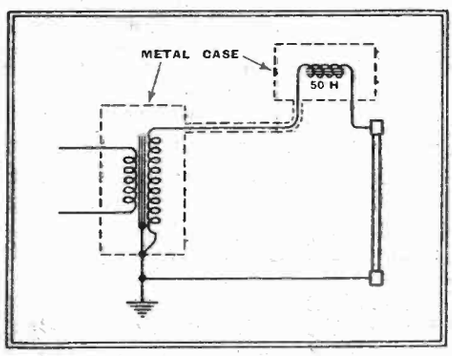


Fig. 6.—Suppression circuit for a single-element sign.

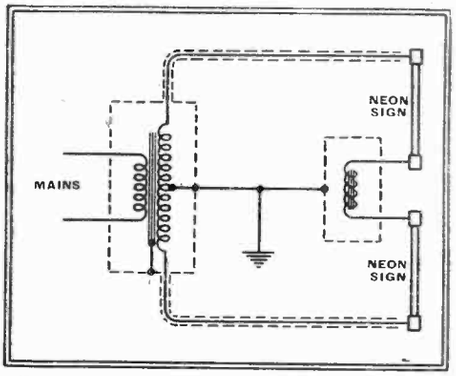
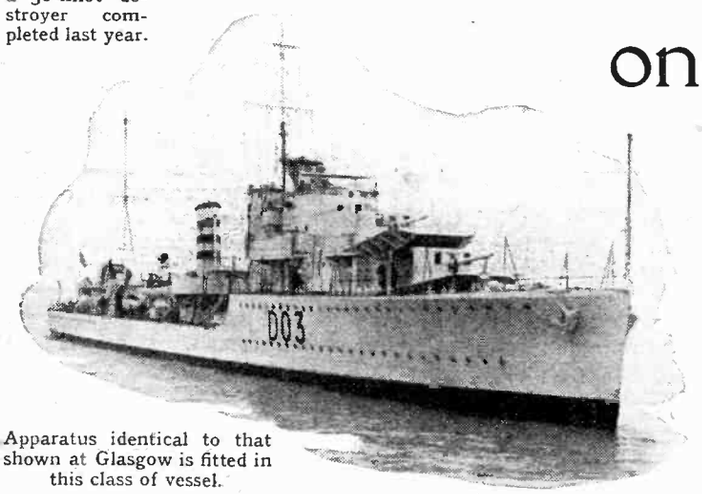


Fig. 7.—Suppression circuit for a two-element sign in which both ends are at high potential to earth.

In the conclusion, the writer wishes to acknowledge the kind co-operation of Messrs. Claude-General Neon Lights, Ltd., for the loan of the signs and cables used in this investigation and for photographs used in illustrating this article.

Naval Wireless on View

UNIQUE OPPORTUNITY AT THE GLASGOW EXHIBITION



H.M.S. *Icarus*, a 36-knot destroyer completed last year.

Apparatus identical to that shown at Glasgow is fitted in this class of vessel.

TO readers of *The Wireless World* who visit the Scottish Empire Exhibition at Glasgow, by no means the least interesting exhibit is to be found on a stand in the Shipbuilding Hall of the British Government Pavilion. Here a complete replica of a modern destroyer's wireless office has been installed. Since visitors to men-of-war are not permitted to enter the wireless offices owing to the confidential nature of some of the apparatus fitted in them, this Glasgow exhibit provides, perhaps, a unique opportunity for inspecting Naval wireless equipment. It provides, incidentally, a better opportunity than a visit to a ship, since rather more space is available at Glasgow than can be spared in a destroyer.

On the left of the stand is a small lobby which conceals certain necessary, but, from the visitors' point of view, not particularly interesting, apparatus. Here are the high- and low-tension accumulators for the receivers, with apparatus for charging them from the Exhibition DC supply. Here also are certain power supply boards and special audio-frequency amplifiers.

At the opposite end of the stand is the main transmitter, which is, in reality, four transmitters in one ; although they are so arranged that only one can be used at a time. It is divided into a number of separate panels ; in the panel farthest from the front of the stand is a small low-frequency[1] set which obtains its supply from an alternator fed by a 20-volt accumulator. This has a range of about 25 miles and is used for communicating with other

[1] In Service parlance, "low frequencies" are those below 100 kc/s (3,000 metres). "High frequencies" range from 6,000 to 30,000 kc/s (50-10 metres).—ED.

Naval Wireless on View—

ships in harbour when steam is not available to run the ship's dynamos. The centre panels contain the main low-frequency set which has a range of 500 miles. This obtains its power from a 5kW alternator fed from the ship's mains. The output from the alternator is fed through a step-up transformer to a full-wave valve rectifier which produces the necessary high DC voltage for the anodes of the transmitting valves. The circuit of this transmitter consists of a master stage followed by a power stage which uses a screen-grid valve to avoid complicated neutralising adjustments. The panel nearest the front of the stand contains the high-frequency transmitter which obtains its power from the same rectifier as the low-frequency set; it has a world-wide range under favourable conditions. In all these transmitters every possible precaution is taken to ensure frequency stability; visitors will, for example, note the anti-drift plug-in coils used in the high-frequency set.

A safety cage prevents access to the back of the panels when the set is working, and allows access when it is necessary to carry out maintenance or repair work; for example, for fitting a new valve. Incidentally, the transmitting valves are made of silica, since this will withstand the very high anode temperatures without the complications of water cooling. When the door of the cage is open a safety switch breaks the power supply to the set and prevents transmission. (It should be added that the glass fitted to the front of the safety cage at Glasgow is for exhibition purposes only). The fourth transmitter which forms a part of the main set is fitted inside this cage; it uses a simple quenched spark gap, takes its supplies from the 5 kW alternator, and is for use in emergency; for example, when valves have been damaged in action by concussion.

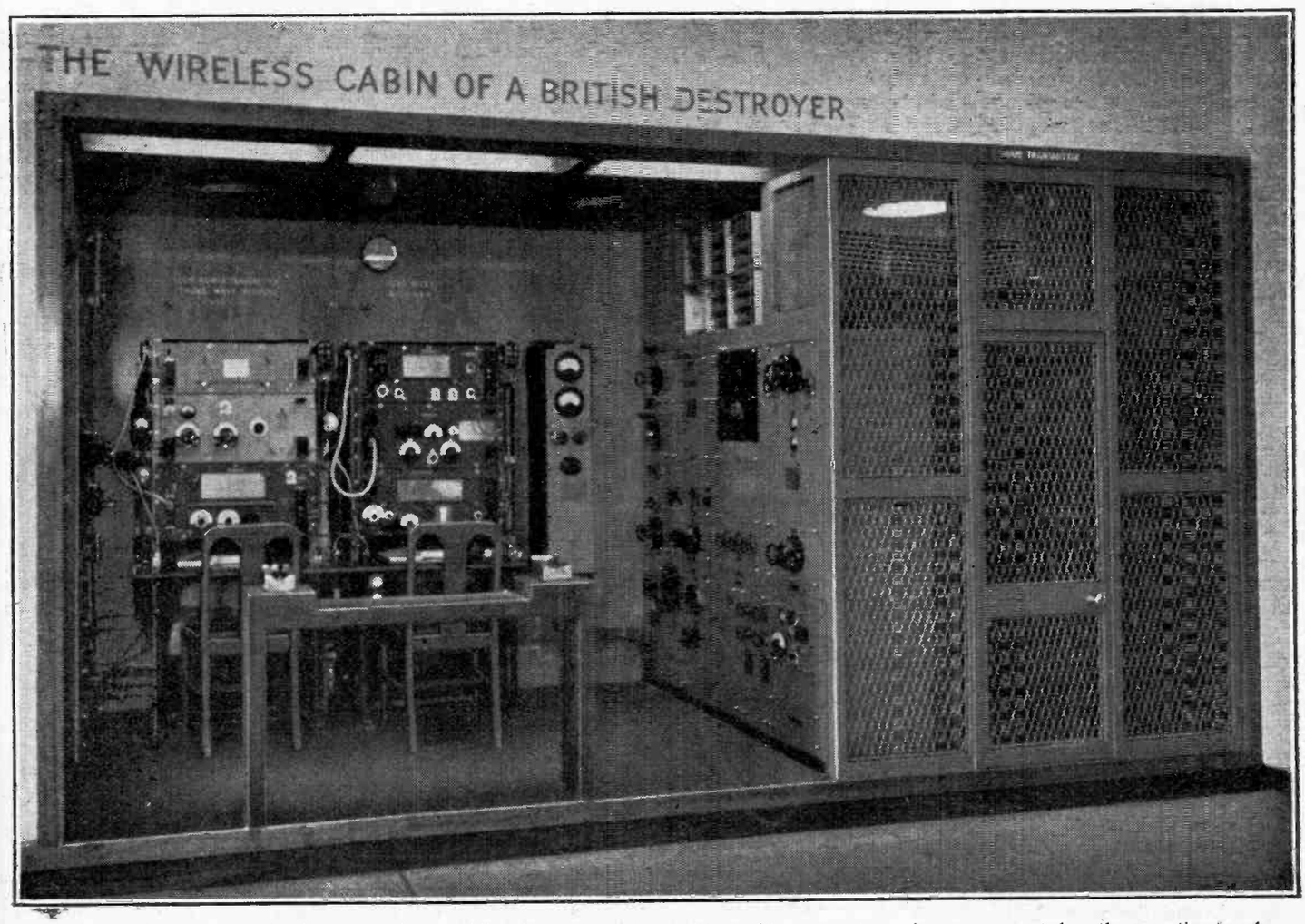
Independent SW and LW Receivers

In the centre of the stand are two racks containing apparatus, each with a table and chair for an operator. The left-hand rack contains a small low-power high-frequency transmitter and a high-frequency receiver; the other rack contains a low-frequency receiver. The high-frequency receiver is a straight set with two RF stages, detector and two AF stages. The low-frequency receiver consists of three separate units, the whole set necessarily being large in order to accommodate the coils required for tuning down to the lowest frequencies required. The centre unit is the tuner; the unit below this contains two RF stages, a detector and a separate oscillator for use when receiving CW signals; at the top is a unit containing two AF stages. This arrangement of the units is dictated by the necessity for placing the controls most frequently used as near the operator as possible.

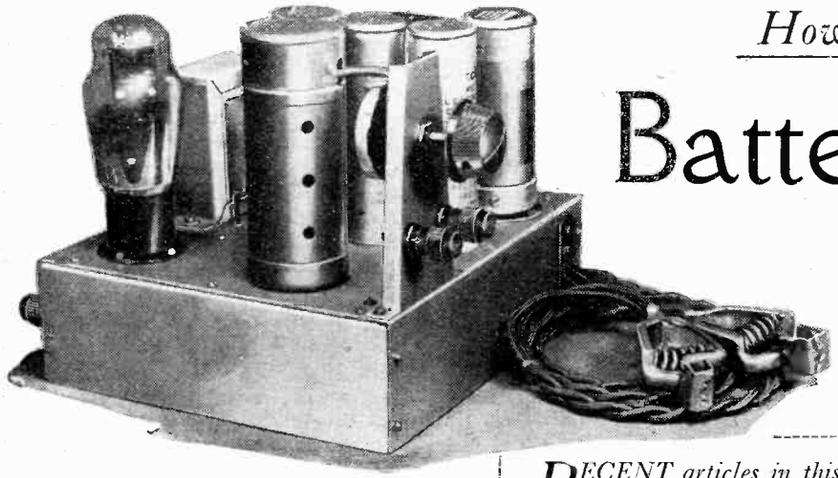
Aerials have been provided for the two receivers, the outputs of which are connected to audio-frequency amplifiers and loud speakers concealed in the roof of the stand; received signals are thus made audible to visitors. Actual transmission at Glasgow is not allowed; dummy aerials, consisting of suitable condensers and resistances, have therefore been connected to the transmitters so that their operation can be demonstrated. A local valve oscillator, installed in the lobby, is used to represent a distant transmitter, and demonstrations of 2-way traffic operating can thus be given. By a similar arrangement, dummy traffic can be exchanged with the replica of a G.P.O. coast station which has been installed by the Post Office authorities elsewhere in the Exhibition.

All the sets on view are standard Naval types of the latest design. They were designed and developed by H.M. Signal School, Portsmouth, to meet Naval requirements. The actual production of the sets in quantity for the Admiralty is undertaken, needless to say, by British wireless firms.

Space will not permit publication of further details, but Naval Telegraphists will be on duty at the stand throughout the Exhibition to demonstrate the equipment and to explain it to visitors.



The large safety cage contains four transmitters, while a low-powered transmitter and two separate receivers are mounted on the operating bench.



How a Receiver is Designed.—XIII.

Battery Quality Amplifier

(Concluded from page 448 of last week's issue)

RECENT articles in this series have dealt with the design of a high-quality amplifier for operation from a battery. It was shown that the use of a car-type accumulator with a vibrator HT supply unit lends itself well to the attainment of good volume at high quality. Constructional details of such an amplifier are given in this article.

CONSTRUCTIONAL DETAILS

THE attainment of high-quality reproduction from battery-operated equipment largely resolves itself into a matter of finding the most economical source of battery power. As explained in the preceding articles, a single six-volt battery of the car type is especially convenient, and enables a really high standard of reproduction to be obtained at good volume. So far as quality and volume are concerned, the battery user can reach the standard long enjoyed by his more fortunate brethren who have mains available. His operating costs, in the form of battery charging, will still be higher, but in normal circumstances should be reasonably low.

The HT supply is derived from the low-voltage battery by means of a vibrator, transformer, rectifier and smoothing circuit, but the amplifier itself is quite straightforward.

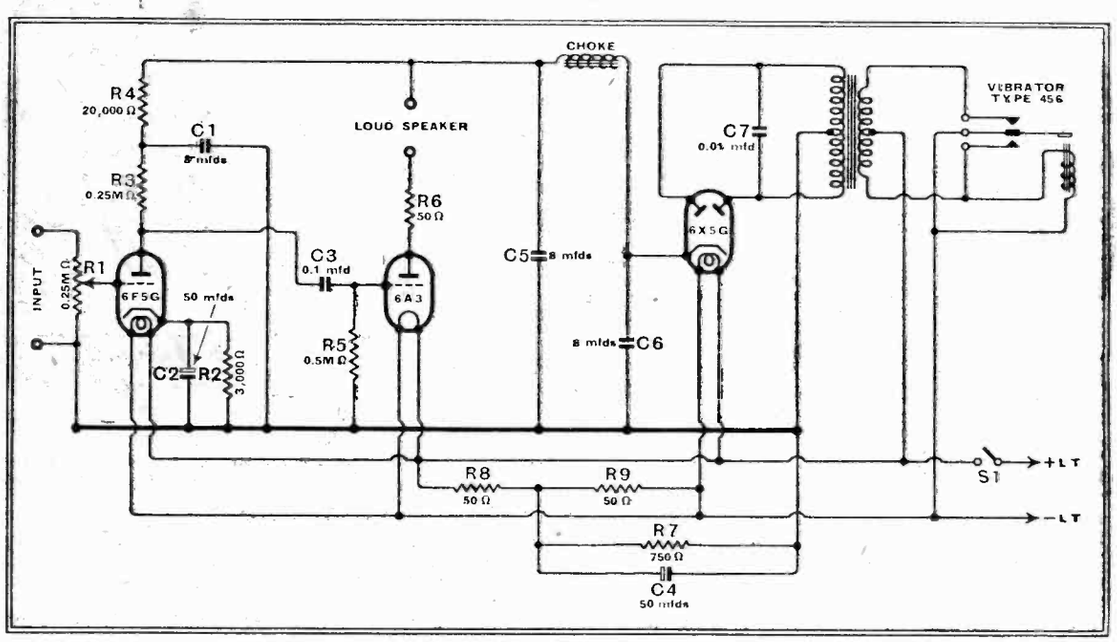
Fig. 3.—The complete circuit diagram of the amplifier and its HT equipment is shown here. An output of some 3 watts is obtained and the amplifier is run from a 6-volt car-type battery.

The complete circuit diagram takes the form shown in Fig. 3, and it will be seen that this is essentially a combination of Figs. 1 and 2, but including the modifications which have been discussed. At the input we have the usual volume control, R1, of 0.25 megohm, and the slider is taken to the grid of the 6F5 valve. It will be noticed that, in spite of the shortness of the leads at this point, they are screened, and the valve is provided with a valve screen. These precautions are necessary to avoid hum pick-up, and it is, of course, equally important to screen the external pick-up leads.

The 6F5 has an amplification factor of the order of 100, and when used with a 0.25-megohm resistance for R3, and a 0.5-megohm resistance for R5, an amplification of the order of sixty times is obtained. The use of a higher value for R5 is hardly permissible when the following valve is a power stage, for the valve-makers usually place a limit to the maximum grid circuit resistance which is considered safe. With R5 having a value of 0.5 megohm C3 can be 0.1 mfd., and will introduce a negligible loss of low frequencies. Decoupling is provided by a 20,000-ohm resistance, R4, in conjunction with an 8-mfd. condenser, C1. The bias for the 6F5 is obtained by means of the 3,000-ohm cathode resistance, R2, and it is shunted by a 50-mfd. electrolytic condenser, C2, in order to avoid negative feed-back effects in this circuit.

The Output Circuit

Turning now to the output valve, a 50-ohm resistance, R6, is connected in the anode circuit to suppress any tendency to parasitic oscillation, and grid bias is derived by means of R7, which is shunted by C4 to avoid feed-back. The output transformer is not included on the chassis, since it is intended that this be mounted with the speaker. The 6A3 requires a load impedance of 2,500 ohms, so that the ratio of the transformer should be chosen to give this value. The ratio is easily calculated by dividing 2,500 by the speech-coil impedance and taking the square root of the result. The transformer primary should have an inductance of some 10 H. at 60 mA, and the leakage inductance should, of course, be low.



Battery Quality Amplifier—

The two resistances, R8 and R9, which are connected across the LT supply, have a value of 50 ohms each. Their purpose is to provide a mid-point connection for the bias resistance. As far as the battery is concerned, the resistances appear in series and give a value of 100 ohms across the LT, so that they increase the drain on the battery by some 60mA. only. From the point of view of the bias circuit, however, they appear in parallel with a total value of 25 ohms, and increase the bias by 1½ volts. In view of the greater tolerance allowed on the bias resistance itself, however, we can ignore this small increase in bias.

Smoothing the HT Supply

The smoothing circuit consists of a choke with the usual 8-mfd. condensers, C5 and C6, and a full-wave indirectly heated rectifier is employed. The valve

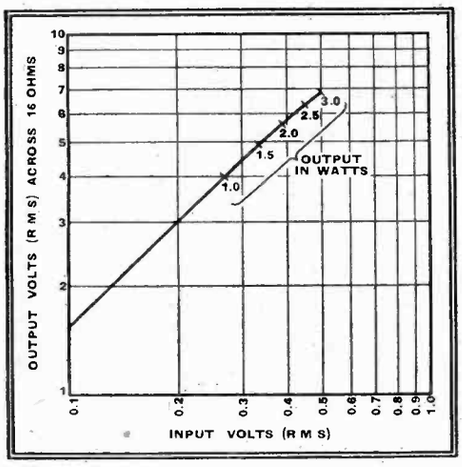


Fig. 4.—The input/output curve of the amplifier is sensibly straight for outputs up to 3 watts.

used must have no internal connection between heater and cathode, and the heater-cathode insulation must be adequate to withstand the full HT voltage. The valve used is the 6X5.

In the mechanical layout of the equipment care has been taken to keep the amplifier proper as far as possible from those parts of the HT equipment which are liable to cause hum. No changes in the layout can, therefore, be advised. Only one point of importance occurs in the construction, and this is in connection with the vibrator. The metal casing of this is necessarily joined to negative LT, but the chassis is at the potential of negative HT. There is thus some 45 volts between the vibrator and the chassis, and care must be taken to see that the vibrator does not contact with the chassis. The most likely point for such an accidental contact to occur is to the mounting screws of the vibrator valve-holder, and in the original amplifier countersunk screws were used for this holder and were deeply countersunk into the Paxolin. An alternative would be to drill a piece of thin Paxolin with four holes to slip over the base of the vibrator so that it comes between the vibrator and the holder.

On test the amplifier proved quite silent in operation with a normal pick-up connected. With the gain control at maximum and no pick-up connected to the input terminals slight traces of hum were evident, due to pick-up on the terminal itself, which is unscreened. With the volume control at a lower setting, however, such hum became inaudible, and with the volume control at maximum and a magnetic type of pick-up connected, the hum also became inaudible. That is due, of course, to the connection of a moderate impedance across the terminals.

The only likely case where hum might be found, and this only in very small degree, is when the volume control is at maximum and a piezo-electric pick-up is used. This is not likely to be a serious matter, however, for in the first place the hum is small, and in the second the output of this type of pick-up is so great that no one is likely to want to use the amplifier with the gain control at maximum. With the control turned down for normal volume the hum is negligible. It may be remarked that with the magnetic type of pick-up the amplifier should not be placed in such relation to the pick-up that the transformer is near the pick-up head, otherwise serious hum may be induced into the windings of the pick-up. This, of course, applies with equal force to an ordinary AC amplifier.

On test the input-output curve shown in Fig. 4 was obtained, and it can be seen that this is nearly straight for outputs up to 3 watts and that for this output an input of 0.49 volt RMS is needed. This is about half the average output of a magnetic pick-up and it is considerably lower than that obtainable from the piezo-electric type. The amplifier was actually tested with a needle armature pick-up of the type rated for an output of about 0.25 volt only and, with the volume control at maximum, ample volume for most purposes was secured with freedom from hum. The over-all frequency response characteristic is shown in Fig. 5, and this includes the output transformer. The component used was actually the Universal Output Transformer connected for the 12.5:1 ratio with a secondary load of 16 ohms. The over-all drop at 10,000 c/s is only 3.25 db. and at 20 c/s, 1.6 db.

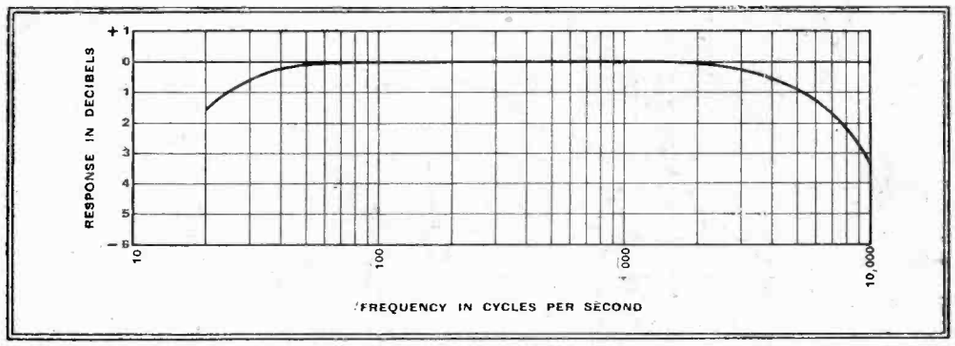
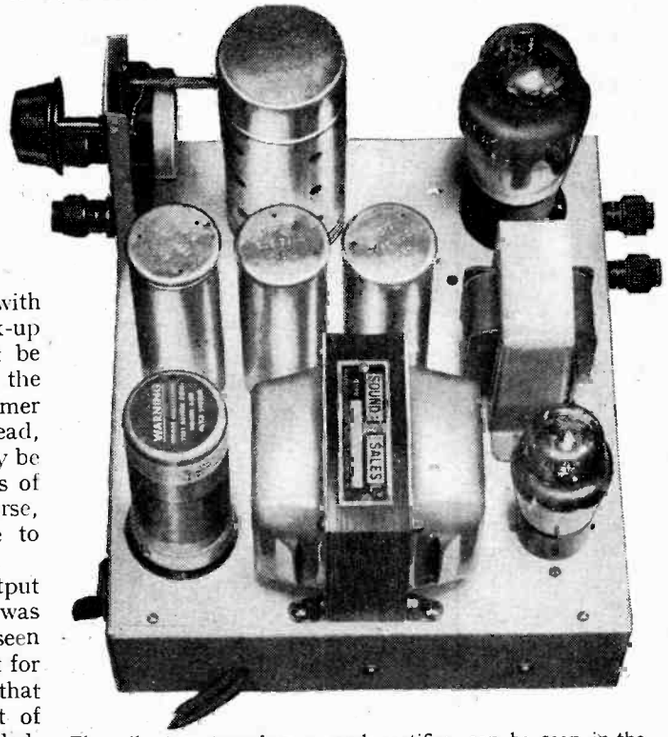


Fig. 5.—This curve shows the overall frequency response, including the output transformer.

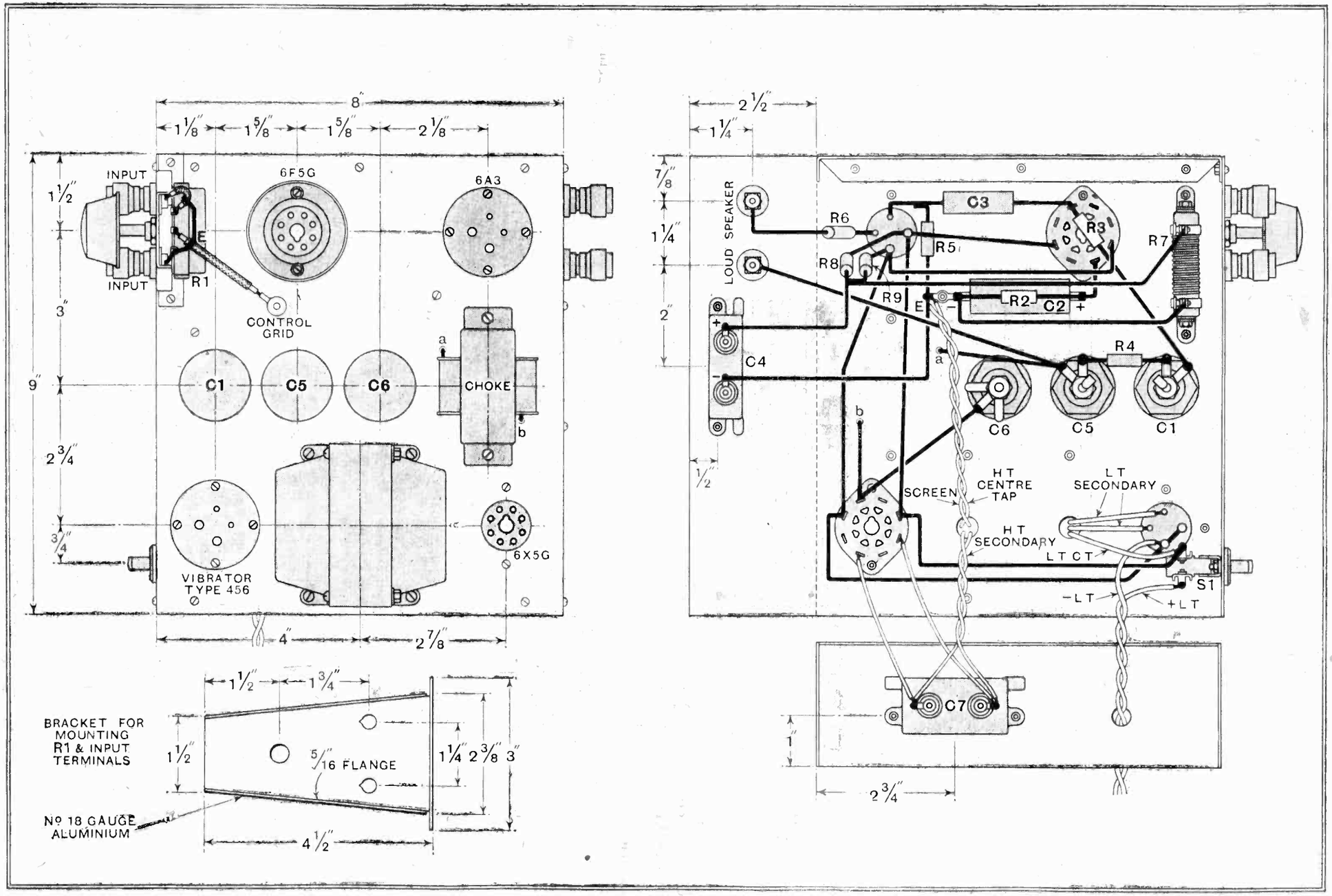
The Battery

For the operation of the amplifier a 6-volt battery of the car type is recommended, and naturally a battery of large capacity should be chosen if a reasonable interval between re-charging is to be obtained. Nothing smaller than a 30 ampere-hour battery should be used and, in general, one of double this size is advisable. The number of hours of operation between charging can be calculated approximately by dividing the capacity of the battery by the current taken from it. In this case the current is roughly 5 amps.,



The vibrator, transformer and rectifier can be seen in the front of this photograph, with the smoothing equipment in the centre and the amplifier proper at the back.

CONSTRUCTION, ASSEMBLY AND WIRING DETAILS OF THE BATTERY QUALITY AMPLIFIER



It should be noted that the "earthy" input terminal is earthed to the bracket by using a metal washer beneath the fixing nut. The other input terminal is, of course, provided with an insulating washer.

Battery Quality Amplifier—

so that a 60 ampere-hour battery may be expected to give some twelve hours' operation, that is, it will have to be charged about once a week if the amplifier is used nearly two hours a day. Most users, therefore, will find it more convenient to have two batteries, so that one can be used while the other is being charged. In choosing batteries care should be taken to make sure that the figure quoted for the capacity is the actual capacity and is not based on the intermittent rating. The capacity of the battery on the intermittent rating is usually given as double that on the actual rating. The latter figure is the one obtained on continuous discharge.

On the Short Waves

THE writer had the good fortune on Monday, May 16th, to be given a very impressive demonstration of the flourishing condition of "56 Mc/s" in Surrey by G5MA, of Ashtead. The apparatus used by G5MA is quite simple and straightforward, but very well engineered, and comprises first—and in my opinion a great deal of 5MA's success on 56 Mc/s may be attributed to this—a steerable horizontal dipole, some 35ft. high, and fed with cab-tyre flex. Secondly, the transmitter used is a 6L6 tritet with 20-metre crystal doubling to 10 metres, followed by a 6N7 double-triode arranged with the grids driven in push-pull and the plates paralleled. This stage is plate-modulated, a flashlamp bulb in the outgoing feeder-line indicating a high degree of modulation.

Finally, a HRO one-ten super-regenerative receiver is used, which is also connected to the steerable dipole *via* a "send-receive" switch.

A most striking point about the whole equipment was the excellent minima given by the dipole when the transmitting station was radiating horizontally polarised waves, which was the case for the following stations which we worked on the evening in question: G8IX Woking, G2MR (also uses a steerable dipole), G3CU Tooting, and G2MC of Pinner, Mdsx.

One station, however, failed to show a minimum, G6VA of Thornton Heath, and in this case it was found that a vertical transmitting array was in use. Since stations were worked from all points of the compass, the great advantage of being able to steer the array for maximum pick-up was soon evident, since this operation automatically orientates the aerial for transmission.

Finally, the performance of the HRO one-ten was impressive, too, all signals being QSA5 R7 to R9, including G2MC Pinner, who produced, in fact, the best all-round signal of the evening.

The signal-to-noise ratio in all cases was such that no increase in power on the part of the transmitter would have effected a material improvement in the readability, but in the absence of a signal, of course, the "super-regen." noise was audible.

The equipment referred to above is quite small and portable, and, since 6.3-volt valves are used throughout is readily adaptable for car use.

Taken in this manner to high ground such as Epsom Downs, one would expect considerable distances to be covered with land-line reliability.

For those who are interested in super-regenerative receivers I recommend a paper by Frick in the January, 1938, issue of *The Proceedings of the Institute of Radio Engineers*. This paper is of the type which appeals not only to the mathematically inclined reader but also to the practical designer.

Before leaving the subject of 56 Mc/s I should like to mention that the centre driving point impedance of three half-waves in line is approximately 300 ohms, and that a quarter-wave line having an impedance of 170 ohms. i.e., four wires on 1in. spacers, should be used as a matching section if a twisted flex main feeder is to be used.

Alternatively, a four-wire open wire-line on 4in. spacers may be used throughout.

Short-wave conditions on the normal frequencies have not been too good recently, quite apart from the severe ionosphere storm on May 11th.

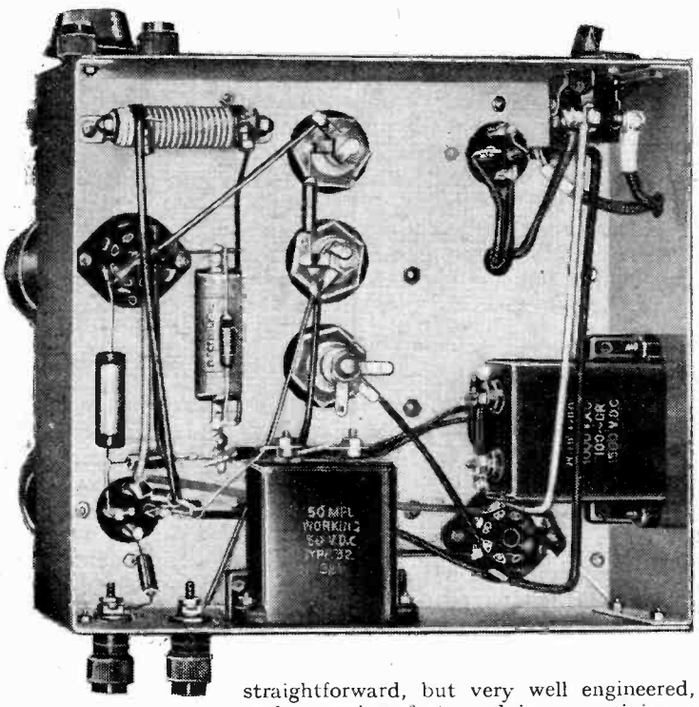
This storm, it is worth noting, occurred 26 days after that of April 16th, and was associated with the same sunspot group on its second rotation.

Recent measurements of the critical frequency of the F2 layer show an average of 8 Mc/s at noon compared with a figure of greater than 11 Mc/s in February.

This fall in the F2 region ionisation, coupled with an increase in the E region level due to increasing daylight, results in the well-known weakness of distant 14 Mc/s signals until after nightfall.

Even powerful stations such as W2XAD on 15.33 Mc/s are not now peaking until late in the evening, and for early evening broadcast reception from the U.S.A. a frequency in the 21 Mc/s band would probably give better results. Even W3XAL on 17.78 Mc/s does not perform as well as one would expect, and in any case a great deal of its programme time is now taken up with announcements and news in foreign languages.

ETHACOMBER.



The wiring is carried out on the underside of the chassis and is quite straightforward.

LIST OF THE PARTS USED IN BUILDING THE AMPLIFIER

1 Vibrator — **Rocke International 456**

1 Vibrator transformer, 6 volts — **Sound Sales V6/300**

1 Choke, 10H., 60 mA., 320 ohms, **Ch** — **Bulgin LF18S**

Fixed condensers:

- 1 0.1 mfd., tubular, **C3** — **T.C.C. 341**
- 1 0.01 mfd., 1,000 volts AC working, 100 c/s, **C7** — **T.C.C.**
- 1 50 mfds., 12 volts, **C2** — **T.C.C. "FT"**
- 1 50 mfds., 50 volts, **C4** — **T.C.C. 521**
- 3 8 mfds., 440 volts, **C1, C5, C6** — **T.C.C. 802**

Resistances:

- 3 50 ohms, ½ watt, **R6, R8, R9** — **Erie**
- 1 3,000 ohms, ½ watt, **R2** — **Erie**
- 1 20,000 ohms, ½ watt, **R4** — **Erie**
- 1 250,000 ohms, ½ watt, **R3** — **Erie**
- 1 500,000 ohms, ½ watt, **R5** — **Erie**
- 1 750 ohms, 20 watts, **R7** — **Bulgin PR4**

1 Potentiometer, 250,000 ohms, tapered, **R1** — **Reliance SG**

2 Valve holders, octal, American type — **Premier Supply Stores**

2 Valve holders, 4-pin, American type — **Premier Supply Stores**

1 Switch, SP, on-off, 1,250-watt, **S1** — **Claude Lyons "BAT" 056**

4 Terminals, ebonite shrouded, **PU(2), LS(2)** — **Belling-Lee "B"**

1 Plug top valve connector — **Belling-Lee 1175**

1 Octal valve screen — **B.T.S.**

2 Crocodile clips — **Goltone R10/50**

1 Yard twin insulated cable, 110/36 — **Lewcos**

1 Length screened sleeving — **Goltone**

Chassis — **B.T.S.**

Miscellaneous: — **Peto-Scott**

2 lengths systoflex, 2 ozs. No. 18 tinned copper wire, etc.

Screws: 4 ¾in. 6BA C/sk., 24 ¼in. 6BA R/hd., 8 ½in. 4BA R/hd., all with nuts and washers.

Valves:

1 6X5G, 1 6F5G, 1 6A3 — **Premier Supply Stores**

PUSH-BUTTON ADAPTORS

For the Conversion of Existing Sets

DETAILS of the American-made Meissner Push-button Tuners, designed for either remote control of, or direct connection to, an existing receiver, have been sent to us by Anglo American Radio, Albion House, New Oxford Street, London, W.C.1. The units provide for the automatic selection of any one of seven chosen stations, and there is an extra button for disconnecting the automatic system.

The Meissner tuner comprises essentially a frequency changer, and perhaps its most interesting feature is the use of "permeability trimming" for the aerial and oscillator coils required for each station. The iron-dust cores for each pair of coils are mounted in a common spindle, and are moved together by turning a single trimming screw.

UNBIASED

By FREE GRID

Wireless as a Maritime Menace

WE hear a lot of loose talk about the value of wireless as a means of saving life at sea, but there is another side of the picture concerning which newspapers are discreetly silent. So far from wireless always constituting a measure of safety at sea, it is sometimes a menace to life and property, and many a proud ship has gone to its doom as a result of its baneful influence. I write somewhat feelingly on this point as I am still somewhat shaky as the result of nearly coming to a watery end while enjoying the hospitality of a friend on board his yacht during the past fortnight.

When I arrived at the port of embarkation in response to the invitation I was painfully shocked to discover that no provision whatsoever had been made on board for maintaining touch with the shore by wireless, either from a safety or an entertainment point of view, and I sought to remedy this deficiency in some measure by hiring a portable receiver from a local dealer. We had perfect weather as we set sail from the port of Chichester, a well-known haunt of would-be seafaring men, and set a course for Ushant, it being our intention to visit some of the delightful little ports situated in the neighbourhood of the Loire Estuary.

The weather was so fine that I camped out on deck, using my portable for the dual purpose of a pillow and as a means of lulling me to sleep by means of Offenbach's famous cradle song which a certain amateur transmitter is so fond of churning out again and again as a test record.

"... hailed a few of the natives."

It continued fine all through the following day, and towards the evening we began to look out hopefully for the friendly beam of the powerful Ushant lighthouse.

We were a little disappointed at not sighting it before nightfall, but when the following day dawned and still no sign of Ushant I, personally, began to get a little anxious. My friend reassured me, however, with some story about the probability that we had got into a contrary current which had unknowingly decimated our speed.

Night came on again, as it usually does, and I began to get thoroughly alarmed, and even my friend fell to perusing a tattered school atlas which served him for a chart. Sextant or other navigational instruments he had none, and so we were unable to determine our position. Some attempts on my part at DF with the frame aerial of the portable proved a complete failure, as, if my results were to be believed, the sun was sinking in the East. However, remembering the case of Columbus, whose inner conviction of eventually sighting the Ambrose Light served him instead of navigation, we took heart again.

I must confess, however, that I was heartily relieved a couple of days later when a cry of "land-ho!" roused me from my slumbers, and a comparatively short time afterwards found us sailing happily into harbour. My friend hailed a few of the natives, but apparently his French was not of the best, and only brought a puzzled look to their faces. To my surprise my own efforts were no more effective, but the recollection that many of the peasants of Brittany speak a dialect akin to Welsh, and are totally ignorant of French, put us in a good humour again. It was not until some time later that it struck us what a large number of advertising posters there were in the Portuguese language, and on enquiry we were amazed to find that we were in the Azores. As soon as I picked up my portable in disgust, preparatory to boarding the mail steamer home, the reason became apparent, for as I did so the compass swung round several points to the southward.

I suppose that the moral is that on a small yacht with limited space, portable receivers, if carried, should be fitted with the old-fashioned type of moving-iron loud speaker rather than the moving-coil type, with its powerful magnet system, or, at any rate, should not be stood near the compass. So far as I am concerned, yachting is now definitely off my list of amusements. I prefer pastimes in which more precise scientific methods are employed.

An Old Spanish Custom

I HAVE just been reading a long and interesting screed from a reader in which he requests certain information which, for a wonder, is not of a technical nature. Indeed, the question is rather a personal one, since he demands to know why it is that I very rarely remove my hat, no matter what function I am attending, and no matter whether I am indoors or out.

I very rarely remove my hat.

The reason for my adopting this custom had its origin in a country which we are apt to associate solely with haughty Hidalgos and languishing Señoritas. This hat business, is, in fact, an old Spanish custom, but I have varied it considerably to suit my own ends.

As visitors to Spain will, of course, know, every Spaniard possesses two hats, one of which he hangs up permanently on a peg in his office while the other he wears when he is out and keeps discreetly in his desk when he is actually in the office, which is seldom. He is thus able to slip out to the "local" to sip his morning glass of Aguardiente without anybody in the office being aware of it since, of course, the presence of his hat on its peg is taken as *prima facie* evidence that he is somewhere about the building. Nobody is really deceived by it, since everybody does the same thing. Nevertheless, the habit persists and is, of course, the origin of the phrase about an old Spanish custom.

We cannot sniff disdainfully at the Spaniards, since there are many customs of a like nature in this country which, although deceiving nobody, are religiously carried out. For one example, I may point to the old Victorian custom, still flourishing strongly, of a girl replying "this is so sudden," to a proposal of marriage just as though everybody didn't know that she and her mother had engineered the whole business.

As for my own habit of constant hat wearing, it is merely a variation of this custom, the reason for the variation being stern necessity since I am unable to afford two hats. The fact of my always wearing my hat and carrying all the remainder of my wardrobe, including my umbrella, on my back, means that Mrs. Free Grid is never able to be sure whether I am in or out, which is a great advantage on many occasions.

I trust that this simple explanation of an apparent mental abnormality on my part will clear up any misunderstanding that may have arisen. If, of course, I could afford two hats I would certainly prefer to make a change occasionally and in the event, therefore, of any of you possessing an old hat which you have discarded, I should be extremely grateful to receive it.

Television Topics

APERTURE EFFECTS AND THE TELEVISION RECEIVER

IN all experimental television work a great deal of time is spent arguing the merits of various amplifier arrangements and their characteristics, and unless care is taken the enthusiast will be misled by his instinctive regard for wide band-width performance and other features such as flat frequency response. Before reaching absurdly large dimensions large band-width can become quite a wolf in sheep's clothing to the unwary designer, and it is useful to review the usual method of estimating high-frequency requirements in a television receiver in terms of picture detail. The following argument seems quite sound and depends on the sharpness with which a sudden transition from black to white, or vice versa, is depicted on the receiver's screen. Unfortunately, a very disappointing result is obtained when the argument is followed by a practical test, so that unless further investigation is made the designer is left in a quandary.

In a 10in. × 8in. picture there are, roughly, 400 lines down the screen, or 50 per inch, thus setting a limit to the vertical detail, for a transition finer than 1/50th inch cannot be depicted. Stroboscopic effects with moving subject matter will further limit the definition with interlaced scanning, but the argument will continue by translating this 1/50th inch into the equivalent definition of detail horizontally along the lines.

The 400 lines are traced out in 1/25th second, giving a line-tracing velocity of 10in. in 100 microseconds, from which it follows that any element of picture detail occupying 1/50th inch will be represented by a signal of 1/5 microsecond duration.

It thus appears that any receiver capable of depicting a black to white transition of this sharpness will require several megacycles of band-width, in fact, much more than is available with the present 3.5 Mc/s separation between sound and vision carriers.

Size of Scanning Spot

When compared with normal viewing distances this microscopic examination of picture detail seems absurd; yet, when carried further, one of the most important factors in control of definition is revealed. This is the finite size and shape of the light-spot which traces out the picture. In other words, although the significance of the time occupied by an element of picture detail is easily translatable into terms of high-frequency band-width, the fact that the picture is traced out by a light-spot which has a size comparable with that of the picture detail seriously modifies the argument by introducing the challenge to fit a round peg into a square hole. The diameter of the light spot in the CR tube is of the order of 1/75th inch. It depends too much on brilliancy and electron beam current to allow a more exact statement, while it also has another feature which is very important in understanding its performance. If light intensity is plotted along a diameter of the spot the contour of brilliancy across the spot will probably look like a broad resonance curve, thus giving an added encumbrance to the problem.

A useful way to realise the effect of these properties of the light spot is to examine the modification produced in an ideal case. Thus Fig. 1 depicts the effects of scanning across a black and white pattern having originally a transition time of 1/5th microsecond. Fig. 1a is the wave-form of the voltage modulating the brilliancy of the spot as it travels across the screen; while the wave-form of light output is shown in 1b.

A very simple method of appreciating this aperture effect is by sliding a penny across any suitable square pattern on this page and mentally assessing the area of the square covered at any instant as the coin slides across. When it is remembered that very few tubes maintain so fine a spot as 1/75th inch, it will be realised that a practical arrangement must have considerable correction for this aperture effect before adequate definition is obtained, for quite apart from any consideration of the sharpness of the signal wave-form supplied by the receiver the spot will always introduce this rounding-off the light output wave-form.

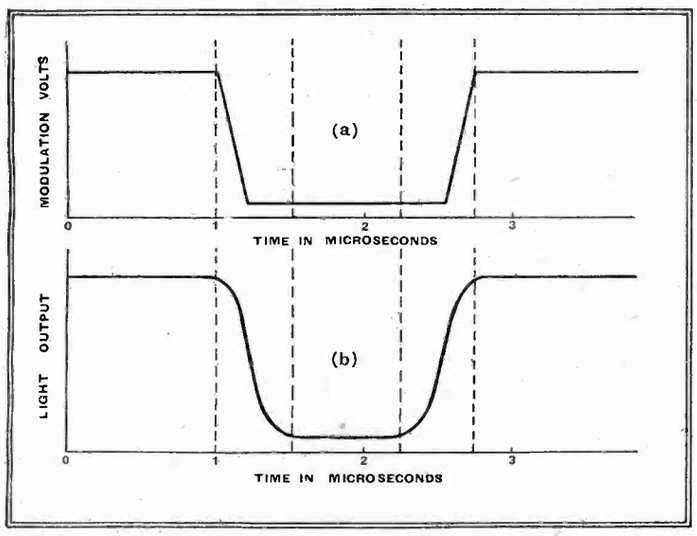


Fig. 1.—The effects of aperture distortion are illustrated in these curves; (a) shows the waveform of the voltage modulating the electron stream, and (b) the corresponding variation in light output. For clarity, the magnitude of the effect is exaggerated.

Fortunately, the correction required is simply a matter of shaping the response characteristic so that those high frequencies which correspond to the apparent cut-off in the light output wave-form are suitably over-amplified. It is of no use to adjust the circuits so that the characteristic rises to a peak at very high frequencies (3 to 5 Mc/s), a procedure which might at first sight seem desirable; for the cut-off point represented by the aperture effect is of the order of 2 Mc/s and so still leaves a crevasse there in the true response curve.

Checking Resolution

The experimental set-up for the measurement of the effect is rather complicated, but the experimenter can obtain some indication of the resolution of the light spot by applying to the CR tube grid a voltage from a calibrated RF oscillator, meanwhile synchronising the scanning to a signal from the vision transmitter. Viewing a small part of the screen through a hole in an opaque card will enable the dot-formation caused by the oscillator, to be seen with freedom from stroboscopic patterns, and by raising the oscillator frequency until the dots are indistinguishable the aperture effect can be measured in terms of visible detail. This is not quite the same result as would be obtained with a suitable square wave-form generator, as the oscillator will modulate the tube with a sine-wave voltage instead of that shown in Fig. 1. This method, therefore, should only be used as a test for the resolution of the CR tube itself, and not in conjunction with any vision-frequency amplifier with which the receiver may normally operate. A suitable circuit for the experiment is shown in Fig. 2. The oscillator should be capable of maintaining about 5V. RMS with a frequency range of 800 kc/s to 3.0 Mc/s.

The unsuitability of the sine-wave source, if used to estimate overall performance via the receiving circuits, is due to

Television Topics—

the difference in performance of the amplifying circuits when dealing with this recurrent type of voltage waveform and when dealing with occasional transients. The former may be dealt with quite faithfully as to the shape of the output waveform, even over a range of frequencies which covers those contained in the transient type of signal and yet the square wave of the transient cannot be correctly amplified. Translating this into terms of picture detail gives the analogy of a receiver which is capable of showing, say, a row of very closely spaced railings in a manner indicating good high-frequency performance and yet it fails to give a clear-cut outline of a house or chimney stack.

An examination of the simplest vision-frequency amplifier

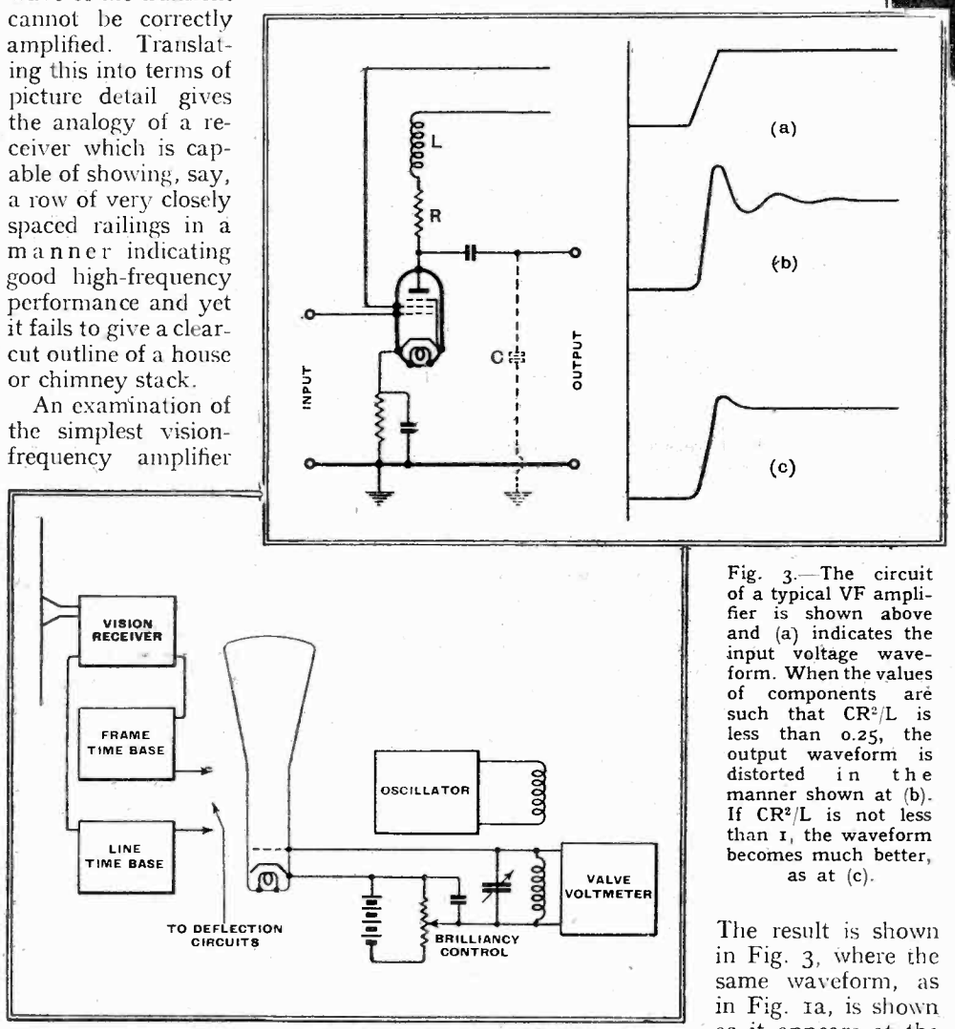


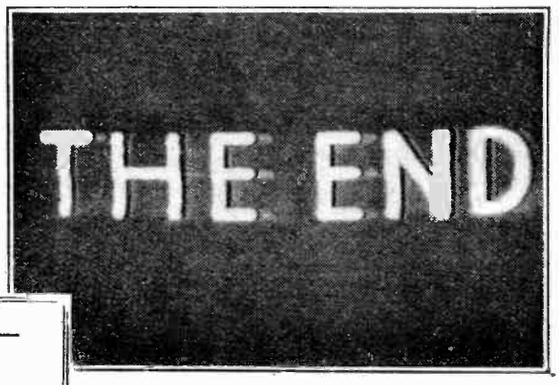
Fig. 2.—An experimental layout for determining the response of a CR tube to high modulation frequencies.

Fig. 3.—The circuit of a typical VF amplifier is shown above and (a) indicates the input voltage waveform. When the values of components are such that CR^2/L is less than 0.25, the output waveform is distorted in the manner shown at (b). If CR^2/L is not less than 1, the waveform becomes much better, as at (c).

will make the mechanism of this defect clear. The usual coupling between stages consists of a resistance and inductance in series, so arranged that the inductance compensates for the falling frequency characteristic produced by the anode-E and grid-E capacities of the system. For a normally corrected stage, where the rise at the high-frequency end of the characteristic is not greater than 2 to 3 db,* the proportions of L, C and R are such that the tuned circuit so formed resonates at a fairly high frequency compared with that at which correction for droop is obtained and, more important still, it is well damped as regards oscillatory currents at the resonant frequency.

In order to raise the gain at high frequencies the ratio of resistance to inductance is lowered, and this, carried to extremes, results in a circuit which has too low a decrement to allow correct amplification of a transient type of waveform, for the shock-excitation of the circuit by the transient will cause it to deliver an oscillatory voltage after the signal has ended. The result is shown in Fig. 3, where the same waveform, as in Fig. 1a, is shown as it appears at the input and output of the amplifier. On the receiver screen this effect gives rise to short flares at the edges of any boundary in the scene or in extreme cases may cause a series of multiple outlines. There is a great deal of difference between a receiver with limited band-width and exaggerated HF boost and one of ample band-width and aperture correction. In the first case, the limited band-width results in too low a frequency at which any of the "ringing" effects of Fig. 3 may occur, so that any abnormal transient effects are very easily noticed. Due to the relatively long time occupied by one cycle of the forced oscillation, very little rise in the frequency characteristic can be tolerated, yet, owing to the addition of restricted band-width to a system having the aperture effect it is even more necessary to apply correction in the form of extra HF gain; it is, therefore, a very difficult matter to reach adequate definition in such circumstances. As the question of correction by HF boost is determined by the band-width on one hand and the spot size on the other it will be seen that, up to a certain limit, the fullest use of the highest frequency available for aperture correction gives a very rapid increase of definition with band-width, and then reaches a limit which, with the present transmissions, tube spot sizes, etc., appears to be in the region of 2.25 Mc/s.

* *E.g.*: Where R is given half the reactance of C at the frequency required and L has a reactance equal to R. (R. C. A. method.)



The visible effect of the distortion shown in Fig. 3B can be seen in this photograph. The right-hand edge of a white object is followed by a black line and then by a white line.

Principles of Radio. Keith Henney. Third edition. Pp. 495+xii. Chapman and Hall, Ltd., 11, Henrietta Street, Strand, London, W.C.2. Price 17s. 6d. net.

THIS is the third edition of an elementary textbook first published about eight years ago and thoroughly proved by the test of time. Considerable changes have been made in the present edition to bring the text up to date, some parts being rewritten and some new material added. In view of the marked advance in the science during the past three or four years, the revision is perhaps not quite as extensive as one might have anticipated.

Nevertheless, the book is a very valuable one in its class, and is highly recommended. It is designed for use by those making a serious study of the principles of radio communication and requiring a sound textbook in which the treatment is of a non-mathematical nature. Lucid explanation is a notable feature.

The first six chapters are devoted to fundamentals and principles of electric circuits, and the remaining thirteen chapters to the application of these principles to radio transmission and reception. Many worked examples are given, and problems are set in most chapters for the student himself to solve.

The clear and simple explanations make the book particularly suitable for those studying privately, and from this point of view answers to numerical questions could have been included with advantage.

O. P.

For Camera Learners

AN exposure chart for beginners in photography, printed in colours and embodying a new and ingenious idea, is an attractive free gift with every issue of *The Amateur Photographer* Novices Number, dated May 25th.

NEWS OF THE WEEK

SCHOOL DEAF-AID

An Experiment at Leeds

THE City of Leeds School for Blind and Deaf has recently been equipped with a special system of hearing aid. The chief feature of this apparatus is that the children live in a complete "sound" atmosphere while using it. Each of the twelve children wear specially constructed adjustable-reed-type headphones with, on the table around which they sit, a microphone by means of which they can hear their own and other children's voices.

A distribution panel enables the teacher to control the tone for each individual child. The teacher has a microphone at the desk and one at the blackboard, and the output from these can be superimposed on the radio programme or whilst a gramophone record is being played, thereby enabling instruction to be given on the programme or recording.

The headmaster states that: "The apparatus is in advance of anything that I have seen so far. The children using the apparatus have very little hearing as measured by audiometer, but they are reacting to the treatment splendidly."

MOBILE TRANSMITTER FOR THE DERBY

APART from the Boat Race, the B.B.C. very rarely uses a mobile transmitter for outside broadcasts. The experiment will be tried, however, on Derby Day, when a van equipped with a replica of the short-wave transmitter used on the *Magician* will travel along the Epsom road with the general traffic stream to pick up and relay the sound of the cavalcade. Barring accidents, John Snagge and Richard North, who will be travelling on the van, will get to the starter's box just in time for the race. Their description of the start will be relayed on about 90 metres to a reception point on the mound stand at Tattenham Corner, whence the signals will be conveyed by line to the control point in the grand stand.

If the mobile transmitter fails to reach the starting point in time, Thomas Woodroffe will give a commentary, aided by a race reader, from the grand stand.

The experimental broadcast from the road is to begin at 12.15 p.m. in the National programme, and the transmission from the Grand Stand will be relayed at 2.50 p.m.

THE R.A.F. AT HOME

Opportunity to Broadcast to Formations in Flight

IN view of the discontinuance of the Hendon air display, very extensive facilities are being given throughout the country for the work of the R.A.F. to be seen in close-up on Empire Air Day, May 28th.

At Northolt, and possibly at other Royal Air Force stations, provision will be made for visitors to actually broadcast instructions to aeroplane formations flying overhead. The Wireless and Electrical School at Cranwell will be open to inspection, and aircraft wireless equipment will be on view in most places.

Visitors to Service aerodromes will find a useful guide in the special R.A.F. number of our sister journal *Flight*, which is on sale to-day.

TELEVISION CHIEF VISITS AMERICA

MR. D. H. MUNRO, television productions manager at Alexandra Palace, sailed on the *Queen Mary* last week to spend a busman's holiday in the States. During his eight-weeks' tour he will study the programme methods of the N.B.C. and C.B.S. television systems.

"D. H.," as he is popularly known at Alexandra Palace where he controls all the "machinery" of production, began his B.B.C. career at the Aberdeen station before coming to Savoy Hill as studio executive.

TELEVISING THE TEST MATCHES

TWO cameras will be mounted on the stand at the Nursery End of Lord's Cricket Ground to show the second Test Match beginning on Friday, June 24th. Television transmissions of the progress of the play are to be given in the mornings from 11.30-12.30, and in the afternoons from 2.30-3.30 and 3.50-5. A third camera, with a telephoto lens, mounted on the roof of a nearby tavern will give close-up shots of the batsmen and bowlers.

Prior to televising the Test Match, O.B.s will be carried out at Wimbledon during the preliminary matches in the International Tournament on June 20th and 21st. The cameras will return to Wimbledon for the semi-finals and final on the Centre Court on June 30th and July 1st and 2nd.

MOVE FOR R.N. WIRELESS

THE wireless research department of the Royal Navy has been working under steadily increasing difficulties in its cramped quarters at the Portsmouth Barracks. The department designs the Navy's W/T sets, and has among other things produced the apparatus for the Queen Bee wireless-controlled aeroplane. Within a year or two, however, the department will have spacious new accommodation in the Royal Naval Signal Schools which the Admiralty is building north of the city.

CHILDREN with very little hearing being taught by the specially constructed deaf-aid apparatus installed at the Leeds School for Blind and Deaf. In the foreground is the microphone by which they hear their own and others' voices, and in front of each child is a volume control.

A CONDUCTOR WHO UNDERSTANDS

THE WIRELESS WORLD understands that negotiations are afoot to bring on to the B.B.C. pay roll Mr. Louis Levy, the well-known conductor who has specialised in orchestral recording on film sound tracks for the Gaumont British Picture Corporation. He has been offered a part-time contract to conduct certain programmes in the Variety Department for a period of twelve months from July 4th next.

His wealth of experience would be an undoubted asset to broadcasting, for too often it happens that the conductor at the microphone has only the haziest notions of the technical problems involved, with the result that fortissimo passages are forced up to a point at which the balance and control engineer must reduce gain drastically, thereby ruining the artistic effect. Pianissimo is also frequently handled without regard to the limits of the microphones and amplifiers.

B.B.C. IN CARDIFF

RUMOURS have been current in Cardiff during the past week that the B.B.C. has chosen a site on the Bute Estate for new studio premises. This is not quite true. The happy financial position which has enabled a large part of the Bute property to change hands for a mere few million pounds does not apply to the B.B.C., which already has more than sufficient demands on its comparatively limited exchequer for new premises in other parts of the British Isles. While up-to-date studios and offices will eventually be required in Wales no move is at present being made to select a site. But so much of Cardiff is Bute Estate, intelligent anticipation is a good guide to the ultimate choice.

GERMANY'S 22-HOUR SERVICE

FOR the past few weeks all the German stations have remained on the air, relaying the Frankfurt-Stuttgart music programme for late-night listeners, until 3 a.m. (B.S.T.). Formerly, these concerts, which are interspersed with foreign language news bulletins, were broadcast from Frankfurt and Stuttgart only until 2 a.m. Three of the German stations which start at 5 a.m. are, therefore, giving a 22-hour service daily.

These late-night broadcasts

News of the Week—

are, however, an experiment until sufficient data has been collected regarding the response of foreign listeners.

RADIO AND AIRWAYS

THE intricate organisation at modern marine airports is illustrated by the fact that Imperial Airways has installed ultra-short-wave apparatus on the launches which act as tenders to their flying boats at the shore control stations in order to send last-minute instructions to the tenders when at a distance from the shore.

Echo-sounding apparatus is also installed on some of the motor launches to facilitate the location of submerged obstructions when patrolling waters prior to the alighting of a flying boat.

INTERFERENCE SUPPRESSION COURSE

BELLING and Lee are running an instruction course on interference suppression at Enfield, Middlesex, from June 9th to the 24th inclusive. The period of the course is two full working days from 9 a.m., and the dates are June 9-10, 13-14, 16-17, 20-21 and 23-24; there are, however, no vacancies for the second period and only a few for the first. The company has secured a list of suitable lodgings in the district at prices averaging 6s. 6d. per day, inclusive of full board.

This opportunity of studying suppression under the guidance of such experts in this field as Belling and Lee should not be missed by service engineers and dealers, who should communicate with the company at once.

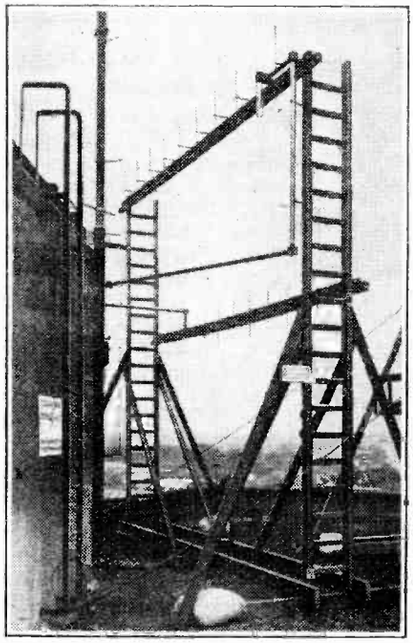
MOBILE TALKIES IN INDIA

THE education and entertainment of the people in rural districts of India presents a difficult problem, particularly as only 7 per cent. of her 353,000,000 inhabitants can read or write. Although the Government has financed a three-year rural broadcasting plan in Delhi Province to provide communal sets in villages of over 600 inhabitants, in other provinces it is, so far, left to private enterprise to meet the villagers' need of entertainment.

In the Bengal Province the Tata Iron and Steel Company, of Jamshedpur, which employs some 20,000 people living in small villages, has recently put into use a British Thomson-Houston sound-film equipment housed in a motor van with an independent generator plant to supply the necessary power. Large permanent concrete erections painted white are used as screens, and weekly shows attracting many thousands are given at each village.

U.S.W. TELEPHONE SERVICE

AN experimental one-metre wireless telephone connection between Eindhoven and Tilburg has been installed by Philips in collaboration with the Dutch National Post, Telephone and Telegraph Service. The Yagi type of aerial, which has an amplification of 3.5 compared with a single dipole, is used for the transmitters and receivers at both ends. The aerials, consisting of a number of parallel rods set up in one plane, include an energised radiator, a reflector and a series of directors.



YAGI transmitting and receiving aerials on the roof of the Philips Works at Eindhoven.

It has been found by experiment that, when working on such a short wavelength, an imaginary line drawn between the transmitting and receiving aerials must be 10 metres above the tops of the trees and buildings in its path. Triode transmitters and autodyne superhet receivers are used at both stations.

FROM ALL QUARTERS

Television Prospects

SIR STEPHEN TALLENTS, B.B.C. Controller of Public Relations, referring to television when speaking at Bristol last week, said: "You all hope that it will be in Bristol to-morrow, but you must remember that this fascinating entertainment is exceedingly expensive, and we all feel we must try it out thoroughly in London before we go to the expense of extending it. It is not just a whim on the part of the B.B.C., but the advice of the Television Advisory Committee."

New Research Laboratory

A £5,000 endowment from a large benevolent society in Denmark has provided for the inauguration of a research laboratory, which will conduct scientific investigations into all matters concerned with electro-acoustics, sound-proofing, studio technique, and so on. The new research body will be a branch of the Telephone and Telegraph Laboratory of the Copenhagen Technical College.

Cuts in Romanian Licence Fees

THE licence fee due for a valve wireless receiver operated in rural areas of Romania has been reduced from 600 to 300 lei (approximately 9 shillings), and the amount due for a crystal set is only 120 lei.

Transmitters on Trains

A NUMBER of trains in Sweden are to be experimentally fitted with USW wireless transmitters, which will enable adequate warning of approach to be given at the numerous open level crossings. The practicability of the system will be tried out with the co-operation of cars equipped with suitable receivers, and then with fixed receivers working PA speakers on the crossings.

Indian Night Wave

BOMBAY (VUB2) changed its night wavelength on May 16th from 90.8 metres to 61 metres. Transmissions on this wavelength are made from 5.30-11 p.m. local time (1-6.30 p.m. B.S.T.).

Mr. King Admonishes C.B.C.

IT is reported by a *Times* correspondent in Ottawa that the Prime Minister, Mr. Mackenzie King, has directed stern criticism towards the Canadian Broadcasting Corporation for permitting a private individual to direct defamatory speeches against the British Government over its networks.

Sound Only

IT is of particular interest, in view of the broadcasts of the Toscanini concerts on the television sound wavelength, to recall that when the Cossor console television receivers were first introduced, the designers felt that sooner or later the B.B.C. would decide to use the television sound channel for high-fidelity broadcasting, an extra position on the waveband switch was provided, in order that all the vision circuits (including CR tube) could be switched off, allowing sound only to be received without retuning.

"Eight Bells" in Portuguese

POPULAR and well-tried B.B.C. programmes have an air of freshness when handled by the Foreign Broadcasts Department. When Harry Pepper's "Eight Bells" show was produced in Portuguese and radiated from Daventry on 19, 25 and 31 metres last week, the programme billing was "producção de 'The Old Salt' (Antigo Lobo do Mar) Harry S. Pepper," and presented "a tripulação do navio, incluindo Shorty, Lofty, Pincher, Shiner e O Sargento," with an accompaniment by the "Grupo Coral Masculino da B.B.C. sob a regencia de Charles Shadwell."

Long Service

A COMPLIMENTARY dinner was given last week by the management of the Telephone and Radio Works of the General Electric Company at Coventry to those employees who have completed twenty-one years' service with the company. More than eighty guests were present, and jointly they represented 2,333 years of service, the long-service record being held by a member of the staff who joined the firm in February, 1888.

British Equipment for High-power Lithuanian Station

IT was recently decided by the Lithuanian Cabinet to order the erection of a modern high-power broadcasting station. A suitable site has been acquired for the purpose at Babtai, about 14 miles from the capital, Kaunas. Work is being commenced immediately, and the station will have a power of 120 kW. It is understood that the transmitting gear and machinery will be of British make.

"If at First . . ."

EARLY in January the B.B.C. attempted to relay a dance programme by Joe Marsala and his band from Hickory House, New York, but atmospheric conditions were bad and the transmission was abandoned. At the end of March recordings of a programme by the band were shipped to England, but a big Foreign Affairs Debate in the House of Commons ousted Hickory House from its place in the schedule. An attempt will be made to let National listeners hear the recorded performance on June 24th.

I.E.E. Wireless Section

THE Committee of the Wireless Section of the Institution of Electrical Engineers has made the following nominations to fill the vacancies which will occur on September 30th:—Chairman, Mr. A. J. Gill (P.O. Eng. Dept.); vice-chairman, Mr. H. Bishop (B.B.C.); committee, Messrs. A. J. A. Gracie (P.O. Eng. Dept.), G. S. C. Lucas (B.T.-H.); J. S. McPetrie (N.P.L.), Col. G. D. Ozanne, M.C. (Wingrove and Rogers), W. J. Picken (Marconi's Wireless Telegraph), and R. T. B. Wynn (B.B.C.).

Is It the Highest ?

ONE of the highest television aerials in the West End of London, that on the new Odeon Theatre, Leicester Square, was recently erected by Belling and Lee. The receiver is situated below ground, and although the feeder, an unscreened balanced line, is 450ft. in length, highly satisfactory results are claimed.

Television in the Commons

IN consequence of widespread requests from Members of Parliament, a television set is to be installed in one of the committee rooms of the House of Commons.

Worthing Council of Science

THE inaugural meeting of the Worthing Council of Science will be held at the Literary Institute Committee Rooms, Montague Street, Worthing, to-morrow, May 27th, at 8 p.m.; *Wireless World* readers are cordially invited.

The Home Laboratory

Part V.—OSCILLATORS

By M. G. SCROGGIE, B.Sc., A.M.I.E.E.

TWO classes of equipment already described in this series—valve voltmeters and cathode-ray apparatus—are both indicators, and without something to indicate they are only half the story. The necessary material for them to work on is provided by signal sources of various sorts, usually oscillators.

A very large number of assorted radio-frequency oscillators are available absolutely free (apart from the cost of a receiving licence). But although transmitting stations are the most authentic sources of signals, in that they are the natural food of receivers, they have the disadvantage of not being under the control of any but exceptionally privileged workers. Moreover, for most quantitative tests a signal modulated by a constantly fluctuating broadcast programme is unsuitable; and the periods of tuning note transmissions are too brief to be very helpful. Even in simple tests on receivers one very soon experiences a need for an oscillator under one's own control.

IN this instalment the shortcomings of the crude type of oscillator are described, and the desirable features of the more refined type of instrument, suitable for testing and experimental work, are discussed.

Refinements Needed

The valve oscillator is almost ideal for the purpose, being silent and motionless, adaptable and compact, and available for both radio and audio frequencies. In its essentials it is also very simple and cheap. That is fortunate, because one can hardly have too many of them about the laboratory. But although simple oscillators have their uses, for testing and measurement purposes there are various extra requirements that are not at all simple to satisfy with any great exactness, and the relationship between the gardener's prize-winning blooms and the insignificant wild flower from which they were evolved is not so remote as that between some laboratory oscillators costing hundreds of pounds and their elementary prototype.

It is necessary or desirable for many purposes that an oscillator should conform to satisfactory standards of waveform purity, frequency stability, and constancy of output. An ordinary circuit such as can be hooked up in a few minutes from common components is likely to be more or less defective in all of these respects.

First, waveform. It is generally at audio frequencies that it is a problem, because radio-frequency circuits are ordinarily more sharply tuned and magnify the fundamental relative to the harmonics; such harmonics as are present may fairly easily be filtered out, but their presence is often no disadvantage and may even be very useful. The reason for harmonic distortion is that when a valve generator once starts oscillations they grow in amplitude until something stops them. Generally that something is grid current, or a bend in the valve characteristic; in other words, a rectifier, which is essentially a distorter. The oscillation grows until the surplus of negative resistance, due to the valve back-coupling, over tuned circuit resistance is neutralised by resistance due to grid current or by reduced average valve conductance. These quantities depend on a variety of conditions that may not be very constant, especially when the frequency of the tuned circuit is adjusted or power is drawn from it; and so the amplitude of oscillation is indefinite. The same influences that result in harmonics and in variations of amplitude are also among those that cause the frequency of oscillation to depart from calibration.

If the oscillator is provided with a reaction control it is possible to prevent gross over-oscillation; but adjustment is critical and has to be done every time the frequency is changed; it is practically essential to use a valve voltmeter or other indicator to show when the normal amplitude is reached, and when taking many readings the adjustments waste a lot of time.

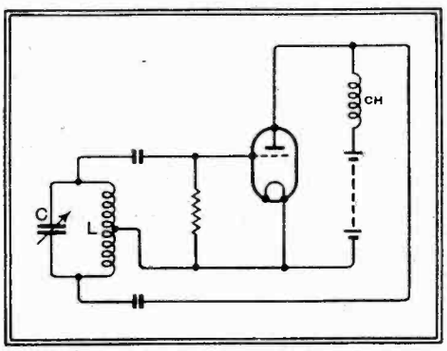


Fig. 1.—This simple Hartley oscillator circuit is not very suitable for laboratory signal sources, because there is no check on oscillation other than the distorting effect of the valve characteristics.

For avoiding these drawbacks there is automatic oscillation control (AOC), which seems to be less well known than one would expect. It is a very near relative of our old friend AVC. The output of the oscillator is rectified and caused to produce a controlling bias that checks any increase in oscillation beyond the desired limits.

To a certain extent that is what actually happens in an ordinary oscillator circuit with grid condenser and leak; for example, Fig. 1. This is an ordinary parallel-fed Hartley circuit, CH being a choke to prevent the oscillatory circuit from being shorted by the HT battery. Oscillations are generated in the circuit LC, and are rectified by the valve in the usual manner of the leaky-grid detector. A negative bias is thus applied to the grid, which tends to check the growth of oscillation. Unfortunately, if the oscillation is very lively, due to close coupling, a high ratio of L to C, or other circumstances, equilibrium is not reached until the amplitude of oscillation has generated sufficient bias to carry the working point of the valve round the lower bend of its characteristic curve; or even beyond it, resulting in "Class C" operation. This is quite inconsistent with a pure undistorted oscillation.

Another disadvantage is that in order to avoid "squegging" (oscillation breaking up into groups of waves at a lower frequency, due to excessively slow leakage) the leak resistance must be made low. This imposes a load on the oscillatory circuit, which in itself lowers the sharpness of tuning, but being a rectifier load the distortion is serious.

There are other reasons why self-control of the valve is bad for its characteristics as an oscillator. But if one wants to modulate the oscillator there is the further disadvantage that, for reasons that would take some space to explain fully, it cannot be effectively done by the convenient and simple process of introducing the modulating voltage into the grid circuit.

It is true that if the coupling or other circuit arrangements are adjusted so that oscillation is not too fierce, then grid rectification control need not cause serious distortion; but to ensure such conditions when L is changed and C is varied necessitates hand adjustment, and we are back where we started from.

To obtain effective AOC a separate rectifier is used. Fig. 2 shows one of the ways in which this can be done. V2 is a diode, the grid and cathode of a disused triode or other valve will do. C1 and R1 correspond to the grid condenser and leak

The Home Laboratory—

in the Fig. 1 circuit, and C2 and R2 form a simple filter to remove the oscillation component in the rectified output, passing only the steady bias.

With this type of circuit it is possible to arrange things so that the oscillation is restricted to the choicest part of the valve's characteristic curve, well away from both grid current and lower bend. If the amplitude of oscillation grows, so does the bias, and the tendency to oscillate is thereby reduced; similarly, a reduction in amplitude is also automatically counteracted. It is not necessary for the bias required for the best working point to be actually equal to the bias obtained from the rectified oscillation; any difference either way can be made up by providing a steady bias, which can be introduced either at X or Y. At Y it is simply in series with the rectified bias, in the oscillator grid circuit. At X it acts rather differently, by controlling the oscillation amplitude at which rectification starts, in the same manner as an AVC delay voltage.

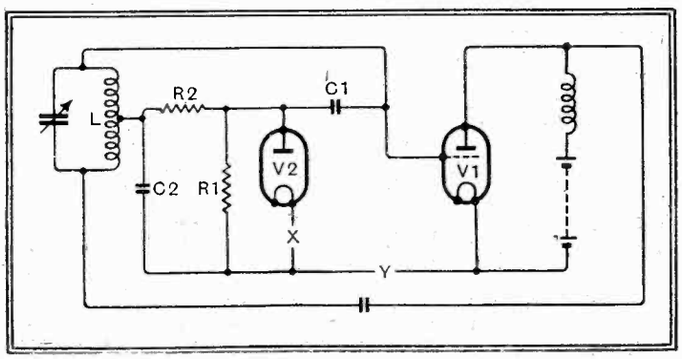


Fig. 2.—Illustrating the application of automatic oscillation control to the circuit of Fig. 1. In the form shown it is still not entirely satisfactory.

Perfect Modulation

Suppose the total bias required is −10 volts. That is the working point on the valve characteristic. If there is no fixed bias it must all be derived from the rectified oscillation, which must therefore reach a peak amplitude of 10 volts or slightly more. In fact, V1 also is likely to rectify slightly. But by providing a fixed bias at Y of, say, about 6 volts, the oscillation amplitude is restricted to 4 volts, and operates only over a very straight part of the characteristic. Now suppose the bias at Y to be slowly increased up to 10 volts. The oscillation amplitude required to maintain the total bias at 10 gradually diminishes to zero. And if the Y bias is reduced to 2, the oscillation is allowed to swell to 8 volts. So if at Y a signal from a relatively low-frequency oscillator having a peak amplitude of 4 volts is superimposed on the steady bias of 6 volts, the high-frequency oscillation is perfectly modulated to a depth of 100 per cent., and all without risk of overloading V1. A similar result can be obtained if the modulating signal is introduced at X.

Varying the modulating voltage controls the depth of modulation; varying the steady bias controls the amplitude of oscillation. If both are fed into the cathode circuit through a common potentiometer, it is possible to control the amplitude of oscillation, leaving the percentage modulation constant and adjustable by a separate control.

It is necessary to say something about R2, C2. To prevent distortion due to the rectifier V2 it is necessary for its circuit to be designed very much on the lines advised for diode detectors, as explained by W. T. Cocking.* This necessitates R1 and R2 being large, but for stability of operation it is better for them not to be too large. If R2, C2 multiplied together are too great there is a risk of motor-boating due to the time-lag between rectification of the oscillation and application of the resulting bias. And if it is too small the oscillation passes through it and the control action fails. Also if modulation is used the filter R2, C2 should allow the modulation frequency to pass freely. The best values are found by experiment. In some cases it is helpful to substitute a choke for R2.

The circuit of Fig. 2 has been used for illustrating the general principle, but in practice it is open to the original objection, because any change in the freedom of oscillation, due, for example, to adjustment of frequency, is liable to cause a large variation in the amplitude of oscillation unless the valve is worked on a markedly curved part of its characteristic.

By far the best way is to substitute for the triode oscillator valve V1 a dynatron, which is just the thing for the job because the control grid is quite separate from the oscillatory circuit, and acts by tilting a straight characteristic bodily instead of increasing curvature. With a suitable valve a very large degree of control results from a small change in bias, so amplication, etc., is unnecessary. In addition to all this the dynatron has substantial advantages as an oscillator and would be preferred quite apart from AOC.

The advantages, and the principles of action, were dealt with at some length in the earlier series of Home Laboratory articles (Aug. 7th, 1936), so will be recapitulated very briefly.

Almost any screen-grid tetrode (but not an output tetrode) with the anode fed at a lower voltage than the screen will work as a dynatron, but the Mazda AC/S2 excels.

If, for instance, the screen is maintained at a steady voltage of 100, the anode-current/anode-voltage characteristic slopes in such a way as to indicate a *negative* resistance between approximately 10 and 90 volts (Fig. 3), and any oscillatory circuit connected in series with the anode oscillates without any coupling to anything else being necessary, so long as the dynamic resistance of the circuit is high enough (losses low enough). The slope of the line is controlled by biasing the control grid; the greater the negative bias the greater the dynamic resistance must be for oscillation to take place. Once it starts, it is usually limited only by whichever bend happens to be the nearer; the maximum amplitude in the above case would therefore be obtained with an anode voltage of 50, and the oscillation peak voltage would be about 40.

If this were connected direct to a AOC rectifier, a bias of nearly 40 volts would be applied to the control grid, which would completely stop everything. With the most efficient oscillatory circuit the bias for just maintaining oscillation in the AC/S2 is no more than about 6 volts, and with the worst circuit likely to be used it is about 2. So with the widest range of oscillatory circuits the variation in amplitude is within these quite narrow limits.

If the desired amplitude is 16 volts (which permits 100 per cent. modulation while still keeping well within the "straight"), and a positive delay voltage of 12 is applied to the cathode of the rectifier, the extreme limits of oscillation, whatever reasonable circuit is plugged in, are about 14 to 18. If a certain amount of care is taken to avoid very large changes in dynamic resistance at different frequencies of oscillation, the limits can be made closer still, probably close enough to regard the amplitude as determined solely by the delay voltage.

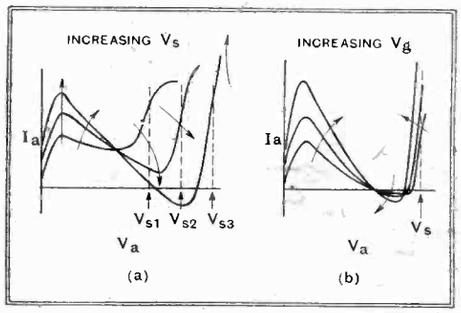


Fig. 3.—Typical characteristics of the dynatron, which lends itself admirably to AOC.

The special advantages of the dynatron are:—

1. No tapping or coupling is required for the oscillatory circuits; so construction, circuit design, and range switching are much simplified; and self-oscillation can be produced in many circuits where it would be impossible otherwise.
2. The control of negative resistance forms no part of the oscillatory system.
3. The frequency of oscillation can be made considerably less dependent on the valve and other incidental adjustments than in other types of valve oscillators.
4. The waveform is also better.
5. The amplitude of oscillation is more definite, and less dependent on the oscillatory circuit.

The last three advantages are realised to an especial degree when AOC is used. So altogether it looks as if the dynatron with AOC approaches the ideal for use in laboratory signal sources. Some suggestions with regard to actual applications, including details of an audio test oscillator, are given in the next article.

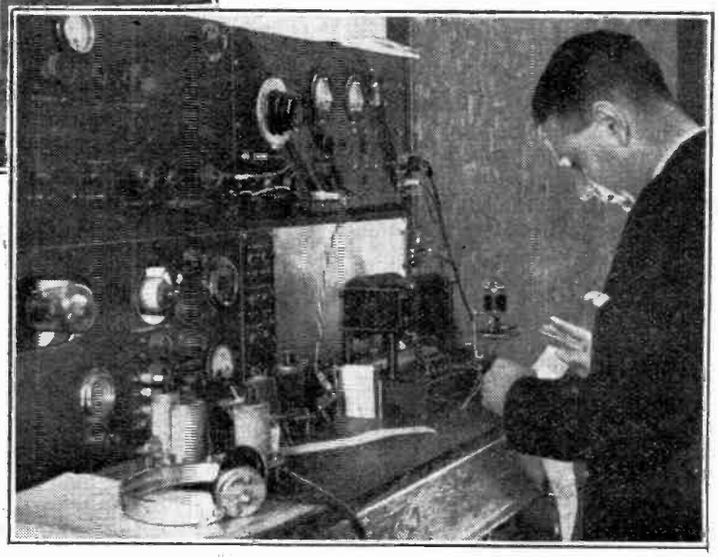
* *The Wireless World*, Jan. 27th and Feb. 3rd, 1938.

New U.I.R. Checking Post

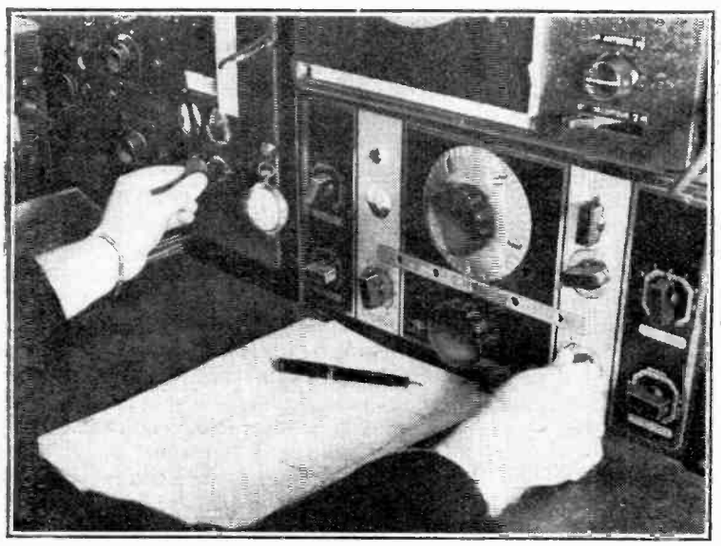
Recent Improvements in Brussels

AFTER starting in the private garage of M. Braillard, on whose shoulders had fallen the task of organising an efficient and independent body to check the various frequencies of the recognised broadcasting stations, the Union Internationale de Radiodiffusion Checking Post vegetated in the cramped quarters of a semi-detached suburban house in the Avenue Floride. It has now built a new house for itself which came into operation at the end of March.

Apparatus hitherto crushed into one room is now distributed over three floors. Next to a large and airy workshop there are various experimental laboratories and five small laboratories for actual measurement and checking service. Each of these is completely shielded on the Faraday cage principle, and an ingenious method has been found that makes possible the closing of the doors in a manner that maintains the continuity of the screen.



Modulation depth can be recorded by means of the equipment seen above.

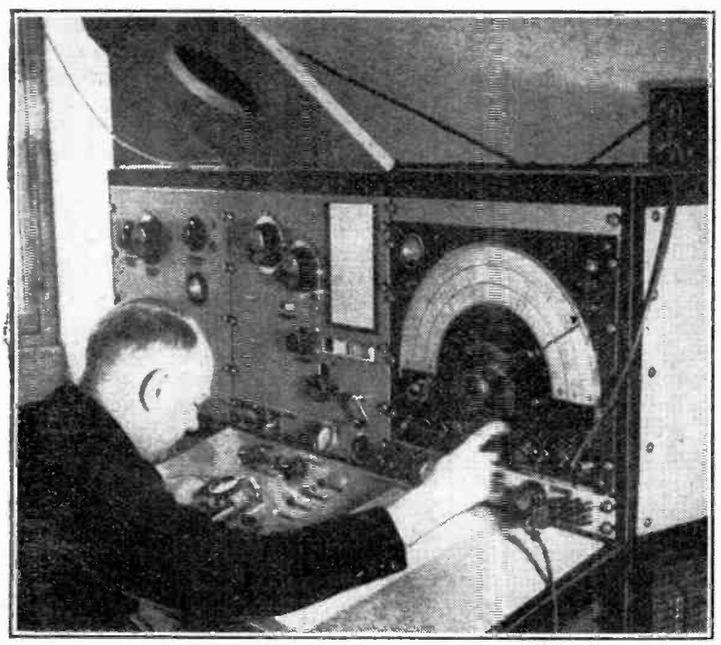


The receiver used for the reception of signals to be measured on the short wavelengths.

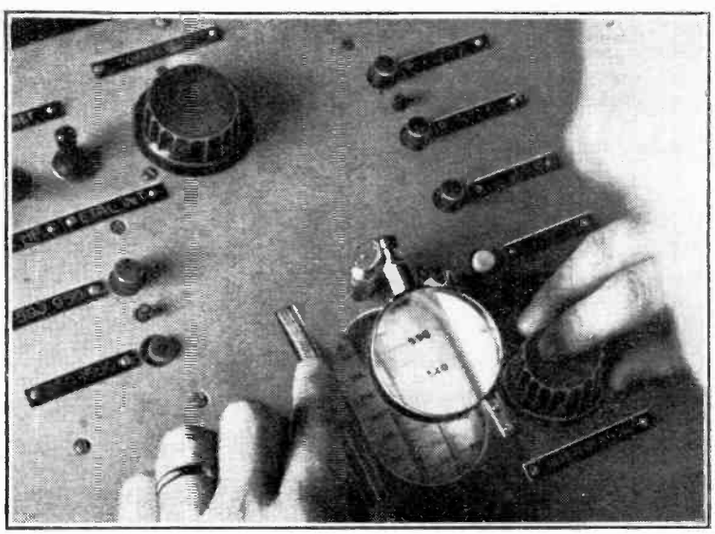
The standard tuning fork is in a special room and there are offices for a draughtsman and other officials of the staff. A conference room and the concierge's flat complete a building which is designed for future extension.

Most of the apparatus is new, and of particular importance is the set for checking the long and medium waves. The short-wave set is the same as was used in the old building, but it is soon to be replaced.

A. A. G.



General view of the new receiver for checking frequencies on the medium and short wavebands on the right.



A close-up of the scale magnifier is seen

New Range of Valves

DATA ON THE MULLARD "E" SERIES WHICH INCLUDES SHORT-WAVE TYPES

THE valves comprising the new range just introduced by Mullard and known as the "E" series differ in several aspects from previous types. The outstanding feature is the use of a short cathode of high emission. This makes for a low heater current, good heat radiation, mechanical rigidity and a compact assembly. The cathode heating time is 10 seconds and all valves are designed for 6.3 volts; with the exception of the EK3, ECH2, and output pentodes, the valves take 0.2 ampere heater current, so that the power wasted in heating the cathode is only 1.26 watts. Rectifiers, however, have 4-volt filaments.

One factor which follows from the small dimensions of these valves is of particular interest to short-wave enthusiasts. Because of the closer electrode spacing the transit time of the electron is lower than in ordinary types and this results in a higher input resistance. The makers, in fact, claim that the performance of these valves at frequencies of the order of 56 Mc/s is intermediate between the existing series of English valves and the Acorn type.

Valves in this series are fitted with the side-contact base for which a smaller capacity is claimed than for the ordinary pin base; it is also specially designed to minimise RF losses between the contacts.

One of the most interesting of the new valves is the EF8; this is a low-noise RF pentode and as such it is of particular interest for short-wave work. Although the valve is called a pentode, it has actually four grids and so would more properly be termed a hexode. Unfortunately, this word is too much associated with the frequency-changer to render its use desirable for an RF valve.

The anode current of a valve is not uniform, but fluctuates, giving rise to the well-known valve hiss. In a RF stage the

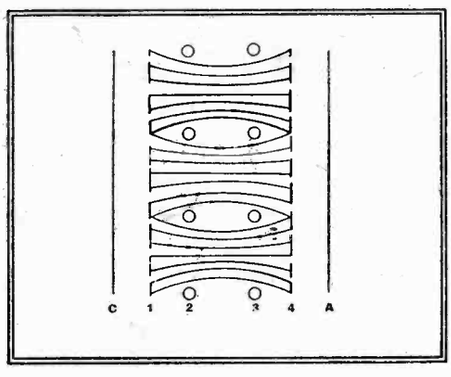


Fig. 1.—This drawing shows part of the electrode assembly of the EF8; a low screen current is obtained by a beam formation of the electron stream which is produced by the auxiliary grid G2.

fluctuating component of the anode current is proportional to the square root of the anode current, the square root of the band-width and to a factor F which is dependent on the construction of the valve. It is convenient to express the valve noise in terms of an equivalent resistance Re which it connected in the grid circuit will produce the same noise through thermal agitation. The convenience is brought about by the ease with which it is possible to compare valve and circuit noise.

Expressed in this way $Re = 2{,}000F^2 ia/g^2$ for a temperature of 300 deg. and with ia representing the DC anode current in mA. and g the mutual conductance in mA/V. The value of the valve as an amplifier increases with the mutual conductance, and if the anode current remains constant the equivalent noise resistance is inversely proportional to the square of this property. In general, however, anode current tends to rise with mutual conductance, and the valve with the highest value of g does not necessarily give the best signal-noise ratio. In general, anode current and mutual conductance are fixed by the other desired valve characteristics, and then the noise can be controlled only by the factor F. In the case of a saturated diode F is equal to 1, for there is then no space charge. In normal operation valves have some space charge and in the case of a triode F^2 has a value of about 0.05 and considerably reduces noise. With a pentode, however, F^2 is about 0.3; that is, for the same current the noise is about six times as great as with a triode.

Reducing Valve Hiss

There is thus scope for considerable improvement in the pentode, and it is found that with this type of valve F^2 is roughly proportional to the ratio of the screen-grid current to the total cathode current. It is, therefore, essential to make the screen-current as low as possible. This can easily be done by reducing the number of turns on the screen-grid while keeping the wire diameter the same. Unfortunately, however, this has the effect of reducing the screening effect and the control grid-anode capacity increases.

In the EF8 the difficulty is overcome by adopting the principles of electron optics. An additional grid is mounted between the control and screen grids, and its turns are wound exactly in front of those of the screen. This grid is maintained at cathode potential. Consequently, the electrons passing this auxiliary grid are grouped in the form of a beam and pass through the interstices of the screen, comparatively few of them reaching the screen itself. The action will be clear from Fig. 1, which shows a sketch of part of the elecrode system of the EF8. The cathode and anode are represented by the lines C and A respectively, and the control and suppressor grids by the dash-lines 1 and 4. The circles 3 represent the turns of the screen-grid and the circles 2 the turns of the auxiliary grid; the paths of the electrons are shown by the horizontal curved lines.

As a result of this construction the screen current of the EF8 is only 0.2 mA. as compared with 4.25 mA. for the older VP4B. The factor F^2 is only 0.084, giving an equivalent noise resistance Re of 4,100 ohms; the noise level of the valve is thus of the same order as that of a triode. The resulting improvement is likely to be more noticeable on the short waves than the medium or long wavebands, for on the latter it is not usually difficult to arrange matters so that valve noise is negligible in comparison with circuit noise, but on short waves this is generally impossible. The low input and output capacities—4.9$\mu\mu$F. and 7.8$\mu\mu$F.—are also helpful. The method of reducing the screen current which has been adopted has one disadvantage. To obtain an adequate electron flow, the auxiliary grid must have a fairly wide mesh and as the turns of the screen grid must correspond with those of the auxiliary grid the screen grid must also be of wide mesh. As a result the effective control-grid-anode capacity is increased. In the EF8 it is about 0.006$\mu\mu$F. as compared with 0.0023$\mu\mu$F. for the VP4B. The anode AC resistance is also somewhat lower than usual, being about 0.5 megohm.

The valve has a mutual conductance of 1.8 mA/V, and in normal operation anode and screen supplies of 250 volts are used, the auxiliary grid and suppressor are tied to the cathode and the grid has −2.5 volts bias. The anode current is 8 mA. and the cathode bias resistance should be 300 ohms.

Not only RF pentodes but frequency-changes have received considerable attention in this series of valves. It is well known that the octode suffers from two main disadvantages—the oscillator frequency is liable to vary with a change in the control grid bias and there are coupling effects between the control and oscillator grids. These difficulties have been very largely overcome in the EK3—the former by electron optical methods and the latter by neutralisation. In order to avoid frequency drift the current to grid 2 (oscillator anode) must not vary during the application of a control voltage to grid 4 (control grid) and the return of electrons from the virtual cathode in front of grid 4 to the oscillator space must be prevented.

These results are obtained in the EK3 by the electrode structure shown in Fig. 2. An electron beam passes through each of

New Range of Valves—

the four pins supporting grid 1 and through the openings in grid 3 into the outer part of the valve. There are thus four beams traversing grid 1. Grid 3 has two gaps and is enclosed by grid 4, the supporting pins of which face the exact centre of each of these gaps. These pins divide and deflect each beam into two halves, and as a result none of the electrons repelled from grid 4 can return through the gaps in grid 3 into the oscillator section.

As a result the mutual conductance between grids 4 and 2 becomes zero instead of 0.5 mA/V, as in the case of the FC4 and EK2. Furthermore, the space charges between the cathode and grid 1 and between grids 1 and 2 are not affected by changes in the bias of grid 4, and these also have no effect on the mutual conductance between grids 1 and 2.

The first improvement results in the elimination of certain unwanted effects between the input and oscillator circuits which sometimes give rise to oscillation. The other two factors result in the virtual elimination of frequency drift.

In addition to the foregoing, the "induction" effect has been largely eliminated in the EK3. This effect can be represented on the medium and long wavebands by a negative capacity between grids 1 and 4, and can be largely neutralised by the connection of an external capacity between these electrodes. On short waves, however, it can be demonstrated experimentally that complete neutralisation of the effect is impossible with only a condenser.

The reason for this is the finite transit time of the electrons between grids 1 and 4. In the FC4 this time is 2×10^{-9} second, and at 15 metres this means a phase shift of some 14.5 deg. The effect can then be represented by a capacity and resistance in series between these two grids. Neutralisation can be effected by a similar external circuit and provided that the transit time is reasonably low this neutralisation will be independent of wavelength. In the EK3 this neutralising circuit is built into the valve and consists of a capacity of 1.6 $\mu\mu$F in series with a resistance of 1,200 ohms.

Proper neutralisation, however, is obtained only for a particular amplitude of oscillator voltage on grid 1—about 8-9 volts. As this voltage usually varies somewhat over the tuning range, it should be adjusted to the optimum value at the highest frequency end of the band. An oscillator grid leak of 50,000 ohms is recommended, and the optimum heterodyne is obtained when the current through it is 320 μA.

In order to keep frequency drift at a minimum it is essential that the screen voltage (G3, G5) be kept constant. The screen-feed potentiometer should consequently draw a heavy current; there is naturally a limit to the current that can be conveniently wasted in this potentiometer, but it must be remembered that frequency drift diminishes as the current increases.

As the complete elimination of the effect is impossible, it is important to choose an oscillator circuit giving maximum stability. The tuned anode circuit has much to commend it and gives a considerable improvement if the reaction coupling is not too tight. Owing to the high mutual conductance of the oscillator section of the valve—4.5 mA/V—tight coupling is unnecessary.

The recommended circuit is shown in Fig. 3 and shunt feed of the oscillator circuit is adopted to avoid applying the HT to the tuning condenser. One disadvantage is that the tuned circuit is damped by the 25,000-ohm feed resistance, but this is not usually serious enough to cause any difficulty. Using this circuit but with a series resistance screen feed instead of the recommended potentiometer, the measured frequency drift at 15 metres for a control grid bias change of -2 to -20 volts is claimed to be 4.5 kc/s.

The valve heater consumes 0.72 ampere and it is rated for operation at 250 volts for the anode and 100 volts for screen and oscillator anode. The normal grid bias is -2.5 volts. The conversion conductance is 0.65 mA/V with an AC resistance of 2 MΩ. Under operating conditions the oscillator anode current is 6 mA., the screen current 5.5 mA., and the anode current 2.5 mA. The input and output capacities are 14.5 $\mu\mu$F and 15 $\mu\mu$F.

This is not the only octode in the "E" series, for there is also the EK2. This is of more conventional design and has input and output capacities of 8.8 $\mu\mu$F and 10 $\mu\mu$F with a conversion conductance of 0.55 mA/V. The screen potential should be 50 volts with 200 volts for the oscillator anode.

Probably of more general interest, especially for short waves, is the triode-hexode ECH2. This has characteristics similar to those of the TH4A in the 4-volt range. Its heater consumes 0.95 ampere, and its input and output capacities are 8.0 $\mu\mu$F and 13.0 $\mu\mu$F. It has a conversion conductance of 0.75 mA/V and an AC resistance of 1.5 megohms.

(To be continued.)

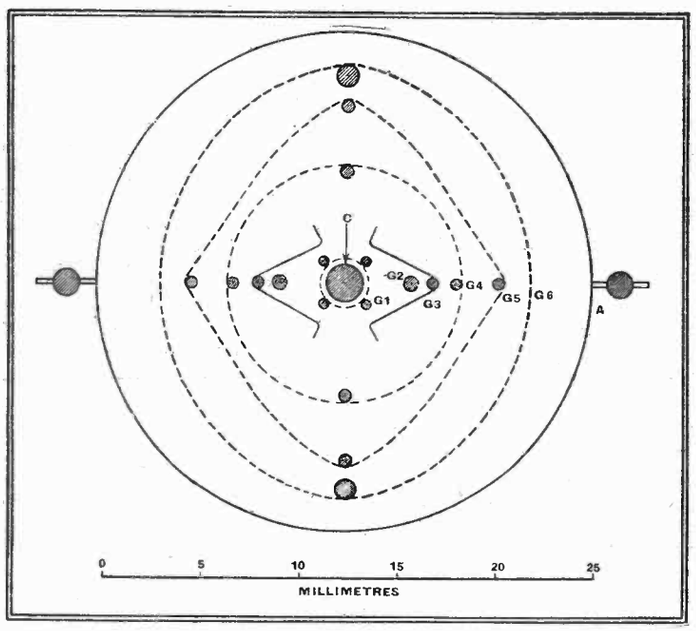


Fig. 2.—The electrodes of the octode frequency - changer EK3 are illustrated in this diagram.

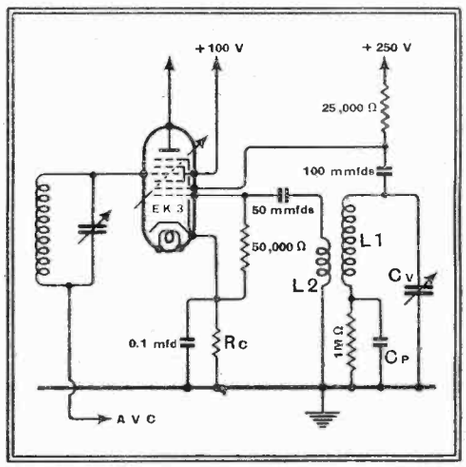


Fig. 3.—The recommended circuit for the EK3 is shown here. A tuned-anode oscillator is used.

PRACTICE IN THE HOME on the Trautonium Electric Organ is now made possible by the inclusion of a special "stop" that enables the operator to listen-in by means of headphones. The equipment can imitate the sounds of any instrument of an orchestra.

Letters to the Editor

The Editor does not necessarily endorse the opinions of his correspondents

Television Responsibilities

AT a time when the B.B.C. and manufacturers should be doing their best to popularise television, the officials of the B.B.C. programmes directorate must be made to realise their responsibilities not only to the public but to the great scientific achievement whose success lies in their hands.

Engineers in the B.B.C., the trade, and outside, have united to make television a technical success with really amazing results. The standard of visual reproduction is such that it is now a joy to see. Yet the quality of the material that is broadcast lags very many years behind the quality of reproduction that is obtainable. The larger portion of it is an insult to the intelligence of viewers.

A typical example of the ineffectual way television is being treated at the productions end took place on Saturday week.

Towards the end of an exciting polo match at Hurlingham—at a time when the game might have gone to either side—the announcer apologised for the poor quality of the transmission and the programme was switched back to Alexandra Palace to a Mickey Mouse film of approximately 1928 vintage. I had been watching the transmission which, on the whole, was better than previous outside broadcasts. For about half a minute there was a little wandering in the upper half of the image, but for four or five minutes before the O.B. was cut off the reproduction had been the best I have ever seen.

Reports to this effect appeared in two responsible Sunday papers, and ample confirmation has been forthcoming that there was no reason whatever for cutting out the end of the match.

In this incident there is evidence of three glaring faults that demonstrate the supercilious incompetence of some of those on whom the future of television rests.

The programme in which viewers' interests had been aroused was broken just before the climax—obviously on the flimsiest of pretexes.

Even had vision transmission been bad there was no reason for cutting the running commentary. The result of the match was not broadcast at the end of the programme.

Viewers interested in polo because of a connection with the game, or those who wanted to see, for the first time, what a polo match is like, are not the type that would readily accept a Mickey Mouse film as a substitute.

On all three counts those in charge showed an irresponsibility which, except in a few instances, is becoming typical of the conduct of television broadcasts.

It must be as heartbreaking for those who built up the technical side of television to its present high standard of perfection, as it is for those who have paid £40 to £100 for their sets, to see the whole success being jeopardised by a few incompetents.

London. W. MacLANACHAN.

Empire Reception

THE article, "Return from Malaya," by "Heptode," in your April 7th issue, contains several statements and opinions which, in the light of my own experience, seem to call for comment and correction.

In the first place, "Heptode" is decidedly unfair to the B.B.C. Engineering Division in his criticism of their methods of collection of reception reports from all parts of the Empire. "Heptode," in his second paragraph, hands a small bouquet to the B.B.C. in this matter, stating (correctly) that they have "not hesitated to invite the co-operation of listeners. . . ." Further on, he accuses the B.B.C. of relying on "official organisations and broadcasting bodies" for such reports, "based on observation by unskilled personnel with inadequate apparatus." This I know to be far from the truth, and surely "Heptode" himself must have heard many times in announcements during Empire transmissions the urgent plea for reports from listeners—particularly of a technical nature. I myself have been in constant correspondence with the Engineering Division practically from the beginning of the Empire Service, and from my own experience have formed a very good opinion of the system which has been developed—and is still developing—by which the best possible use is made of the *regular* technical reports from a widespread network of technically intelligent listeners. Quite recently, indeed, the mechanism of this co-operation has been greatly speeded up, by an arrangement made by B.B.C. for regular weekly *cablegram* reports from a selected number of such observers in all parts of the world.

"Heptode" states first that "there is never a night when reception of the B.B.C. service is not possible . . . and there are few nights when reception on an adequate receiver falls below entertainment value." Then he proceeds to find fault with programme timing, on the grounds that "reception is always better after 8.30 p.m. (Malaya time) after the programme for Malaya has concluded." May I point out that Transmission III (referred to by "Heptode" as "for India") has no less than *four* frequencies, in as many different bands, directed toward *Malaya* (I take this information from my current copy of B.B.C. Empire Broadcasting). With three frequencies directed to Malaya in Transmission II also, it seems that "Heptode's" part of the Empire is particularly well served by the Empire Service. Here in Western Canada we are comparatively neglected, with only *two* frequencies directed towards us, in Transmission VI only.

On this matter of programme timing and local reception conditions, I venture to say most emphatically that "Heptode's" "experience in the earlier days of short-wave development in North America and India" can have no more relation to the present-day state of affairs than the well-known and oft-quoted "flowers that bloom in the Spring"! In this part of the world the extent of development, combined with changes in natural conditions, can be briefly indicated by the actual carrier strength of the Daventry transmissions as received here, which have increased from a normal R2 to zero, in the early days of the Empire Service, to a normal R8, Merit 5 signal nowadays, and a signal voltage at my aerial often reaching approximately 10 *millivolts* per metre.

"Heptode's" ideas of American receivers, judging from his eulogy of their performance in comparison with British sets, must be formed from the two or three makes of U.S.A. origin of large and expensive type, which have established quite an extensive market throughout the world. Thus, he has apparently become convinced that the *typical* American set has at least one stage of RF amplification, and *two* IF stages. This, I am well aware, is a very wide-spread misconception both in the Old

Television Programmes

An hour's special film transmission intended for the industry only will be given from 11 a.m. to 12 noon each weekday.

Sound	Vision
41.5 Mc/s.	45 Mc/s.

THURSDAY, MAY 26th.

3, Jack Hylton and His Band. **3.25,** British Movietonews. **3.35,** 149th edition of Picture Page.

9, "Re-view," remembered by Queenie Leonard, Charles Heslop and others. **9.25,** Gaumont-British News. **9.35,** 150th edition of Picture Page. **10.5,** News Bulletin.

FRIDAY, MAY 27th.

3, "Pride and Prejudice"—Jane Austen's story specially adapted for television. **3.55,** Gaumont-British News.

8.15, (sound only) London Music Festival—Toscanini conducting the B.B.C. Symphony Orchestra. **9,** Friends from the Zoo, introduced by David Seth-Smith. **9.15,** British Movietonews. **9.25,** Cabaret. **10,** Preview. **10.10,** News Bulletin.

SATURDAY, MAY 28th.

3. "Re-view," as on Thursday at 9 p.m. **3.30,** British Movietonews. **3.40,** Catch-as-catch-can Wrestling Demonstration.

9, "Broadway," one of the original American gangster stories. The scene is set at the Paradise Night Club, New York. Cast includes Hartley Power and Gina Malo. (Marlene Dietrich and Gina Malo made stage débuts in "Broadway.") **10.15,** News Bulletin.

SUNDAY, MAY 29th.

8.50, News Bulletin. **9.5,** Master Peter's Puppet Show. **9.35,** Cartoon Film. **9.40,** British Movietonews. **9.50-10.20,** "Riders to the Sea," a play by John M. Synge.

MONDAY, MAY 30th.

3-4.10, Repetition of Sunday's evening programme.

8.15, (sound only) Toscanini Concert. **9,** Eastern Cabaret; a development of the popular feature "Cabaret Cruise." **9.40,** Gaumont-British News. **9.50,** "The River," a film depicting the story of the Mississippi Valley. **10.20,** News Bulletin.

TUESDAY, MAY 31st.

3-4.30, Victoria Hopper as Teresa in a special production of "The Constant Nymph," the famous play by Margaret Kennedy and Basil Dean.

9, C. H. Middleton "In Our Garden." **9.10,** Cartoon Film. **9.20,** "Three - Four." The story of the waltz, from the days of Mozart to the present day. **9.50,** British Movietonews. **10,** Television Spelling Bee. **10.15,** News Bulletin.

WEDNESDAY, JUNE 1st.

2.30, The Derby; O.B. from Epsom. The progress of the race will be followed by a camera fitted with a 12in. lens. Two other cameras will also be at work.

9, "Derby Day," the operetta by A. P. Herbert with music by Alfred Reynolds. **9.50,** Gaumont-British News. **10,** News Bulletin.

Country and in other parts of the Empire —and is far from the actual truth. "This small type of set with no RF stage, low sensitivity and a limited wave coverage" (I quote "Heptode" again) which I admit *is* "unsuitable for Empire listening" can also be taken as typical of the *average* American type of set. Considering the much greater efficiency of British valve types, I have no doubt that the *average* British set will out-perform the *average* American type, each having the same number of tuned circuits and AF stages. The larger and *much* more expensive type of set, such as Scott, Silver, Midwest (to mention the products of three U.S.A. manufacturers who have, I believe, gone out after export trade more than others) can (or should) only be compared with the larger and finer British sets—such as, for instance, the G.E.C. Fidelity Eight praised by "Heptode." Incidentally, I do not doubt that this same set, if designed for British valve types rather than the U.S.A. types used would put up an even finer performance—at the possible expense of ease of replacements in remote places and greater cost of valves.

Dealing with "Heptode's" final complaint of interference from commercial stations, I can only say that, from my own past experience, a complaint *to the B.B.C.* stating definite identification of the offending station, will produce prompt and usually effective action in the matter. At the same time, it seems very hard to believe that, with a reasonably selective superhet., in a good state of alignment, even PLF should cause a "wipe-out of everything on the 16-metre band."

Interference from legitimate transmissions, however, pales into insignificance when compared with the extremely serious and ever-increasing interference caused throughout the world by the operation of so-called "short-wave therapy" apparatus, each of which is fundamentally a powerful SW transmitter, usually having raw AC on its anodes, and quite as usually with no attempt (on the part of its manufacturers) at keeping the RF output of the apparatus from feeding back into the power lines, and so radiating for thousands of miles. Here, in the mornings, it is quite usual to find thirty or forty roaring "transmissions" from these infernal machines, over the whole frequency spectrum from about 9 Mc/s upwards—and almost invariably one sweeping back and forth across each of the European SW broadcasters. Quite often it is possible to recognise (from the 100-cycle "note" of the modulation) several of these outfits, which must almost certainly be in Europe, as 50-cycle supply is not used on this continent. A few 25-cycle (50-cycle note) appliances are heard at times, probably located in Eastern Canada, where (in Ontario) 25-cycle supply is widely used.

So far as the B.B.C. Empire Service is concerned, my own opinion is that the Corporation has done a remarkably fine job of work. Technical excellence of the Daventry transmissions, as heard here, is always head and shoulders above that of any of the other high-powered European stations, German, French or Italian. As to programme material—well, surely it must be recognised that every taste can hardly be pleased at all times! Personally, I find most of the B.B.C. programmes very enjoyable, and far preferable to the U.S.A. commercial broadcasting which must be our usual "local" fare.

Princeton, B.C., Canada. SYDNEY R. ELLIOTT.

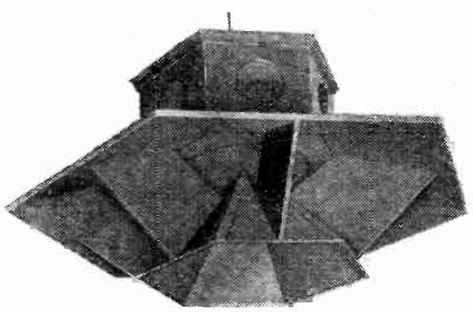
Goodmans Concentric Diffuser

A GENERAL PURPOSE PA LOUD SPEAKER

THE conventional directional baffle or horn type loud speaker is often at a disadvantage for interior sound reinforcement and it becomes necessary to group a number of units radially to achieve the desired result. This is uneconomical, particularly when the aggregate power-handling capacity exceeds the input necessary to attain the required sound level.

To meet the demand for a single reproducer with non-directional properties Goodmans Industries, Ltd., Lancelot Road, Wembley, have developed a multi-cellular baffle loud speaker with remarkably good characteristics, both as regards frequency response and uniformity of distribution. It has a massive permanent magnet unit with a 1¾-inch speech coil working in a flux density of over 14,000 lines, and the diaphragm has been specially developed to maintain correct tonal balance under conditions of 360 deg. radiation.

Under test in a room much smaller than the restaurants, dance halls, etc., for which it was designed, the diffuser showed some measure of its capabilities for permeating the whole volume with sound without giving any strong clue to the location of its source. The high frequency response necessary for good diction in speech has been achieved without emphasis on sibilants, the transient response is in itself confirmation of the high degree magnetic flux and the damping which it provides, and last, but by no means least, the bass response is remarkably broad and



Goodmans Concentric Diffuser loud speaker designed for 360-degree radiation.

smooth. In fact, the general effect on both speech and music is so good that one might seriously consider the reproducer for domestic high-quality reception in a large living-room. As the baffle diameter is only 3ft. some other reason must be sought for the excellent low-frequency response, and the most probable explanation is to be found in the loading of the partially enclosed back of the diaphragm and the correct phasing of the radiation from the relief holes. The power handling capacity is conservatively rated at 20 watts peak, which should be sufficient for most indoor requirements when the efficiency of the magnet system is taken into account. The weight is 44 lb. and the standard finish is in brown enamel. A strong galvanised hook bolted through to the framework of the loud speaker unit is provided for suspension. The price is £15.

RANDOM RADIATIONS

By "DIALLIST"

Ultra-short-wave Quality

ONE doesn't need to be very bold to predict that the present series of B.B.C. relays on the ultra-short waves of excerpts from concerts given during the London Music Festival will have its effect in educating a considerable number of listeners to appreciate the high quality that is obtainable from transmissions that are not cramped by the limitations of the longer-wave bands. Our ears are curiously ready to accept the reproduction to which they have been accustomed as "almost perfect" until the hearing of something vastly better makes us realise what we have been missing. Old hands who cast their minds back to the early 1920's will appreciate the truth of *that* statement. The first loud speaker (the old Brown Type H) was nothing more nor less than a large telephone receiver with a conical horn attached to it. Its response peaked fairly sharply in the neighbourhood of 700-800 cycles; it could do nothing with low notes and very little with high ones. Yet we accepted it, and the other simple horn loud speakers of similar types which followed it, as furnishing quite excellent reproduction.

Wireless Landmarks

Personally, I shall always regard the coming of the old "Kone" loud speaker as one of the most important landmarks in the story of radio reproduction. Imperfect as it was, it showed listeners of the period that, though they hadn't missed it, their sets had been giving them nothing whatever of the bass. There followed the great "Bring out the bass" campaign, and after that the way was opened for the slow but steady development of high-quality reproduction. But only up to a point. When the official separation of channels on the broadcast band was made first ten kilocycles, and later nine, it seemed that there could be little further progress. Now the way is opened again, and opened more widely than ever by this relaying of items from big concerts on the ultra-short waves. To those who have television sets, and to those who make up or buy for their "broadcast" receivers ultra-short wave adaptors such as that described recently in *The Wireless World*, the quality obtainable from these transmissions within the service area of the Alexandra Palace will come as a genuine revelation. I have mentioned before that many of those whom I've taken to see television for the first time have been almost more impressed by the quality of the sound reproduction than by what they saw on the viewing screen.

The Fly in the Ointment

But there is one very serious hindrance to the growth of broadcasting on the ultra-short waves whose importance doesn't seem to be as fully realised as it should be. I'm referring to the interference caused by the ignition systems of so many makes of motor vehicles. Unless you happen to live in a place where there is little motor traffic or have facilities for erecting a high "anti-static" aerial, this interference may be so poisonous that it entirely discounts the pleasure derived from real high-fidelity reproduction. I'm convinced, too, that the prevalence of this kind of interference is one of the reasons why television is not becoming more rapidly popular as a hobby. It's no fun installing either a high-fidelity USW sound receiver or a televisor if you are constantly to be subject to outbursts of raucous noise from the loud speaker and, in the case of the televisor, to snowstorm effects on the viewing screen. I feel most strongly that unless this problem of interference from motor vehicles is tackled quickly and firmly the whole future of both television and high-quality reception of sound on the ultra-short waves may be in jeopardy.

▪ ▪ ▪

Cosmic Data

NO one can do much serious work on the short waves or the ultra-shorts without wondering whether it is possible to establish a definite relationship between such phenomena as magnetic disturbances, sunspots, displays by the Northern Lights and the ranges achieved by wireless transmissions at various frequencies. Everyone knows that a violent magnetic storm is usually accompanied by partial or complete dislocation of short-wave wireless communications in certain parts of the world; but what are the effects of the minor disturbances of which we hear very little, though they occur quite frequently? Is there, again, a direct relationship between the number of sunspots and good, bad or indifferent short-wave reception? And how do the Northern Lights come into the wireless picture? The great difficulty that most people have is to obtain regular and reliable data of the phenomena that occur. Such a service is now available, and if you are genuinely interested and not merely curious I shall be glad to tell you how to get into touch with those who conduct it.

What the Service Is

It sends through the post regular weekly reports collated from data supplied by observatories in the United States, in Hawaii, in Puerto Rico, in Western Australia, in Manilla, in Japan and in France. The subjects covered are magnetic conditions, the state of the sun's surface, the height of the Heaviside layer as measured with transmissions of various frequencies, and (this from Japan only) the dates and times during the

Broadcast Programmes

FEATURES OF THE WEEK

THURSDAY, MAY 26th.

Nat., 7, "Rhythm Exchange" between the Quintette du Hot Club de France in Paris and Carroll Gibbons and the Savoy Hotel Orpheans in London. 7.40, "Hits," a programme of popular tunes compèred by Leslie Mitchell. 8.40, Talk on the Inland Waterways by F. Rayner.

Reg., 6, "Serenade"—The Little Orchestra. 7.30, Midland Parliament—a discussion on Family Allowances. 9, "Mercenary Mary," musical comedy.

Abroad.

Budapest, 7.45, From the International Eucharistic Congress—The Gala Procession on the Danube.

FRIDAY, MAY 27th.

Nat., 7.30, "Rhythm Express." 8.15 and 8.55, Third Concert in London Music Festival, conducted by Toscanini. 10.20, "London Souvenirs," Yvette Guilbert.

Reg., 6.40, Crypts, Vaults and Roman Remains under London. 8.15, "A Formby Do" (George Formby). 9.30, Northern Music Hall.

Abroad.

Leipzig, 8, Dresden Philharmonic relayed from Dresden.

SATURDAY, MAY 28th.

Nat., 1, and 5.45, Middlesex *v.* The Australians; commentaries during the first day's play at Lords. 8, Palace of Varieties, including Claude Dampier and Nosmo King. 9.35, "The Face at the Window"; a revival of the Victorian thriller enacted by Tod Slaughter and his Company.

Reg., 8.30, The Brotherhood of the Coast—pirate history. 9.10, Third Festival Concert from Mountain Ash—"Samson" by Handel.

Abroad.

Breslau, 8, Silesian Music Festival—Backhaus, pianoforte, and the Philharmonic.

SUNDAY, MAY 29th.

Nat., 12, Rawicz and Landauer, pianofortes. 1.30, Troise and his Mandoliers. 7.35, Bird Songs. 9.5, Theatre Composers, No. 1—Lionel Monckton.

Reg., 4, Music from Paris. 6.15, Round the Courts. 7.15, Theatre Organ. 9.5, Sermons in Stone—Wesley's Chapel, City Road, London.

Abroad.

Berlin, 8, "The Barber of Seville," opera (Rossini).

MONDAY, MAY 30th.

Nat., 1.15 and 5.45, Cricket Commentaries: Middlesex *v.* The Australians. 7, Monday at Seven. 9.20, The World Goes By. 9.35, Eddie Carroll and his Orchestra.

Reg., 7.30, Unusual Occupations—Ratcatcher. 8.15 and 8.55, Toscanini Concert—Verdi. 8.40-8.55, I Knew a Man—Chaliapin; Talk by Ivor Newton.

Abroad.

Vienna, 7.25, From the State Opera.

Rennes, 6.45, "How France has Overcome the Petrol Problem."—Talk in English, by Professeur Savage.

TUESDAY, MAY 31st.

Nat., 1.15 and 5.45, Cricket Commentaries. 8, A Musical Comedy, "Betty." 9.20, My Best News Story, by H. S. Scott-Harden, "News from Port Arthur." 9.40, Soldiers' Chorus.

Reg., 7.30, Swift Serenade. 8, The Parnell Commission—a feature programme about the Irish Party Leader. 9, Variety from Coventry.

Abroad.

Leipzig, 9, Seventh Symphony (Sibelius) by the Leipzig Symphony Orchestra, conducted by Weisbach.

WEDNESDAY, JUNE 1st.

Nat., 12.15, Going to the Derby; commentary by John Snagge on the road leading to Epsom. 2.50, The Derby, running commentary from Epsom. 6.45, André Fleury at the Concert Hall Organ. 8, Geraldo and his Orchestra. 9.40, Cads' College, presented by the Western Brothers.

Reg., 7.30, The World Goes By. 8, From the Palace of Engineering at the Empire Exhibition. 8.15, Act II of Wagner's opera "Die Walkure" from Covent Garden.

Abroad.

Deutschlandsender, 7.30, Concert by the Berlin Philharmonic, conducted by Karl Fiedler.

week at which wireless blackouts have occurred. These postal reports are sent in code, of which more in a moment, but you may also hear daily reports given out in plain English by tuning in W1XAL of Boston, Massachusetts on 11.79 megacycles on any evening from Monday to Friday at 10.55. Unfortunately, you can't always be sure of picking up W1XAL, so the postal reports are valuable.

A Clever Code

By using a code it is possible to send an enormous amount of such data in a single sheet. Here, for example, is a string of letters and figures that tells you all kinds of things about April 6th: MAG 4593X, 2105X, SOL 40720, KHL 3417X, 44026. Let's decipher MAG, or Magnetic Conditions, first of all. The first figure of the first group always indicates the day of the week; 4 thus means Wednesday. The second figure indicates the magnetic character; 5 stands for a day of moderate disturbance. The third figure shows the kind of disturbance; 9 means that it was marked by irregular oscillations. The fourth figure has various meanings; in this case 3 indicates that the time when the disturbance began is indicated in the following group. No fifth figure is used in the first group, so X appears in its stead. Now for the second group, which is quite plain sailing, 2105X simply meaning that the disturbance began at 21.05 hours G.M.T. Had it both begun and ended on April 6th the figure 7 would have appeared in the fourth place of the first group and there would be a third group showing the time at which the disturbance disappeared. In SOL (Solar Conditions) the first figure 4 again stands for the day of the week. The second and third figures indicate the number of sunspot groups, 07 standing for seven. The fourth and fifth figures indicate the number of individual spots—in this case 20. If there are more than 99 individual spots an asterisk after the group means add 100 to the last two figures. Under KHL for April 6th there are actually 19 groups of five figures each, but I have only quoted two of them. KHL itself stands for Kennelly-Heaviside layer. In the first group the initial figure is the index number of the observatory making the measurements; here 3 stands for Washington D.C. The second figure is the day of the week, whilst the third and fourth show the hour G.M.T. at which measurements were made. The fifth figure is not used, and X replaces it. In the second group the first three figures represent the frequency in kilocycles divided by 10, i.e., 4,400 kilocycles. The last two figures give the height of the reflecting layer in kilometres divided by 10. Thus, the frequency of 4,400 was found to return from a height of 260 kilometres. Similar ingenious combinations are used to convey the other data given.

One Lives and Learns

A study of such data may soon serve to shatter some cherished beliefs. You realise, for example, that sunspots don't necessarily cause magnetic storms when you turn to records such as those of March 14th, 23rd and 24th. On March 14th eleven sunspot groups were recorded, containing 125 spots. Yet magnetically it was a quiet day. But on March 23rd a magnetic storm of great violence began at 5 p.m. and continued until 11 a.m. on the 24th. There were then but five sunspot groups containing 30 spots in all. Tokyo recorded no wireless blackouts during the week beginning March 13th, when the sun was so spotty; nor, curiously enough, were any recorded during the week beginning March 20th, when that magnetic storm occurred.

Club News

London Transmitting Society

Headquarters: 40, Raeburn Road, Edgware.
Meetings: Thursdays at 8 p.m.
Hon. Sec.: Mr. G. Yale, 40, Raeburn Road, Edgware.

Entrants for the challenge cup competition are reminded that the closing date is May 28th. The Society has decided to present a separate prize in this competition, full details of which were given in *The Wireless World* last week.

Southend and District Radio and Scientific Society

Hon. Sec.: Mr. J. M. S. Watson, 23, Eastwood Boulevard, Westcliff-on-Sea.

On May 15th a very successful 1.7 megacycle field day was held. Sixty-one persons took part, including thirteen members of the Ilford and District Radio Society. First and second arrivals at the hidden transmitter were Mr. G. T. Peck and Mr. E. B. Greenwood respectively. The next field day is due on June 26th.

Exeter and District Wireless Society

Headquarters: 3, Dix's Field, Exeter.
Meetings: Mondays at 8 p.m.
Hon. Sec.: Mr. W. J. Ching, 9, Sivell Place, Heavitree, Exeter.

At a recent meeting the Society's new amplifier, which is under construction, was given some preliminary tests. Several minor faults came to light, but it was clearly shown that the reproduction which could be expected when the amplifier is complete will be of a very high order.

Cardiff and District Short-wave Club

Headquarters: Globe Hotel, Castle Street, Cardiff.
Hon. Sec.: Mr. H. H. Phillips, 132, Clare Road, Cardiff.

A lecture on "B.C.L. Interference and its Cures" will be given to-night (May 26th) by Mr. R. T. Matthews.

This Society circulates a magazine entitled "The News Reel," free to members.

Kingston and District Amateur Radio Society

Headquarters: The Three Fishes Hotel, Richmond Road, Kingston.
Meetings: Alternate Wednesdays at 8 p.m.
Hon. Sec.: Mr. D. N. Biggs, 44, Pooley Green Road, Egham.

Senior members of the Society are very busy instructing the local territorials in the morse code and the fundamentals of radio transmission.

Golders Green and Hendon Radio Scientific Society

Headquarters: 60, Pattison Road, London, N.W.2.
Hon. Sec.: Lt.-Col. H. Ashley Scarlett, 60, Pattison Road, London, N.W.2.

At the conclusion of the recent annual general meeting a talk entitled "4-metre Micro-waves," was given by Mr. D. N. Corfield, who illustrated his remarks with a transmitter and a receiver.

On May 22nd a field day was held. A 5-metre field day will be held on June 19th.

Radio, Physical and Television Society

Headquarters: 72a, North End Road, London, W.14.
Meetings: Fridays at 8.15 p.m.
Hon. Sec.: Mr. C. W. Edmans, 72a, North End Road, London, W.14.

It has been decided that a 2½-metre wavelength shall be employed for this year's field days since the dimensions of a 2½-metre aerial are small, and it is possible to construct extremely portable apparatus. It is believed that no other Society has attempted to hold a field day using so short a wavelength. Dr. C. G. Lemon has delivered a lecture to the Society in which he described several super-regenerative receivers suitable for 2½ metres. A separate-quench receiver was tried out during the lecture and found to work well.

Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

PIEZO-ELECTRIC CRYSTALS

AFTER it has been cut from the mother-crystal along selected axes, so as to exhibit not only a definite frequency, but also a predetermined temperature co-efficient, a final and more precise adjustment of the crystal oscillator is secured by hand-grinding. For instance, one or more of the opposite faces are uniformly tapered, to alter the temperature-coefficient slightly, or small depressions or concavities are ground out in order to reduce the fundamental frequency to a small but desired amount, without at the same time altering the temperature-coefficient. The treatment is stated to produce constant-frequency crystals which are capable of controlling a higher level of power than usual, without risk of fracture.

Standard Telephones and Cables, Ltd. (assignees of G. W. Willard). Convention date (U.S.A.), May 1st, 1936. No. 479637.

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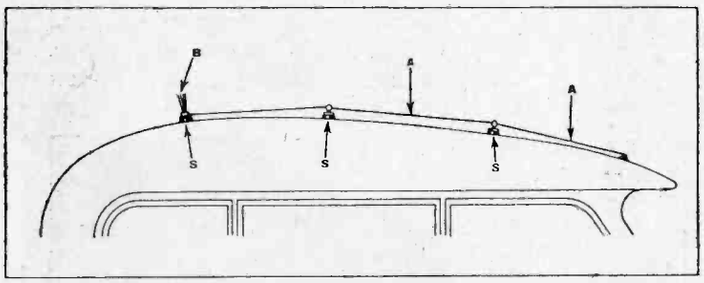
MOTOR CAR AERIALS

THE Figure shows the fitting of a wireless aerial A to the outside of the roof of a saloon car The insulators S are made with a hollow rubber base, which adheres to the roof by "sucker" action, so



Method of fitting an aerial to the roof of a saloon motor car

that the arrangement is easily fitted or dismantled. The free end of the aerial is fitted with a bundle B of short wires, or by a decorative figure or "mascot" to serve as a capacity loading.

K. T. Hardman. Application date, June 8th, 1937. No. 481242.

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CATHODE-RAY TUBES

THE fluorescent screen of a cathode-ray tube is usually deposited on the inside surface of the glass bulb, the latter being bulged outwards in order to resist the external pressure to which it is exposed. As a result the scanning stream sweeps over a curved, instead of a plane surface, and the picture is correspondingly distorted.

To avoid this difficulty, a cathode-ray tube is made with a "false" closure plate, which is plane and not curved. This is protected against the full atmospheric pressure by an outer cap or chamber of glass sealed over the end of the tube. The space between the "false" closure and the outer cap is partly exhausted, so that it has not to withstand the full atmospheric pressure. At the same time it serves to reduce the pressure on the inner tube when the latter is fully exhausted.

The fluorescent screen is now mounted on the flat closure plate, where it can be scanned linearly, the picture being viewed through the outer glass cap.

Radio-Akt D. S. Loewe. Convention date (Germany), September 25th, 1935. No. 481445.

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TELEVISION SYSTEMS

WE have already had two different systems of television in operation, one using straight-line and the other interlaced scanning. It is also possible that, in future, special programmes may be transmitted using a higher line-frequency than usual, in order to cater for large-scale reproduction in cinemas and theatres.

According to the invention, the time-base circuit for a receiver is designed so that it can rapidly be adjusted to receive, at will, transmissions using either straight or interlaced scanning, or those sent out on a higher line-frequency than usual. The result is secured by using two relaxation oscillation-generators for synchronising, the frequency of the impulses being adjusted to the desired value by switching different condensers into circuit.

Radio-Akt D. S. Loewe. Convention date (Germany) August 22nd, 1935. No. 479139.

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SHORT-WAVE SYSTEMS

WHEN transmitting on wave-lengths of the order of a few metres the usual practice is to apply the modulating signals after the carrier-wave has been multiplied up to the required frequency, because it was thought that the frequency-multiplication of a wave already modulated would produce a considerable amount of distortion.

It has now been found that this is not so, provided suitable precautions are taken. The inventors describe an arrangement in which a high-frequency wave is first modulated by applying signal voltages to the suppressor grid of a pentode valve, and the modulated output is then applied to one or more frequency-changing pentodes, so as to step-up the carrier frequency to the desired value. Each of the frequency-changing stages is operated with a sufficiently negative grid bias to produce an increase in the percentage modulation of the carrier-wave output.

Standard Telephones and Cables, Ltd. (assignees of Le Materiel Téléphonique Soc. Anon.). Convention date (France) March 6th, 1936. No. 480548.

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CONTROLLING "VOLUME RANGE"

A VARIABLE-ATTENUATION network, which includes a negative-resistance feed-back, is used in a broadcast, television, or other transmission system to contract (or expand) the volume range, as conditions may require. For instance, the signals may be "concertinaed" so as not to fall below a predetermined level in the presence of cross-talk or other disturbance. This maintains a high signal-to-noise ratio, and permits the normal operation of echo-suppressing and similar services, while shutting out interference. The "distorted" signals are afterwards restored automatically to normal.

The attenuation link consists of a thermionic amplifier having a non-ohmic input, preferably comprising a pair of dry-contact rectifiers connected back-to-back across the line. The shunt impedance is made to diminish with increase in signal amplitude in order to contract the volume, and to increase with the signal amplitude when expansion is required.

C. E. P. Jones. Application date, August 5th, 1936. No. 479388.

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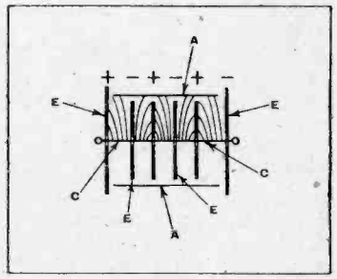
SHORT-WAVE OSCILLATORS

THE ordinary magnetron tube consists of a cylindrical anode and a coaxial cathode, with an external magnetic field to force the electron stream to follow a spiral path. It has been found that such a tube operates more efficiently if the magnetic field is slightly inclined to the cathode, so as to exert a radial component, though a more convenient way of securing the same result is to apply a transverse electrical field from two electrodes arranged at each end of the cylindrical anode.

The figure shows a development of the latter arrangement in which the transverse control is more evenly applied by using a number of biasing electrodes E, which are arranged vertically along the length of the cathode C and extend nearly to the cylindrical anode A. The positive and negative voltages which create the static field indicated in the drawing can now readily be adjusted



Electrode assembly of ultra-short-wave oscillator valve.

until the electrons follow the required spiral path.

Telefunken Ges Fur Drahtlose Telegraphie m.b.h. Convention date (Germany), July 16th, 1936. No. 481251.

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SELECTIVITY AND TONE CONTROL

AS the selectivity of a set is increased—by narrowing the accepted band of frequencies—the high notes tend to be cut so that the tone response is deepened. Independent control of the tone is usually effected by varying a resistance or capacity, or the bias on the grid of one of the amplifiers.

According to the invention, both adjustments are made by means of a single control-knob, but they take place one after the other, and not simultaneously. For instance, the first movement of the control-knob adjusts the selectivity of the set, and the listener can then decide whether or not to alter the tone response by making a further movement of the same knob. The arrangement simplifies control of the set, since the listener is neither called upon to learn the operation of two separate control knobs, both of which have a similar effect on the quality of the sounds produced, nor to remember the correct sequence in which they should be used. The selectivity of the set may in practice be set at a fixed level by the operation of the wave-change switch, movement of the control knob then serving merely to regulate the tone.

Standard Telephones and Cables, Ltd. (assignees of Standard Villa Mossagi Reszveny Tarsasag). Convention date (Hungary), July 9th, 1936. No. 480839.