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## THE BATTLE OF THE GIANTS.

THE "Plan de Prague," which came into operation at the end of June last, based on decisions previously taken at the Washington Conference, made the best of a bad job, namely, an attempt to fit into a narrow broadcasting band an innumerable list of European transmitters. Many exclusive wavelengths were cut down, more common waves were created, and others were shared by two or more countries; in fact, every effort was made to satisfy most of the claimants whilst still adhering to a co-ordinated plan with a view to securing a degree of order in the ether.

From the date it was carried out the "Plan de Prague" in turn has been highly praised or ruthlessly condemned, and it would be difficult for the average listener to distant stations to express his opinion regarding the success or failure of the scheme. Are general conditions better or worse than they were a year ago? An evening spent with a highly selective wireless receiver will demonstrate that, like the proverbial curate's egg, the broadcasting band is good in parts; but the small separation between frequencies necessitated by the narrowness of the band and the number of wavelengths to be allocated does not give sufficient elbow room, especially as on most nights some stations stray from their official positions.

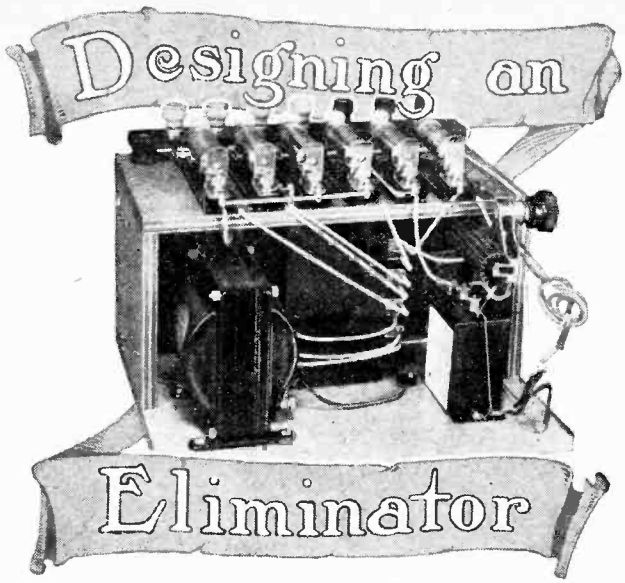
For close on three months the authorities have been given an opportunity of studying the working of the scheme, and at The Hague, where a conference is being held, the matter again comes up for general discussion. For the present it is difficult to see how any improvement can be made so long as the broadcasting band remains within such narrow boundaries, and stations are as numerous as at present. The Prague Plan, in its foundation, is based on the aerial energy of the respective transmitters, at the time it was prepared. This important factor is changing rapidly and is likely to annihilate the entire scheme.

Gradually, with the evolution and development of the wireless programmes, most authorities have put forward schemes either for an increase in the number of stations to supply an extended service or, alternatively, an increase in the power of the transmissions, thus obtaining greater range. With the centralisation of activities in the respective capitals, the latter scheme has been mostly favoured, and if a short study be made of the developments which are taking place in a number of European countries, it will be found that within the last year many additional high-power transmitters have come into operation. Moreover, the constructional programmes of most foreign broadcasting concerns call for a further increase. Taking Great Britain alone, the new Brookmans Park dual transmitter will work with an energy of 30 kilowatts in the aerial; and we are promised in the future four more similar installations.

On the Continent we find proposals to endow Strasbourg with a 12-kilowatt station, and to erect a 30-kilowatt transmitter at Bordeaux. Madrid intends to use 20 kilowatts, Barcelona 10, Rome 50, Milan 20, Naples 7, Prague 60, and so on.

If it is assumed that certain individual countries will look to an increased transmitting energy as a means to rid themselves of interference both local and distant, and thus ensure a better service to their licence-holders, we may be sure this example will be followed generally, with the inevitable result that the "Plan de Prague" must fail.

So far as can be foreseen, the near future will bring with it a Battle of Giants, an event which will benefit no individual country, but which, on the other hand, in the present limitations of the wave band, will sadly hamper broadcasting developments in Europe.




# Notes on Current Practice in Home-constructed H.T. Mains Units.

By W. I. G. PAGE, B.Sc.

PROBABLY the largest item in the upkeep of a simple radio receiver is the high-tension battery. Notwithstanding this, there are many listeners who have electric light in their houses and who refrain from constructing an H.T. battery substitute because they fear that the calculation of the resistance values and the design of the filter to suit their sets is too complicated for them. Let it be said at once that the science of decoupling or the process for preventing unwanted couplings when two or more A.C. potentials are common to one circuit has been so thoroughly developed during the last year that H.T. eliminators can now be designed either for A.C. or D.C. in which there is no trace of motor boating, hum, distortion, or loss of amplification.

Besides the obvious advantage conferred by a mains unit of a trouble-free anode supply, there is the question of economy. It should be pointed out that a unit of electricity can be purchased from a lighting company for, say, 5d., whilst the cost of a unit obtained from high-tension batteries would be about 30s. to 40s. Thus an A.C. eliminator costing, perhaps, £5 to £6 would soon pay for itself. Another advantage is the constancy, within small limits, of the voltage of the supply mains and the fact that power valves with a more liberal anode current than that usually to be extracted from batteries can be included in a mains set without producing any noticeable increase in the quarterly lighting bill.

### Voltage Regulation.

There are several fundamental differences between battery and mains supply. First, a change in current in the feed to any valve, when a battery is used, is not accompanied by any serious change in voltage, whereas with an eliminator, owing to the common resistance network which is always present, the voltage-current relationship is a steep slope known as the voltage-regulation curve. If, for instance, the power valve of a mains receiver is exchanged for another having double the anode current, the plate voltages on all the other valves will drop. Our aim, therefore, is to design an eliminator with the minimum common internal resistance. Secondly, if, when using a battery, we desire a voltage below the maximum (perhaps for the screen of an S.G. valve), we simply make connection to the necessary tapping, but we cannot obtain a lesser voltage than that of the mains unless we use a resistance. Here, again, a change in feed current results in a change in applied voltage. This difficulty is partially overcome by using separate potentiometers for all feeds of, say, 2 mA. and under, the resistance values being so chosen that the constant current passing through the potentiometer is over four times that of the feed to the valve.

Where a power valve is concerned it would be uneconomical to use a separate potentiometer; a series resistance is used in its place. Thirdly, to smooth out the ripple which is always superimposed on D.C. mains and is present in rectified A.C., it is necessary to make unstinted use of inductance and capacity, the association of which will inevitably mean resonance at some low frequency. There are certain minimum inductance and capacity values which must be exceeded to prevent the circuit being tuned to a frequency above about 25 cycles, otherwise hum will be heard in the loud speaker. A high-tension battery is devoid of ripple troubles, but with age will develop an appreciable internal resistance which, however, will be independent of frequency.

### Filter Circuits.

In brief, by comparison with a battery, an eliminator has a high internal resistance producing a sloped voltage-current regulation curve, a resonant frequency, no direct means of providing a lower voltage than the mains except by voltage-dropping resistances, and sufficient common impedance to necessitate the deflection of speech currents which would otherwise cause low-frequency reaction and various forms of interruption. The filter in Fig. 2 for A.C. or D.C., used with or without one of the rectifiers of Fig. 1, is designed to be a fair compromise between cost and the ideal condition where the various difficulties are avoided. It should be noted that no potentiometer is included that is common to two or more circuits (except in the case of the feeds to two S.G. valves).

We can now discuss the relative merits of the various forms of rectifier available for H.T. mains units for A.C. The valve rectifier is cheap, but has a filament of limited life, and where the full-wave type is used a tapped transformer of rather elaborate design must be employed, having a voltage of, perhaps, 500 across the outers of the secondary. The dry copper-oxide metal rectifier, being electronic in action, has a practically everlasting life, its efficiency is about 70 per cent., and its internal resistance is lower than that of the valve, so that the voltage regulation curve is less steep. Full-wave metal oxide rectification is effected by a bridge circuit, and the transformer secondary is

**Designing an Eliminator.—**

untapped and need have a voltage little in excess of that across the primary. The metal rectifier is rather sensitive to overload, and should always have a flash lamp fuse incorporated (fusing point between 100 and 200 mA.), and not more than 4 mfd. shunted immediately across the output, otherwise the A.C. load may be too heavy.

All rectifiers, except the voltage-doubling condenser bridge circuit, should have a reservoir condenser immediately across the output to charge up during the rise in voltage and to discharge into the load circuit during the voltage decline. With regard to the merits of half-wave and full-wave rectification, it should be stated that the former is rather cheaper where small outputs are desired, and although the rectified output is 50 cycles from a 50-cycle supply, the ear can tolerate from the average loud speaker without annoyance quite a large amplitude of ripple at this frequency. Full-wave rectification gives an output of 100 cycles from a 50-cycle supply, and less smoothing equipment is required to give the same freedom from ripple as compared with the half-wave method, but 100-cycle ripple is more audible from the loud speaker. It is thus rather a question of swings and roundabouts. For large outputs full-wave rectification has the greatest application.

In Fig. 1 (*a*) and (*b*) full-wave and half-wave valve rectification is shown. In (*c*) a metal-oxide full-wave bridge is illustrated. A Westinghouse unit of this type,

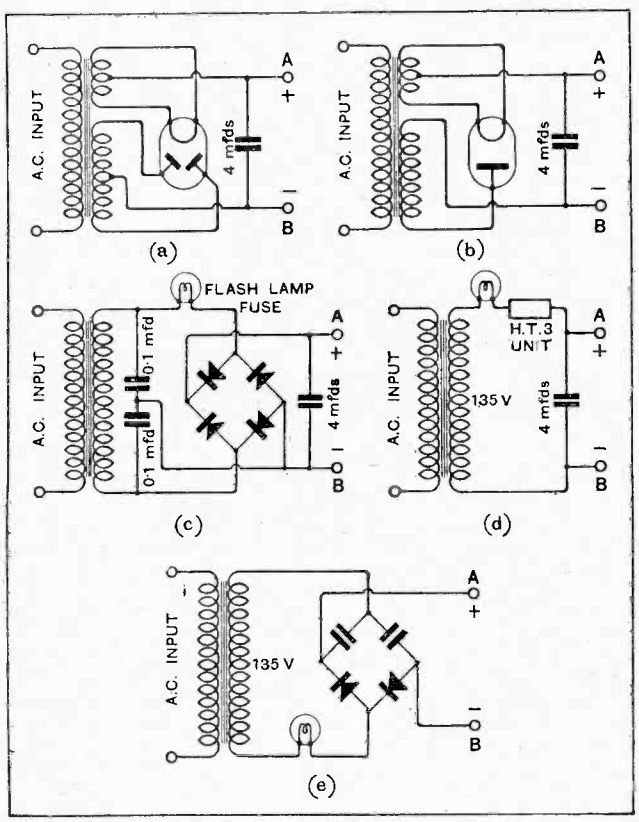



**Fig. 1.—Five methods of rectification at present in use. In each case the terminals A and B are connected to a smoothing circuit such as that shown in Fig. 2. (a) Circuit for full-wave valve rectifier. (b) Half-wave valve rectifier. (c) Full-wave bridge with metal-oxide rectifier. Note the double 0.1 mfd. condenser across the transformer secondary. (d) Half-wave Westinghouse metal rectifier (H.T.3). (e) Condenser-rectifier bridge giving full-wave rectification and a voltage step-up irrespective of the transformer.**

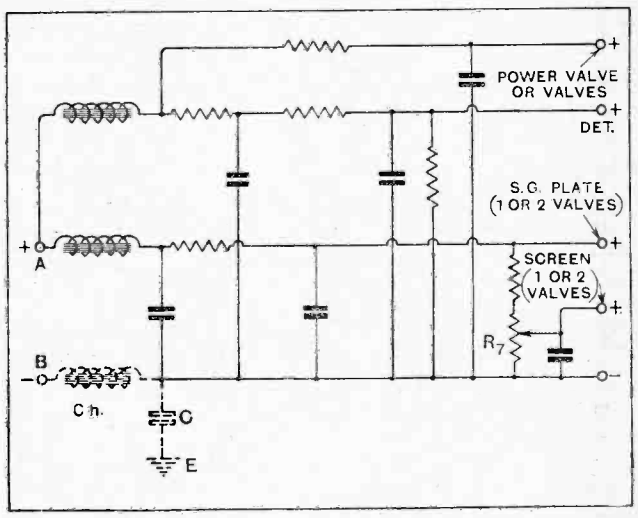
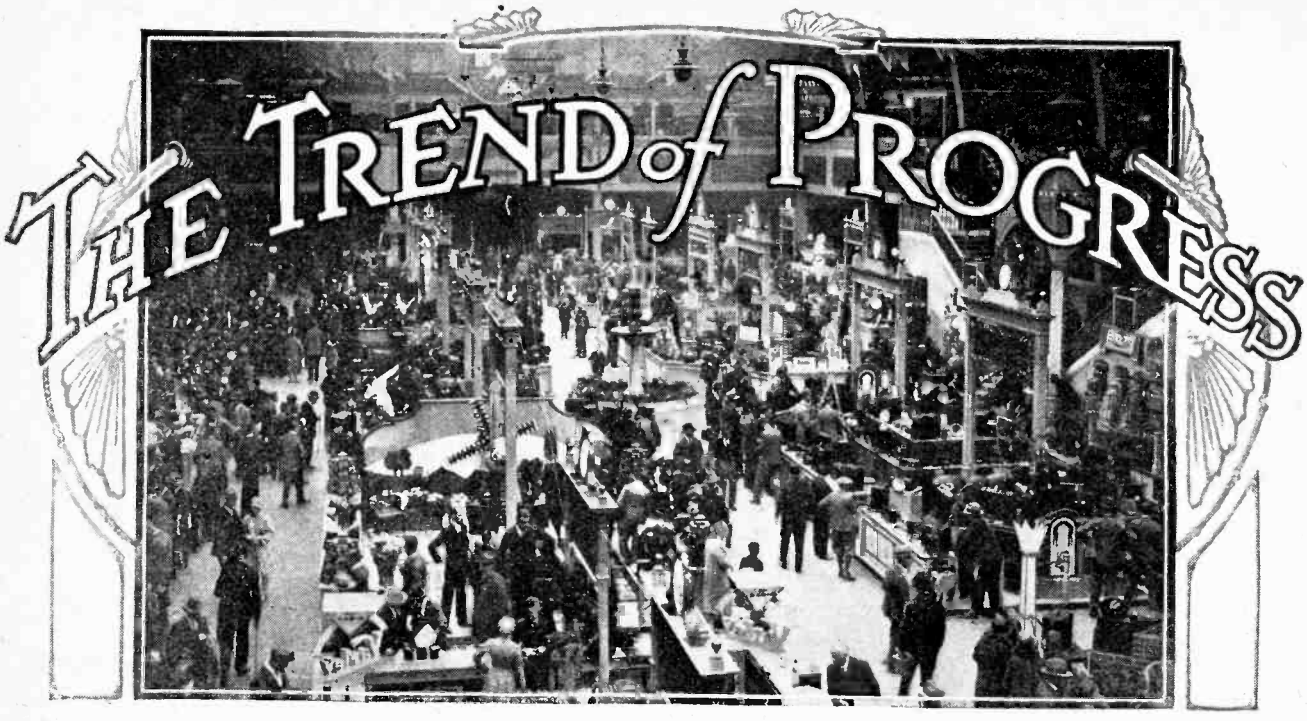



**Fig. 2.—A comprehensive smoothing and voltage-dropping circuit for modern 3-, 4- and 5-valve receivers. The terminals A and B can be connected to any of the five rectifiers in Fig. 1. If a choke Ch and an earth condenser C (shown in dotted lines) be added, the above circuit becomes an efficient H.T. eliminator for D.C. mains.**

known as the H.T.I., is manufactured giving the large output of 100 mA. at 200 volts, thus being suitable for moving coil speakers; note should be made of the flash lamp fuse and the centre-tapped double 0.1 mfd. condenser which will remove the last traces of hum. In (d) a Westinghouse H.T.3 half-wave unit is shown; the transformer secondary should give 135 volts and the smoothed voltage output will be 120 when the load is 20 mA.—a sufficient anode supply for most 3-valve kit sets. An interesting condenser-rectifier bridge, known as the H.T.4, is shown in (*e*) which gives a step-up irrespective of the transformer. With a load of 30 mA. the voltage developed is 180; with 50 mA. (the maximum permissible) the voltage is 150, both these outputs being obtained with 135 volts across the transformer secondary. This "voltage-doubling" device functions by virtue of the fact that the peak voltage charges in the condensers and the secondary voltage are additive. As explained in the inscription, the circuit of Fig. 2 can be used as a complete D.C. eliminator, while for A.C. it can be connected to any of the rectifiers of Fig. 1. Potentiometers are included where the valve current does not exceed 2 mA., and a desirable refinement for critical screen voltage control is used wherein one limb of a potentiometer consists of a continuously variable wire-wound potential divider.

The various 2 mfd. condensers can conveniently consist of a single tapped condenser block which confers the benefit of compactness, easy wiring and, last but not least, cheapness. Interchangeable clip-in resistances are used except for $R_7$ so that the anode feed may easily be changed to suit any valve.




## Our Impressions of Olympia, 1929.

THE outstanding impression carried away after a visit to Olympia has been that real progress is in evidence in almost every section of the Exhibition, and in the pages which follow we endeavour to present to the reader our views on what are the principal indications of progress made during the past year in the design and production of apparatus of all kinds. Something should also be said for the Exhibition itself, for therein, too, we have an illustration of the growing importance of the wireless industry of this country and a definite indication of its increasing stability.

The days appear to have passed when firms of mushroom growth came into the wireless industry with no experience of technical ability, but merely with the intention of making capital out of the ignorance of the general public in technical matters. To-day it is almost impossible to sell "junk" to the public, and we take considerable credit to ourselves because we believe that our efforts to distribute technical information amongst the public have contributed very largely to bring about that happy state of affairs so much in evidence at Olympia this year, where the bulk of the apparatus is above criticism technically and every stand impresses the visitor with confidence that the firm represented is a *bona fide* unit of the industry.

The Exhibition itself is larger than any Wireless Exhibition that has previously been held in this country, and the stands are more numerous; yet it is pleasing to observe that by the careful planning of the stands the organisers have been able to eliminate any impression of overcrowding in the hall. A specially constructed staircase leading from the main hall to the gallery is an innovation which has proved a most happy addition, not only from the point of view of the general appearance but because it has tended to attract the attention of the public to the gallery.

The most important innovation this year, and one on which we heartily congratulate the Radio Manufacturers' Association, is the provision which has been made in the gallery of soundproof demonstration rooms available to exhibitors. This has given the public opportunities to hear reproduction on the spot, and we hope that if in future Exhibitions space can be provided this feature may be extended so that every exhibitor can demonstrate. But we realise that with the number of exhibitors to be accommodated it was not possible for more demonstration rooms to be provided this year at Olympia. Whilst congratulating the organisers on this arrangement, we do not feel that we can be equally enthusiastic regarding the facilities arranged and the permission granted for loud speaker demonstrations in the open on every stand. There were times when in visiting the stands and conversing with the exhibitors one felt the need for a megaphone to carry on a conversation at all. We do not want to suggest that demonstration of this kind should be cut out altogether, but perhaps some arrangement could be made next year whereby a limited number of stands are permitted to demonstrate at one time.

Before passing on to our observations on the trend of technical progress we take this opportunity of extending our congratulations to the Radio Manufacturers' Association as the organisers of what is undoubtedly the finest Radio Exhibition which has yet been held.

# TYPES OF NEW RECEIVERS

THIS has been a year of consolidation rather than of innovation. The critical visitor to Olympia finds little that is radically new, but is confirmed in the opinion that manufacturers have now completely mastered the practical application of technical developments introduced during the two preceding years—which, after all, is far more important than the adoption of novelties merely for their own sake. There has been a definite all-round improvement in quality of reproduction, sensitivity and selectivity; further, sets have been "tidied up" to such an extent that, almost without a single exception, the exhibits are entirely capable of meeting the needs of the particular type of user for whom they are designed.

It would be idle and inopportune to indulge in vain conjecture as to the developments likely to be introduced in the immediate future, and, indeed, one gains the impression that no very sweeping modification of generally accepted standard practice is anticipated. This has had an important bearing on design, as many firms have deemed it safe to embark on an extensive manufacturing programme; in consequence, a large number of sets, instead of being mere assemblies of components, are designed as units, or, where it is found to simplify and cheapen the production of several models, as an arrangement of two or more units. This procedure—provided that production is large enough in the matter of quantity—makes for economy, the saving being passed on to the consumer either in the form of cheaper sets or better sets at the same price.

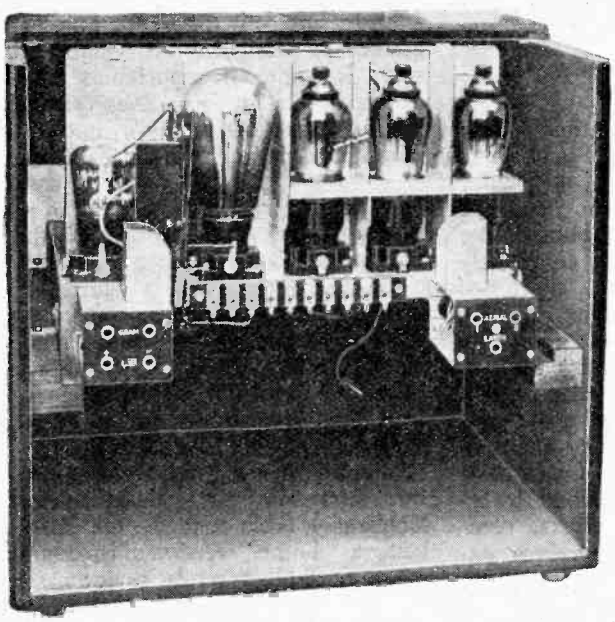
Metal lends itself admirably for use in these modern manufacturing schemes, and we find that it is applied extensively; it is almost the exception to find a receiver without a metal chassis, which generally forms part of the screening system—which, by the way, is in almost every case infinitely more thorough and effective than that of last year. From this it may be concluded that much better use is being made of the properties of the screen-grid valve.

In the matter of externals it is clear that polished wood is still the most generally used material for containers. Examples of other methods of construction are not lacking; the new Amplion, Cossor, and Marconiphone (type 47) sets are typical of those housed in metal cabinets, and show the wide scope in the finish that can be given. Another method is exemplified in the Ediswan and Philips (three-valve model) sets, where a leatherette covering is applied to the metal.

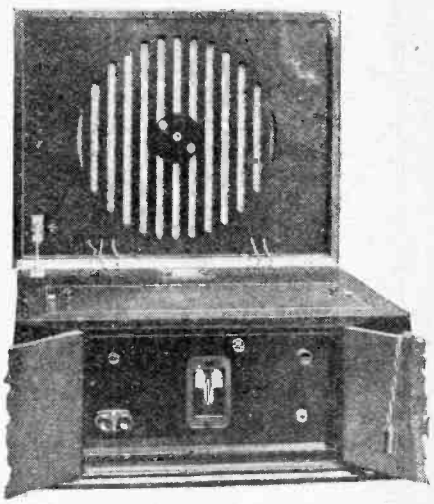
Tuning control is nowadays largely effected through edgewise drums, and the conventional circular dial is seldom seen. One guesses that this is because the thumb-operated discs are considered to be more attractive to the eye and more likely to appeal to the non-technical potential user. This form of control has another important advantage: we still find that complete "ganging" of condensers is but rarely attempted (the Burndept "A.C.7" is one of the outstanding exceptions), but that the side-by-side mounting of two edgewise dials affords in a large measure the advantages of single-knob tuning. This feature is included in perhaps the majority of sets having H.F. amplification. In the Marconiphone Model 56 receiver we find an elaboration of this scheme; its four tuned circuits are permanently ganged in pairs and the two dials are mounted side by side. The Columbia five-valve set includes a similar method, but here the two sets of condensers are coupled through a slipping clutch so that they may be operated together or individually as required; this is a promising line of development.

Another minor improvement in control, found in a number of sets, is the provision of a scale arranged at a convenient angle for reading the figures.

There is a definite increase in the



Marconiphone "3-H.F." receiver, with back cover removed. Space for batteries or mains unit is provided in the base.



Gambrell mains transportable receiver, with frame aerial and loud speaker in lid.

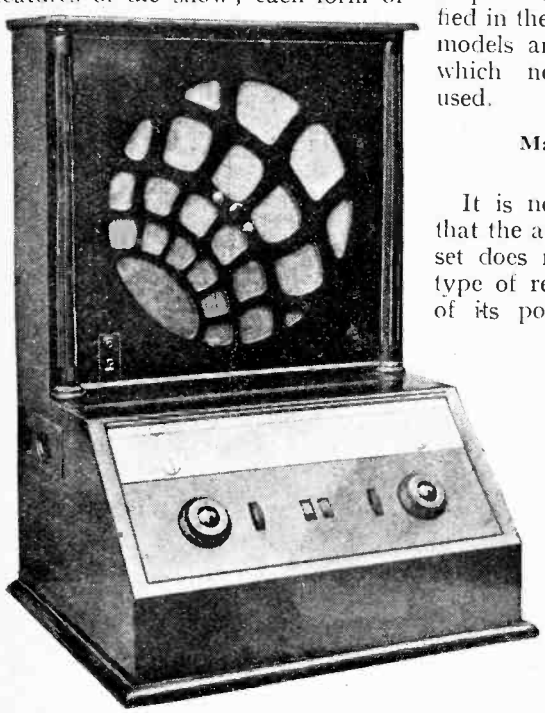
**The Trend of Progress.—**

practice of calibrating directly in wavelengths, instead of on an arbitrary scale. Naturally, this feature adds appreciably to the cost of production, but it is found in some quite inexpensive sets, and seems likely to be adopted to a still greater extent in the future.

Volume control methods have not undergone any radical changes, although the provision of means whereby the aperiodic aerial coupling may be critically and continuously adjusted has points of novelty; it is included in Amplion and Marconiphone sets. With regard to devices for inclusion in the L.F. side of the set, it is observed that the anode potentiometer method is widely used.

A third form of control—that of tone—is coming into use; it is embodied in the Columbia radio-gramophone, while the "Novotone" device is built into the Gambrell instrument.

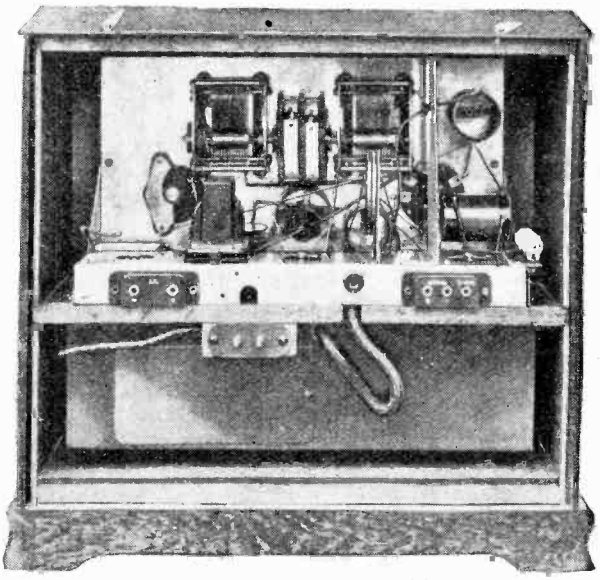
It is seldom that provision is not made for the use of a gramophone pick-up, except in the case of the simplest and least expensive type of set. As was to be expected, the radio-gramophone, complete with turntable, is one of the outstanding features of the show; each form of reproduction is, in a sense, complementary to the other, and the many excellent examples exhibited go to prove that it is not a difficult matter to combine the best features of both in a single instrument. No attempt has been made to take a census, but it is not likely to be wide of the mark to say that the majority of radio-gramophones include a built-in frame aerial which, thanks to the ample room available in the containing cabinet, is generally of sufficiently large dimensions to be reasonably effective. In several instances frames are built into flaps hinged to the sides of the cabinet, so that they may be orientated (this method is adopted by the British Radio Gramophone Company), while it is usual to provide an external knob for rotating built-in loops. A third course is exemplified in the Igranic "A.C.3" bureau models and radio gramophones, in which non-directional frames are used.



The evolution of the portable: the McMichael Table Model.

### Mains Transportable Sets.

It is not an exaggeration to say that the average buyer of a portable set does not choose that particular type of receiver solely on the score of its portability, but because he wishes for a completely self-contained piece of apparatus that can be moved from room to room—and very seldom, if ever, farther afield. The truth of this seems to be generally realised, and several firms have produced mains transportable receivers, complete in themselves except for a connection to the electric supply mains. One of the first examples of this type was the R.I. All-Electric Three, which, thanks to a circuit arrangement of high efficiency, has sufficient sensitivity (though including but three valves) for average requirements without the use of any aerial. Among other interesting sets in this



Interior of the Kolster-Brandes 3-valve mains set.

category are the Gambrell, Ediswan, and Lotus mains transportable models. The Burndept "A.C.7" and Igranic "A.C.3" (the latter in the bureau model) are representative in their two spheres of a different line of attack in designing self-contained sets; like the transportables they are complete in themselves (except for a mains connection), but are mounted in larger pedestal cabinets.

### Table Portables.

The general tendency towards the avoidance of a number of interconnected accessories is illustrated in other directions; battery-operated self-contained sets are now being made in a form in which portability is not the first aim of the designer, who has been more concerned in evolving a set for home use. Examples of this procedure are to be seen in the G.E.C. and McMichael table models, the latter being a "home" version of the long-range portable recently reviewed in these columns. There is also a tendency towards enclosing loud-speaker and set in the same cabinet;

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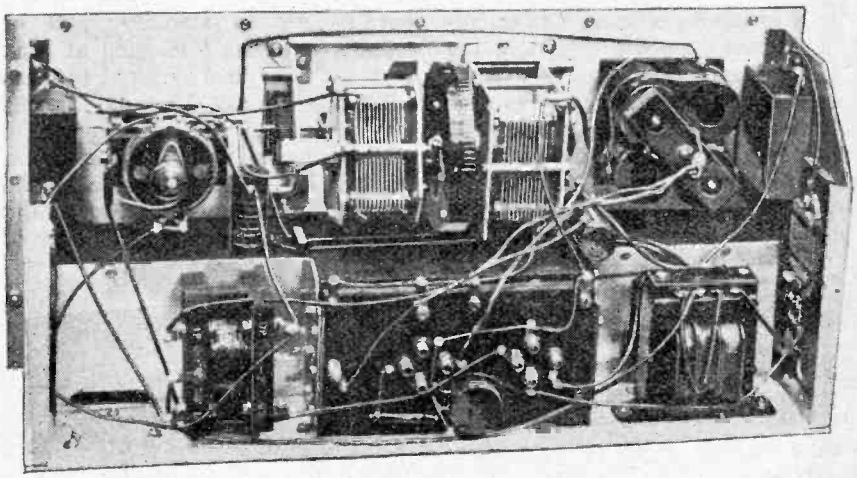
for instance, the new Cossor two-valve mains receiver is supplied in this form as well as in the conventional table pattern.

It is almost certainly correct to say that the present-day "standard" receiver is an H.F.-det.-L.F. three-valve combination with a pentode either definitely specified or optional in the last position. There are but few firms who do not produce something on these lines, but there is infinite variety in details of design. Grid-circuit detection is almost exclusively used in this class of set, but anode bend is adopted in several cases, notably in the Pye No. 350 A.C. set, which includes low-loss circuits specially suitable for working in conjunction with this type of rectifier.

The basic three-valve circuit of the type discussed in the preceding paragraph is as popular for mains operation as for battery feed, and, thanks to the increased efficiency of indirectly heated valves, is generally quite as effective—indeed, much more effective—than the average four-valve set of a year or two ago.

Reverting to the question of detection, it is clear that the anode bend method has gained ground, but only in sets having an exceptionally efficient single H.F. stage (as the Pye No. 460), or in those with two or more H.F. stages.

There has been no great change in the L.F. amplifier except that there seems to be an ever-increasing number of sets with a single stage. In these sets there is a tendency to increase magnification by using a high-ratio L.F. transformer, such as in the new Ferranti A.C. receiver.



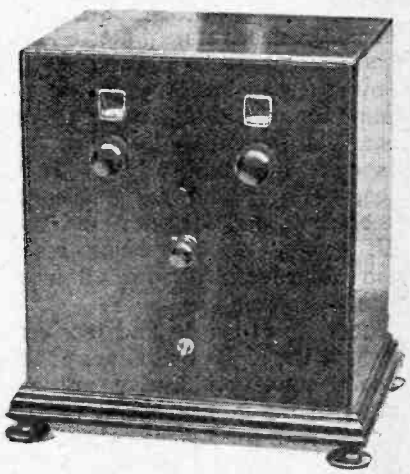
A modern portable set chassis: the McMichael portable.

It is found that practically all sets of the more ambitious type include at least some measure of decoupling, and in many cases, particularly where mains feed is provided, this refinement is included in every circuit that might conceivably give rise to interaction troubles.

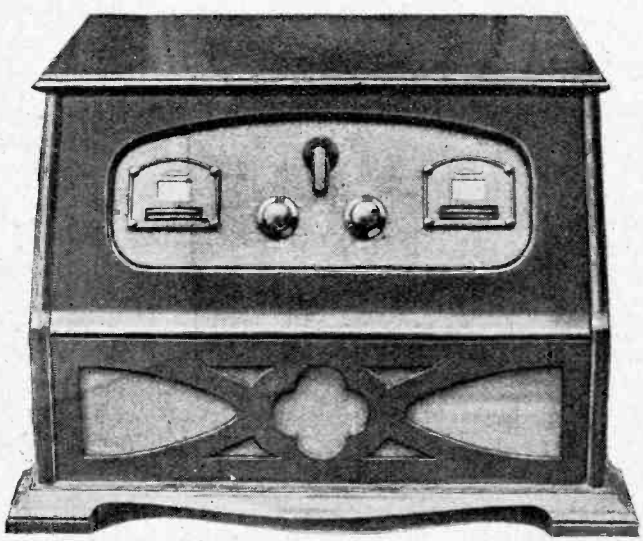
In mechanical details there has been a general all-round improvement since last year; variable condensers with inadequate bearings or switches likely to develop faulty contacts after a few months' use are hardly ever seen, and almost every set should work for years without failure of its moving parts.

It has already been suggested that the outstanding feature of present-day set design is tidiness, and to this end the tendency is to include the set proper, as well as its accessories—batteries or mains unit, loud speaker, and even frame aerial—in a single container. In quite inexpensive battery sets, space for batteries is often included in the cabinet.

Although the general average of selectivity has been improved to such an extent that the requirements of the average user are adequately satisfied, there seems to be no determined attempt to cater for the potential purchaser whose letter-paper is headed, say, "Potters Bar." He is, of course, in a minority, and, commercially, can hardly be considered, although from the technical point of view it would be interesting to see what sort of comparatively simple arrangement could be devised for him.



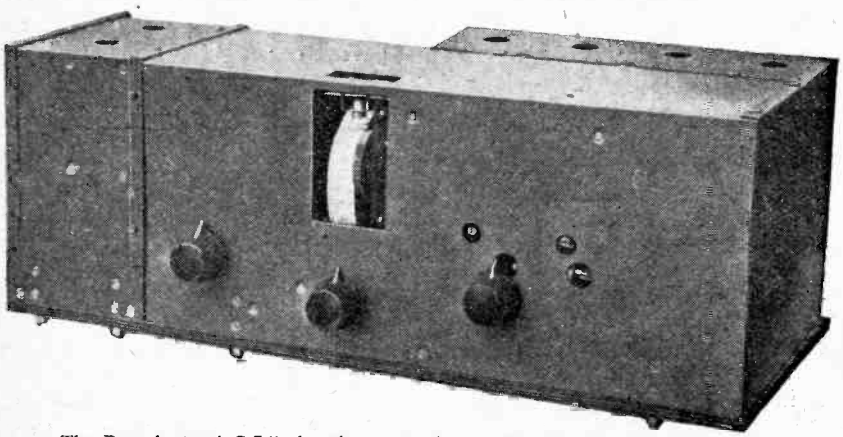
The new Ferranti all-mains receiver.



A good example of British design and construction: the Pye No. 350 three-valve A.C. set.

# H.F. AMPLIFICATION IN MODERN RECEIVERS

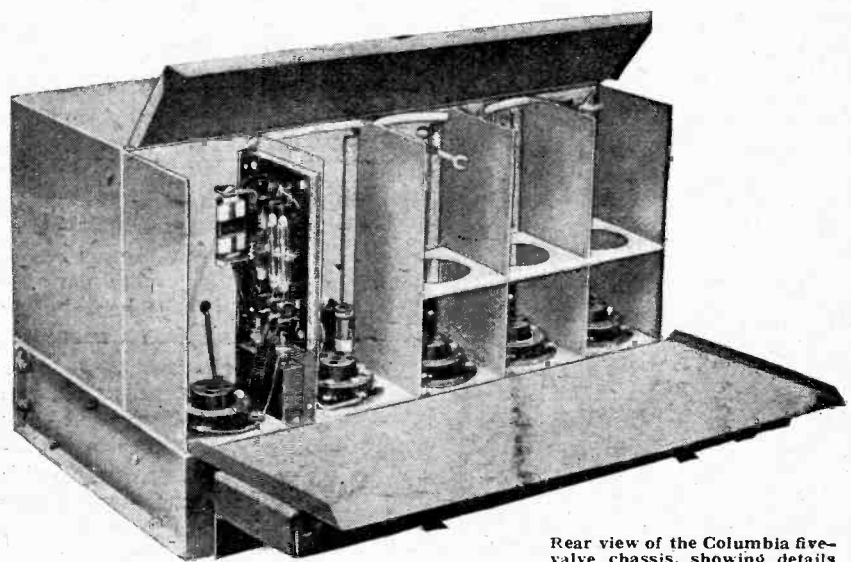
THE imminence of the regional scheme, with its twin-wave high - power transmitters, seems to have exercised a premonitory influence on the design of the high-frequency portion of this year's receivers. The need for greater selectivity that will be manifested under the new conditions is probably responsible for a general tendency to amplify more at high-frequency and less at low. Of modern four-valve receivers, quite a fair percentage have two H.F. stages followed by an anode-bend detector feeding directly to the output valve, whereas a couple of years ago one was certain to find a single H.F. stage, of very dubious efficiency, preceding a grid detector and two L.F. stages, reaction being relied upon almost entirely for all long-range reception.



The Burndept "A.C.7" chassis removed from its cabinet. This "2-H.F." set exemplifies modern tendencies in construction and screening.

Those who hope to find receivers in which the high possibilities of the modern screen-grid valve are exploited to the utmost extent will be disappointed, for a stage-gain of two or three hundred times cannot at present be attained in any design suitable for factory production. Instead of one high-gain stage many manufacturers have wisely preferred to offer two stages of moderate gain, and have thereby provided a greater degree of amplification and better selectivity than can be had, even in the laboratory, from a single stage. The higher coil losses permissible when two stages are substituted for one have the further great advantage of permitting less perfect screening without danger to stability, and of making it possible to gang at least two of the three tuning controls without loss of amplification. In this way the extra selectivity and the additional amplification of the second stage are made available while keeping a maximum of two tuning controls and avoiding all danger of losing the side-bands of the received telephony. One of the Rees-Mace portable receivers, for example, employs two tuned stages, the two intervalve transformers being tuned by a single knob, while there is a separate tuning control for the frame. It is interesting to note that for the complete screening of the H.F. stages tin-plate boxes are used, this material being chosen, we understand, because the seams of the boxes can readily be soldered up to provide the thorough screening that is so essential in a set of this type.

An interesting contrast in two H.F. receivers is presented by considering together a Burndept and a Philips set. In the former the whole of the amplifier is enclosed in a compact aluminium container which appears to provide almost perfect screening between successive stages. In the latter the use of toroidal coils has made possible the construction of an effective two-stage amplifier in which screening is practically non-existent, metal only being used in the form of a skeleton framework upon which the receiver is built. It seems probable that in this case any small stray couplings that may exist have been deliberately pressed into service to prevent oscillation instead of provoking it. If this guess is correct we have here an excellent example of the way in which the very limitations of factory production can be used as a help instead of a hindrance in the design of an efficient receiver. Both these receivers are completely ganged, there



Rear view of the Columbia five-valve chassis, showing details of the screening system.

**The Trend of Design.—**

being but one control knob for all three tuned circuits.

In place of the two-position wave-band switch to change over from the medium to the long waves, the Burndept receiver employs a three-way switch. By this means the range of 200-550 metres is divided into two parts, and the variation in stage gain so often noticed in passing from one end of the medium wave-band to the other is very materially lessened by avoiding the large change in L/C ratio that is otherwise inevitable in tuning over this wide range.

### Screening Materials.

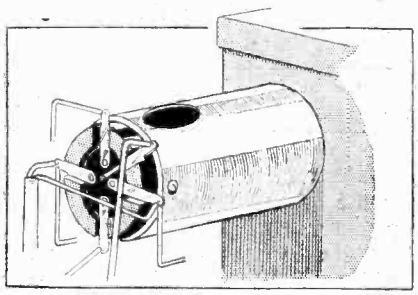
Apart from the Philips receiver just mentioned, there is noticeable a distinct tendency to use a greater amount of screening than has been customary in the past. The favourite material for the purpose is aluminium, partly owing to its lightness, and partly owing to the ease with which it can be worked. As aluminium cannot be soldered, the general custom is to make the boxes or other containers in separate sections and to build up the sections into the finished article by means of bolts. Only in cases where the compactness of the receiver, the high overall amplification, or the high efficiency of each individual stage is such as to make the most perfect screening essential are other materials preferred.

The only two receivers employing three H.F. stages both make use of what appears to be nickel-plated brass for the very perfect screening that their very high amplification demands, while in a single-stage receiver seen on the Varley stand, in which single-layer coils of thick wire are used throughout, a copper screening-box surrounds the detector grid circuit. This receiver shows a further refinement of screening, which consists of a brass tube surrounding the screen-grid valve and protecting it, as shown in the sketch, from the field of the coils. The tin-plate boxes of the Rees-Mace portable have been mentioned on the previous page.

In general one may say that screening, which a few years ago bore a shame-faced air of being a last-minute addition to stabilise an untuly set, is now so generally recognised as the prime essential of a successful high-frequency amplifier that it tends to the opposite extreme of controlling the whole lay-out of the receiver. One of the happiest examples of simultaneous design of set and screening system is undoubtedly found in the McMichael portable receiver.

The Marconiphone Co. and the Columbia Graphophone Co., the latter a newcomer to the wireless trade, both offer receivers embodying three stages of tuned high-frequency amplification. With three stages available, there is no need to make any attempt to extract the maximum amplification from each stage, so that very compact construction has been made possible. The result is a receiver in which overall selectivity should be very high indeed without danger of any loss of side-bands due to over-sharp tuning, while the overall amplification is probably better than the theoretical maximum which two stages ought, on paper, to provide. The use of astatic coils in combination with very thorough screening ensures stability, while the comparatively high losses of the coils have made it possible to reduce the tuning controls to two edgewise drums which can be rotated together with one hand. This method of attaining high amplification, though not cheap, offers a luxurious simplicity in use that cannot be surpassed by any other type of design.

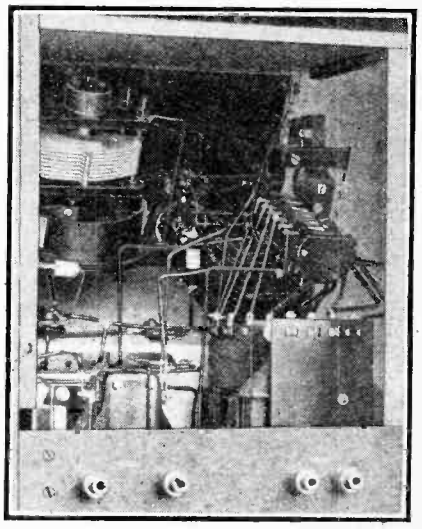
The widest choice of receivers is offered in the "1-H.F." class, of



**The H.F. valve of the Varley set is enclosed in a brass tube projecting from the main screening box.**

which there are very many examples. The design of the coils varies very widely from set to set, but it is interesting to note that even where coils of quite high efficiency are employed it is still considered necessary, in almost all cases, to use a grid detector aided by the use of reaction.

This suggests that the makers of



**Interior of the "H.F." end of the Pye No. 350.**

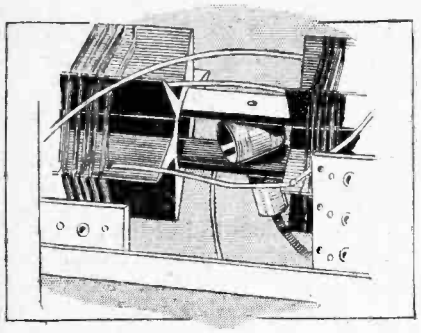
the sets are doubtful of the ability of their receivers to provide, with only two tuned circuits, the selectivity that will be needed when the Regional Scheme comes fully into operation, and may perhaps be taken to indicate that they expect their clients to follow the advice of the B.B.C. and reduce their aerials to quite small dimensions. With small aerials the selectivity of two tuned circuits may be expected to be reasonably adequate, while the incorporation of reaction will enable stations at long distances still to be received.

The Ediswan receiver contains single-layer coils for both aerial and intervalve tuning on the medium wave-band. The fact that the aerial coil is wound with stranded wire suggests that the receiver is intended either for use with quite a small aerial, or with a very loose aerial coupling, as otherwise the benefits conferred by this expensive form of winding would not be evident. It was difficult to follow out the switch wiring, but it appeared that a loading coil was used for the long waves, being shorted out on the medium wave-band. In the Pye three-valve set, on the other hand, two entirely separate high-frequency

**The Trend of Design.—**

transformers, with a complete switch-over of all connections, have been preferred. A photograph indicates the extreme neatness of the arrangement, and shows the arm that goes through the screening-box to gang the aerial-circuit switch with the intervalve-circuit switch that is actually shown. The only definite data for stage-gain that was offered us, on any stand, referred to this receiver. The amplification for the medium-wave band is given as 96 times, with 160 times on the long-waves.

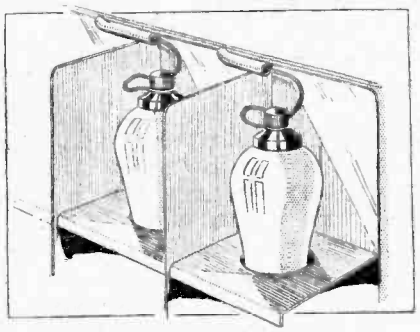
In the Ferranti three-valve receiver the coils used are wound in slots in a ribbed ebonite former as shown clearly in the sketch.



**H.F. transformers in the Ferranti set, showing mounting of the reaction coil.**

Readers of *The Wireless World* will hardly need to be reminded that high-frequency transformers constructed on these lines offer many valuable advantages when used with screen-grid valves.

Binocular coils do not appear to have received much attention, though they are in evidence in a McMichael set which, with only one high-frequency stage, is recommended for use with a frame aerial. The ingenious method in which one pair of reaction coils (one coil being coupled to each half of the binocular



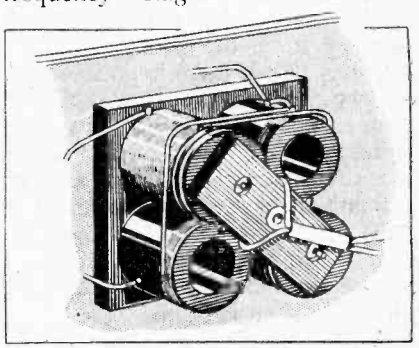
**H.F. valve mountings in Marconiphone Model 56 set. Screening tubes are provided for the anode leads.**

pair) is made to do duty on both wave-ranges is indicated in the accompanying sketch.

The comments so far made have been applied impartially to all sets, whether tuned anode, tuned grid, or tuned transformer circuits have been adopted. The simple tuned anode is giving place, by degrees, to its more elaborate rivals, both of which offer advantages in lessening inter-stage coupling. In the cases where transformer coupling has been adopted, it has usually been preferred for the sake of the extra selectivity that, at the cost of a small decrease on amplification, it can be made to yield. Tuned anode circuits are, on the whole, mainly to be found in receivers with but one stage of high-frequency amplification, while the decoupling advantages offered by the other two circuits have made them the favourites where more than one stage is employed.

Untuned couplings are chiefly to be found in the portable receivers, where the use of a frame makes up for an extreme lack of selectivity in the amplifier itself. A very useful compromise, offering an increase both in signal strength and in selectivity, is found in many portables which have one tuned and one untuned stage.

Even the briefest survey of the receivers offered at this year's Show makes it very clear indeed that the bad old days when the high-frequency stages were included



**Assembly of medium and long-wave binocular anode coils in the McMichael portable. Swinging reaction coils are mounted on a pivoted block.**

merely as a selling point, with no real hope that they would contribute anything to the amplification of the receiver, are past and over. Though one could not say that every amplifier comes up to the standard of the best on view, there is certainly none that fails to contribute a very considerable share to the performance of the set into which it is built.

# OPERATING FROM THE MAINS

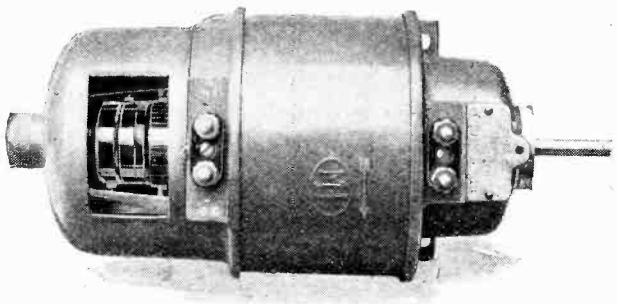
THE majority of the listening public have yet to appreciate the success which attends both long range and quality reception which has been brought about by the remarkable progress revealed during the past few months in valve manufacture. Makers of sets are emphasising the outstanding quality of reception combined with an ability to receive distant stations, coupling with these claims the merits of "all-mains" working. It is this last observation which is responsible for the improved performance, first by the use of the new indirectly heated valves, and secondly by the facility with which the comparatively heavy H.T. demands of a generous output stage are obtained from the mains.

To the statement "mains operated" so freely announced at the stands must be added the initial letters "A.C." Whereas at last year's exhibition there were more D.C. than A.C. mains-operated sets there are now comparatively few D.C. models.

With the comforting remark that the D.C. supply is shortly to be substituted by A.C. the manufacturers have shunned the problem of the D.C. mains-operated set and at the moment are congratulating themselves on having achieved the almost unexpected and outstanding results given by the A.C. equipment.

**The Trend of Design.—**

There are exceptions among the exhibits of the mains-operated set manufacturers of previous years, where D.C. as well as A.C. sets are still to be found. On the other hand, the majority of the exhibitors of "all-mains" operated sets, such as Philips, Ferranti, Colvern, Cossor and many others, provide exclusively for A.C. supply. With the fairly reliable estimate of three to five representing the ratio of D.C. to A.C. mains supply the scarcity of D.C. equipments is significant. Had there been a mains valve taking a current appreciably less than 0.1 amp. and a potential approaching that of the normal D.C. supply voltage there is no doubt that D.C. mains equipments would have equalled in numbers those designed for A.C. supply. The listener who has D.C. supply is disappointed. Any of the A.C. mains-operated sets can, however, be used with D.C. supply with the aid of a small D.C. to A.C. rotary converter. Such a machine has been developed by the M-L Magneto Syndicate, Ltd. This machine is of the double-wound armature type and, like M-L generators, has a permanent magnet field. The A.C. output is 40 watts.



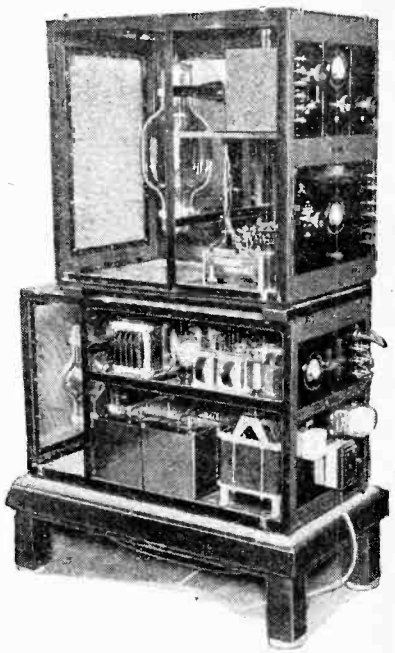
**Small M-L alternating current generator, permitting the use of A.C. mains receivers with D.C. supply.**

Another machine of interest to those with D.C. supply is one arranged to step-up the mains voltage to 500, thus affording a solution to the problem of operating generous output valves with a modest mains potential.

In design, the A.C. mains-operated sets possess little novelty. A transformer produces the potentials required for a metal or valve rectifier, heater current for the indirectly heated valves, as well as A.C. filament current for an output valve; while in some instances an additional potential is provided for a grid biasing rectifier. It is the exception rather than the rule to fix the available anode potential at a maximum of 150 volts, as was the case last season. Rectified potentials of 250 volts are common, brought about by the use of such output valves as the P.625, P.625A, and the P.T.625, while in more than one receiver of the popular class the anode potential approaches 300 volts to suit the new pentode valve, the P.M.24A. An even division roughly exists in the sets shown between the use of metal and valve rectifiers.

**Grid Biasing Methods.**

Examples of the three common methods of obtaining grid biasing in the A.C. mains-operated set are to be found. In order of popularity these are: (1) "free" grid bias produced by a voltage across a resistance which is traversed by the anode current; (2) a separate rectifier, and (3) the use of a potential divider across the H.T. supply. The first is favoured because of its small cost and its freedom from the complications of unwanted couplings. Like the potentiometer arrangement, this method results in a reduction of the maximum anode voltage, grid bias being obtained by robbing the H.T. potential. The potential thus taken is not accompanied by the drawing of a supply of current that is made available by the high voltage rectifier. Method (2) is invariably carried into effect by the use of the special Westinghouse rectifier produced for the purpose. The merit of this arrangement is complete separation of grid and anode circuits. The potential divided method (3) is only adopted when the various anode potentials required in the receiver are produced by means of a potentiometer. This third method is, where necessary, associated with the use of feed resistances to avoid couplings between the several valve stages. Several of the A.C. mains-operated sets are fitted with grid biasing cells. It is the low cost of the grid cell as compared with other biasing devices that accounts for its continued use. The inclusion of cells in mains-operated receivers is to be deprecated, on the grounds that a loss of voltage is only discovered in consequence of a falling-



**Complete mains-operated speech amplifier for public address purposes developed by Partridge and Mee.**

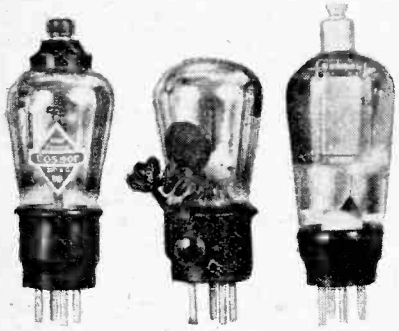
off in performance. When this point is reached the valves will almost certainly have suffered damage by being operated at the full anode potential maintained by the eliminator.

A departure from the established practice of last season, when manufacturers were opposed to the use in home equipments of voltages much in excess of 200, is the provision in several sets in the radio-gramophone class of anode potentials of the order of 500 volts. These outfits are, of course, essentially designed for hotel and cinema work. A notable change among the large mains-operated installations for public address purposes is the substitution of a single high-powered valve in the place of a parallel-connected group. It is invariably the practice to build a high voltage rectifier associated exclusively with the output stage when the speech output exceeds more than a few watts.

# VALVES OF TO-DAY

PROGRESS in receiver design is almost entirely dependent upon valve development, as witness the abundance of all-mains receivers at Olympia this year—an advance following close on the heels of the A.C. valve which has only lately been *generally* obtainable from the group of well-known valve makers. Valves with indirectly heated cathodes have suffered from a serious defect—namely, grid emission—but a cure has been found and applied, with the result that this year is being known as an "all-mains year," so quickly does receiver technique respond to the influence of the valve.

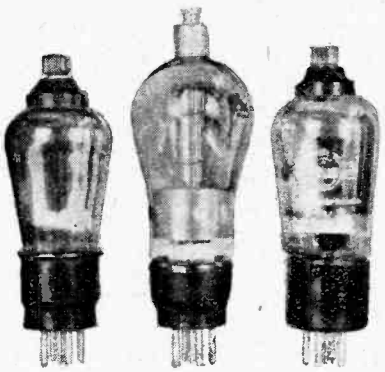
Last year saw the introduction of the pentode, which has now consolidated its position and is to be found fitted as standard in many sets, especially portables, where space considerations demand the minimum number of valves and couplings. There are many new pentodes available, amongst them a type capable of enormous output when using 300 volts H.T. and having a filament suitable for direct A.C. heating. Hitherto the low maximum permissible anode voltage somewhat restricted the output, and incidentally the input of the pentode.



A B C

**Three typical battery-fed screen-grid valves. (A) Mazda 215 S.G. The anode-grid capacity is 0.005$\mu\mu$F; a stage gain of about 150 is possible (unneutralised). (B) Cleartron S.G. valve with anode terminal in base and press-button connection. (C) Cossor 220 S.G.**

Screen-grid valves for battery heating have been improved to such a degree that it is now possible to make the definite statement that, with a simple coupling, a stable amplification is obtainable up to four times that possible with the best neutralised three-electrode valve. The demise of the latter is, therefore, complete. The universal adoption of the screened valve where H.F. amplification is used not only makes for considerably greater stage gain, but there is also the advantage of simple waveband switching and the application of reaction without aerial reradiation.



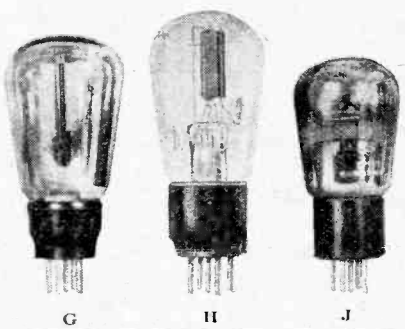
D E F

**Indirectly heated screen-grid valves for A.C. mains. (D) Cossor MSG41 with a slope of 2 mA./volt. (E) Mazda AC/SG with which the remarkable stage amplification of about 250 (unneutralised) can be attained. The inter-electrode capacity is 0.0045$\mu\mu$F. (F) Mullard S4V with an amplification factor of 1000.**

Perhaps the most striking addition to the enormous range of valves now available is the series of indirectly heated screen-grid valves with remarkable constants. There are four such valves at the moment on the market with which a simple coupling coil can be used and stable amplifications up to nearly 250 times, or about six times that of the best possible neutralised triode, are possible. Before discussing specific cases of valve design, tribute must be paid to those manufacturers who have developed the 2-volt three-electrode valve, so that its characteristics for a given filament wattage are as good as, and in some cases better than, those of similar 6-volt valves. Reference is here made to the new 2-volt battery valves with mutual conductances approaching 4 mA. per volt—a great achievement.

It is understood that the popularity of 2-volt valves in general is such that their output from at least one well-known factory is considerably greater than all other types put together. This can be accounted for by the big demand for such valves for portable receivers and for home sets where the L.T. accumulator has to be carried to the charging station. Little advance appears to have been made with directly heated A.C. valves with fat, short filaments for A.C. potentials below 1 volt. They may confer the slight advantage of easier wiring, but there appears to be no directly heated model which has not got an indirectly heated counterpart with substantially better characteristics, and there is no advantage in price. There is a welcome standardisation of valve bases and holders for all A.C. valves, the fifth contact being centrally disposed on the base. It is understood that all pentodes will fall into line with this arrangement in due course; at present there are only one or two to be found without a side terminal.

Referring again to A.C. valves with independently heated cathodes, it has apparently needed a great deal of research to combat the evil of emission taking place from the control grid—a condition which is worse in its effect in a receiver than the copious flow of grid current. It is almost impossible to prevent the



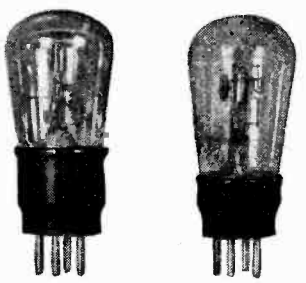
G H J

**Indirectly heated triodes. (G) Mazda AC/HL with a slope of 2.6 mA./volt. (H) Marconi MH4 valve. (J) Mullard 354V with an amplification factor of 35 and a slope of 2.5 mA./volt.**

coating of the cathode from finding its way to the grid, but the problem of avoiding a sufficient temperature rise to prevent the grid from emitting has been tackled particularly by the Metro-Vick research department, and the fruits of their labour are

**The Trend of Progress.**—evident in the present range of Mazda A.C. valves. In the first place, instead of a separate heater and insulator, the heater is dipped into porcelain "slip" so as to be coated with an adherent insulator. This produces a cathode of small diameter and considerable length, resulting in the watts dissipation per cm. being small, thus maintaining a cool grid. To allow for any small heat radiation from the grid, a number of A.C. valves also have open or ventilated anodes.

Where lighting mains are available, there is a great advantage in using A.C. valves, not only because of the cheaper and constant voltage supply, but also for the reason that, compared with battery valves, a

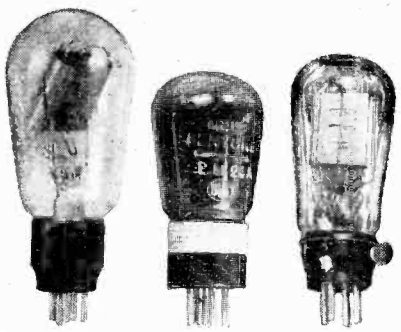


K L

**Directly heated A.C. valves. (K) Osram D8. A special detector consuming 1.6 amps. at 0.8 volt. (L) Cossor 82.MD.**

better mutual conductance and hence performance can be obtained. The A.C. valve does not suffer from a potential gradient down the filament, as it has an equipotential surface and there is no field around it tending to restrict electron flow.

Including the four A.C. screened valves already referred to, there are at present about nineteen indirectly heated valves marketed. The Mazda AC/HL is an improved AC/G with an A.C. resistance of 13,500 ohms and an amplification factor of 35; the AC/P has a mutual conductance of 3.75 mA./volt and an A.C. resistance of 2,650 ohms, while the AC/P1 is a super-power output valve having the high amplification factor of 5 and an A.C. resistance of 2,000 ohms, and is capable of delivering at 200 volts H.T. 1 watt of undistorted A.C. output. This is accepted as being adequate for a moving-coil loud speaker for any ordinary domestic purpose. The Marconi and Osram MHL4 has the necessary characteristics for an anode bend detector, and will accept up to about 25 volts grid swing

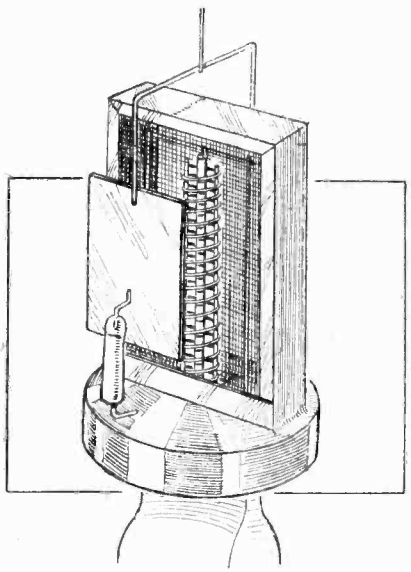


M N P

**Typical pentodes. (M) Osram PT 625 for anode voltages up to 250. (N) Mullard PM24A for 300 volts H.T. (P) Mazda 230-Pen. The outer grid is connected to the control grid as a safeguard.**

when the high-tension voltage is 200. With an A.C. resistance of 8,000 ohms and an amplification factor of 16 it would be permissible to link such a detector to an L.F. transformer of high primary inductance. The ML4 is a power output valve with a slope of 2 capable of accepting about 45 volts grid swing with 200 volts H.T.

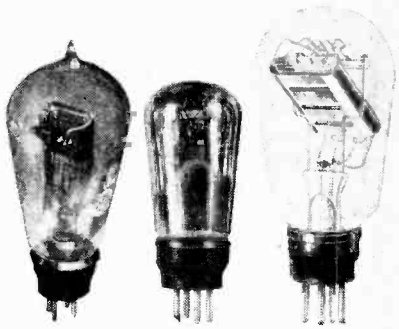
Of the Mullard A.C. valves, mention should be made of the 164V, which has the characteristics of the well-known steep slope "D" valves, but an even better mutual conductance of 2.4 mA./volt. The



**The electrode disposition in the Marconi M.S.4—the S.G. valve for A.C. mains. The interelectrode capacity has been reduced to 0.0045 $\mu\mu$F by the use of a cross-mesh screening grid. A stage amplification of nearly 200 with stability is possible (unneutralised).**

power output valve of this series—the 104V—has the remarkable slope of 3.5 and an A.C. resistance of 2,850 ohms. There are no fewer than five Cossor A.C. valves (other than the S.G. valve for A.C.) having A.C. resistances from 2,000 to 20,000 ohms.

As for screen-grid valves, about a year ago it was not possible to obtain a stage amplification greater than about 80 before instability set in, however perfect the screening in the receiver might have been. By a careful investigation of the effect of two screening grids in cascade or by using a cross-mesh screen, it has been found possible during the last year to reduce the interelectrode capacity to the extremely low figure of 0.0045 micromicrofarads, allow-



Q R S

**Power output valves. (Q) Osram LS6A giving a very large power output. (R) Mazda P.240; a 2-volt battery valve with the remarkable slope of 3.7 mA./volt. (S) Marconi PX4; a new 4-volt power valve.**

ing single-stage amplifications up to 250 with stability and without neutralisation. The Mazda 215 S.G., the AC/SG, and the Marconi and Osram MS4, have capacities of about the figure mentioned. With low-loss circuits it is the valve capacity which limits the amplification possible before oscillation commences. As an example let us take the Mazda 215 S.G. with a capacity of 0.005 $\mu\mu$F; the maximum attainable amplification (unneutralised) is about 150; if the capacity had been 0.05 $\mu\mu$F—a figure not unknown quite a short time ago—the maximum amplification would be 60, or hardly any more than that of the much cheaper triode.

A very controversial point now arises. With such meticulous care to avoid the very minutest loss due to valve capacity, it would seem incongruous with valves for H.F. cir-

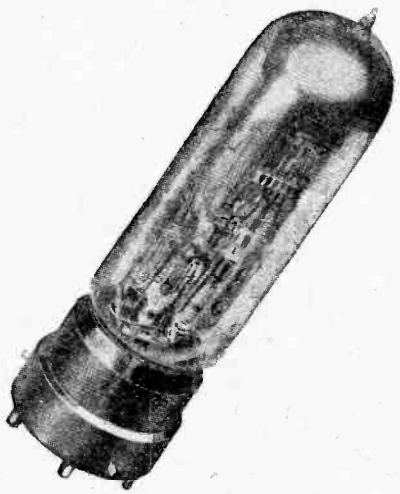
**The Trend of Progress.—**

cuits to use an ordinary valve base and valve holder, which together add a minimum of about 500,000 ohms (at 300 metres) in shunt with the dynamic resistance of the tuned circuit. If the latter is of the Litz low-loss type with a dynamic resistance of possibly 300,000 ohms, as soon as the valve and holder are put in circuit the impedance drops to 188,000 ohms, or a little over half its original value. A decapped valve acts as a shunt of about 5 megohms and has a negligible effect. Will a new method of mounting valves for H.F. circuits be seen during the coming year?

With regard to special detectors, beyond the indirectly heated "D" valves there does not appear to be any newcomer. A screened valve with an A.C. resistance not above 20,000 ohms would find a large field of application for aperiodic coupling in portable sets and for anode bend detection.

Readers may have been wondering why with each new range of valves the leaky grid detector of the series becomes more sensitive. This method of detection depends upon the bend in the grid current curve, which is bound up with the question of emission velocity from the filament. In its turn this is affected by the working temperature, and herein lies the explanation. Successive oxide-coating processes have resulted in lower and lower filament temperatures, and if one of the new valves be compared with a former type—each having the same A.C. resistance and amplification factor—the greater sensitivity of the new valve with the lower working temperature will be most marked.

There is an abundance of pentodes this season. In spite of the theoretical disadvantage of disparity



Loewe multiple valve (triple) containing detector with contact for reaction and two resistance-coupled L.F. stages.

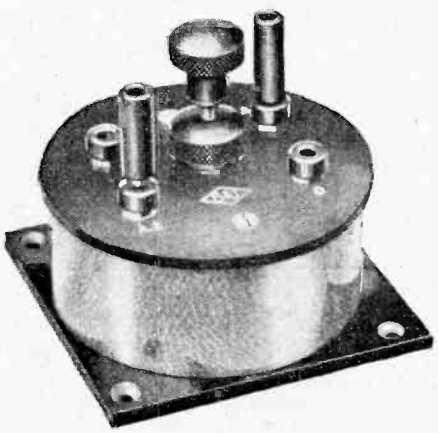
of impedance relationship between loud speaker and valve, the results obtained without any output coupling device are often very brilliant and pleasing, this effect being probably due to the pentode and loud speaker combination having a greater response to the high notes which may have easily been suppressed earlier in the receiver. Pentodes suffer from the disadvantage of running into anode distortion before the available grid base is used; in this connection a welcome addition to the range is the Mullard P.M.24A for use with 300 volts on the anode and 200 volts on the auxiliary grid. Very large power outputs are possible before anode curvature distortion starts. The new Mazda pentodes (230-Pen and 425-Pen) contain an outer third grid which is connected to the control grid and not to the filament in the conventional way. In the event of the outer grid touching the anode, all the valves in the receiver are saved from destruction. Particularly efficient are the new Marconi and Osram pentodes with 2-, 4- and 6-volt filaments having slopes ranging from 1.65 to 2. The 6-volt member—the PT625—will deliver a very large undistorted output with 15 volts negative bias, 250 volts on the anode, and a maximum of 200 volts on the screen-grid.

Mutual conductance which is synonymous with a figure of merit for L.F. valves has been improved considerably; the Mullard P.M.256, for instance, has a conductance of 3.25 mA. per volt, the figure for the Marconi and Osram P.625 is 2.5, and those for the new 2-volt Mazda output valves—the P.220 and P.240—3.4 and 3.7 respectively. Thus there is now little need for more than one valve between the detector and the loud speaker.

# ACCESSORIES OF INTEREST

UNDER this heading we may include all those pieces of apparatus, such as loud speakers, batteries, and gramophone pick-ups, which may be considered as external adjuncts to the receiving set proper. While they do not rank as components in the same sense as condensers and valves, they are none the less essential to the completion of any wireless equipment.

The manufacture of accumulator batteries had reached the stable state long before the advent of broadcasting, and one does not expect to find in this quarter any changes of a revolutionary character. Of the



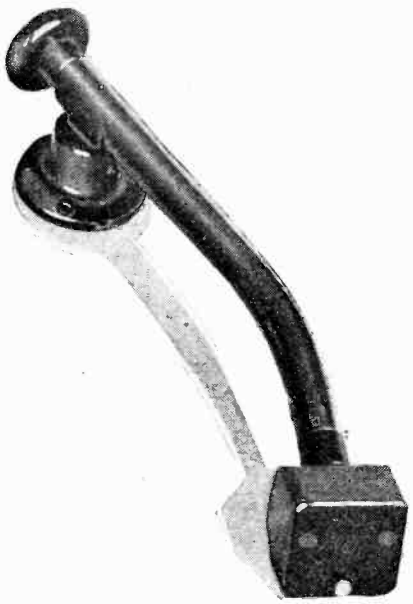
B. & J. rejector unit with Litz-wound coils.

numerous types of battery produced specially for radio work, the greatest activity would appear to be among unspillable cells for portable sets and large-capacity "mass" type cells for sets using the popular 2-volt series of valves.

In spite of the enormous increase in mains-operated sets, the dry cell H.T. battery continues to hold its own. The fact that a firm of long experience in the wireless industry is marketing H.T. batteries as a new line this year may be taken as an indication that this much maligned but none the less convenient source of H.T. will survive for many years to

**The Trend of Progress.**—come. The demands of the portable set and of people living in remote country districts are sufficient to ensure this.

In view of the immediate necessity of improving the selectivity of out-of-date receivers to cope with the new Regional station, one might have expected to see more rejectors and

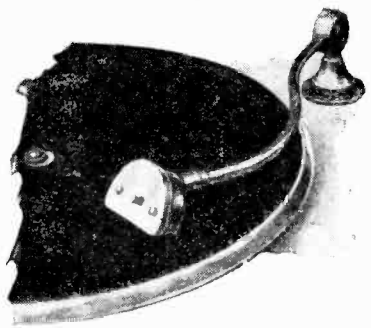


The new Marconiphone pick-up and tone arm.

selectivity units for attachment between the aerial and the set. With one or two notable exceptions, manufacturers in general do not seem to be alive to a demand which is likely to be felt during the next few weeks for accessories of this type. The few rejector units on view, however, are well designed, and in most cases are wound with Litz wire to ensure a high value of H.F. current in the closed circuit. It is interesting to note that the New London Electron Works, Ltd., are marketing a 50ft. length of aerial wire in accordance with the suggestions put forward in a recent B.B.C. pamphlet on the subject of selectivity.

Lissen needle armature pick-up and moulded tone arm.

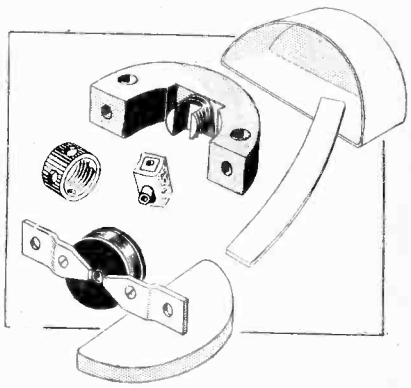
Gramophone attachments for the electrical reproduction of records are among the most important accessories of the modern radio receiver. This year we are able to report a very marked advance in the design of electrical pick-ups, not only as regards frequency characteristics, but also in the matter of record wear and needle track alignment. In all the leading makes the pick-up is mounted at an angle with the tone arm. By fixing this angle in relation to the length of the tone arm and the position of the tone arm pivot, it has been



Burndept needle armature pick-up and tone arm.

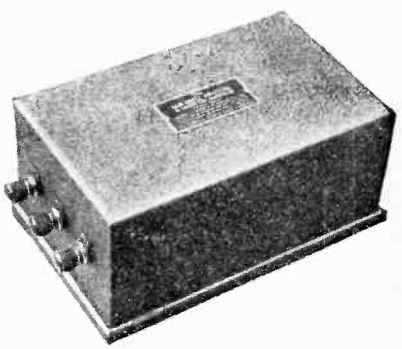
found possible to reduce tracking errors to within 2 or 3 per cent.[1] The improved tracking in conjunction with a general lightening of the moving parts and a reduction in the degree of damping, have reduced record wear almost to vanishing point. Tests have proved that with modern pick-ups it is possible to play a record more than two hundred times before the first traces of wear are apparent, while the useful life in practice is considerably more than this.

The influence of the standard frequency records recently issued by the Gramophone Co., Ltd., is to be observed throughout the Exhibition.



Component parts of the Burndept pick-up.

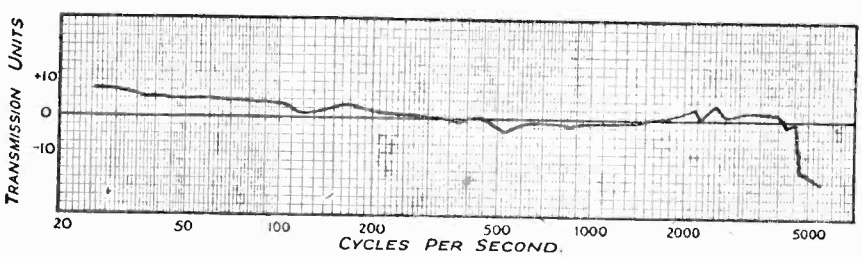
Even if frequency characteristics are not published there is evidence that all the leading makers are using these records in their design departments, and that empirical methods of development are giving place to exact measurement. One of the first conclusions to be forced on the notice of designers is that the mass of the reed or armature has, in the past,



Gambrell "Novotone" tone correction unit.

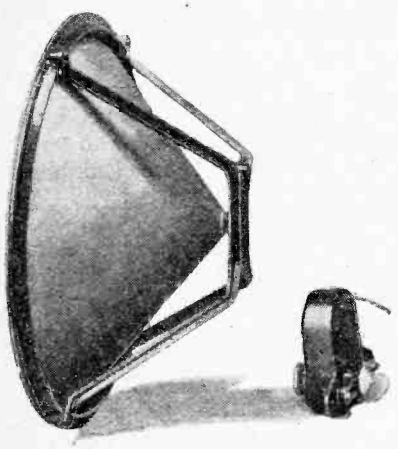
been far too great, with the result that a nasty resonance has appeared within the range of fundamental frequencies used in speech and music. Consequently, we find this year that the successful pick-ups employ reeds

[1] See *The Wireless World*, August 7th, 1929, p. 132.



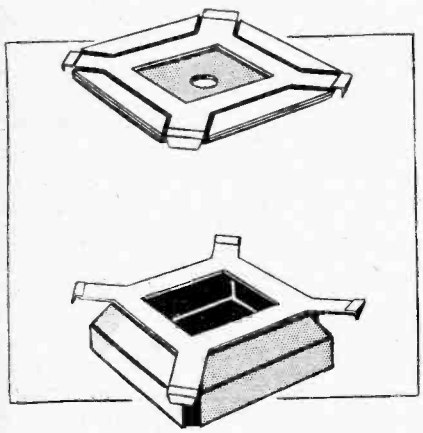

Characteristic of the new Marconiphone pick-up.

**The Trend of Progress.—**
of microscopic dimensions; the modern pick-up and its moving parts are now reduced to the scale of a wrist-watch.



Brown "Vee" unit and cone chassis.

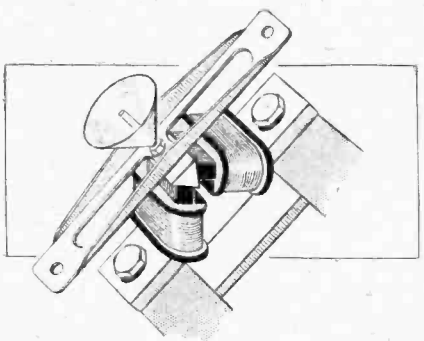
The new Burndept "Needle Armature" pick-up is illustrative of the trend of pick-up design. Its small dimensions and graceful design may be judged from the accompanying photograph. The needle itself forms the armature and carries the magnetic flux; there is no moving part other than the small clamping screw and boss. The output is comparatively small, but the frequency characteristic is practically perfect and does not show more than a two-decimal variation between 125 and 6,000 cycles. Below 125 cycles there is an increase in the output to compensate for the restriction in amplitude of the low notes on the record.



Baker "Selhurst" parallel action centring device.

The Lissen pick-up also works on this principle, but dispenses with the set screw. The needle is embedded in a block of rubber, from which it can be easily withdrawn and replaced. The general level of output is of the order of 0.4 volt R.M.S.

Finally, there is the new Marconiphone pick-up, in which an excellent frequency characteristic has been achieved without dispensing with an armature, though this has been reduced to exceedingly small dimensions. It is significant that this pick-up has been developed in conjunction with the Gramophone Co., Ltd., and is one of the first products of the amalgamation. Obviously no one is in a better position to know the type of characteristic required in a pick-up than the makers of the records, and it is safe to assume that the characteristics of this pick-up may be taken as a standard for comparison.



Sketch showing the principle of the Brown "Vee" unit.

While on the subject of gramophone accessories, mention should be made of the "Novotone" filter unit. This instrument is connected between the pick-up and the amplifier, and, while compensating for high- and low-note loss, also raises the general level of the voltage output from the pick-up by about four times. A good modern pick-up does not require any correcting device, but the same cannot be said of the overall characteristics of an electric gramophone including the amplifier and loud speaker. The fact is that the "Novotone" does effect a remarkable improvement, which has been convincingly demonstrated.

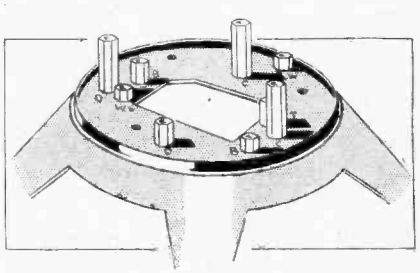
No new principle in loud speaker design has appeared in practical form. The field is still divided between the moving coil and balanced armature types, and numerous detail refinements are evident. The general trend is towards the production of "chassis" units ready for assembly

B.T.H. cone unit with concentrically corrugated diaphragm.

in a pedestal cabinet together with the remainder of the radio and gramophone equipment. In other words, the loud speaker must now be regarded as a component rather than an accessory.

Considerable ingenuity has been displayed in the design of vibrating reed and balanced armature movements, and a large variety of units of every conceivable type are now available at competitive prices.

Among complete cone units incorporating reed and balanced armature movements are the Brown Vee unit and the B.T.H. cone unit assembly. The latter equipment comprises a cone chassis in which the diaphragm is provided with concentric corrugations. These corrugations facilitate the formation of nodes so that the effective diameter of the dia-



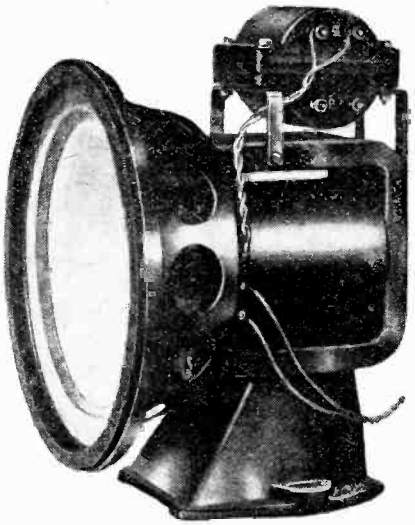
Baker "Selhurst" universal cone chassis.

**The Trend of Design.**—phragm automatically adjusts itself to the frequency applied by the drive. At low frequencies the whole of the diaphragm is set in motion, while at high frequencies only the centre of the cone near the apex is in action.

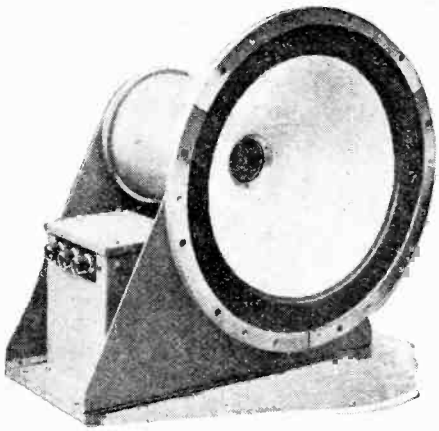
Messrs. Baker's "Selhurst" Radio have produced a Universal cone chassis, the frame casting of which is provided with a series of holes and raised lugs which are tapped to fit the majority of balanced armature movements on the market. Another ingenious development exhibited by this firm is the parallel-action centring device incorporated in the 1930 "Super Power" moving coil loud speaker.

The policy of "chassis" construction has also extended this year among makers of moving coil loud speakers. Messrs. Kolster-Brandes, Ltd., and the G.E.C. are among the firms showing this form of construction for the first time. The production of a moving coil unit is also a new departure for Messrs. Ferranti, Ltd. This unit is beautifully constructed and incorporates a valve rectifier for energising the field magnet from A.C. mains; full details of the flux density, etc., are given in the report in the previous issue.

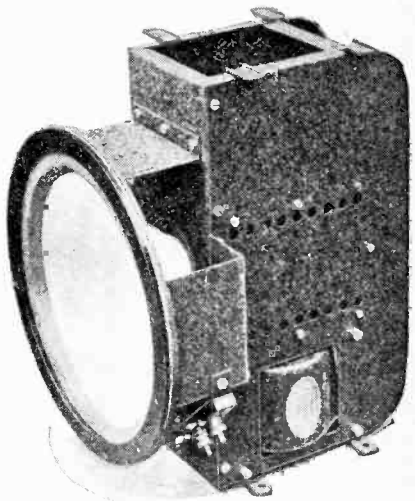
In view of the success of last year's Marconiphone moving coil loud speaker, considerable interest attaches to the redesigned model for 1930. The cone diameter has been reduced and the centring "spider" is now omitted, giving a much more compact and robust form of construction. The production costs have also been reduced, but the quality of reproduction maintains the high standard of the previous model. We have heard the new model in operation, and it is evident that while the sensitivity to weak inputs is quite equal to the old model, the power handling capacity has been considerably improved.



Redesigned Marconiphone moving coil unit.



G.E.C. moving coil loud speaker unit.



Moving coil unit for A.C. mains—a new product of Messrs. Ferranti Ltd.

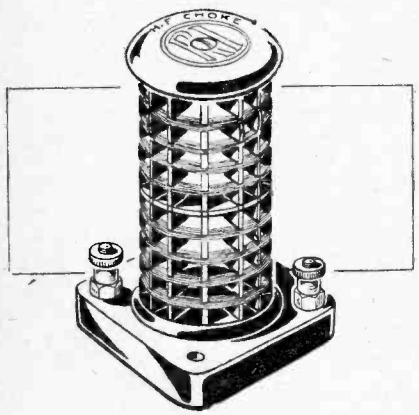
# NEW COMPONENTS SEEN AT OLYMPIA

IN a review of the components shown this year we find that the tendency is in the direction of improvement in quality rather than in quantity. This is evidenced by the increase in the number of manufacturers now supplying precise details of the performance of their wares under varying conditions of use. Information of this nature is becoming more and more essential to the set manufacturers, as well as to the home constructor, because it is only by a knowledge of the performance of the component parts that a high standard of reproduction can be attained in the complete receiver. We see, therefore, curves and figures displayed showing the impedance of such components as H.F. chokes at different frequencies. The "Dual Astatic" H.F. choke of R.I., Ltd., is a case in point. Furthermore, this component is astatically wound, so that the external magnetic field is kept within reasonable bounds. The Eddystone version is now accompanied also by a curve showing its impedance at different radio frequencies.

Information of a similar nature is being given by makers of L.F. chokes. With the ordinary type the inductance changes with the value of the steady current passing through its windings, due to the influence of ampere turns on the permeability of the iron. The Wearite choke does not suffer any appreciable change in inductance between fairly wide limits of current value, this feature being emphasised in the family of curves published for their range of constant inductance L.F. chokes under different conditions of working. Another example is the Varley constant inductance choke. A value of 20 henrys is maintained when carrying D.C. currents of from 1 to 100 mA.

The several improvements made in valve design, particularly as regards super-power valves, have brought into being some additions to the range of heavy-duty output chokes. A typical example of modern practice is reflected in the Pye No. 687 model.

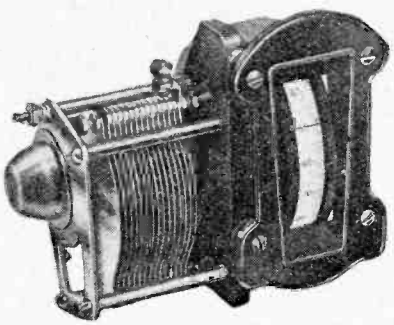
**The Trend of Design.—**
Sectional windings are employed, the ends being brought out to sockets mounted on a strip of insulating material. The sections may be connected in a variety of series-parallel arrangements, and thereby enable inductance values of from 1 to 32 henrys to be made available.



R.I. Dual Astatic H.F. choke with cover removed.

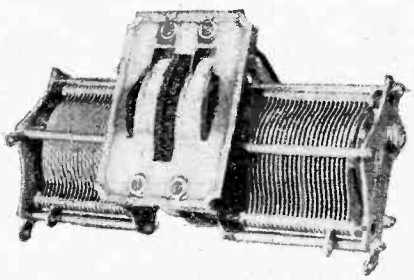
In spite of the technical difficulties concomittant with true ganging of H.F. circuits, many component manufacturers are giving attention to the design of condenser units for this purpose. A noteworthy example of the steps taken to compensate for discrepancies in the incidental capacities across the various circuits is exhibited in the design of the Utility "Mite" double condenser unit. Here the rotors are linked and driven by a drum control. To enable the small differences in capacities to be corrected, provision is made for rocking the two sets of fixed vanes. By an ingenious mechanical arrangement, the stators are moved differentially.

Pye sectional wound heavy duty L.F. choke Model No. 687.



Polar condenser in which the slow motion controls would be adjacent when a dual assembly is used.

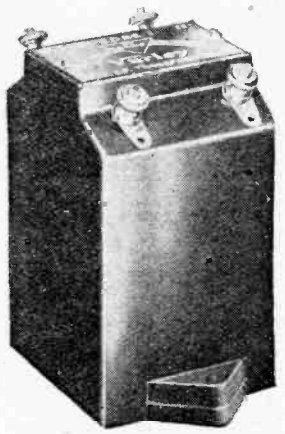
When additional capacity is introduced into one circuit, the value of the capacity across the other is reduced. This must not be confused with a "trimming" device, since a given angular displacement of the stators does not represent a constant capacity change between minimum and maximum values of the condensers. It should be regarded as a compensating device which will require adjustment at various positions of the rotors.



Burton Twin Drum condenser giving coarse tuning on the centre adjacent controls and fine tuning on the outer controls.

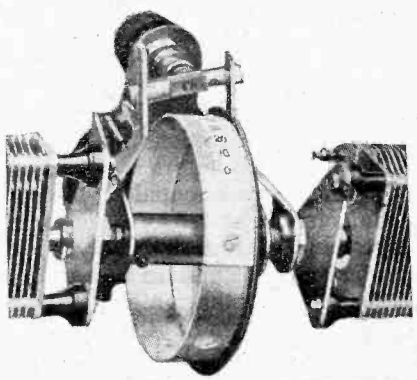
The semi-ganging of circuits, as obtained by the adoption of drum controls—arranged so that the operating edges are adjacent and placed conveniently for combined movement by one finger—is being widely adopted by set manufacturers. Consequently, we find an extensive range of condenser units exhibiting this feature. In the majority of cases both slow- and direct-drive drums are provided. Coarse adjustment is obtained by mounting the two direct-drive discs side by side, and fine tuning is then carried out independently by means of the slow-motion drives, which are mounted generally on the outside. There are, however, some exceptions, notably in the case of the Polar assembly, where the slow-motion drives are adjacent and the coarse adjustments on the outside.

This method of tuning calls for a right- and a left-hand style of condenser. Manufacturing difficulties may occasionally arise. There is at least one example of a condenser designed for optional right- or left-hand drive. This is the J.B. "Universal Log" model, which is made in four sizes, ranging from 0.00015 mfd. to 0.0005 mfd. An adjustable steel centre spindle is fitted, and a single-hole fixing bush is provided at both ends.



Special high permeability material is used for the core in this Varley "Ni-core" L.F. transformer.

While one does not find many special components designed particularly for use in portable sets, there are nevertheless some which can be included in this class. This fact is rather surprising, in view of the great popularity enjoyed by this

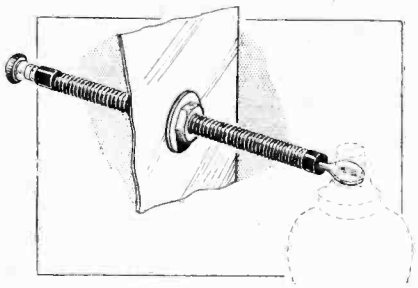


Provision is made for moving the fixed vanes by differential action in the Utility "Mite" double condenser.

**The Trend of Design.—**

type of receiver during the past twelve months and the present indications that it is likely to continue. The previously mentioned Utility "Mite" and the new J.B. "Tiny" condensers are, however, two excellent examples of real endeavour to produce a suitable component of very small physical size. The "Tiny" is fitted with a slow-motion drive, and, complete with knob, pointer and scale, costs 10s. for a 0.0005 mfd. size and 9s. 6d. for the 0.0003 mfd. model. Other sizes are available. Formo and Burton are two others firms who make condensers smaller than the familiar pattern, and these could be included under the same heading.

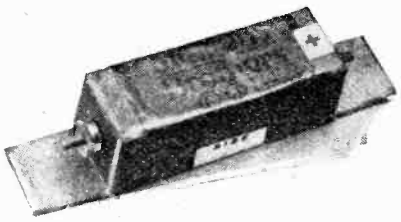
In some cases manufacturing costs have been the prime mover in the design of a component. For example, the wider use of mu-metal, and similar material, for the core in L.F. transformers has enabled the manufacturer to produce a component



Bulgin "safety connector" for use with screen grid valves.

cheaper than one of equal quality using common transformer steel. In many cases a superior component has been developed. In view of the special properties possessed by these substitutes for steel, some care is required in their use, and this has occasioned a new method of linking together L.F. amplifying stages. Many of these transformers will not stand for more than one or two milliamps of current through their primaries, so that arrangements must be made to deflect the steady anode current through a parallel circuit and pass the A.C. component only through the windings. A discussion of these couplings does not come within the scope of this section, being concerned as we are only with components. Nevertheless, mention must be made of this as it is a vital factor in the employment of such components as the R.I. "Hypermu" L.F. transformer and the Varley "Ni-core" range.

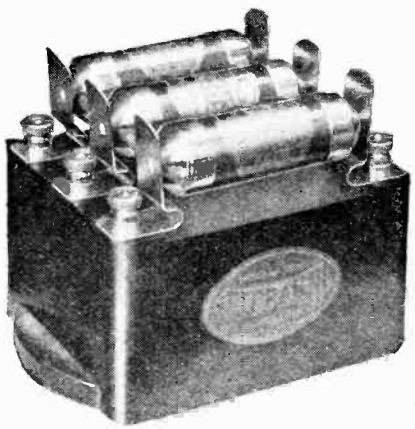
The Varley "Ni-core" L.F.



For biasing a S.G. valve the Siemens 0.9 volt cell is ideal.

transformers are likewise restricted in the value of steady current that may be passed through their primary windings. The "Ni-core I" will carry 2.5 mA. and "Ni-core II" 2 mA. only. The former costs £1 and the latter 15s. Both have a ratio of 4 : 1.

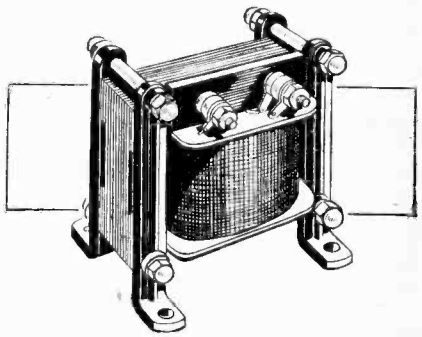
As an illustration that the development in one direction engenders improvements elsewhere can be cited the case of the screen grid valve. Its wider use since first pointing the way towards higher H.F. stage gain in a comparatively simple manner has resulted in component manufacturers producing additional parts especially for use with this device. Bulgin has evolved an interesting safety connector for the anode of the valve. This takes the form of a flexible wire encased in an armoured sheath to which is attached a fixing bush for anchoring to vertical screens or the side of a screening box. One end of the lead terminates in a spade connector for fixing under the top terminal on the valve, while the other end is finished off by a small terminal for attaching the lead carrying the H.T. As the connector is permanently fixed to a rigid part of the set, no damage can be done by removing the valve without first totally disconnecting the H.T. supply.



Ferranti triple anode feed unit.

While on the subject of screen grid valves, mention must be made of the special grid bias cell developed by Messrs. Siemens Bros. and Co., Ltd., and now shown for the first time. It has a voltage of 0.9, and will give to the operating grid of a screen grid valve just the right amount of bias for the best working conditions. Hitherto the lowest voltage cell available was 1½ volts, and this over-biased the modern S.G. valve.

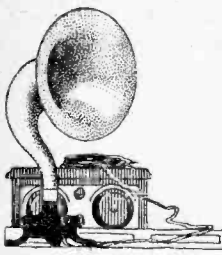
A new component, illustrating the more universal use of special devices to combat motor-boating in mains-driven sets, is a product of Ferranti.



Wearite constant inductance L.F. choke.

This is one of a range of anode feed resistance units comprising three resistance holders and three by-pass condensers. Its normal use is as a triple device where space is limited, but it has a further application, namely, that of a fixed potentiometer to supply the screen potential for a S.G. valve. Used in this manner, it assures a constant voltage on the screen of the valve in spite of slight fluctuations in the current.

Since the set manufacturer is endeavouring to make his products more like pieces of furniture than at any previous period in the short history of broadcasting, it behoves the component maker to add his mite towards this end. We thus find such firms as Ormond, famed for their dials, now showing these in a variety of colour schemes.



# AIDS TO SELECTIVITY

## Some Notes on the Use, Construction and Performance of Rejectors in a Simple Aerial Circuit.

By H. B. DENT.

IT is anticipated that the majority of broadcast listeners living in the north of London will be affected in one form or another by the change over from the Oxford Street site to Brookmans Park for the London Regional transmitter. Possibly by the time these notes appear in print all those so concerned will have had an opportunity to test the selectivity of their sets under the new conditions. Owners of receivers incorporating H.F. amplifiers with sharply tuned circuits should find no difficulty in listening to alternative programmes, but there must be many possessing less ambitious sets who will find that with the new station in operation the alternative programmes are now no longer receivable, or heard only during intervals in the transmission.

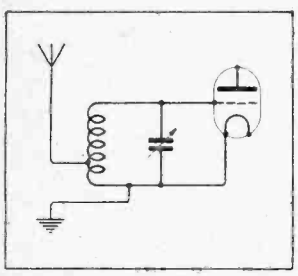


Fig. 1.—Typical aerial-grid circuit used in modern sets.

For the present, one programme is to be transmitted from the new station, and since the alternative is either Daventry 5GB, or some of the more powerful Continental stations, the problem resolves itself into a consideration of the ways and means of eliminating the signals from the powerful local transmitter and rendering reception of considerably weaker signals possible. When the full programme of the new London Regional station is in force, it should be far easier to separate the two transmissions, because less amplification will be required. It is apparent that a modification or addition to the set will be necessary, but until it has been possible to study at first hand the effect on one's particular receiver, it is somewhat difficult to decide on the nature and extent of these modifications.

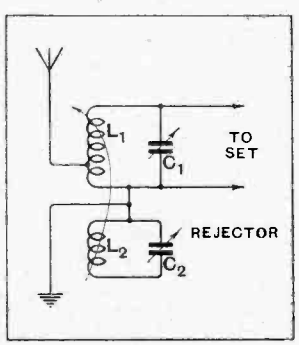



Fig. 2.—Circuit of a simple "absorption" type rejector.

In the meantime some good work can be done with a rejector circuit, and this is perhaps the most satisfactory method of making provision, temporarily at least, for alternative programmes. Of course, this is really a palliative, but oft-times recourse has to be made to palliatives until a remedy can be prepared. It is the object of these notes to discuss the best method of applying a rejector which will meet the immediate needs until such time as a more permanent cure can be devised. Perhaps the most popular type of aerial circuit used to-day is that shown in Fig. 1. This, then, will be taken as the basis for our discussion. It matters little what function the first valve performs, whether H.F. amplifier or detector, although if a high-frequency amplifying stage precedes the detector it will, by virtue of the higher selectivity, simplify the filtering-out of the unwanted signals.

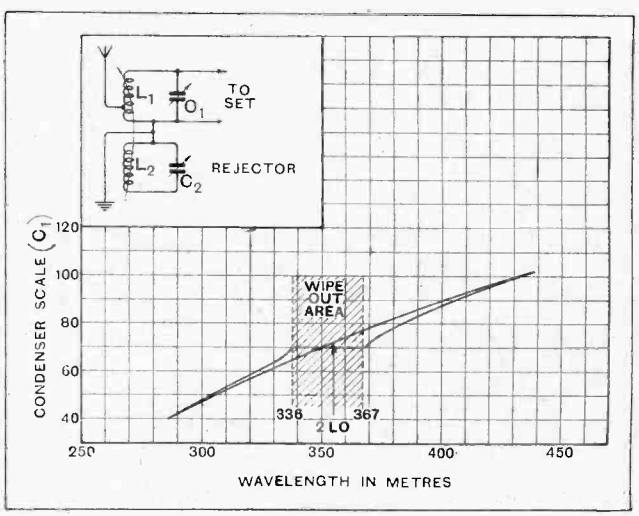



Fig. 3.—Curves showing the effect on the tuning of a circuit when a rejector is coupled to it. The uninterrupted curve is the normal calibration.

### Absorption Rejectors.

For the purpose of this discussion rejectors will be divided into two classes—the "absorption" type and the "series" type. In effect they are identical, and it is only in their application that they differ. The "absorption" type, of which a typical example is shown in Fig. 2, consists of a tuned circuit $L_2$ $C_2$, arranged so that the coil $L_2$ is inductively coupled to the aerial-grid coil $L_1$. It is desirable to use a low-resistance coil for the rejector, a small inductance in conjunction with a large capacity giving the best results. This must be judged by the effect the presence

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of the rejector has on the receiving circuit. An appreciable resistance, that is, H.F. resistance, in the rejector circuit will necessitate a very tight coupling between the two circuits, and this will absorb energy from the aerial-grid circuit over a wider band of wavelengths than is really desirable in the interests of selectivity.

The ideal rejector is one that absorbs energy from the receiving circuit over a band of frequencies equivalent to that occupied by the modulation of the transmission it is desired to reject. This is not possible to achieve in a simple arrangement, but with the exercise of a little care in the design the "wipe-out" area can be kept reasonably small.

The curves in Fig 3 show the effect on the tuning of a circuit similar to that depicted in Fig. 2. The

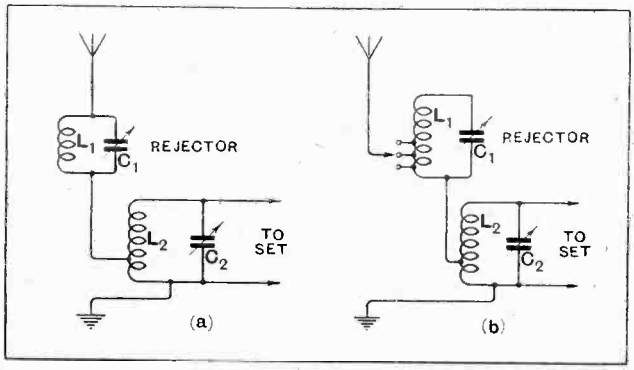


**Fig. 4.—Circuits of the two "series" type rejectors. That shown in (b) is generally more satisfactory than the arrangement (a).**

coupling between the aerial circuit and the rejector was such as practically to eliminate signals from 2LO (Oxford Street site) at a distance of $1\frac{3}{4}$ mile. The "wipe out" area in this case represents a matter of 31 metres; that is to say, nothing can be received between the upper and the lower limits, or between 336 and 367 metres. A looser coupling has the effect of reducing the width of the "wipe out" area, but this is offset by the breaking through of signals from the unwanted station, so that little is gained by adopting this course. In this particular case the coil $L_2$ was wound with Litz wire, 40 turns being used on a 3in. diameter former. The condenser $C_2$ had a capacity of 0.0005 mfd.

### Series Rejectors.

The "absorption" type of rejector necessitates a slight modification to the set, since space must be found inside the cabinet for the rejector coil and its condenser. However, there are alternative arrangements which can be applied external to the set and give very much the same results. These will be classified under the heading of "series" type rejectors because they can be connected in series with the aerial. Typical examples are shown in Fig. 4 (*a*) and (*b*). The arrangement in Fig. 4 (*a*) will be passed over with but a mention, and is only included to complete the series. It is effective certainly, but the coupling is far too tight for practical use, as the "wipe out" area extends over an unnecessarily large part of the waveband covered by the receiving circuit.

The circuit given in Fig. 4 (*b*) will be found satisfactory in most cases and readily lends itself to use with most receivers. The remarks passed regarding the type and size of coil apply with equal force to this case, although owing to the aerial-earth damping, possibly solid wire of fairly stout gauge could be used in place of the Litz. A practical test showed that a coil wound with 40 turns of No. 22 S.W.G. D.C.C. wire gave good results. The tappings for the aerial connection were made at 10th, 15th, and 20th turns from that end of the coil connected to the aerial terminal on the set. With the aerial connected across 15 turns of the coil, little could be heard of the local station when the aerial condenser was detuned 10 divisions, on a dial marked 0-180, either side of resonance. The "wipe out" area was of the same order as that recorded with the direct absorption type, shown in Fig. 2.

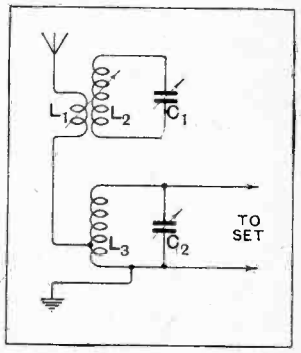


**Fig. 5.—Modification of Fig. 4 (b) which justifies the use of a low resistance rejector circuit $L_2C_1$.**

A variation of this arrangement is given in Fig. 5. In this case a small coil $L_1$ is coupled to the main rejector coil $L_2$. Tests showed that there was some justification for using Litz, although quite a good performance was recorded when solid wire of the gauge mentioned above was employed. The aerial coil $L_1$ consisted of 15 turns of fine gauge wire wound over one end of $L_2$. Eight distance pieces were used and the turns spaced to occupy $\frac{1}{2}$in. in length.

This rejector was particularly good and measurements showed that the "wipe out" area was of the

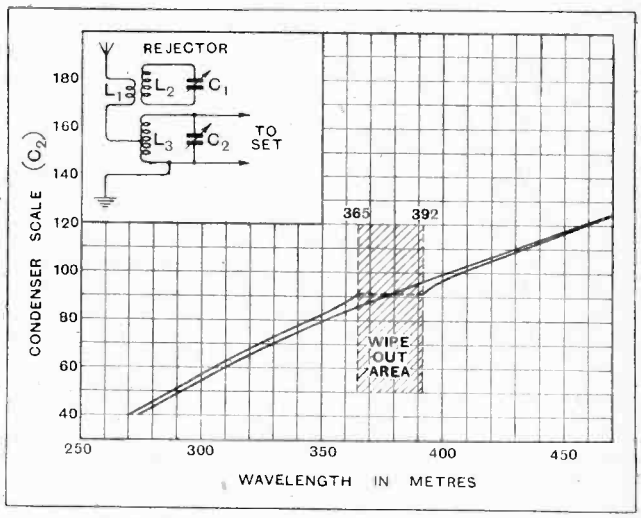


**Fig. 6.—With the "series" type rejector a tight coupling tends to shift the "wipe-out" area to one side of the actual wavelength of the rejected signal (in this case that of 2LO).**

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same order as that given in Fig. 3. Whereas previously the local station's programme was audible over the whole range of the tuning condensers, with the rejector in position it was possible to receive signals as near as ten divisions off tune either side of that corresponding to the tuning position for the local station.

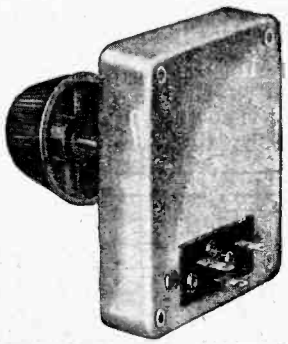
### The "Wipe Out" Area.

During the course of these observations on the performance of the various arrangements mentioned here, some rather peculiar effects were recorded. For example, with certain types of "series" rejectors it was noticed that the "wipe out" area was displaced and actually occupied a position some metres above the normal tuning position of 2LO. This is shown in the curve given in Fig. 6. With this particular arrangement signals from the London station were fairly completely rejected, yet the blank area, as subsequently found by taking a calibration curve of the circuit with and without the rejector in position, showed that this appeared to be effective between 365 metres and 392 metres. This was finally checked with a heterodyne wavemeter and no signals could be tuned in between these two limits, although sundry Morse C.W. stations were heard on either side of the "wipe out" area.

It is not the purpose of these notes to explain the cause and effect, the object being to record observations with the various arrangements depicted here. Far more detailed investigation will be necessary before many of the rather unusual effects noticed can be satisfactorily explained; for the moment, the practical application of the rejector circuit is the first aspect to receive attention.

# SOME INTERESTING AMERICAN APPARATUS.

THE Rothermel Corporation's programme for the coming winter season includes the marketing in this country of a number of new components not previously available on this side of the Atlantic. In addition, many of their familiar lines have been remodelled by the manufacturers. Some new designs of Magnavox moving-coil loud speakers are now available. These are catalogued as "X-core" type and are supplied with 7¾in. and 10½in. diaphragms. The A.C. models include mains and input, transformers, and dry metal rectifier, the prices ranging from £8 5s. to £11. A new component is the Mershon "Amrad" electrolytic condenser of high capacity and tested to withstand 400 volts D.C.; single and double types are available. The leakage current is given as 1½ to 2 mA per 10 mfds. capacity.



**Electrad super-Tonatrol. A power potentiometer rated to dissipate 5 watts.**

Some new "Royal" metal-cased fixed condensers, ranging from 0.1 to 4 mfds., are now listed. These are tested to withstand 1,650 volts, and prices range from 2s. to 7s., according to size.

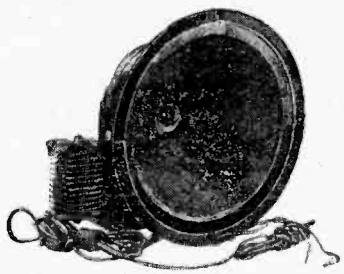
### New Volume Control.

Of particular interest is the new "Electrad" super Tonatrol. This is made as a variable high resistance and a potentiometer, and is claimed to dissipate 5 watts at any position of the contact. The resistance element consists of a special graphite preparation fused at high temperature to an enamelled steel plate. A floating silver contact is employed, which adapts itself to any slight inequality of the surface and ensures smooth action. It is protected by a metal case with bakelite insulation and fitted with stout bronze contact springs. Prices are as follows: Resistances of 10,000 ohms and 50,000 ohms cost 12s 6d., and potentiometers of 10,000 and 25,000 ohms are offered at the same price. A special gramophone pick-up "fade-out" device for use with two turntables is priced at 15s.

### Electric Gramophone Motor.

Constructors of electrically driven gramophone equipment will be interested in the Bodine A.C. induction motor. This is a high quality piece of apparatus, and complete with turntable and necessary controls costs £10 10s. It is made for 110 and 220 volts 50 cycles A.C. supply mains.


**Two types of American condensers. That in the cylindrical container is an "Amrad" 90 mfds. electrolytic condenser; the other a "Royal" 2 mfds. 1650 volts test component.**



**New Magnavox "X-Core" moving coil loud speaker.**

A range of power amplifiers for public address, and similar uses, and designed for A.C. mains operation, is another new feature. These are used extensively in the U.S.A. and are products of the Samson Electric Co.

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## BOOKS RECEIVED.

*Radiotechnik (Part VI) Die Elektrischen Wellen*, by Dr. F. Kiebitz, Professor of the Berlin University.—A short text-book on the propagation and theory of wireless waves. Pp. 125, with 28 diagrams. Published by Walter de Gruyter and Co., Berlin and Leipzig. Price Rm.1.50.

*Short Stories in Science*, by J. G. Crowther.—A popular treatise on natural science, including the Nature of the Universe, Refrigeration, Volcanoes, Lightning, The Atom, The Raman Effect, and many other subjects. Pp. 213. Published by George Routledge and Sons, Ltd., London. Price 5s. net.

*Radio Telegraphy and Telephony*.—A complete text-book for students of wireless communication, by Rudolph L. Duncan and Charles E. Drew. Pp. 950, with 468 illustrations and diagrams. Published by John Wiley and Sons, Inc., New York, and Chapman and Hall, Ltd., London. Price 37s. 6d. net.

# Broadcast Brevities

*By Our Special Correspondent.*

## *A New 5GB.—B.B.C. Under Fire.—"Broadcasting House."*

### The Rebuilding of 5GB.

The B.B.C. has wisely decided to rebuild 5GB (Daventry) before it takes its permanent place in the regional scheme. "Daventry Junior" has always been a makeshift station and, judging from what I saw on my first visit to Daventry, the marvel is that the breakdowns have been so few. Contrasted with the "spick-and-spanness" of Brookman's Park, 5GB is a "hookup" in the best English sense of the word.

When rebuilt, the station will be a replica of the Brookman's Park station, but with only one transmitter. In this respect it will resemble the projected regional station for Ulster. The increase in power from 25 kW to 30 kW will, it is hoped, help to cut out that very noticeable interference from Langenberg.

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### B.B.C. Disappoints at Olympia.

"And when the sun rose, where were they?" This question, in various forms, seems to have been on the lips of most visitors to Olympia. Where are the B.B.C.?

On the first day of the Show the much-heralded diorama was out of action; but, ignoring this lapse, the best friend of the Corporation could hardly describe the B.B.C.'s rôle at Olympia as a spectacular one.

Echoing John Henry, "It's all wrong." The B.B.C., as providers of the celestial food on which all those beautiful receivers thrive, should have taken Olympia by storm, demanding a place in the sun, and not merely an odd corner or two.

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### Those Programmes.

If we imagine a succession of long waves of rather small amplitude we obtain a graphical delineation of the quality of the B.B.C. programmes. The waves of popular opinion are usually a little out of phase, so that when the B.B.C. programmes are emerging from one of the troughs, the public are just beginning to realise how bad the programmes have been. We seem to have reached such a stage at the present moment.

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### Dance Titles Again?

Some of the criticism is being levelled at the dance programmes broadcast from outside sources. Personally, I know nothing more boring than to listen to a succession of unannounced items given by a disheartened cabaret band which is bound to secrecy regarding dance titles and which dare not burst into song lest the dread secret should be revealed. I should not be surprised, however, if the B.B.C. were shortly to remove the ban on dance titles, despite the risk of "song-plugging." Special care would be taken, of course, to prevent as far as possible any subsidising of artists by the dance publishers

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### Morbidity at the Microphone.

The subject-matter of a singular broadcast from 2LO on October 10 is the beginning of the end of a man's life. The action occurs during the infinitely short space of time taken by sudden death to establish itself. The title of the drama is "The First Second," by Peter Godfrey, and it will be produced by Lance Sieveking.

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### Below the Scenes at Portland Place.

Although "Broadcasting House" will not be ready for occupation until June, 1931, some of the toughest work has already been accomplished. To appreciate the immensity of the work the best plan is to take a seat in one of the crane buckets—a privilege I enjoyed last week—and allow yourself to be gently lowered 40ft. below the surface of the road, until the bucket grounds on the reinforced concrete foundations. You are then on the lowest of the three basement floors, above which the building will tower another eight storys.

Col. Val Myer, the architect, drew my attention to a bubbling spring which will have to be diverted and "tanked" before the massive retaining walls around the site can be completed.

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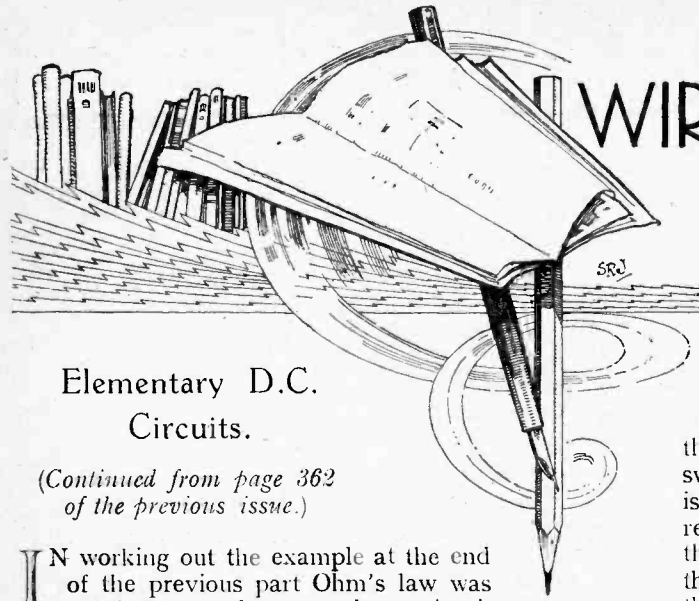
### Sound-proof Walls.

A really unique feature of "Broadcasting House" will be the absence of a central well which all normal buildings of its size require for lighting and ventilation. The centre will be taken up by a tower with sound-proof walls of solid brick 3ft. thick, and this will house the main studios and a theatre capable of accommodating 1,000 people. The studios will be two storys in height and will be acoustically insulated from each other by single floors accommodating offices.


**THE FUN OF THE FAIR. An interesting photograph taken on the opening day of the National Radio Exhibition. There have been record attendances.**



# WIRELESS THEORY SIMPLIFIED

By S. O. PEARSON, B.Sc., A.M.I.E.E.

## Elementary D.C. Circuits.

(*Continued from page 362 of the previous issue.*)

IN working out the example at the end of the previous part Ohm's law was applied to the complete circuit consisting of a 6-volt battery and an external resistance of 3 ohms connected across its terminals. The current was found to be 1.875 amps. and not 2 amps. as might at first have been expected, the reason being that the resistance of the battery itself makes its influence felt. From this it is clear that the electromotive force actually applied to the external 3-ohm resistance must be less than 6 volts. This is the truth, and its value can be very easily found by applying Ohm's law to the external resistance only. Let V denote this reduced value of the E.M.F. which is effective in driving the current through the resistance R. Then by Ohm's law

$$V = I.R \text{ volts.}$$
$$= 1.875 \times 3 = 5.625 \text{ volts.}$$

So that although we have a 6-volt battery we are left with only 5.625 volts at the terminals when a 3-ohm resistance is connected across it. The remaining 0.375 volt has been absorbed in driving the current (1.875 amp.) through the internal resistance (0.2 ohm) of the battery. This can be verified by applying Ohm's law to the resistance of the battery, viz.: The E.M.F. required to drive a current of 1.875 amps. through a resistance of 0.2 ohm is $1.875 \times 0.2 = 0.375$ volt. as before. This loss of pressure due to the internal resistance of the battery is commonly referred to as the *voltage drop* in the battery. It is always present to some extent and militates against efficiency, causing waste of energy in the battery, and, in the case of high-tension batteries in wireless circuits, it very often results in instability and violent oscillation or howling.

### Electromotive Force and Potential Difference.

Now we must get back to symbols for a little while and introduce one or two new and important terms which recur very often in discussing the operation of any receiving circuit. The same circuit as that of Fig. 1 of the previous instalment is reproduced in Fig. 1, with the addition of an ammeter A, a voltmeter V and a switch S. It will be supposed that the ammeter, which is connected in the main circuit, has a negligibly small resistance so that it does not reduce the current, and that the voltmeter which is connected directly across the battery terminals has such a high resistance that the current taken by it is negligibly small.

When the switch S is closed and a current of 1 ampere is flowing round the circuit the voltmeter will give a reading V which, as we have seen, is less than the electromotive force of the battery; but if S is opened the voltmeter reading will rise until it equals the actual E.M.F. of the battery, because the current has now ceased and therefore no fraction of the E.M.F. is being absorbed in overcoming the battery resistance. From all this it might at first appear that the E.M.F. of the battery is not a constant thing, but varies according to the current. But this is not the case—the electromotive force of a battery is a constant quantity (except when the battery is running down), depending only on the chemicals and elements from which it is made and, to a certain very small extent, on the temperature. It is only the resulting electrical pressure existing between the terminals which varies, and it is here that we must introduce the term "potential difference" (P.D.).

### Voltage, Pressure and Potential.

The electrical pressure between any two points in a circuit, as measured with a voltmeter, is called the potential difference between those two points. When measured in volts it is sometimes referred to as "the voltage." For the word "potential" we can always substitute the word "pressure," meaning, of course, electrical pressure.

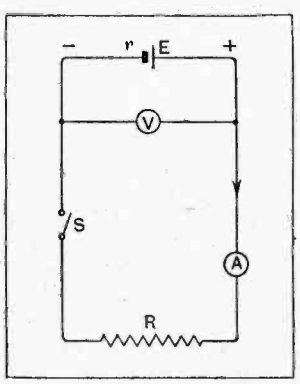



**Fig. 1. — Simple circuit showing loss of voltage in the battery due to internal resistance.**

It is very important to get a clear conception as to the difference in meaning between electromotive force and potential difference. Although each is measured in volts they really have different meanings, which must not be

**Wireless Theory Simplified.—**

confused. Electromotive force is the driving force set up in the cells by electro-chemical action (or in a dynamo by electromagnetic action), and is a constant in the case of a battery or cell. Potential difference, on the other hand, is the resulting pressure built up when the current is being forced against the various opposing resistances in the circuit. If the circuit is open the resistance is infinitely great and the potential difference between the terminals of the battery builds up to a value exactly equal to the E.M.F. To assist in grasping this idea of opposed forces, consider a steamer standing stationary on a calm day in still water and that suddenly the engines are started and propellers rotated so as to give a steady forward thrust of, say, 50 tons. The steamer will immediately begin to move and its speed will get faster and faster; but it will not go on accelerating indefinitely—there will come a time when the resistance of the water and air will prevent further gain of speed. The speed will build up to just such a value that the resisting forces exactly oppose the driving force.

This is precisely what happens in our battery circuit: When the switch is closed the current builds up until it has reached just such a value that the resisting forces exactly counterbalance the driving (electromotive) force. The E.M.F. is the driving force, and the potential difference is the resulting back pressure due, in this case, to the motion of the electrons against the resistance in the external circuit.

### Potential.

There is yet another aspect of the word "potential" which must be considered. In our wireless work we often encounter the phrase "plate potential" or "anode potential." For instance, when it is stated that a valve is meant to operate with an anode potential of 150 volts most readers will know that this indicates that the valve should be operated with a potential difference of 150 volts between the anode and *the negative end of the filament*. But why the negative end of the filament? The reason is that the negative end of a valve filament is usually "earthed" in a receiving set, so that the potential of the anode is really the potential difference in volts between the anode and earth. In general, then, it must be understood that the *potential at any point in a circuit is the potential difference between that point and "earth,"* the potential of the earth being considered as zero.

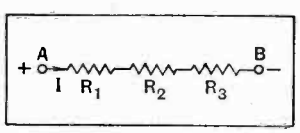



**Fig. 2.—Resistances in series. Total resistance $= R_1 + R_2 + R_3$.**

The energy possessed by anything is the capacity it has for doing work of some kind. For instance, a wound clock spring has the capacity for driving a clock for a definite length of time. In the same way a battery or an accumulator possesses energy which is stored in a chemical form, and, when a current is drawn from the battery, work of some kind is done, the nature of this work depending on the type of apparatus connected to the battery.

In the simple battery and resistance circuit which we have been considering the work done is represented by the driving of the electrons through the resistance of the circuit, this causing the resistance wire to become heated. Actually the energy which is coming from the battery is not being destroyed, but simply converted into heat—another form of energy. It is a well-known law that no energy can ever be created or destroyed, but merely converted from one form into another. By suitable means we are able to convert the stored energy in the battery into motion, light, sound, heat, etc.

The temperature to which our resistance wire will be raised will depend on the rate at which energy is being put into it, that is, on the rate at which work is done, and it is this rate of expenditure of energy with which we are most concerned. It represents the *power* being expended in the electric circuit.

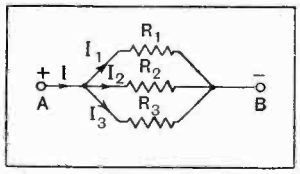



**Fig. 3.—Resistances in parallel. The current divides in inverse proportion to the respective resistances.**

In ordinary mechanical things the rate of doing work, i.e., the power, is given by the product of the driving force and the rate of movement of the driven body, and similarly in the electric circuit the power is equal to the product of the electromotive force (electric driving force) and the current (rate of movement of electrons). The unit in which the electric power is measured is the *watt*, where one watt is the power represented by a current of one ampere flowing under a pressure of one volt. Thus in a circuit where the pressure is E volts and the current I amperes the power being expended is given by

$$P = E \times I \text{ watts.}$$

If the potential difference between the ends of a circuit is E volts and the current in it is I amperes the power being put into it is $E \times I$ watts no matter into what form it is being converted. But when the circuit consists of a simple resistance of R ohms the whole of the power is utilised in producing heat. From Ohm's law we know that $E = I \times R$, and, substituting this in the above expression for the power, we get

$$P = I^2R \text{ watts.}$$

### Heat Losses in Relation to Current and Resistance.

This is a very useful expression indeed, and enables us to calculate the power, in watts, being lost as heat in any circuit where we know the resistance and the current. It should be noted that the power being converted into heat is proportional to the *square* of the current, so that by doubling the current in a given circuit we expend four times the power. This is obviously the case, because in order to double the current the voltage must be doubled also.

The conclusion is that whenever a current flows through a circuit heat is produced, and, conversely, whenever heat is produced by an electric current resistance is present in the circuit. The latter fact will prove of great assistance to us when considering alternating current circuits at a later date.

**Wireless Theory Simplified.—**

**Series and Parallel Circuits.**

A number of resistances are said to be connected *in series* if they are so arranged that the same current passes through each in turn. In Fig. 2 we have three resistances, $R_1$, $R_2$ and $R_3$, connected in series, and it can be shown very easily that the total resistance R of this circuit is equal to the sum of the individual resistances, namely:—

$$R = R_1 + R_2 + R_3.$$

It is very important to remember that at any instant *the current is the same at every point in a series circuit.* Series connection is sometimes referred to as cascade connection.

Resistances are said to be connected in parallel when arranged as shown in Fig. 3. Let E be the potential difference applied between the ends A and B of the circuit. Then the individual currents through the respective resistances $R_1$, $R_2$ and $R_3$ will be $E/R_1$, $E/R_2$ and $E/R_3$, and the total current will thus be $I = E(1/R_1 + 1/R_2 + 1/R_3)$ amps.; therefore $I/E = 1/R_1 + 1/R_2 + 1/R_3$. But by Ohm's law E/I is the combined resistance R of the circuit, and thus I/E is the reciprocal 1/R. For the parallel circuit, then, we have

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

or, expressed in words—for resistances in parallel the reciprocal of the resultant resistance is equal to the sum of the reciprocals of the individual resistances.

**Numerical Example.**

Suppose that in a receiving set we are using three valves each rated for a filament voltage of 5.5 volts, but requiring currents of 0.1, 0.25 and 0.3 amp. respectively. Dividing each of these currents into the voltage we get for the resistances of the valve filaments 55 ohms, 22 ohms and 18.33 ohms respectively. The reciprocal of the combined resistance is thus

$$\frac{1}{R} = \frac{1}{55} + \frac{1}{22} + \frac{1}{18.33} = 0.1184,$$

and the resistance $R = \frac{1}{0.1184} = 8.47$ ohms.

This is the equivalent resistance of all three valves in parallel, and if our working is correct the total current will be obtained by dividing the voltage by this figure:

$$\text{Total current } I = \frac{5.5}{8.47} = 0.65 \text{ amp.}$$

Also $I = 0.1 + 0.25 + 0.3 = 0.65$ amp., which checks both the method and calculation as being correct.

In the foregoing pages we have discussed the fundamental principles of the very simplest of electric circuits chiefly for the benefit of those readers who have not studied these principles before in any detail. The discussion is necessarily very brief, but it is hoped that sufficient has been said to give the reader a good idea of what takes place in such circuits. Without these fundamental ideas it would be impossible to follow intelligently the succeeding discussions on alternating current circuits and the application of the principles to receiving circuits.

# BY-PASS CONDENSERS FOR HIGH FREQUENCY.

## Taking H.F. Resistance Into Account.

MOST modern receivers positively bristle with decoupling resistances and condensers that are intended to divert into harmless paths the various alternating currents that might cause trouble if allowed to stray about. When it is currents of low frequency that we are trying to by-pass through earthing condensers to the filament of the valve it is only necessary to choose condensers of large capacity, the type having paper dielectric serving perfectly well.

The selection of a condenser for a high-frequency circuit, however, needs rather greater care. When dealing with high-frequency currents it is no longer quite safe to assume that of two condensers, one having ten times the capacity of the other, the larger will offer one-tenth of the impedance to their flow. There now enters into the question the resistance offered by the condenser plates themselves to the passage of high-frequency currents.

Let us imagine that a foil condenser is constructed from a long, narrow strip of waxed paper, with a very thin metal foil on each side, and that connection is made to the two foils at the same end. If a high-frequency voltage is applied to the terminals the full voltage will be operative across the waxed paper dielectric in their immediate neighbourhood, but owing to the very appreciable resistance of the foils the voltage-drop along them will be great enough to render the far end of the strip practically inoperative as a condenser. The far ends of the foil are, in fact, protected from the applied voltage by a very thorough and elaborate decoupling scheme of series resistance and parallel capacity. A two-microfarad condenser constructed on the lines suggested, in which the shortcomings of many paper condensers are illustrated in exaggerated form, might well offer no less impedance to currents of very high frequency than a condenser of nominal capacity one-tenth or one-hundredth of its value, but with foils of negligible resistance. In the usual mica condenser, for example, there are usually two sets of small paralleled foils, so arranged that every individual foil in each set makes direct connection with the appropriate terminal on the case. With such a mode of construction the effective resistance of the foils will be negligible.

Several manufacturers of paper condensers have arranged to make connection to each foil at a very large number of places, so that with their products the full rated capacity will be effective even at very high frequencies. The choice of one of these, or of a mica condenser, is a measure of precaution that it would be wise to take when choosing condensers to by-pass high-frequency currents in a modern high-gain amplifier. —A. L. M. S.

# THE PENTODE AS AN ANODE RECTIFIER

## Incorporating the Detector in a Receiver.

By A. L. M. SOWERBY, M.Sc.

(*Concluded from page 286 of the September 18th issue.*)

BEFORE building a receiver in which the pentode occupies the position of detector, it is desirable to know a little more of its behaviour than can be brought to light by the simple measurements that were described in the first part of this article. We have seen that the characteristics of the pentodes at present available are such that resistance-coupling to the next valve is desirable, and that by suitable choice of auxiliary and signal-grid voltages and of anode resistance we can obtain more sensitive detection than the three-electrode valve can provide. We have still to consider the effect on the efficiency of rectification of shunt capacities in both plate and auxiliary grid circuits, and to investigate the damping effect that the detector produces on the tuned circuit from which, in a normal receiver, it receives the voltage that it is called upon to rectify. Further, it will be of interest to make some sort of rough estimate of the rectified low-frequency voltage that the pentode will hand on to the next valve for further amplification, and of the most satisfactory high-frequency input that the valve requires for efficient rectification.

### By-pass Condensers.

In order to determine whether the presence or absence of shunt capacities in anode or auxiliary-grid circuits affect in any way the process of rectification proper[1], a constant high-frequency voltage was applied to the valve and the change in plate current due to the rectification of this voltage was read. In order to ensure that the input to the valve really did remain constant while alterations were being made to its plate circuit, the arrangement shown in Fig. 7 was adopted. The resistance *r* had a value of some 150 ohms, which was deemed low enough to be negligibly small in comparison with any parallel resistance due to the valve, while it was found to be high enough to flatten the tuning of the circuit sufficiently to make certain that capacity changes due to the condensers connected would not, by upsetting the tuning, introduce unintentional alterations of the input voltage.

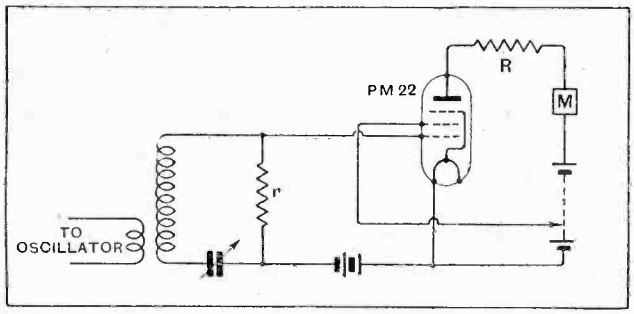



**Fig. 7.—Using the pentode detector as in the above circuit, condensers were connected across plate and auxiliary-grid circuits. No change in rectified current was observed.**

With these precautions condensers of various values, ranging from 0.0001 mfd. to 0.01 mfd. were connected in turn between plate and filament and between auxiliary grid and filament of the PM22. The deflection in the meter M obtained when no external capacity was connected across either of these paths remained unchanged whatever the value of the condenser used. From the point of view of the rectification of a carrier wave only, any value of external capacity from zero upwards may be used without in any way affecting the efficiency of the rectifier.

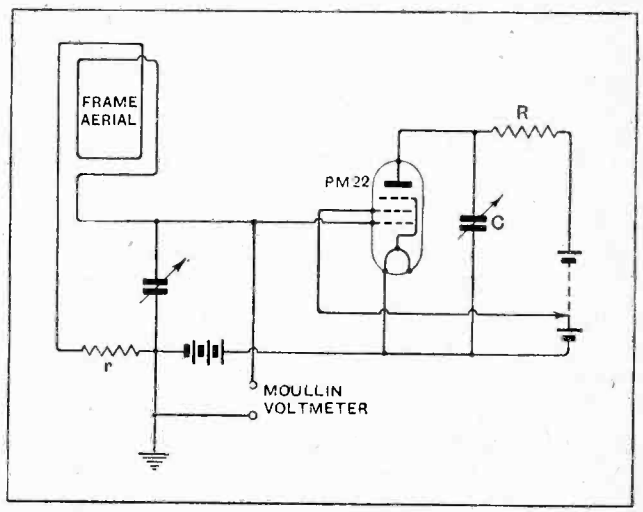



**Fig. 8.—With the aid of a calibrated condenser C and a Moullin voltmeter, this circuit enables the damping introduced into the tuned circuit by the detector to be measured. The magnitude of the damping is compared with that produced by the resistance r. See Figs. 9 and 10 for the results obtained.**

It has, however, been shown that the presence of a shunting condenser across the anode circuit of the valve is an essential to the proper reception of a modulated wave.[2] Furthermore, it is known[3] that this condenser helps to reduce very considerably the load imposed by the detector upon the tuned circuit from which it is supplied with signals, so that we must not conclude from the experiment just detailed that it is safe to omit this condenser entirely.

[1] *Journal I.W.T.* Vol. I, No. 4, pp. 148–151.

[2] *The Wireless World.* March 13th, 1929, p. 279.

[3] *The Wireless World.* May 22nd, 1929, p. 524.

**The Pentode as an Anode Rectifier.—**

To investigate the connection between the load on the input circuit and the output capacity, the apparatus shown in Fig. 8 was set up. The frame aerial used had an inductance of 225 microhenrys, and the circuit as a whole, including all losses due to the Moullin voltmeter and the dielectric losses due to the pentode rectifier, but not including any feed-back through the latter, had a high-frequency resistance of 7.9 ohms at the wavelength of 2LO (356.3m.). The resistance $r$ represents one of a series of small high-frequency resistors, any one of which could be put into the circuit at will.

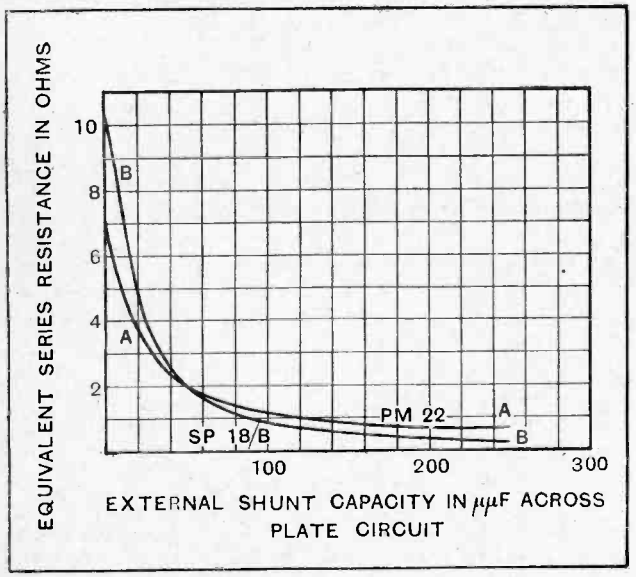



**Fig. 9.—Equivalent series resistance introduced by detector with different output capacities. See Fig. 8.**

The first step was to tune in 2LO and to read on the Moullin voltmeter the voltage induced by that station across the tuned circuit for a number of different values of the resistance $r$. During this process the filament of the pentode was not lighted. These results were then plotted as a curve, so that the resistance required at $r$ to reduce the high-frequency voltage to any value within the range of measurement could be read off. Incidentally, this series of readings gave the high-frequency resistance of the circuit that has just been quoted.

**Damping in Grid Circuit.**

The filament of the pentode, adjusted for rectification ($E_a = 145$v., $E_{aux.} = 20$v., $E_g = -5$v., $R = 0.22$ megohm), was then lighted, the circuit retuned, and the voltage was read on the Moullin voltmeter for various settings of the calibrated shunt condenser C. For all settings of this, the voltage was slightly lower than had been obtained with the pentode filament unlighted, showing that there was reverse reaction through the grid-plate capacity of the pentode. Each of these voltages could equally well have been attained with the filament of the PM22 disconnected, but with some value of $r$ in the tuned circuit. The value of $r$ equivalent in reducing the voltage to the presence of the pentode was read off from the curve already mentioned, and the results so obtained were plotted, as shown in Fig. 9 (curve A), against the value of external shunt capacity added at C.

As a comparison this series of readings was repeated, the pentode being replaced by a Cosmos SP18/B valve ($m = 35$, $R_o = 70{,}000$ ohms) in order that the damping introduced by the pentode might be compared directly with that produced by an ordinary valve of roughly similar characteristics. Curve B of Fig. 9 shows the equivalent series resistance introduced by this valve for different values of external shunt capacity.

**Equivalent Series Resistance due to Damping.**

Comparison of the two curves shows that for an external shunt capacity of 0.0001 mfd., which is about the largest value that can be used without audibly sacrificing the higher musical notes, the equivalent series resistance introduced by either of the two detectors examined is in the neighbourhood of one ohm. This damping need not be regarded too seriously, though one would greatly prefer that it should be absent altogether. The result of the damping is shown in another form in Fig. 10, where input voltage, using the circuit of Fig. 8, is plotted against the value of external shunt capacity. The reduction of voltage at the grid of the detector due to the damping that it imposes amounts to about 12 to 15 per cent. with the suggested shunt capacity of 0.0001 mfd.

A separate experiment on the same lines showed that there was no advantage to be gained by connecting a condenser from auxiliary grid of the pentode to filament. The source of current for this circuit, however, was a small block of H.T. accumulators, in good condition and freshly charged, so that it is probable that the impedance between auxiliary grid and filament was in any case very small, even in the absence of a condenser. If an eliminator were used it would probably be necessary to connect a condenser here also. In any case it would be advisable, in a practical receiver, to decouple this circuit with the usual condenser and resistance, so that the point really does not arise.

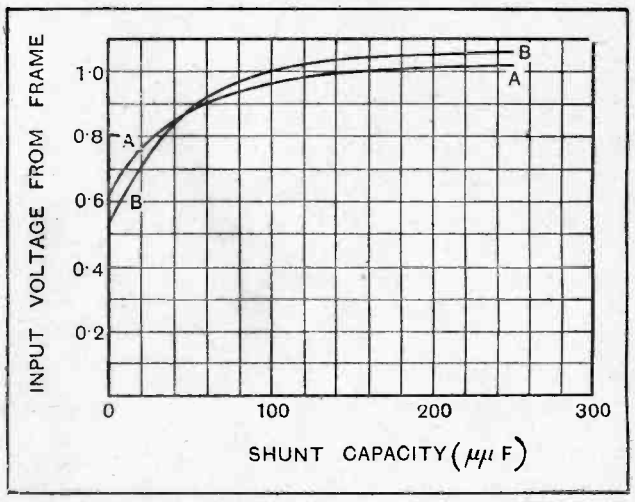



**Fig. 10.—Reduction of input voltage due to damping of frame aerial by reverse reaction through the detector. Compare Figs. 8 and 9.**

**The Pentode as an Anode Rectifier.—**

The last measurement made consisted in supplying the pentode with high-frequency modulated at 500 cycles by a low-frequency generator, measuring both the input of high-frequency and the output of rectified " signals." It is not necessary to describe the apparatus used for producing the " signals " for rectification; it amounts practically to setting up a private 2LO for oneself and

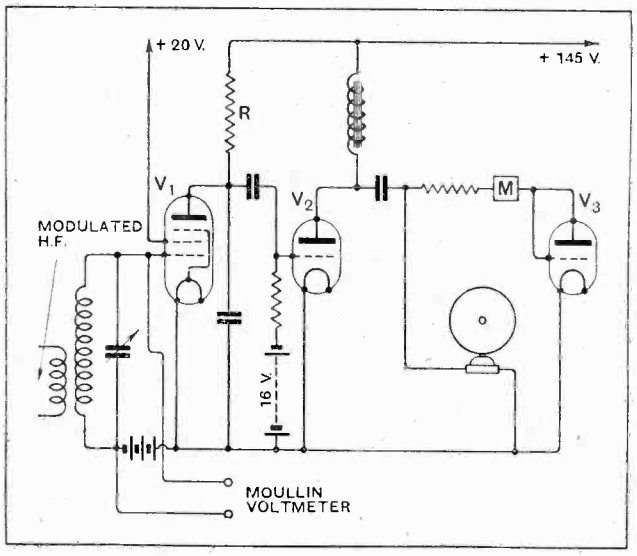



**Fig. 11.—$V_1$ is the PM22 detector, $V_2$ an amplifier and $V_3$ together with the meter M, measures the audio-voltage across the loud speaker. The Moullin voltmeter measures the high-frequency input. With this circuit the L.F. output to be expected from the detector for any given H.F. input of normal modulation was determined. See Fig. 12 for results.**

using it to transmit a continuous " tuning note " from one side of the room to the other. The apparatus is complicated, but perfectly well known to all those who are interested in such experiments.

The chief difficulty that arises in connection with it lies in determining the degree of modulation in use; for the present purpose this was got over by adjusting the modulation-depth to be approximately the same as that of 2LO when sending out loud passages of dance music. The pentode detector, with its associated valves, was employed in making this adjustment.

### Measuring the L.F. Output.

In order to read the low-frequency voltage developed across the resistance in the anode circuit of the valve, an amplifying valve followed by a Taylor voltmeter was used, the two together having previously been calibrated. The detector together with the valves and meters used to measure input and output respectively are shown in Fig. 11. In this $V_1$ is the PM22 valve adjusted as an anode detector as before, R being again 0.22 megohm. The modulated high-frequency voltage applied to its grid from the miniature transmitter was measured by a Moullin valve voltmeter. The 500-cycle output was applied to the grid of $V_2$, a D.E.5a valve amplifying in the normal manner. A loud speaker, introduced in order to have an aural check on the proper behaviour of the entire apparatus (11 valves in all were employed, not counting mains rectifiers) was fed from this valve, and the voltage developed across it measured by means of the Taylor voltmeter shown. $V_3$, the valve forming part of the Taylor voltmeter, was a D.E.R., the meter M being a microammeter. Before connecting the pentode, known 500-cycle voltages were applied to the grid of $V_2$, and the corresponding readings of M noted, so that the voltage developed across R in the complete set-up could be determined by simply reading M.

### Detector Efficiency.

The results derived from all this equipment are given in the curves of Fig. 12, in which the R.M.S. value of the modulated high-frequency input is plotted against peak audio-volts output. Curves are included for two values of anode resistance with the pentode, and for two other valves. The pentode will give, without overloading, an output just large enough to supply a second pentode used in the conventional manner as output valve, requiring for the purpose to be supplied with about 1.3 volts R.M.S. of normally modulated high-frequency. Thus where adequate high-frequency amplification is available, there is no need to interpose a low-frequency stage between the detector and the output valve, even though there is no transformer to provide a little free amplification.

Since the peak value of the high-frequency voltage is about 2.15 times the R.M.S. voltage when the modulation is 50 per cent., this is the largest input with which

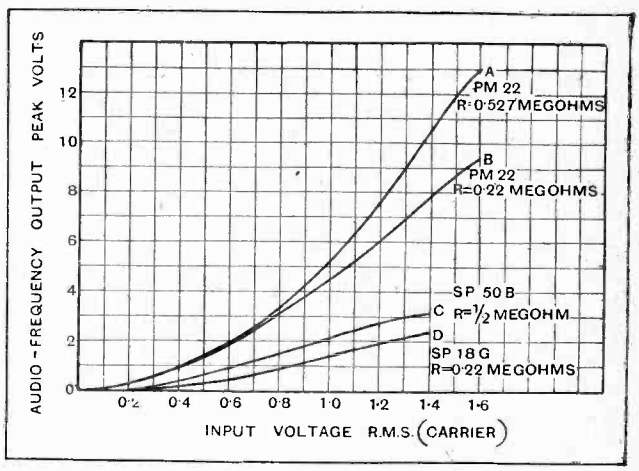



**Fig. 12.—Rectified L.F. output from pentode and other detectors supplied with normally modulated high-frequency.**

it will deal. This is indicated in the curves by a tendency to flatten out at the upper ends. The greater output of the pentode, as compared with the triodes, is sufficiently obvious from Fig. 12 to require no further stressing.

Summing up all that has come to light during these measurements, we may say that the pentode forms an unusually satisfactory resistance-coupled rectifier for small and moderate high-frequency voltages. It is about twice as sensitive as the triode that it replaces, and introduces about the same amount of damping into the grid circuit. In this latter respect, indeed, it might be

**The Pentode as an Anode Rectifier.—**

made perfect if the valve makers chose to produce a special model of the valve for this purpose.

With the triode there is no hope whatever of doing away with this unwelcome effect, for it owes its origin to the capacity between grid and plate of the valve. In the pentode, although two grids, earthed so far as signal potentials are concerned, are interposed between plate and signal grid, the capacity between these electrodes remains practically unreduced because the leads to both are taken out at the base of the valve. If the lead to the plate were brought through the top of the bulb, as in the screen-grid valve, and some small attention were paid to screening within the valve, the grid-circuit damping could quite easily be reduced to completely negligible dimensions. If a valve on these lines were produced it would be the first to be specifically designed for rectification since the days of the old soft grid-detector. Two models would be needed, one having figures like those of the PM22 here discussed for resistance coupling, and one with an A.C. resistance of not more than 10,000 ohms for use with a transformer for large inputs. The latter valve at least would also find application in another important direction.

# CURRENT TOPICS.

### HAPPY PROPHETS.

The enthusiasts who predicted a record success for the 1929 National Radio Exhibition have been more than justified. During the first three days over 40,000 visitors passed through the turnstiles, and the average daily attendance exceeded that of 1928 by nearly 3,000.

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### GOOD BUSINESS.

Within a few hours of the opening of the Show enough business had been transacted to cover the entire cost of the Exhibition.

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### A NEW HUNTING GROUND.

The B.B.C. test transmission van is now being used in the Glasgow district in a search for a site for the Scottish Regional station. We understand that the Post Office will not contradict the rumour that the van is hunting for "pirates."

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### CUTTING OUT THE CACKLE.

Broadcast advertisements are stated to have killed enthusiasm for wireless in Spain. A new State decree, which establishes a system of wireless licences, stipulates that not more than a hundred words of advertisement matter shall be broadcast in one hour.

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### SHORT-WAVE PICTURE TRANSMISSION.

Experiments in "Fultograph" picture transmission on short waves are being conducted at Vienna. These tests, which enable definite comparison to be made regarding the relative ranges of telegraphy, telephony and picture telegraphy, take place daily on a wavelength of 41-42 metres. The call sign is UOM, and the following schedule is observed :—

Telegraphy.—10.10 a.m. to 10.20 a.m.
Telephony.—10.20 a.m. to 10.30 a.m.
Picture Telegraphy.—10.35 a.m. to 10.45 a.m.

In the afternoon a similar transmission takes place at 3.10 p.m., continuing until 3.45 p.m. Reports on reception will be welcomed by Fultograph Gesellschaft, M.B.H., Austria, IV Prinz Eugenstrasse 10, Vienna.

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### BRITISH WIRELESS GEAR FOR POLAND.

An important success for British industry has been secured by Marconi's Wireless Telegraph Company, Ltd., who have been successful in obtaining one of the largest orders given of recent years in connection with broadcasting services. This order is for a large extension of the Polish broadcasting organisation which, following the English example, is to be remodelled so as to provide alternative programmes for the greater part of the country.

The new equipment will comprise one 120 kW. aerial input broadcasting transmitter with full modulation, two high-power regional stations with 16 kW. aerial input, and three local relay stations. The 120 kW. station will be situated near Warsaw, and will be used in addition to the 12 kW. Marconi station, which is already giving such an excellent service at Warsaw and has been in operation there since 1927.

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### MOROCCO JOINS THE MOVEMENT.

The first wireless show in Morocco is to be held from November 30th to December 8th.

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### ULSTER SHOW.

The Belfast Wireless Exhibition will hold sway in the Ulster Hall from October 9th to 13th.

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### FRENCH LOUD SPEAKER "WAR."

A campaign has been opened in several districts in France against noisy loud speakers. At Châteldon, Puy-de-Dome, an article of French law has been invoked whereby it is an offence to create "nocturnal uproar," even inside a house, if it is audible in the street. A by-law has been created forbidding "open window" loud speakers after 10 p.m.

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### BROADCASTING FOG SIGNALS.

To overcome the difficulty experienced by navigators in judging the distance of a fog syren, an interesting experiment in wireless telephony is to be made, probably at the Cumbrae lighthouse, by the Clyde Lighthouses Trustees. After the sounding of each blast from the syren the words "one," "two," "three," will be transmitted at intervals corresponding to the time the sound waves would take to cover one mile. By noting the time lag between the reception of the wireless signal and the sound of the syren, mariners will be able to determine with fair accuracy how far their ship is from the source of sound. At the moment when the syren sounds, the name of the station or lighthouse will be given.

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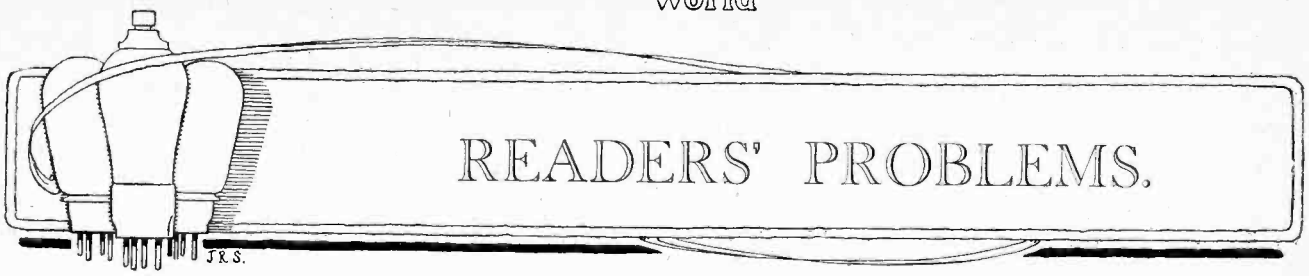
### T.C.C. ELECTROLYTIC CONDENSERS.

We regret that in the Show Forecast in our issue of September 18th the impression was conveyed that the Telegraph Condenser Company, Ltd., had entirely redesigned their electrolytic condensers of the 2,000 mfd. type. This is not the case. The company has, in fact, added to the range by producing a double type of the same condenser with a capacity of 4,000 mfd.


**A WARM WELCOME. There have been no "lost children" at Olympia, every visitor being given the opportunity of securing the best Guide to the Show before entering the portals of the Exhibition.**




# READERS' PROBLEMS.

"The Wireless World" Supplies a Free Service of Technical Information.

*The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.*

### A Selective Two-valve Set.

*I have a straightforward direct-coupled two-valve set consisting of a leaky-grid detector with reaction, followed by a transformer-coupled L.F. stage. This functions well on my local station, but the arrangement does not permit me to receive other stations, owing to lack of selectivity. I understand that you have published a two-valve receiver which has a high degree of selectivity, and shall be glad if you would give me the details of this.* R. W. G.

A set such as you have in your possession is an extremely unselective arrangement, and it is possible by careful design to produce a receiver having a degree of selectivity greatly in excess of this without in the least sacrificing distance-getting properties, and without appreciable loss of quality.

A receiver of this type was described in full on page 143 of the issue of this journal dated February 6th, 1929. Home-constructed coils were used, and full details were given. In case you do not care for the task of coil construction, you will find that these coils are available commercially.

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### Correct Milliammeter Position.

*I have a milliammeter with a scale reading of 0 to 50 mA, and have been advised that the correct position for this is between the H.T.– and the L.T.– terminal of the set in place of the usual short length of wire that connects these terminals together inside the set. I have temporarily connected it in this position, but notice that the needle is constantly and regularly fluctuating. The movement of the needle is not large, but the rapidity of the fluctuations are such that the needle appears almost as a blur. Reception is considerably distorted. Can you tell me where I have gone wrong?* J. E. G. M.

The sole purpose of putting a milliammeter in the position you show is to enable a reading to be taken of the total current consumption of the set. To leave a meter in this position, however, is wasting its potential usefulness, and, furthermore, it will cause low frequency instability and consequent distortion unless shunted by a large capacity condenser. The trembling of the needle and the distortion you notice are due to the fact that you have inserted the meter in this position without such a shunting condenser. A meter having this scale reading should be connected in the plate circuit of the last valve, where it will act as a useful indicator of overloading of this valve. In order to make quite sure that you place it in the right position, we give a diagram in Fig. 1.

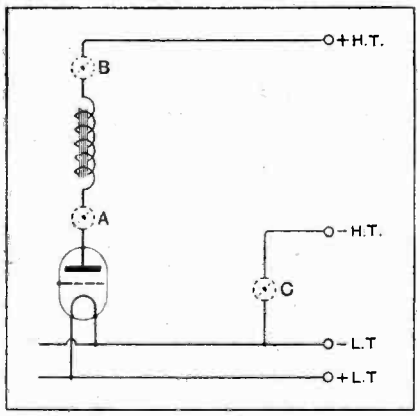


**Fig. 1.—Alternative positions for an anode current milliammeter. The correct position is at B.**

You will notice that the meter is shown in three positions, (A), (B) and (C). (C) is incorrect for the reason we have just stated; (A) is also incorrect, because the meter is at the high potential end of the external anode impedance. It should be connected at the low potential end of the choke, that is, in position (B).

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### Safety First.

*Can you give a definite ruling upon the question which has arisen among members of our local radio society as to whether it is necessary to turn the H.T. eliminator off first or to turn the filaments of the valve off first when "closing down" for the night?* P. N.

The rule is that the eliminator should be switched off *first*, and when preparing to receive signals again the eliminator should be switched on *last*. In many cases eliminators are designed to avoid this difficulty, and when this is so it is immaterial which is switched off first. It is most imperative, however, that where this safeguard is not provided the eliminator should be switched off before the filaments are turned off, otherwise there is risk of damage to the eliminator, and risk of shock to any person who accidentally touches certain parts of it. The effect of leaving the filaments on for fractional time after the eliminator is extinguished is that the fixed condensers discharge themselves in a normal manner through the appropriate receiver circuits.

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### Record III. or New Kilo-Mag Four?

*I am thinking of constructing one of the new receivers which have appeared recently in your journal, but cannot make up my mind whether to construct the "New Kilo-Mag Four" or the "Record III," and should be glad of your guidance on this point. I may say that I want long range, but do not desire to sacrifice quality on this account.* D. H. G.

The question of which of these two receivers to construct depends solely on whether you wish the set to be operated entirely from A.C. mains or otherwise. Both sets are long-range instruments, and both are productive of good quality. If you have A.C. mains in the house, we should certainly advise the "Record III"; otherwise, of course, the "New Kilo-Mag Four" should be chosen.

### RULES.

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given: under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

*Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.*

### A.C. Valves in the New All-Wave Four.

*I have had the "New All-Wave Four" receiver in operation since it appeared in your journal last year. I now desire to use it with A.C. valves, but do not wish to use one of the new screen-grid type valves, but wish to employ an ordinary A.C. triode. Can you tell me what alterations I should have to make? I wish to retain my existing aerial-grid coils and H.F. transformers, if possible.* S. F. B.

The best advice we can give you is to refer to you to page 274 of our issue dated September 5th, 1928, where you will find full constructional details of a receiver which is to all intents and purposes the "New All-Wave Four," modified and rebuilt for use with A.C. mains, using a triode, such as you describe. You can use your existing aerial-grid coils and H.F. transformers.

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### Pick-up Position.

*My present set consists of one H.F. valve followed by an anode bend detector and two stages of resistance coupling. I wish to use a gramophone pick-up, but am uncertain whether to use two or three valves—that is, should the pick-up be used in front of the detector valve or in front of the first L.F. valve? I should be glad if you would decide this point for me.* L. L. H.

In your particular case we would certainly advise that the pick-up be used in front of the detector valve. It may be placed in the grid return lead of that valve, but if you intend to insert a jack for the purpose make sure that no fixed condenser present in the set is in parallel with the pick-up, otherwise a loss of high notes will occur.

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### Choke Filter Again.

*I have constructed a straightforward three-valve set for use in connection with a D.C. mains eliminator; the H.F. valve is coupled to the detector by a transformer of the type used in several of your recent sets. I find, however, that "motor-boating" is very persistent. Can you suggest the cause of this? I enclose a theoretical diagram for your guidance.* G. P. R. N.

It is quite a straightforward matter to diagnose your trouble from the diagram. The trouble is evidently due to the fact that you do not use a choke filter output circuit in conjunction with the output valve. In all probability you will find that if this is used the set is completely stable.

We give herewith, in Fig. 2, the connections for adding a choke filter output circuit. There is a right and a wrong way of connecting the loud speaker, and if you adopt the wrong method results will be just the same as though you had not adopted the choke filter. The wrong method is shown in dotted lines. It will be seen that although this method of connection gives the advantage that no direct current passes through the loud speaker windings, thus safeguarding it from breakdown, it still permits the A.C. component of the energy present in the plate circuit of the valve to pass through the source of H.T. supply. A study of the correct method of connection clearly shows that the A.C. energy is almost entirely diverted to filament negative *via* the loud speaker.

With regard to the extra fixed condenser shown in series with the loud speaker, this is not absolutely necessary unless headphones are to be used. If you contemplate the use of long extension leads it is advisable to put in this extra condenser, and its value must be 8 mfd. and the value of the condenser normally in position must also be 8 mfd.

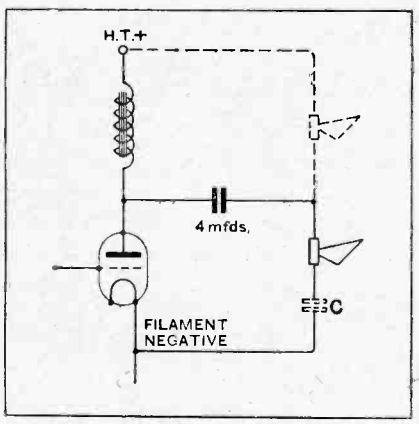


**Fig. 2.—Illustrating the correct method of connecting the loud speaker in a choke filter circuit.**

The reason is that you have two condensers in series with each other, and although they have this large capacity, the resultant capacity (in accordance with the rule for condensers in series) will only be 4 mfd. You will thus see that if you use one condenser it should have a 4 mfd. capacity, but if you use two, both must be 8 mfd.

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### New Valves in a New Set.

*I notice that the designer of the "New Kilo-Mag Four" mentioned that in all probability new valves which will be suitable for use with the "New Kilo-Mag Four" will be shortly available. Can you tell me when these are likely to appear?* S. R. D.

We would refer you to page 205 of our August 28th issue, where some of these new valves are reviewed.

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### A Pick-up Recorder?

*I am thinking of experimenting with the making of gramophone records, and should be grateful if you could tell me the best type of gramophone pick-up to use, and, if possible, inform me how to use it.* P. N. M.

You are evidently under the misapprehension concerning the precise function of a gramophone pick-up. This instrument is solely intended to be used in cases where it is desired to convert the acoustic energy from the record into electrical energy so that it may be amplified and passed to a loud speaker which again converts it to acoustic energy. It is impossible to use a pick-up for the reverse process.

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### An Accumulator Charging Precaution.

*I wish to charge my H.T. accumulators from my mains, which are A.C. Until recently the mains have been D.C., and the job has been done by means of a simple lamp resistance. I propose, in the interests of cheapness, to build the A.C. charger described in your isue of August 3rd, 1927. Can you inform me if this is still to be recommended?* G. N. R.

We should not advise you to make use of this instrument now, as it means that the accumulators will be directly coupled to the A.C. mains, and, in view of the regulations that are now in force, it is advisable to use a transformer to isolate the rectifier, and the accumulator on charge. This prohibits the use of a cheap bell-ringing transformer, and means that you must build your instrument with a proper transformer having two secondary windings (we here assume that you are intending to use a valve rectifier).

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### Transformer Ratio.

*My friend who is constructing a receiver intends to use a moving-coil loud speaker which is wound to a low resistance. He intends using a pentode valve in the last stage, and has requested me to write to you to ascertain whether it would be correct to use one of the many transformers which are specially designed for use after a pentode valve.* D. G. L. H.

It is not possible for us to give a definite reply in this case. You will appreciate that in the case of a low "resistance" loud speaker it is necessary that the secondary of the transformer be also wound to a low "resistance," which in the ordinary course of events means a big step-down in ratio. Many of the transformers you mention have only a small step-down and are intended primarily for the purpose of enabling the pentode type of valve to be used in connection with a moving-coil loud speaker of the "ordinary" type, that is, the type wound for use after the ordinary super-power valve. This obviates the necessity of winding the actual coil with a large number of turns.

We advise, therefore, that before purchasing a transformer you ascertain from its makers what type of loud speaker is intended to be used in conjunction with it.

You will appreciate that in order to "match" the output valve or valves with the loud speaker it is really necessary to use an output transformer whose primary is wound to harmonise with the output valve or valves, and whose secondary is wound for use in conjunction with the particular *type* of loud speaker concerned. You will perceive from this that the ratio of the transformer then automatically settles itself.

# The Wireless World

AND RADIO REVIEW

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## TELEVISION.

THE past week has seen the inauguration of experimental transmissions of the Baird system of television from the B.B.C. London station, 2LO, but the number of people who are the wiser now that these transmissions have begun is very limited indeed, and the whole position appears to us to be so absurd that we wonder whether the inauguration of these experiments is really intended to be taken seriously or not. Those who have witnessed Baird television demonstrations in the past will know that only two or three people can "look in" at a time to one instrument, and there are, we understand, at the very most half a dozen instruments set up in this country to receive the B.B.C. transmissions. Add to this the fact that the transmissions are being conducted at 11 o'clock in the forenoon—a time when very few of those likely to be interested in the development of television are able to avail themselves of the transmissions—and we have altogether a collection of very good reasons why television is not likely to make much progress in this country at present.

The Baird Company are not at present undertaking to manufacture television receiving sets; their object appears to be to endeavour to establish a patent situation under which they license radio manufacturers generally and draw royalties on every receiver sold. This is no doubt a policy which it is thought will, in the end, be to the advantage of the Baird Television Company's shareholders, but in the meantime manufacturers are, quite naturally, in no hurry to sign a licensing agreement which will presumably tie them up to paying royalties over a period, whether or not they may be dependent on Baird patents in the manufacture of receivers. The only way in which we can foresee success attending the efforts to launch television is if these efforts are wholehearted, and there is a genuine endeavour made to rouse enthusiasm on all sides. The Baird Company will gain nothing by stifling the project at the outset because they desire to guarantee their own participation in the financial gain which may accrue, neither can we expect any headway to be made so long as the B.B.C. conduct the experimental transmissions at a time when the amateurs and experimenters who are most likely to provide the enthusiasm needed to carry the thing through are unable to participate in the tests. It would be far better that the transmissions, or at least some part of the transmissions, should take place in the evenings or over week-ends, for that is the only way in which publicity amongst enthusiasts can be attained and when it will become possible for them to co-operate in the experimental transmissions and probe the possibilities of the system.

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## OLYMPIA SHOW COMPETITION.

AT the time of writing, a few days still remain before the entry forms for *The Wireless World* Olympia Show Competition are due to be received, but already a large number of early entries are reaching us. We anticipate that it will not be possible to announce the result of the ballot for two or three weeks, owing to the time required in the task of sorting out the votes and ascertaining the winners in each class.

Meanwhile, we hope that every reader has participated in the ballot by completing an entry form to send us. As soon as results are known they will be announced in *The Wireless World*, and the prizes will be awarded, whilst the winning apparatus will be reviewed in the pages of this journal.

# TRANSMITTING ON ULTRA-SHORT WAVES

By R. L. SMITH-ROSE, D.Sc., Ph.D., A.M.I.E.E., and J. S. McPETRIE, B.Sc.

## Experimental Transmitting Apparatus for Wavelengths below 10 Metres.

ALTHOUGH it has been possible for some time past to generate on a laboratory scale oscillations of a frequency corresponding to wavelengths below 10 metres, the introduction of such wavelengths into commercial communication is taking place very slowly. This is partly due to difficulties in the technique of generation with appreciable power and the construction of sufficiently sensitive receivers, and partly to the very limited range which can be obtained in the transmission of such waves directly along the ground. Communication over anything but the shortest distances must therefore take place by means of waves transmitted through the atmosphere, and although this has been stated at times to be impossible a small amount of evidence to the contrary is now becoming available. With a view to assisting those readers who may care to experiment on the ultra-short wavebands, this article contains a brief description of some experimental transmitting apparatus which has been constructed and made to work; a further article describing a simple receiver for such short wavelengths will, it is hoped, be published later.

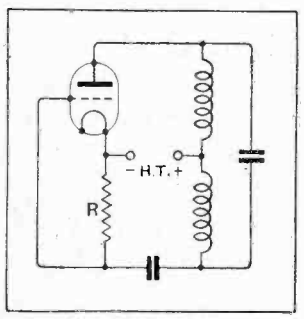


Fig. 1.—Circuit diagram of single-valve oscillator for very short wavelengths. The D.C. supply connections are omitted for simplicity.

It may be said at the beginning that very few, if any, new principles have to be learnt and followed in the construction of short-wave apparatus, provided that due allowance is made for the change of frequency in regard to the effect of reactances, mutual couplings, etc. It has to be realised, for instance, that at a frequency of 100 million cycles per second, the reactance of a straight piece of No. 47 S.W.G. Eureka wire may be much more important than its ohmic resistance, and that when a straight wire is arranged in the form of an aerial and is tuned to the working frequency the radiation resistance is usually the predominating factor which limits the current flowing in the aerial.

In the design of a valve transmitter it is natural to give early consideration to the actual type of oscillating valve circuit which it is proposed to employ. In a more comprehensive paper published in the current number of *Experimental Wireless* a somewhat detailed study is given of the various sorts of circuit of both the one-valve and two-valve type, with a discussion of their relative suitability for work at extremely high frequencies. One of the most important precautions to be taken in the construction of short-wave transmitters is to ensure that the coupling *via* the inter-electrode capacities of the valve is assisting the coupling due

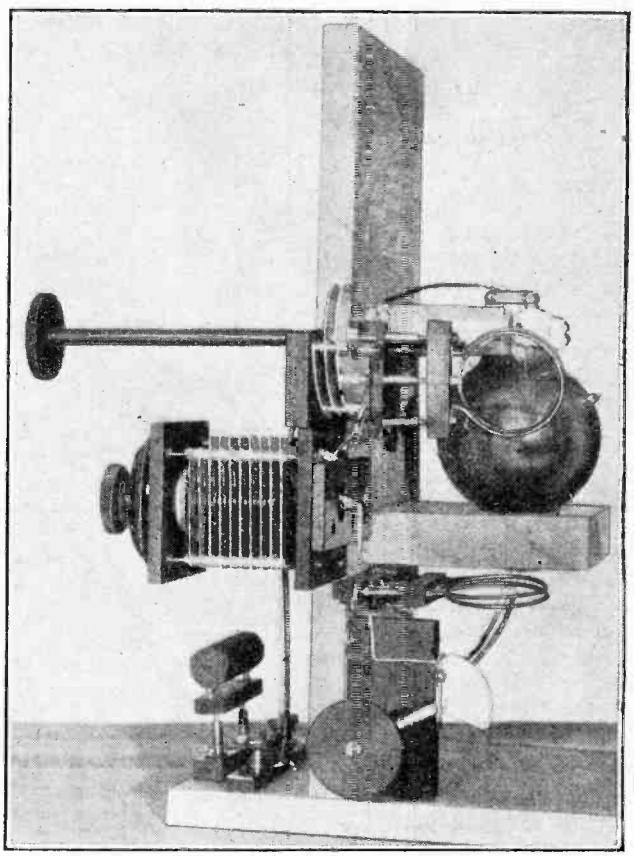

Fig. 2.—Single-valve transmitter for wavelengths down to 5 metres, employing a 100-watt valve in the circuit of Fig. 1.

**Transmitting on Ultra-short Waves.—**

to any mutual inductance whether stray or intentional. Many layouts of an otherwise useful circuit will not oscillate for the sole reason that these couplings are opposing each other.

### A Single-valve Transmitter.

A most useful single-valve circuit for short-wave working is that sometimes known as the series-fed Hartley circuit illustrated in Fig. 1. Before attempting the construction of a transmitter based on this circuit it is important to get a clear idea of the magnitudes of inductance and capacity which are available for work on the wavelengths in question. To crystallise the reader's ideas it may be stated that a single turn loop of thick copper wire about 12in. diameter has an inductance of less than one microhenry, and that this requires only 36 micro-microfarads of capacity to tune it to a wavelength of 10 metres, or 9 micro-microfarads to tune to 5 metres. There is, therefore, not much to spare in the matter of inductance and capacity, and every effort must be made to keep the dimensions of the subsidiary portions of the valve circuit as small as possible in order that the bulk of the small inductance and capacity available may be in the main oscillatory circuit.

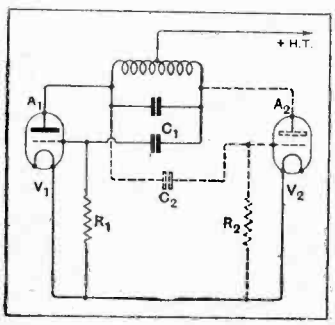


**Fig. 3.—Circuit arrangement of two-valve oscillator showing its derivation from the series-fed Hartley circuit of Fig. 1.**

Reverting to the circuit diagram given in Fig. 1, it is to be observed that a centre tapping point is required on the inductance loop. While this may be made at the top of a single turn loop it is usually more convenient to use a two-turn loop in order to bring the tapping to the bottom of the coil where connection has to be made to its ends. In order to cover different ranges of wavelength it is convenient to mount these two-turn coils on small insulating blocks with three pins giving connections to the ends and centre of the coil. A single-valve transmitter employing a 100-watt valve in a circuit arrangement similar to that of Fig. 1 is shown in the photograph in Fig. 2. The transmitter is mounted on a panel of American whitewood, which material has a very low dielectric loss when kept dry. The main inductance is the two-turn loop to be seen in front of the valve. This is formed of No. 14 S.W.G. copper wire into a coil 2½in. in diameter, mounted on an ebonite block with the necessary three-pin connection. This coil is mounted directly on its tuning condenser, which contains two moving and three fixed plates as shown, and has a capacity of about 20 micro-microfarads. It will be noticed that an extended control handle is provided for this condenser in order to minimise hand capacity effects when tuning. The larger variable condenser seen to the left of the photograph is used for variable retroaction. As shown, this condenser is unnecessarily large and its capacity, while not being very critical,

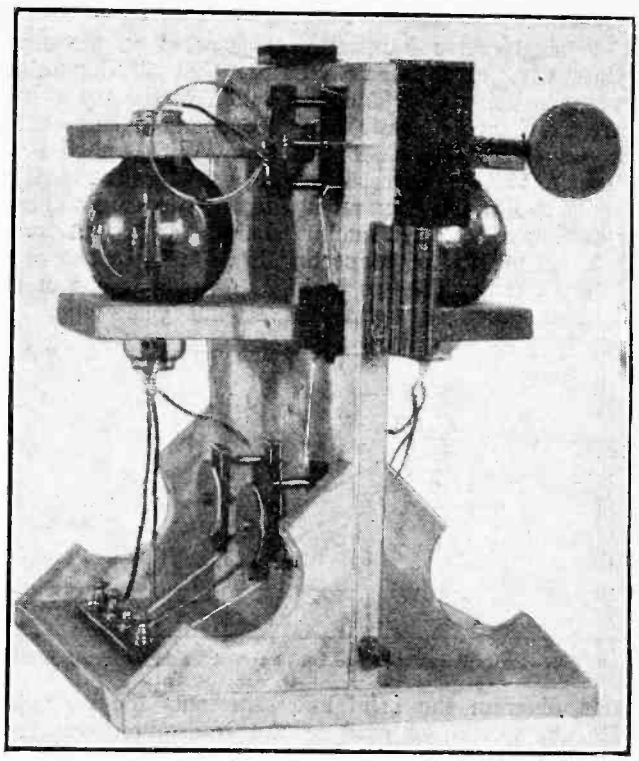

**Fig. 4.—Two-valve 200-watt transmitter, wavelength 5 to 30 metres, using the circuit of Fig. 3.**

need only have a maximum value of 100 micro-microfarads. The two-turn coil mounted horizontally beneath the valve formed, with the variable condenser below it, a rejector circuit in series with the grid leak. This was originally inserted as a means of ensuring that the self-capacity of the grid leak itself did not cause difficulties, but later experience has proved that it is difficult to use it effectively owing to the fact that it provides another circuit to tune, and that it is more convenient and practically as effective to do without it or replace it by a choke coil. Owing to the symmetry of the circuit the positive H.T. supply lead does not really demand the insertion of a radio-frequency choke coil, but this and most other arrangements can be used more effectively on the shortest wavelengths when such a choke is used. Very little knowledge is available as to the behaviour of chokes at very high frequencies. A useful design, as shown in Fig. 2, consists of from 100 to 150 turns of No. 47 S.W.G. copper wire wound at uniform spacing on a three inch former of ebonite of American whitewood one inch in diameter.

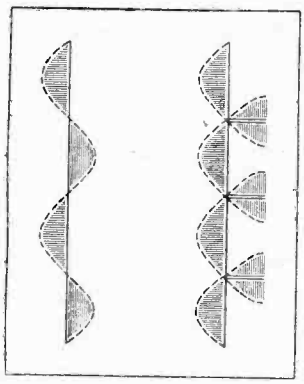

**Fig. 5.—Diagram showing the use of phasing coils in an aerial two wavelengths long to give maximum radiation in a horizontal plane.**

**Transmitting on Ultra-short Waves.—**

A single-valve transmitter constructed on the above lines with care taken to ensure that all dimensions between the valve and the tuned oscillatory circuit are as short as possible can be operated successfully at wavelengths down to 4 metres. With limited high-tension voltage increased output may be obtained by using two valves in parallel, but the two valves chosen must have closely similar characteristics. A more efficient method of connecting two valves to one oscillatory circuit is shown in Fig. 3, which is one of the circuits described by Eccles several years ago. In

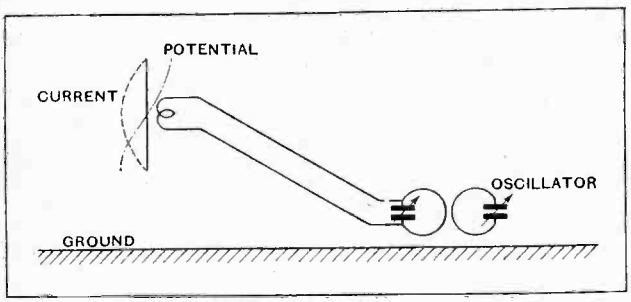


**Fig. 6.—Inductive coupling to half-wavelength ungrounded aerial.**

this diagram the solid line represents the series-fed Hartley circuit as used in the transmitter described above. The broken line shows the manner in which the second valve is connected. It will be seen that this circuit is really a double series-fed Hartley circuit, the two valves of which supply the oscillatory circuit alternatively. Each valve in such a transmitter may be tested individually under working conditions by converting the oscillator in succession into its two constituent single-valve circuits, and testing each in turn. Some readers may prefer to consider the two-valve circuit as one, operating on the familiar "push-pull" principle, with variable capacity coupling between the anode and grid coils.

**200 Watt Transmitter.**

A short-wave transmitter of 200 watts input designed to work on wavelengths between 5 and 30 metres with the circuit arrangement of Fig. 3 is illustrated in the photograph, Fig. 4. The whole of the transmitter, less the direct-current supplies, is mounted on an American whitewood panel as shown. The valves are placed on opposite sides of the panel in order to shorten, as much as possible, the leads between them. Although the anode current is really fed in at a constant potential point of the oscillatory circuit it is desirable to insert choke-coils in the high-tension supply leads in order to ensure that no high-frequency power loss occurs in these leads. Various sizes of condenser have been tried for coupling the anode of one valve to the grid of the other, and the most suitable has been found to be a variable condenser having a maximum capacity of about 50 micro-microfarads. The main tuning condenser should preferably have a somewhat smaller capacity.

The coils forming the inductance for such a transmitter may be constructed either of copper rod about $\frac{1}{8}$in. diameter, or of aluminium tube of a larger size. The dimensions of the coils are so small that the ohmic resistance is not very important, but it is desirable to have a substantial size of conductor in order to secure rigidity, and so avoid slight changes in wavelength due to vibration. The variable condensers employed may be constructed conveniently from the standard low-loss transmitting type with some of the plates removed and additional spacing washers inserted. Every effort should be made to obtain a very low minimum capacity, if the shortest wavelengths are aimed at.

A similar type of transmitter, employing two 250-watt valves will be found described and illustrated in the paper published in *Experimental Wireless* referred to above. It may also be recalled that a portable transmitter employing two valves arranged in the push-pull connection of Fig. 3 was described in *The Wireless World* about a year ago.[1] In this case, however, the minimum wavelength was about 30 metres, and two L.S.5A valves were employed, capable of handling a power input of 20 watts.

**Valve Requirements for Transmitters.**

Valves intended to deal with power at very high frequencies must have special design features not essential for those working at lower frequencies. The first feature desired is low self capacity and mutual capacity of the electrodes. This means that the leads to the electrodes should be brought out of the glass envelope as far as possible from one another. This separation of the leads, however, is limited by the inherent increase in inductance due to their greater length.

Several years ago Franklin drew attention to the possibility of the glass envelope melting as a result of the heat generated by eddy currents in metallic deposits which occur on the inside of the glass during evacuation of the valve. In certain types of transmitting valves

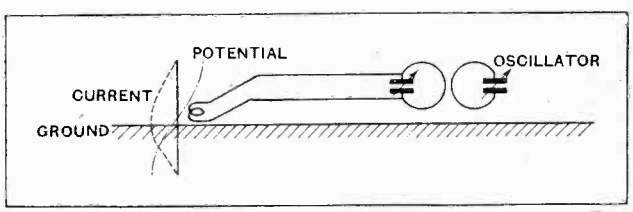


**Fig. 7.—Inductive coupling to grounded quarter-wave aerial.**

it has been customary to use copper foil screens on the outside of the envelope to avoid breakdown from this cause. Large dielectric losses may also be experienced in those portions of the glass which lie within the high frequency field between the grid anode. The envelope should, therefore, be of as great dimensions as is consistent with short leads from the electrodes. The neck of an ordinary transmitting valve is in a concentrated part of the field and punctures were very common at this point when valves were first used on short wavelengths. The field may be reduced by continuing the grid mesh beyond the ends of the anode. This construction concentrates the radio-frequency field between the grid and anode, and so reduces that which reaches

[1] *The Wireless World*, October 10th, 1928, page 501.

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the glass walls of the valve. It is also advisable to thicken the leads to the electrodes at the places where they enter the glass.

### Aerials and Signalling Arrangements.

The portable transmitter referred to above was connected to a short aerial through a variable coupling condenser from one end of the oscillatory circuit, an earth connection being taken to the centre point of the inductance, at which point the high-tension direct current is also supplied to the circuit. While this method may still be employed for wavelengths below 30 metres, it is found that when the wavelength is less than 10 metres only a very short aerial is available if the difficulties of phasing in alternate half wavelengths are to be avoided. For example, on a wavelength of 5 metres a 30ft. aerial is about two wavelengths long, and the distribution of current therein will be as shown in the left-hand side of Fig. 5, where the distance of the wavy line from the vertical line indicates the magnitude of the current, and the shading and the side of the aerial on which it is placed indicates the direction of this current. It is seen from this diagram that there are two equal loops of current of each of the two opposite directions, and there will thus be no field due to the whole current in a direction perpendicular to the aerial. From this it results that there will be no radiation from such an aerial in the horizontal plane, although there will be some radiation in other directions. By inserting suitable inductances in the aerial the distribution of current in successive portions of the aerial may be altered as indicated in the right-hand diagram of Fig. 5. It is now seen that throughout the length of the aerial the currents are all in the same direction, and will thus assist each other in producing strong radiation in the horizontal plane. This is the method successfully employed at the Marconi beam stations, where aerials of several half-wavelengths in height are employed.

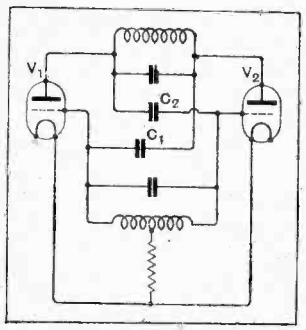


**Fig. 8.—Circuit diagram of an alternative push-pull oscillator employing tuned circuits in both anode and grid circuits.**

In order to avoid the complications arising from the use of phasing coils in the above manner it is convenient in experimental work on very short waves to employ short, straight aerials the length of which corresponds to either a half or a quarter of the working wavelength. In the former case the aerial should be supported at a suitable distance above the ground, the ends being insulated, since these are the points of high potential variations. The aerial may be energised by inductively coupling the oscillator to a point near its centre, as indicated in Fig. 6. In the case of the quarter-wave antenna, this should be connected either to earth or to a suitable counterpoise at its lower end, at which point the maximum current will be obtained (Fig. 7). For efficient radiation on very short wavelengths the antenna should be situated in as open a space as possible. In the radiated field objects act as reflectors when their linear dimensions are comparable with the working wavelength. The buildings associated with a short-wave station are usually such that they give rise to an appreciable amount of scattering and loss. The only method of diminishing the loss of useful radiation in this manner is to place the aerial at some distance, two or three wavelengths, from any buildings and supply energy to it from the transmitter by means of a transmission line. Such a line may be formed either of a pair of straight, parallel Lecher wires, or of a twin conductor comprising an inner wire surrounded by a concentric metallic sheath. In either case the line should be such that it has maximum current loops at each end, which is obtained when the length of the line is an integral number of half wavelengths. A line of fixed length may, however, be effectively varied by tuning it with variable condensers at one or both ends, as indicated in Figs. 6 and 7, which show the principles of feeding half- and quarter-wave aerials through transmission lines. A Lecher wire transmission line may be conveniently formed of two copper wires of about No. 16 or 18 S.W.G. stretched parallel at three or four inches apart, and at a distance of at least a foot from all other bodies except their supports. The wires are short-circuited at each end and adjusted either by length or by varying the condenser to obtain maximum current at each end.

A half-wave antenna may conveniently consist of two telescopic brass or aluminium tubes supported at the centre. This antenna is tuned by altering its length, the current being observed on a suitable thermal ammeter inserted at its middle point where the current is a maximum. Owing to the fact that the radiation resistance of a half-wave antenna is in the neighbourhood of 80 ohms, the actual ohmic resistance of the antenna, including the ammeter, is not of serious importance. In a recent experiment the replacement of an antenna of ¼in. brass tube by a No. 30 S.W.G. Eureka wire only reduced the current by 30 per cent. On account of this high effective resistance the tuning of a half-wave antenna is not very sharp. Since, however, the radiation resistance is the predominating factor limiting the current, the efficiency of such an aerial is very high, and practically all the energy supplied to it is converted into useful radiation.

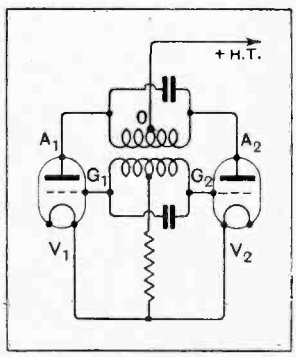


**Fig. 9.—Circuit of Fig. 8 with the coupling condensers omitted. The necessary coupling is obtained by the mutual inductance of the tuned circuits.**

The variable condensers in the Lecher wires form a useful method of altering the current in the aerial without disturbing the balance between the two valves of the oscillator. The Lecher wires are useful in addition for measuring the wavelength, which can be carried out approximately by running a shorting wire bridge along

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the wires. This alters the current in the aerial except when the bridge is at a potential node on the wires. The positions of consecutive potential nodes are one half-wavelength apart, and can be determined to within about 1 cm. An alternative method of locating these potential nodes is to bridge the wires with a small thermo-galvanometer to determine the positions of maximum current. In either case these positions can be determined with fair accuracy, since at the points in question there are practically no radio frequency potentials, and body capacities will therefore have little

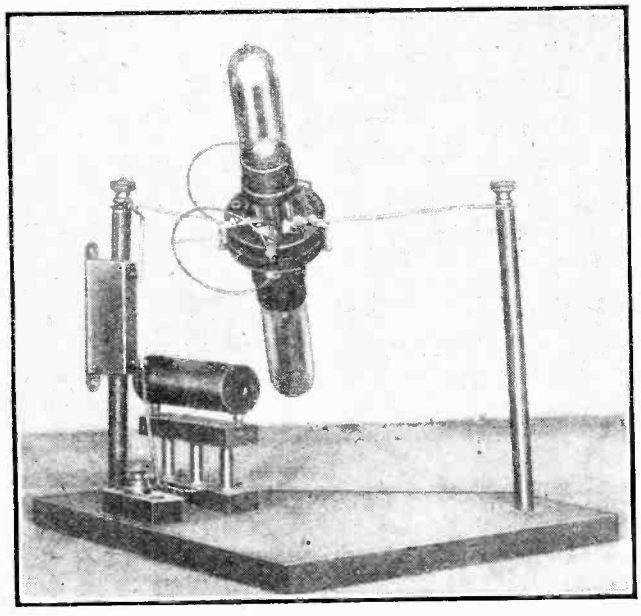


Fig. 10.—Two-valve oscillator using the circuit of Fig. 9 and operating on a wavelength of 1.8 metres.

effect. The whole Lecher wire system should, however, be erected as far as possible from all other bodies in order to avoid spurious effects due to the proximity of these at potential antinodes on the wires.

**Signalling.**

Signalling with low-power short-wave transmitters may be carried out by using a suitable key in the high-tension supply as with the portable set already referred to, or by short circuiting a small coil placed near the tuned oscillatory circuit. The tuning of a receiver at wavelengths of the order of 5 metres is so sharp that the change in the frequency of the transmission brought about by the latter method is sufficient for the signal to become inaudible in the receiver when the coil, coupled to the tuned circuit, is short-circuited. An alternative method of keying for signalling purposes is to attach one terminal of a transmitting key to one wire of the Lecher system, and simply to operate the key by means of a long handle. The closing of the key contacts adds a small lumped capacity to the Lecher wires, which is sufficient to change the heterodyne note in the receiver. Keying by this method produces extremely clear signals and does not alter the load on the transmitter to any appreciable extent.

**An Oscillator for Extremely Short Waves.**

In the two-valve "push-pull" circuit described above, and illustrated in Fig. 3, grid leaks $R_1$, $R_2$ were employed to fix the D.C. potentials of the two grids. A suitable value for the resistance of these leaks has been found to be 0.5 megohm, although this value is not so important as the self-capacity, which should, naturally, be kept as low as possible. It has been found that for low-power work leaks of the deposited metallic-film type are suitable. A consideration of Fig. 3 will show that the circuit will oscillate just as well if the grid leaks are replaced by any circuit which has a high impedance at the frequency of the oscillator. For example, $R_1$, $R_2$ may be replaced by chokes, the D.C. potential of the grids being fixed by a suitable resistance in the common lead from the filament to the common point. Another method of having a high impedance between the two grids is to replace $R_1$ and $R_2$ by a tuned circuit, as shown in Fig. 8, which is another of the two-valve balanced circuits first described by Eccles and Jordan. The connection to the filament, in this case, is made to the middle point of the inductance. Suitable choke coils may be of the single-layer solenoid type described above in connection with the circuit details relating to Fig. 2.

In the double-valve oscillator of Fig. 3 the condensers $C_1$ and $C_2$ act as retroaction condensers from the anode of one valve to the grid of the other. In the circuit in Fig. 8, however, these condensers are not required, as the mutual inductance between the anode and grid coils may be made to provide the necessary retroaction. The diagram of such a circuit is given in Fig. 9. This type of oscillator has the disadvantage that there are two circuits to tune, and that it is difficult to vary the coupling between the grid and anode coils when working on very short wavelengths. At very high frequencies the electrostatic coupling between the grid and anode coils may become important, and this coupling is of opposite sign to that intentionally introduced by the magnetic induction. With the two-valve oscillator using the circuit shown in Fig. 9 it has been found possible to obtain oscillations at various wavelengths down to a lower limit at about 1.5 metres. This limit is really set by the dimensions of the valves and the time taken by the electrons to travel from filament to anode inside the valve. Fig. 10 shows a view of a two-valve oscillator which operates on a wavelength of 1.8 metres. Two short-path receiving valves are mounted on low capacity holders "back-to-back." The inductances are formed of loops of No. 16 S.W.G. copper wire about 2in. in diameter, and all subsidiary connecting wires are reduced in length to the minimum, and no tuning condensers are used.

The high tension feed is through a piece of No. 47 S.W.G. Eureka wire which acts as a choke and fuse combined. A choke coil is included in the grid lead, while a condenser of 0.01 microfarad capacity is provided.

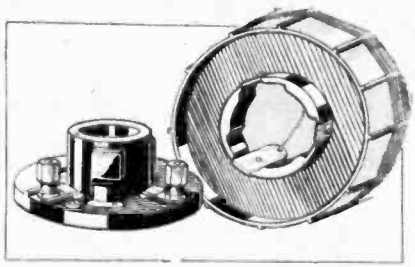
It is, of course, very difficult to obtain any appreciable output from such oscillators, and when an attempt is made to increase the power by the use of larger valves it is usually found that the minimum wavelength attainable increases.

# The NEW KIT SETS

## Home Constructors' Receivers Seen at Olympia.

WHAT is a "Kit" set? Strictly speaking, this description should be applied only to complete sets of parts for receiver construction, but it has, very conveniently, been extended to cover circuit arrangements sponsored by various manufacturers who, although they issue descriptive literature, do not supply all the necessary components. This scheme offers what is, in some cases, an important advantage; existing pieces of apparatus in the possession of the constructor may be used.

Indications are not lacking that the building of sets in this way, involving as it does nothing beyond the assembly and wiring of a few readily obtainable parts, is increasingly popular, and the Olympia Exhibition showed that an infinitely greater diversity of kits are now available than at any previous time. Last season's sets have undergone modifications in much the same way as have complete commercial receivers, and there has been a distinct tendency to improve their performance, to simplify their operation, and to render their construction even easier than previously.

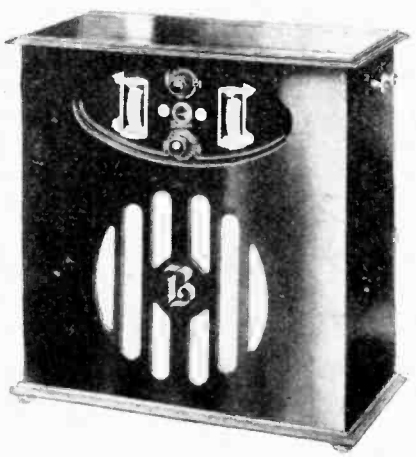


Non-reversible mountings for interchangeable coils in the Brown receivers.

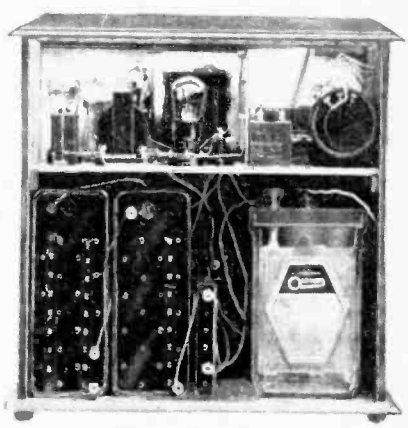
With one or two exceptions, all the sets offered are three-valve H.F.-det.-L.F. combinations; indeed, it is becoming more and more apparent that this excellent circuit arrangement is regarded as a standard one for meeting average requirements. Perhaps the most striking innovation is the introduction of kits for A.C. mains operation—not simply ordinary battery sets arranged to be more or less capable of working with an H.T. eliminator, but receivers designed specifically for this form of supply for their filament and anode circuits.

The purpose of this article is briefly to describe the principal features of sets that are either entirely new this autumn or that have undergone considerable modification, and no attempt will be made to treat anything but the main features of the various designs: detailed descriptions and test reports will, no doubt, in most cases, come at a later date.

The Brown sets, recently introduced by the well-known firm of loud speaker manufacturers, are typical of present-day tendencies in several respects. Four distinct models are available; two for battery feed and two for mains supply. Each type is



Brown three-valve set, complete with loud speaker.



Interior view of Brown kit set, showing how batteries are mounted behind the loud speaker.

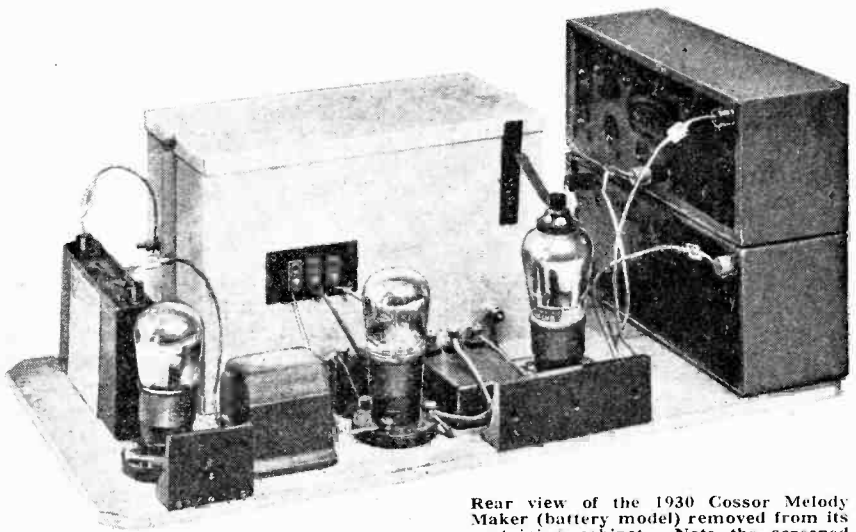
**The New Kit Sets.**—available with or without a built-in cone loud speaker. In every case there is ample room inside the containing cabinet for batteries or mains unit. The circuit arrangement embodies a single H.F. amplifying stage (screen-grid valve), grid detector, and an output valve coupled by means of a Brown Type A low-frequency transformer. Reaction is provided, and the tuning condensers are controlled by edgewise dials.

Interchangeable coils, wound on large ribbed bakelite formers, are used. These coils are provided with a particularly good form of bayonet catch mounting, of which the studs look as if they should be entirely free from that annoying form of trouble due to intermittent contact. The aerial-grid coils have three separate aerial tappings, brought out to sockets mounted on the former itself in such a way that an adjustment of coupling may readily be made to suit varying needs in the matter of selectivity. It should be added that the coil mountings are so arranged that they cannot possibly be inserted incorrectly in their holders.

The new "Bullphone" kit sets are supplied with bakelite panels, into which are moulded the necessary holes for securing the various components. The "Nightingale Three" is a detector-2-L.F. receiver with transformer coupling, while the "Screened Grid Three" embodies an H.F.-det.-L.F. circuit. The dual range coils used have built-in switches operated through rods projecting through the panel.

### A New Departure.

The "1930 Cossor Melody Maker" has been completely redesigned, and bears but little resemblance to its prototype. It will be generally agreed that the majority of home constructors' difficulties are in some way associated with the H.F. stage; here a bold attempt has been made to remove possible causes of trouble by supplying all the apparatus associated with this part of the receiver—coils, tuning condensers, reaction condenser, wave-range switch, etc.—as a complete manufactured and wired unit, contained in a two-compartment screening box for mounting inside the cabinet. Advantage has been taken of the fact that this method of construction lends itself to "ganging" of the two tuned circuits, and consequently we find that they are controlled by a single knob.



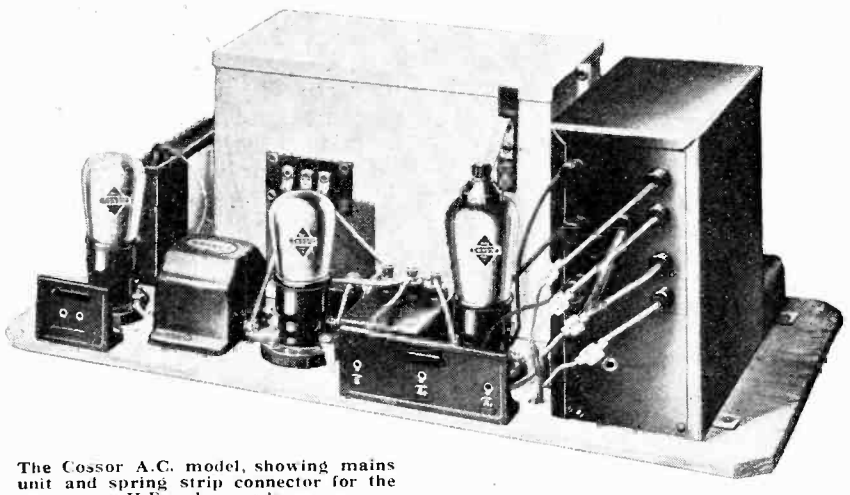
Rear view of the 1930 Cossor Melody Maker (battery model) removed from its containing cabinet. Note the screened H.F. unit.

The circuit arrangement embodies the conventional H.F.-det.-L.F. combination, but double-wound transformers are used as H.F. couplings. As the H.F. unit is ready wired when purchased, it will be appreciated that the work remaining for the home constructor is considerably lightened, and is still further simplified by the provision of such refinements as a spring connector for the H.F. valve anode terminal and an aerial series condenser moulded into the terminal strip. Waveband changing is effected by a three-position switch which also controls the filaments.

Another distinct model for A.C. mains operation is supplied; it differs from the battery set only in details, and includes a factory-made power unit which fits the space inside the cabinet occupied normally by the H.T. battery. Directly heated A.C. valves are used in this set.

### Ferranti Sets.

The Ferranti "Screened Grid Three" has been modified in details, and now includes a volume-control resistance connected across the primary of the L.F. transformer: separate decoupling resistances and condensers have been replaced by the new anode feed units, in which the two components are combined.



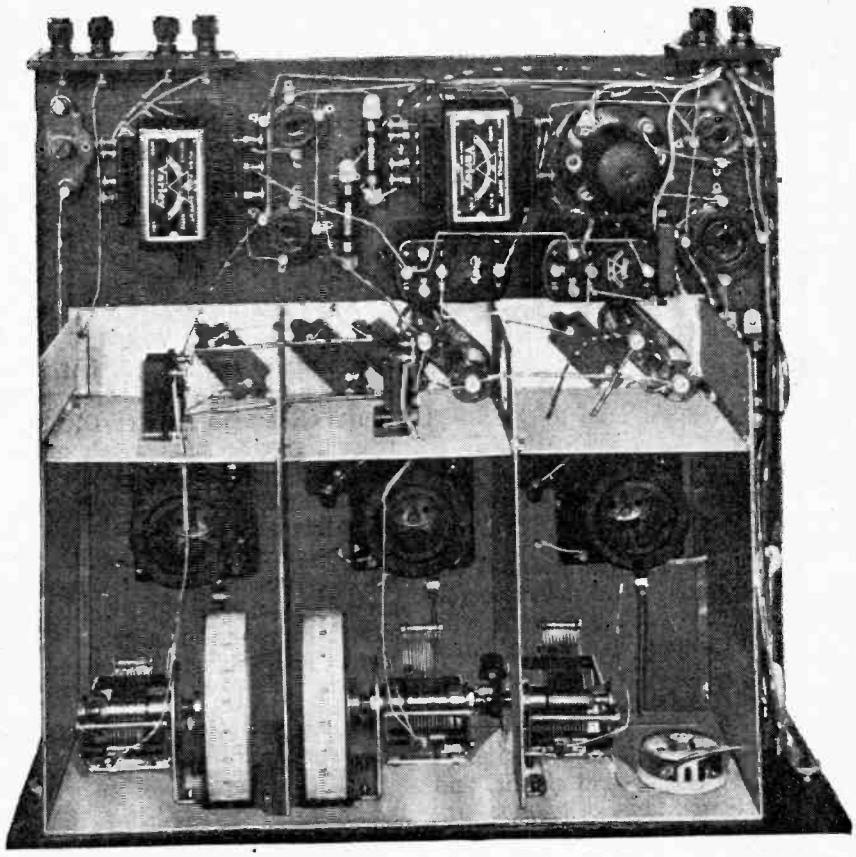
The Cossor A.C. model, showing mains unit and spring strip connector for the H.F. valve anode.

**The New Kit Sets.—**

through the side of the cabinet. It is observed that decoupling is provided. There is space for batteries or mains unit on the base-board at the back of the cabinet, behind the lateral screen.

Volume control, in the case of the battery set, is effected through a rheostat in the H.F. valve filament circuit, while in the A.C. set a potentiometer feed for the screening grid serves a similar purpose. Indirectly heated valves are used in the latter receiver.

In both models provision is made for using a gramophone pick-up and the edgewise condenser dials are mounted side by side so that they can readily be rotated together, thus providing simultaneous tuning of the two circuits over parts of the scale.



Plan view of the Mullard "Orgola Senior"; a six-valve receiver with two H.F. stages and push-pull output.

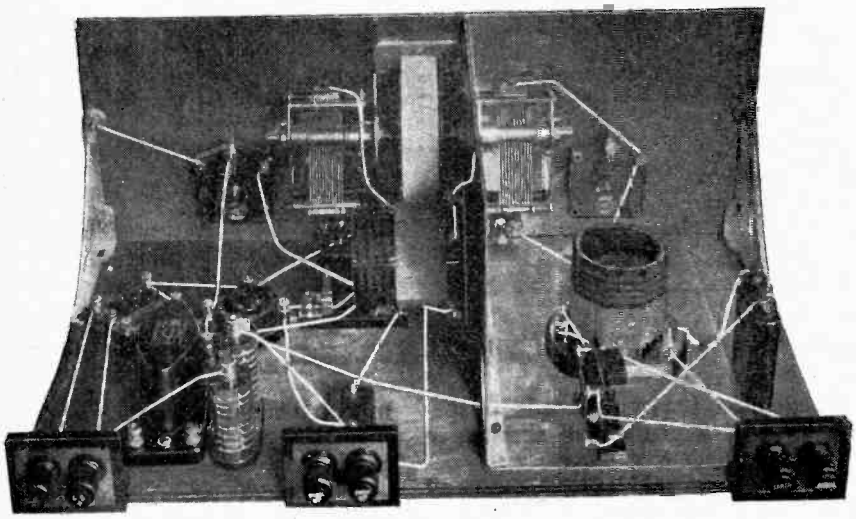
### An Entirely New Range.

Mullard kit sets for this season are entirely new. The first is the "Orgola Three," with a tuned grid H.F. amplifier and grid detector with reaction, followed by a pentode with transformer coupling. The two tuning condensers are ganged, with a "trimmer" across the aerial-grid coil; it is noted that lucid and helpful instructions are given regarding the proper use of this adjustment.

Reaction control is on the differential system, and, as provision is made for altering the inductive relation of the feed-back coil with respect to the grid winding, it should be possible so to arrange matters that regeneration is particularly well under control. Continuously variable aerial coupling, adjustable within wide limits, is also provided.

The design provides for connection of a pick-up in the detector grid circuit, and a switch is connected so that it may be put into operation in the easiest possible manner.

All the above applies also to the A.C. model, which uses indirectly heated valves. In addition, it has a bias cell for the H.F. valve, and the usual alteration is made to the low-tension circuit. This set is provided with H.T. current by a Mullard eliminator, and a special low-voltage transformer is supplied for feeding the valve heaters.

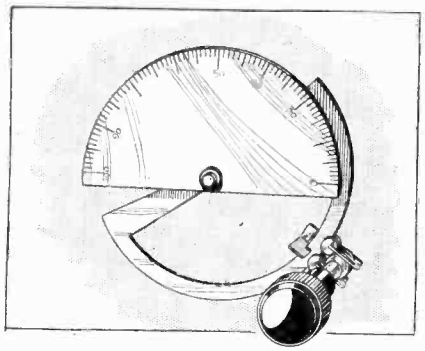


Rear view of the Mullard "Orgola" three-valve set. The detector grid coil is mounted on the vertical screen.

### An Ambitious Product.

A six-valve kit set—the "Orgola Senior"—has also been evolved by the Mullard firm; there is little doubt that this is the most ambitious receiver yet produced in "kit" form. It embodies two H.F. stages, anode bend detector, and two L.F. amplifiers with push-pull output. The high-frequency valves are coupled by the

**The New Kit Sets.—**
Tuning condensers of 0.0005 mfd. are now used.



**Reduction gear drive for the ganged tuning condensers of the new Cossor kit set. A system of friction wheels operating on a metal arc is employed.**

A new kit set, with one H.F. stage and anode bend detection followed by two L.F. amplifiers with push-pull output has been introduced. A pick-up jack is fitted, with contacts so arranged that insertion of the plug will switch off the H.F. valve filament, insert the pick-up in the detector grid circuit, and also short-circuit one of two feed resistances connected in series with the detector anode, thus increasing its H.T. supply voltage, and consequently making this valve act as an amplifier without alteration of its grid bias.

Since it was reviewed in these columns, the Formo "S.G.3" has not been altered to any extent, although a minor improvement has been effected by fitting tuning dials of a new pattern.

**The Lewcos "Chassis."**

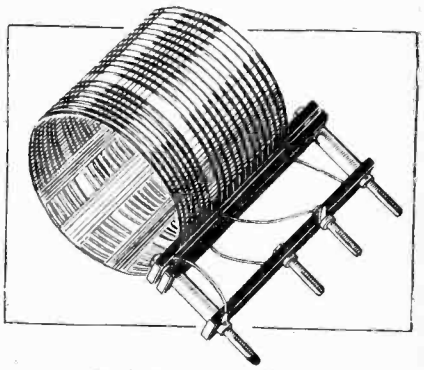
The Lewcos "Kit Assembly" is so nearly a complete receiver in itself that it might perhaps be described as a chassis rather than as a kit. With the exception of three variable condensers and an on-off switch, it comprises all the components of a conventional H.F.-det.-L.F. receiver. All these parts are mounted on a bakelite base, and are completely wired. Transformer coupling is used for both H.F. and L.F. stages. By fitting sockets for indirectly heated valves and a link for making the necessary alteration to the heater or filament circuit, the set is made suitable for either battery or A.C. mains operation.

An unusual method of waveband changing is used in the Lewcos set; the blocks carrying the aerial-grid and intervalve coupling coil assemblies are mounted in guides so that they can be moved bodily by means of push-rods: the connections of the coils are changed through contacts mounted on the underside of the movable bases.

**A Kit Set Brought Up to Date.**

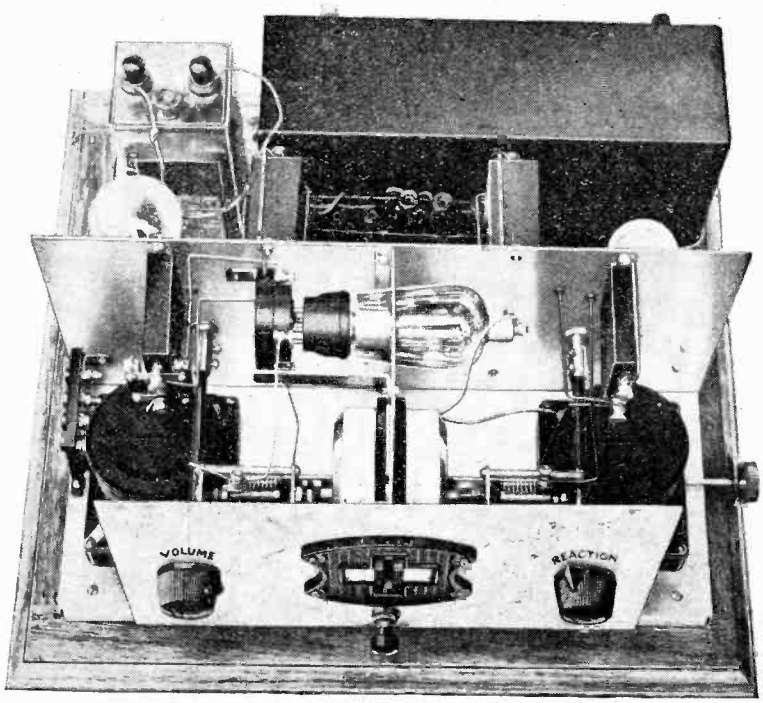
The Lissen H.F.-det.-L.F. set is substantially unchanged, but provision is now made for operating it in conjunction with A.C. or D.C. high-tension supply units which may be mounted inside the cabinet. A revised model for frame aerial operation has been introduced; a special cabinet, with a frame built into its lid, is supplied, and more complete screening for the H.F. valve plate circuit components is provided. A short-wave kit set is another new production, for which a series of special coils, a choke and short-wave tuning condenser have been designed. The set, which covers all wavelengths between 10 and 200 metres, comprises a reacting detector followed by two L.F. stages.

The new Lotus kit sets, supplied in forms suitable for both battery and A.C. mains feed, have several interesting features. Both models are similar and embody the conventional circuit: they are assembled on a metal chassis with transverse and lateral screens on which many of the principal components are mounted in the factory before the kits are dispatched.



**A Lissen short-wave coil.**

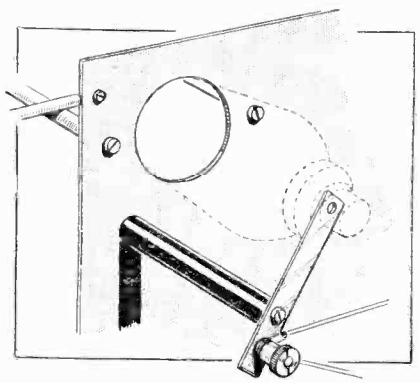
Dual-range coils with built-in switches are employed: these switches are "ganged," and are operated through a knob projecting




**Interior view of the Lotus kit set (battery model) showing arrangement of semi-ganged tuning condensers.**

**The New Kit Sets.—**

parallel-feed method and their condensers are ganged; as there is a separate condenser for the aerial-grid circuit, the total number of tuning controls is reduced to two, and there is no reaction. Decoupling is provided in the anode circuits of detector and first-stage L.F. amplifier.



Details of the rigid H.F. valve anode connector in the "Music Magnet."

Volume control is effected by dimming the H.F. valve filaments, and there is also a variable condenser feed for the aerial coupling in order that overall selectivity may be under control. Screening is, of necessity, somewhat elaborate, and it is observed that the valves are so mounted that they are unaffected by the field of the inductance coils. Precautions are taken to prevent the application of H.F. voltages to the L.F. amplifier, and stabilising resistances of 100,000 ohms are inserted in series with the output valve grids. Wave-range switches are included in the coils, and a gramophone pick-up is connected in the same way as in the case of the three-valve set.

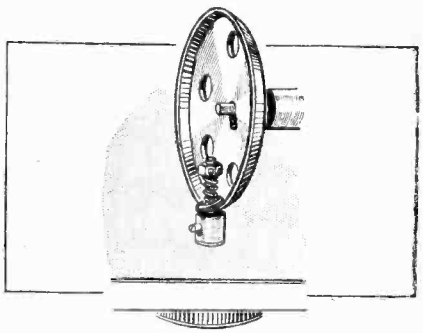
Both the "Orgola" and the "Orgola Senior" receivers may be fitted into a gramophone cabinet complete with turntable, pick-up, and built-in loud speaker; full instructions for thus converting the receivers into radio-gramophones are issued.

**A Well-designed "Music Magnet."**

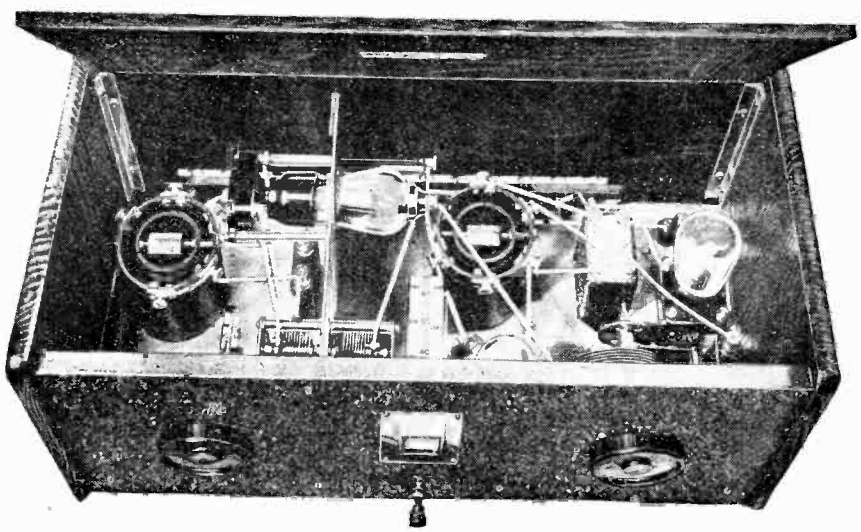
At the first glance one is apt to form the impression that the new Osram "Music Magnet," already known to readers of our "Kit Constructors' Notes" section, has not been altered to any great extent, but a more careful examination shows that attention has been devoted to almost every detail of its design. The arrangement of the filament switch has been modified: this, taken in conjunction with the provision of an H.T. fuse, should render the set completely immune from risk of filament burn-outs. The drive mechanism of the gang condenser has been redesigned, and the coils have been altered considerably, with the result that H.F. losses have been reduced.

**Wavelength Calibration.**

Perhaps the most important modification is the provision of a condenser scale calibrated directly in wavelengths—as far as is known, this is the only kit set with this refinement.



The friction-driven crown wheel through which the double condenser of the "Music Magnet" is operated.



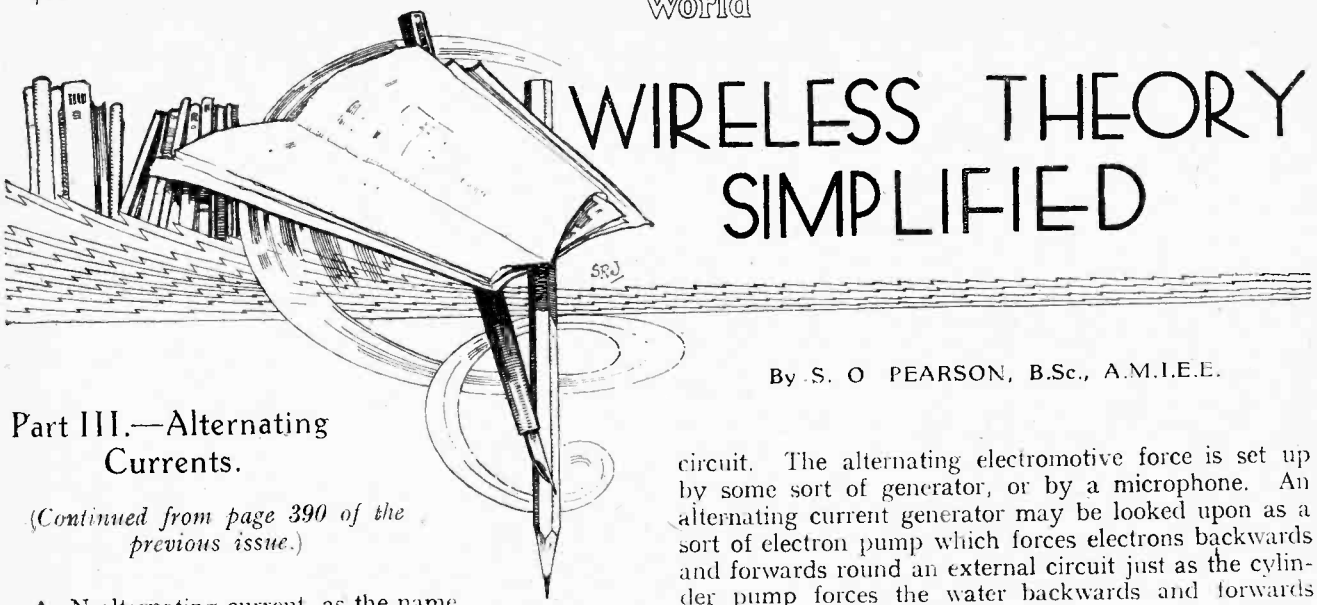
The new Osram "Music Magnet," with single knob tuning and calibrated wavelength scale.

Other modifications include a new L.F. transformer with high-permeability core, and an improved form of grid condenser and leak assembly:



altogether, a most interesting set. It is now supplied complete with an oak cabinet in sections ready for assembly by the constructor.

The requirements of the home constructor living near a high-power station are catered for in an interesting and unconventional manner by the Varley Regional R.D.3 receiver, for which special components and an instructional leaflet are supplied. There is little risk in hazarding a guess that this set is the forerunner of a type that is bound to be popular in the near future. It embodies a detector with two low-frequency stages—clearly here is its principal feature of interest. The tuned aerial coil is coupled by means of a variable condenser to a tuned filter circuit. This set should have at least as good selectivity as the average receiver with a stage of H.F. amplification.



# WIRELESS THEORY SIMPLIFIED

By S. O PEARSON, B.Sc., A.M.I.E.E.

## Part III.—Alternating Currents.

(*Continued from page 390 of the previous issue.*)

AN alternating current, as the name implies, is one which flows first in one direction and then in the opposite direction alternately round a circuit, the reversal taking place at regular intervals. It will be remembered that a direct current was represented by a continuous stream of electrons moving in one direction round and round a closed circuit, being driven by a constant electromotive force. In the case of an alternating current the electrons representing it are rushing backwards and forwards round the circuit, and therefore the electromotive force driving them must also be periodically reversing or alternating.

A direct current was likened to a continuous stream of water flowing through a hose pipe connected to a tap which supplied the necessary driving pressure, and we can extend this analogy to meet the case of an alternating current. Imagine the hose pipe removed from the tap and then having its two ends connected to the opposite ends of a cylinder in which a double-acting piston moves backwards and forwards. Such an arrangement is shown in Fig. 1. The whole thing—hose pipe and cylinder—are assumed to be full of water without any air bubbles. As the piston moves from left to right it forces water out of the right-hand end of the cylinder, through the pipe and back into the left-hand end. When the piston comes to the end of the stroke all the water comes to rest, and then, when the piston begins to move from right to left, the flow of water in the pipe reverses. In this arrangement we have an alternating current of water.

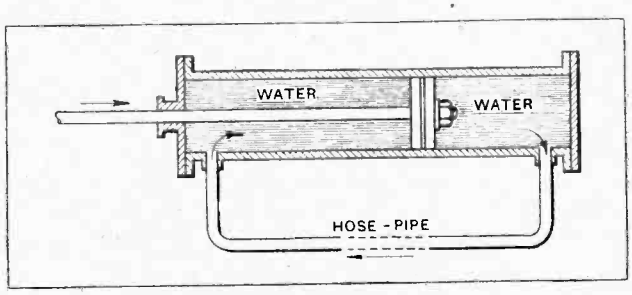



**Fig. 1.—Cylinder pump and pipe arrangement illustrating the action of a closed alternating current circuit.**

Now an alternating current of electricity (A.C.) follows very similar laws. There is a driving or electromotive force which keeps on reversing and so forcing the electrons backwards and forwards round a closed electric circuit. The alternating electromotive force is set up by some sort of generator, or by a microphone. An alternating current generator may be looked upon as a sort of electron pump which forces electrons backwards and forwards round an external circuit just as the cylinder pump forces the water backwards and forwards through the hose pipe.

### Frequency.

It is necessary to know several things about an alternating current in order to define it fully or make any calculations relating to it. For instance, it is necessary to know how many times the current reverses its direction every second and how it varies from instant to instant. It is usual to consider the current as positive when flowing one way round the circuit and negative the other way round. It is quite immaterial which direction we choose as positive provided that, once having made our choice, we adhere to it.

The variation of the current from the time it starts from zero and passes through one complete sequence of positive and negative values back again to zero, is referred to as *one cycle*, and the time of one cycle in seconds or fractions of a second is called a period. The *frequency* or *periodicity* is the number of cycles passed through in one second, and thus the frequency is expressed in cycles per second. The standard commercial frequency of A.C. supply systems in this country is 50 cycles per second. Audible sounds are represented by a whole range of frequencies from about 25 cycles per second to 10,000 cycles per second or more according to the individual. Radio frequencies range from about 20,000 cycles per second up to several millions—a wavelength of 300 metres corresponds to a frequency of 1,000,000 cycles per second or 1,000 kilocycles per second, the wavelength being inversely proportional to the frequency.

An alternating current may vary from instant to instant according to any law or without any apparent law, but it is usual for the time of one complete sequence

**Wireless Theory Simplified.—**

of positive values to be equal to the time of a complete sequence of negative values. These two sequences are called the positive half cycle and negative half cycle respectively. These names also apply to alternating electromotive forces and magnetic fluxes.

### Sine Wave of Alternating Current.

If a graph is plotted showing the variation of current with time, the curve takes the form of a wave which may be any shape but is periodic—that is, it keeps on repeating itself as time progresses. Such a wave is shown in Fig. 2.

The simplest alternating current to deal with both in practice and in theory is one which gives a sine wave when all the successive values are plotted as a

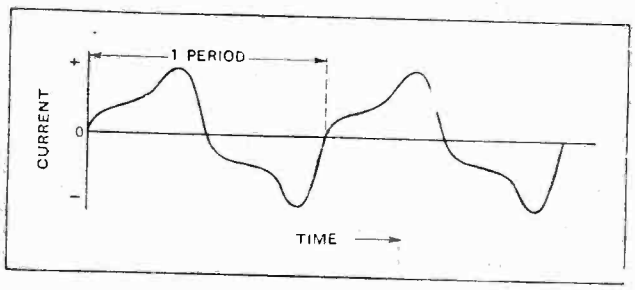



**Fig. 2.—Showing how an alternating current can be represented as a graph.**

graph to a time base, and this law is always assumed when working out alternating current problems unless otherwise stated. A sine wave of current is shown in Fig. 3.

### The Effective Value of an Alternating Current.

The first thing we notice about the curve is that it is symmetrically placed about the base or zero line—that is to say, the positive half waves are exactly balanced by the negative half waves, and therefore the average value of the current taken over any whole number of cycles is equal to zero. It is clear then that to express the value of an alternating current in amperes we must adopt some means of comparing it with a direct current as regards its useful effects. For instance, either an alternating current or a direct current will produce heat if passed through a resistance wire, and it is on this basis that the strength of an alternating current in amperes is defined. The useful or *effective value*, as it is called, is defined as the value in amperes of *the steady direct current which would have the same average heating effect in a given fixed resistance*. This means that an alternating current whose effective value is 1 ampere will liberate heat in a given resistance at the same average rate as a direct current of 1 ampere in an equal resistance, i.e., the power in each would be the same. It is necessary to say *the same average rate* because the heat is given to the resistance by the alternating current in little pulses, the power falling to zero every half cycle as the current passes through its zero values.

If we know the shape of the alternating current wave it is an easy matter to determine its effective value. Assume any wave shape for the present, and let $i$ be the value of the current at any one instant. Then in a resistance of R ohms the power at that instant will be $i^2R$ watts (see Part II, last issue). Let I be the effective value or the value of the direct current which has the same average heating effect. Then from the definition above—

$I^2R$ = mean value of $i^2R$ over a whole cycle.

$I^2R$ = (mean value of $i^2$) × R

or $I^2$ = (mean value of $i^2$);

and taking the square root of each side, the effective value is—

$$I = \sqrt{\text{mean value of } i^2} \text{ amperes.}$$

Putting this result into words: the effective value of an alternating current is equal to the root of the mean value of the squares of all the successive instantaneous values, and is often abbreviated to ROOT MEAN SQUARE value or R.M.S. value. *Virtual value* is another name frequently employed.

### Effective Value of a Sine Wave.

Referring again to the sine curve of Fig. 3, it will be noticed that the current starts from zero and builds up to a maximum positive value which we have denoted by $I_m$ in the figure, then falls to zero again, and once more builds up to the maximum value $I_m$, but this time in the reverse direction, being now negative. This maximum value $I_m$ is called the amplitude of the current.

But the amplitude is not the useful or effective value of the current, and it behoves us to find what relationship exists between the effective value and the maximum value. To do this consider a sine wave of current which builds up to a maximum value of 1 ampere in each direction. Such a wave has been drawn to a suitable scale in Fig. 4, and is shown by curve (1). If we now divide the base line up into, say, 20 equal parts and measure the vertical distance from the centre of each part to the curve itself, we get the values of the current corresponding to the various instants de-

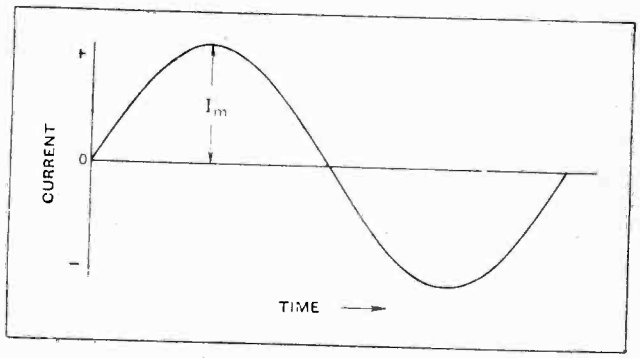



**Fig. 3.—Simple sine wave of current.**

picted by the centres of the 20 equal intervals. We require the *root mean square* value of the current, and so the next thing to do is to square each of the current values so obtained, i.e., multiply each value by itself and plot the figures thus found as a new curve to the same base line. If the sine curve (1) is accurately

**Wireless Theory Simplified.—**

drawn, it will be found that the new current squared curve (2) shown shaded will be another sine wave of half the wavelength or double the frequency. Note that even over the negative half cycle the current squared is still a positive quantity, because when two negative quantities are multiplied together the product is positive—the old saying that "two negatives make a positive," etc.

It will be seen that the new curve (2) is not symmetrically placed about the base line, as is the case for

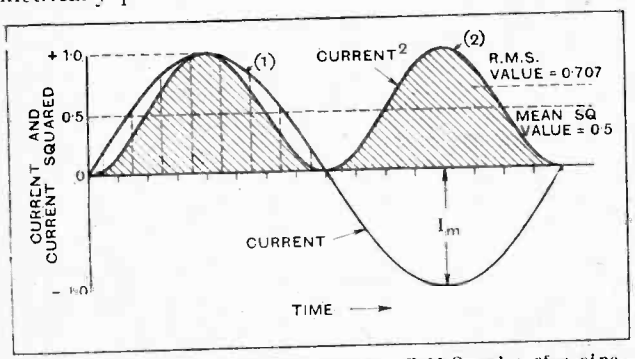



**Fig. 4.—Diagram for showing that the R.M.S. value of a sine wave is 0.707 of the maximum value.**

the current curve. In fact, the new curve is so disposed that at its lowest points it only just touches the base line, so that *its* centre line falls at a height above the base line *just equal to half the maximum height.* Therefore, the *mean square* value is equal to $\frac{1}{2}$ in this case where the maximum value of the current is 1 ampere.

Thus if the maximum value of the current is $I_m$ amperes, the *mean square* value will be $\frac{1}{2}I_m^2$, and the *root mean square* (R.M.S.) value is the square root of this, namely:—

$$\text{R.M.S. value} \qquad I = \sqrt{\tfrac{1}{2}I_m^2} = \frac{I_m}{\sqrt{2}}$$

$$\text{or} \qquad I = 0.707\ I_m$$

This is a very important result—it means that for a sine wave the effective value is 0.707 of the maximum value of amplitude, or, conversely, the maximum or peak value is $\sqrt{2}$ times or 1.414 times the effective value. The same rules apply to alternating electromotive forces and potential differences.

Alternating current ammeters and voltmeters are always calibrated to read directly in effective or R.M.S. values.

The relationship between the effective value and maximum value for a sine wave has been arrived at by graphical means without the use of mathematics; but even so there may be some who will at first find a little difficulty in following the reasoning. This need not cause any misgiving, as the work to follow will be based, not on the particular reasoning referred to, but on the result, namely, that the ratio of the effective value to maximum value for a sine wave is 0.707.

*(To be continued.)*

# CURRENT TOPICS.

### PERILS OF THE PORTABLE.

A portable owner who switched on his set in a Birmingham street has been fined 10s. for drawing a crowd which caused obstruction.

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### "Q" CALL WITH A KICK IN IT.

Among a collection of new Morse abbreviations suggested by the amateur transmitters of America is the following:

QLF: Say, OM, send with your LEFT foot now.

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### SUN SPOTS MISFIRE.

Despite the recent prediction of Professor Stetson, astronomer at Harvard University, that the present month would be a bad one for wireless reception owing to sunspots, listeners are failing to note any reduction in signal strength. It seems that a sunspot means nothing to Brookman's Park.

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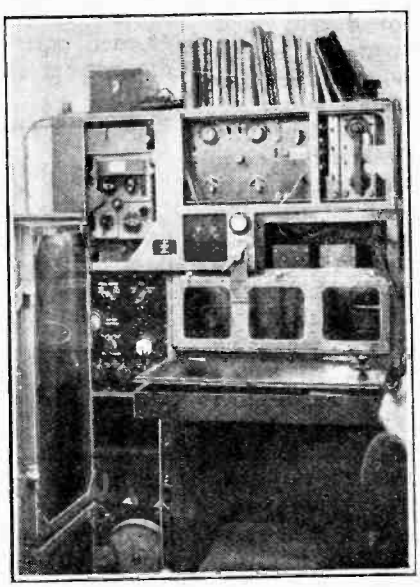
### LISTENER'S LICENCE CANCELLED.

To Mr. A. Britton, of Fishponds, Bristol, apparently belongs the unenviable distinction of being the first listener to have his licence suspended by the Post Office for having caused interference by oscillation.

It is well known, of course, that the Post Office reserves the right to take action of this kind, a statement to this effect being printed on each licence issued; but the interesting point now arises whether the offender is doomed never again to hear a B.B.C. programme on his own receiver or whether a limit is set to the period of penance. A statement regarding the P.M.G.'s powers in this direction would be welcome.



**WIRELESS WITHOUT WEIGHT. The radio cabin on the R. 101, Britain's new airship, which is undergoing preliminary trials this week. Note the aluminium case containing the apparatus.**

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### B.B.C. ESCAPES CRITICISM.

The recent drought is said to have been exceptional in that no one attributed it to wireless.

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### NEW B.B.C. OUTPOST.

The B.B.C.'s new receiving station at Tatsfield, Surrey, is now in use and the apparatus at Keston is being dismantled.

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### AMATEURS UNITE AT MANCHESTER.

In connection with the Manchester Wireless Exhibition, which opens at the City Hall on Wednesday next, October 16th, the Association of British Radio Societies is organising a National Radio Convention. The plans include several social functions, discussions on amateur topics, and visits to the Exhibition and other places of interest in the Manchester area.

The Convention will be open to members of any radio society. Those wishing to attend are invited to apply for particulars to Mr. L. A. Gill, Secretary of the Association, Hope House, South Reddish, Stockport.

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### LECTURE BY DR. N. W. McLACHLAN.

Under the auspices of the Association of British Radio Societies, Dr. N. W. McLachlan, M.I.E.E., F.Inst.P., will lecture on "The Ideal Loud Speaker" at a

meeting in the Albert Hall, Peter Street, Manchester, on Monday, October 28th, at 7.30 p.m. The lecture will be followed by demonstrations in tone compensation and control for electric gramophones.

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### POST OFFICE AND SICK "PIRATES."

In a letter to an enquirer, the Post Office states that during the past four years 3,230 prosecutions have been undertaken against infringers of the Wireless Telegraphy Acts. In taking legal proceedings, adds the Post Office, full consideration was given to the circumstances of each case, including the age of the offender and any special factor such as his ill-health.

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### BRITISH COASTAL WIRELESS: A DANE SPEAKS OUT.

Captain G. Mikkelsen, a Danish navigator, has made a statement deploring the lack of wireless facilities in North Britain, writes a correspondent. "Along the coasts of Norway, Sweden, Denmark and the Faroe Islands," says the captain, "there are wireless stations to aid navigators, but when proceeding round the north coast of Scotland and the Orkney and Shetland Isles, valuable time is lost. In foggy weather the navigator must take his observations from the sun or rely on the chart before taking the dangerous passages on this coast."

It is possible that the worthy captain has overlooked the existence of the beacon station at Wick, which is extensively used by ships skirting the northern coast of Scotland.

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### CALIBRATION SIGNALS FROM GERMANY.

In view of the increasing congestion of the ether and the consequent necessity that transmitting stations should not depart from their allotted wavelengths, it is essential that means should exist for their exact calibration.

For some time past the German high-power transmitter at Koenigswusterhausen has broadcast at regular periods calibrated waves for the benefit of Europe in general, and of its own country in particular. These special transmissions take place on the 14th and 15th day of each month, according to the following schedule :—

| Time. | Kc. | Metres. | Signal. |
|---|---|---|---|
| **First Day.** | | | |
| 06.00-06.05 | 345 | 870 | A |
| 06.15-06.20 | 333 | 900 | O |
| 06.30-06.35 | 323 | 930 | G |
| 06.45-06.50 | 257.5 | 1164 | J |
| 07.00-07.05 | 256 | 1170 | K |
| 07.15-07.20 | 250 | 1200 | O |
| 07.30-07.35 | 248 | 1210 | P |
| 07.45-07.50 | 243 | 1235 | X |
| 08.00-08.05 | 238 | 1260 | Y |
| 08.15-08.20 | 207.5 | 1444 | Z |
| **Second Day.** | | | |
| 06.00-06.05 | 538 | 557 | A |
| 06.15-06.20 | 429 | 700 | O |
| 06.30-06.35 | 353 | 849 | G |
| 06.45-06.50 | 284 | 1055 | J |
| 07.00-07.05 | 276.5 | 1084 | K |
| 07.15-07.20 | 273.5 | 1097 | O |
| 07.30-07.35 | 267 | 1124 | P |
| 07.45-07.50 | 260.5 | 1152 | X |
| 08.00-08.05 | 233 | 1288 | Y |
| 08.15-08.20 | 217.5 | 1380 | Z |
| 08.30-08.45 | 224 | 1340 | Q |

At the beginning of each transmission a short tuning signal is sent out, and is followed by the call-sign in Morse, as given in the fourth column. In the event of any unforeseen interruption taking place, in order that the time schedule should not be completely upset, the "missing" signals are specially broadcast at the end of the transmission and an announcement made to that effect.

Again, should the 14th or 15th day of the month coincide with a Sunday or holiday, the transmission of the calibrated signals is postponed until the following day.

As these signals are accurately measured, the broadcasts are regularly used by both German telegraphy and telephony transmitters to check their wavelengths, and should also prove of use to amateurs for the calibration of medium- and long-wave wireless receivers.

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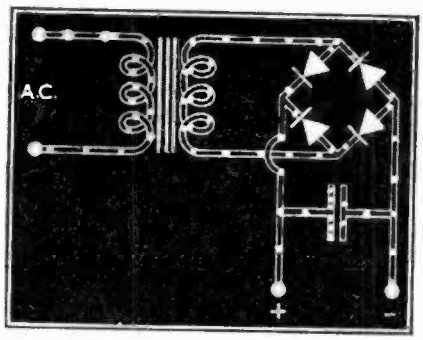
### ANIMATED WIRELESS DIAGRAMS.

Secretaries of radio societies will be interested in a clever film, entitled "Rectification," which has been produced by the Westinghouse Brake and Saxby Signal Co., Ltd., to demonstrate the action of electric currents in circuits employing the




**ANIMATED CIRCUITS. A "still" taken from the film "Rectification," showing how the current flows in the "bridge" method of obtaining full-wave rectification.**

Westinghouse metal rectifier. It is expected that this film will be included in the series of lectures which will be given by the Westinghouse Company to a selected number of radio societies.

Much more clearly than the simplest book of words, the film shows the difference between alternating, direct, half-wave and full-wave rectified currents. Working circuits are shown of half-wave rectification using the Westinghouse H.T.3 rectifier, full-wave rectification with the H.T.1 type, and voltage doubling rectification with the H.T.4 type.

The moving diagrams, of which a specimen is shown herewith, were drawn in the same manner as "cartoon" films, forty separate pictures being necessary for a complete cycle of operations.

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### TRIPLE RADIO FUSION IN U.S.

Over 700 American wireless patents have come under a single control as the result of the merger between the three radio concerns, Kolster, Earl and Freed-Eisemann. The new organisation is the second largest of its kind in the United States, the Radio Corporation of America coming first.

### THE INVENTOR'S FRIEND.

Inventive minds will find much to interest and encourage in *The Inventor*, the official journal of the Institute of Patentees, which makes its first appearance this month. The journal sets out "to promote the burgeoning of new ideas."

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### U.S. TO AUSTRALIA *VIA* BRITAIN.

The British Post Office switched Australia through to America by wireless telephone on September 25th when the new short-wave radio telephone service between England and Australia was linked up with the Atlantic telephone service.

Speech from New York passed over land wires to the short-wave transmitting centre of the American Telephone and Telegraph Company in Lawrenceville, New Jersey, thence by radio to the short-wave receiving station of the British Post Office at Baldock, Herts, and thence by wire *via* London to the Post Office transmitting station at Rugby. From there a direct radio link carried the speech to the receiving station of Amalgamated Wireless of Australia and by wire to Sydney. The path of speech from Australia was again to Baldock, thence through London to Rugby and onward *via* the American Company's short-wave receiving station at Netcong, New Jersey, to New York.

Conversation was carried on successfully over a distance of 15,000 miles. It is probable that the England-Australia telephone service will soon be open for commercial use.

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### PREMIER'S U.S. SPEECH ON SHORT WAVES.

As stated in *The Wireless World* in July last, the American National Broadcasting Company's short-wave stations will be used to relay the speeches of the Prime Minister during his visit to the United States.

On Friday next, October 11th, Mr. MacDonald's speech at a dinner to be given in his honour by the Council of Foreign Relations at the Ritz-Carlton Hotel, New York, will be relayed all over America. We understand that the transmission will also go out from 2XAD, Schenectady (19.56 metres), 2XAF, Schenectady (31.48 metres) and 8XK, Pittsburgh (35.25 metres). The speech will begin at 9 p.m. (2 a.m. G.M.T.).

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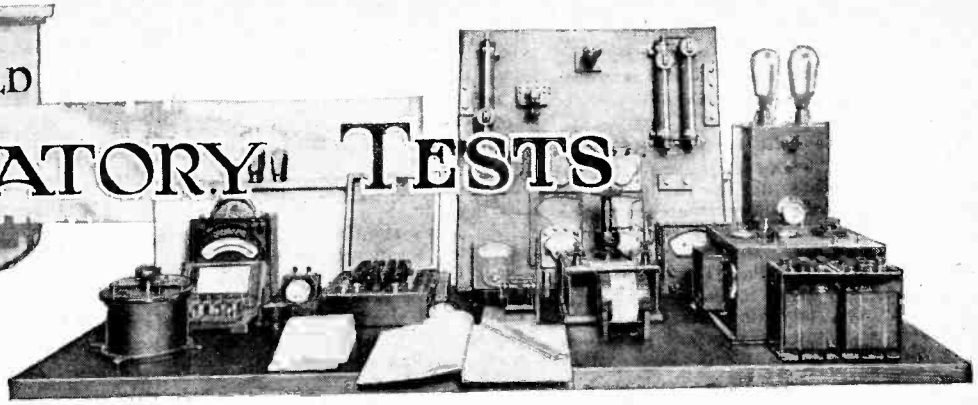
### A "B.B.C." FOR CANADA.

A chain of high-power broadcasting stations across Canada is recommended in the report of the Royal Commission recently appointed to investigate Canada's wireless problems. It is also recommended that a State-owned corporation should be set up, similar to the B.B.C., and that funds necessary for the operation and maintenance of the service should be obtained from licence fees and programmes sponsored by advertisers, together with a Federal Government subsidy of $1,000,000 annually for five years.

As a nucleus of the broadcasting chain, it is suggested that seven 50-kilowatt stations should be erected to give reliable service over the populated areas of the Dominion.

WIRELESS WORLD

# LABORATORY TESTS



## A Review of the Latest Products of the Manufacturers.

### MODIFICATIONS TO STANDARD WET BATTERIES.

Readers will be familiar with these batteries since we have published test reports from time to time on various sizes. The latest improvements take the form of attention to details, the fundamental principle being the same as discussed in our reviews. To facilitate the initial assembly, and also ease the replacement process, the zincs and sacs are now supplied in the form of a cartridge which drops into the glass container. These are made for Nos. 3 and 4 size jars A further improvement is the provision of a cork stopper, with a centre hole to clear the carbon rod. This is to prevent evaporation and, incidentally, creeping of the electrolyte, and replaces the earlier method of covering the top of the fluid with oil. It is a far better seal and results in a more workmanlike finish than was possible with the earlier models.

The cartridge, complete with cork, for the No. 3 size jar, costs 5d. each, and for the No. 4 size the price is 7d. Spare jars cost 2d. for No. 3 size and 2½d. for the No. 4 size. It is not essential to purchase new jars as the cartridges can be used with the ordinary No. 3 and No. 4 size containers.

The makers are the Standard Wet Battery Co., 184-188, Shaftesbury Avenue, London, W.C.2.

New cartridge-type zinc and sac for Standard Wet H.T. batteries.

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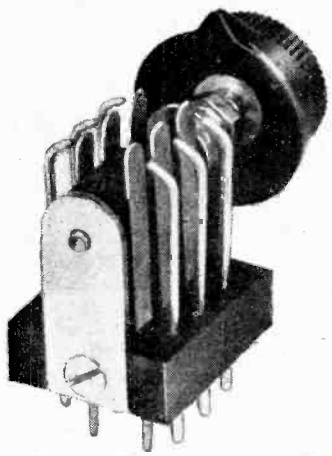
### DETEX SWITCHES.

Since the advent of the screened valve the switching from medium to long waves has become a fairly simple matter, and many new multi-contact components have been developed. Where space behind the panel is limited, the Detex change-over switch should be found a useful asset, as this component takes up very little panel space. A single-hole fixing bush is fitted.



A feature of this Detex switch is the provision of a delayed action contact for filament or H.T. control.

The body of the component consists of a machined ebonite block, and this supports the contacts and bearings for the operating spindle. A point of particular interest is the provision of one contact having a slight lag behind the others. This is so arranged to be the last contact to "make" and the first to "break."

The wiring of a receiver can be arranged so that the H.T. circuit is always the last to be completed and the first to be broken when switching off. This feature assures that the H.T. blocking condensers will not be left in a charged state.

These change-over switches are made by Detex Distributors, Ltd., 66, Victoria Street, London, S.W.1, and prices have been fixed as follows: Two-pole, 3s. 6d.; 3-pole, 3s. 9d.; 4-pole, 4s.; 5-pole, 4s. 3d. and 6-pole, 4s. 6d.

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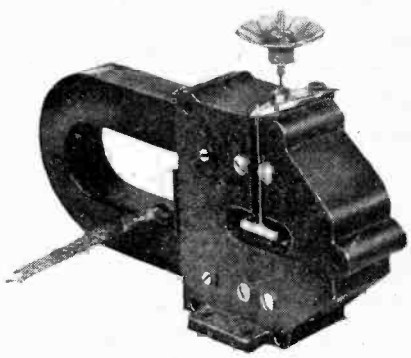
### "ISOMONA" LOUD SPEAKER UNIT.

This is a balanced armature movement for incorporating in cone-type loud speakers and consists of a massive permanent magnet fitted with two laminated pole-pieces shaped to concentrate the flux at each end of the armature. This is disposed centrally in the air gaps and fixed at its centre. The polarising coils, of which there are two, are disposed either side of the fulcrum with the armature passing through their centres.

The spindle, carrying the cone, is attached to the centre of a short stiff reed, one end of which is rigidly fixed while the free end is connected by a thin rod to one extremity of the vibrating armature.



"Isomona" cone loud speaker unit: a balanced armature movement.

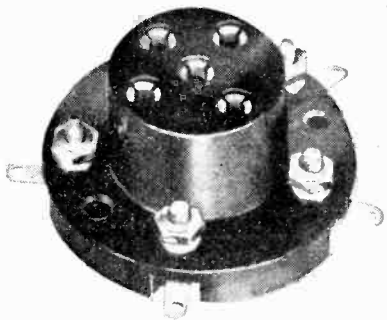
The pole-pieces, coils and armature are encased in a black crystalline-finished aluminium cover built up from two castings clamped together. A lug on each casting is provided for fixing purposes, four screws being supplied.

These units are supplied by Messrs. Haw and Co., 20, Cheapside, London, E.C.2, and the price is 21s.

## WEARITE 5-PIN VALVE HOLDER.

This valve holder is fitted with five sockets, four being disposed as usual, and the fifth situated centrally with respect to these. It has been placed on the market by Messrs. Wright and Weaire, Ltd., 740, High Road, Tottenham, London, N.17, to meet the requirements of the new 5-pin A.C. valves, but it can be used also with the ordinary 4-pin type, thereby facilitating easy change of valves for experimental purposes.

The body is made from moulded material, and the sockets are split to ensure a good electrical contact with the pins on the valve. Soldering tags, in addition to terminals, are provided, these being fixed by small screws to the base of the sockets.



Wearite 5-pin A.C. valve holder.

The terminals are clearly marked by appropriate letters moulded into the material, and two screw holes are provided for fixing purposes. The price is 1s. 3d.

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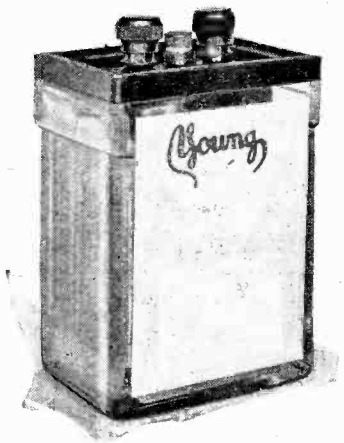
## YOUNG'S "DRI-POWER" ACCUMULATORS.

These accumulators, which are available in various types, including car-starter batteries and cells for wireless purposes, have their plates embedded in a gelatinous substance saturated with acid. Since there is no loose liquid they are unspillable, and the smaller sizes are particularly suitable for use in portable sets. Generally the employment of a solid electrolyte leads to a loss in ampere-hour capacity for any given size of battery, but the makers of the "Dri-power" cells claim that this disadvantage has been satisfactorily overcome.

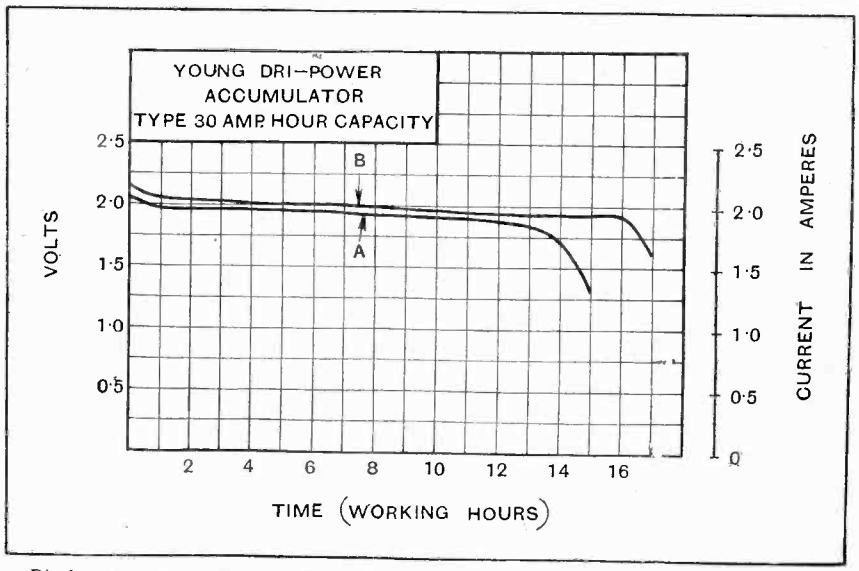
Furthermore it is claimed that a special process of manufacture enables the cells to be roughly handled, in the electrical sense, without seriously impairing the life of the battery. To test this statement we subjected a sample 2-volt cell to a period of heavy discharges and charging at a higher rate than normal.

Subsequently a discharge curve was taken of the cell after a normal charge, the rate of discharge being approximately 2 amps. at the start. The voltage was maintained at a good level during this test, and it was found that the ampere-hour capacity returned to normal after a short period of normal charge and discharge. Since an accumulator can often be seriously damaged by the treatment it receives when first put into use, this test would appear to confirm the makers' claim that these cells are very robust and will not deteriorate if subjected to periods of rough handling.




Young "Dri-power" 2-volt L.T. accumulator with solid electrolyte.

Two-volt cells in glass containers and filled with "Dri-power" solid electrolyte are available in 20-, 30- and 40-ampere-hour sizes, the prices being 14s. 6d., 16s. 6d. and 18s. 6d. respectively. These are supplied fully charged. High tension units of 24 volts each in glass containers and with solid electrolyte are available also at £1 10s. each. These have a milli-ampere-hour capacity of 7,500 at a discharge rate of 15 mA or 5,000 mA-hour capacity at 50 mA discharge.




Discharge curve of Young "Dri-power" accumulator. Curve "A" taken after a period of over-charge and discharge. Curve "B" shows normal life on one charge after a period of normal treatment and recuperation.

The makers are the Young Accumulator Company (1929), Ltd., Burlington Works, Rigault Road, Fulham, London, S.W.6.

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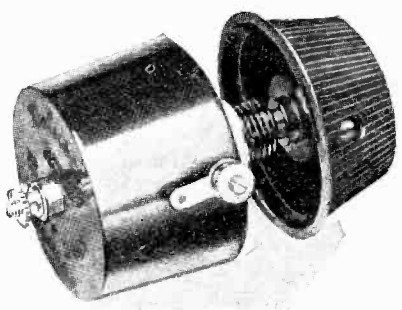
## HARLIE VOLUSTAT.

These variable resistances, which are made in three ranges, namely, Universal type, 50 to 500,000 ohms; medium resistance type, 2,000 ohms to 2 megohms; and high resistance type, 10,000 ohms to 10 megohms, function on the compression principle. The ingredients and quality of the resistance material has been, it is claimed, the subject of much experiment since the constancy of these resistances depends on the use of a mixture which will not pack when compressed, but returns to its original volume when the pressure is released.

Practical tests show that the resistance can be set at any given value, and it will keep this value for a long period. We did not subject the sample to the passage of heavy currents, but to that which would pass normally when the component was used as a volume control. The measured maximum and minimum values of the sample tested were found to be 720,000 ohms and 43 ohms respectively. Nominally these are 500,000 and 50 ohms, this being the "Universal" model.



Harlie "Universal" type Volustat.

The makers are Messrs. Harlie Bros., Balham Road, Lower Edmonton, London, N.9, and the price of all three types is 7s. 6d. each.

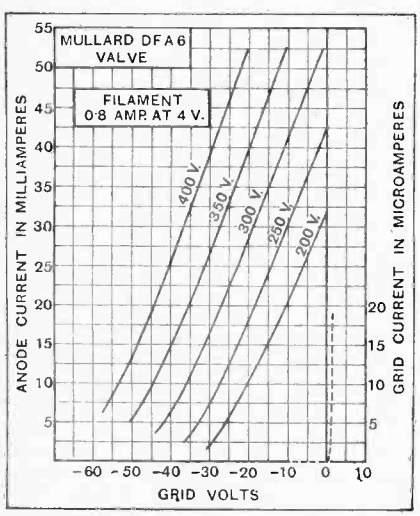
# VALVES WE HAVE TESTED

## Mullard D.F.A. Power-Amplifying Valves.

THE three valves dealt with under this heading are the D.F.A.6, D.F.A.7, and the D.F.A.8. Each requires 4.5 volts across the filament, and consumes 0.85 amp. of current. Since a 6-volt accumulator will normally be used, a fixed resistor of about 1.8 ohms, connected in the positive L.T. lead, will be necessary to absorb the excess voltage. The maximum plate potential is 400 volts in each case. The D.F.A.6 and D.F.A.7 are power output valves, the principal difference being in the grid swing that can be handled by each without causing grid current to flow.

### D.F.A.6.

The particular function of the D.F.A.6 is an output valve in an amplifier designed to operate a moving-coil loud speaker. Its rated characteristics, measured at 100 volts H.T. and zero grid bias, are A.C. resistance 4,500 ohms, amplification factor 6.4, and mutual conductance 1.45 mA. per volt. The sample tested, however, did not show such a good mutual conductance under these conditions, the figures obtained being, A.C. resistance 5,900 ohms, amplification factor 5.7, and "slope" 0.97 mA. per volt.




**Average values under normal working conditions; A.C. resistance, 4,630 ohms; amplification factor, 5.7; mutual conductance, 1.23 mA/volt.**

Under working conditions, i.e., with 400 volts on the anode and minus 40 volts grid bias, an improvement in the efficiency of the valve was recorded the A.C. resistance dropped to 4,630 ohms; the amplification factor remained the same, but the mutual conductance improved to 1.23 mA. per volt. From the figures obtained it is possible to calculate the maximum undistorted power, in watts, that the valve may be expected to deliver to the loud speaker. This, of course, must be based on the relationship between the impedance of the speaker and the A.C. resistance (or impedance) of the valve. Assuming that the loud speaker impedance is equal to, or only slightly greater than, the A.C. resistance of the valve and that there are no other factors likely to modify the results, an undistorted output of approximately 1.4 watts should be available. This is sufficient to operate a good moving-coil loud speaker at something approaching full volume.

The following tabulated matter gives an indication of the anode current at various anode potentials and optimum grid bias, and will be a useful guide when choosing an output choke or transformer.

**D.F.A. 6.**

| Anode Volts. | Grid Bias. | Anode Current. |
|---|---|---|
| 200 | — 18 volts | 12.5 mA. |
| 250 | — 22 ,, | 15.5 ,, |
| 300 | — 27 ,, | 19 ,, |
| 350 | — 34 ,, | 22.5 ,, |
| 400 | — 40 ,, | 25 ,, |

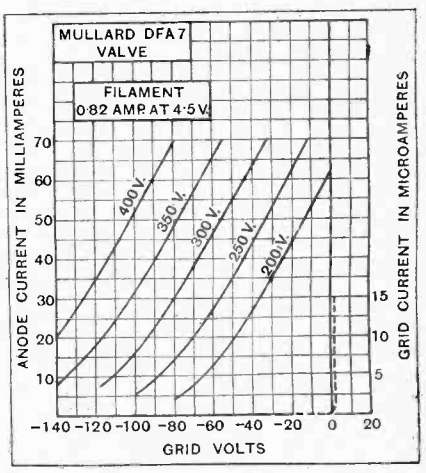
### D.F.A.7.

Like the D.F.A.6, this is a terminal valve and should be employed in the output position when very big grid swings have to be accepted in the last stage. With the maximum plate potential a grid bias of the order of 120 volts should be used. Its measured characteristics at 100 volts H.T. and zero grid bias agreed very closely with those given by the makers. These values did not alter materially under working conditions, as will be seen from the following table.

**D.F.A. 7.**

| Conditions. | A.C. Resistance, Ohms. | Amplification Factor. | Mutual Conductance. |
|---|---|---|---|
| Maker's rating 100 v. H.T. zero G.B. .. | 2,850 | 2.4 | 0.85 mA/V. |
| Measured at 100 v. H.T., zero G.B. .. | 2,860 | 2.3 | 0.80 mA/V. |
| Measured at 400 H.T. — 120 G.B. .. | 2,570 | 2.2 | 0.85 mA/V. |

Subject to the same conditions as mentioned with regard to the power output from the D.F.A.6, the maximum undistorted power given by the D.F.A.7 will be of the order of 3.4 watts.



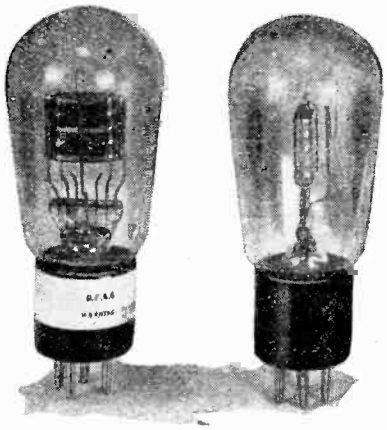

**Average values under normal working conditions; A.C. resistance, 2,570 ohms; amplification factor, 2.2; mutual conductance, 0.85 mA/volt.**

### D.F.A.8.

Although this is a power amplifying valve, in that it is designed to operate with a high anode potential, it does not come within the

**Valves we have Tested.**—

category of super-power valves, since it will neither accept a very large grid swing nor deliver much power in terms of output watts. Its particular use is as a penultimate valve in an amplifier operating from a single H.T. source of the order of 400 volts. Its characteristics are given as 15,000 ohms



Typical examples of valves of the D.F.A. series.

A.C. resistance, 19.5 amplification factor, and 1.28 mA. per volt mutual conductance.

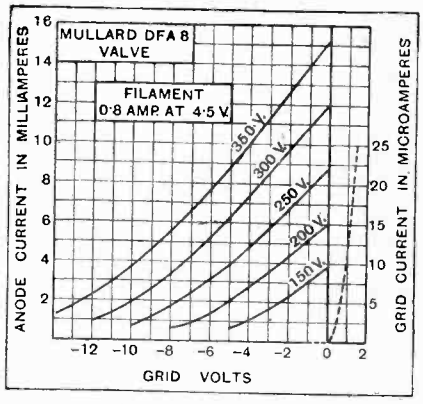
Measurements made with a specimen D.F.A.8 at 100 volts H.T. and zero grid bias gave the A.C. resistance of the particular sample tested as 28,000 ohms. The amplification factor was found to be 20, and the mutual conductance 0.7 mA. per volt. Tested under normal operating conditions with a high anode potential and suitable grid bias the average values were found to be: A.C. resistance 20,000 ohms, amplification factor 22.2, and mutual conductance 1.12 mA. per volt.

A resistance-capacity intervalve coupling would appear to be the most suitable arrangement to adopt, since power resistances capable of passing a current of the order of 5 to 10 mA. are readily obtainable. The following table shows the anode current at various grid potentials with different values of anode voltage.

D.F.A. 8.

| Anode Volts. | Normal Grid Bias (Amplifier). | Anode Current in mA. |
|---|---|---|
| 200 | − 4½ volts | 2.4 |
| 250 | − 6 | 3.1 |
| 300 | − 7½ | 3.8 |
| 350 | − 9 | 4.5 |

The valves in this class are not "gettered," the required vacuum being obtained by pumping for a long period. Each specimen was tested for reverse grid current, but not the slightest trace was to be found. The inside of the glass




Average values under normal working conditions; A.C. resistance, 20,000 ohms; amplification factor, 22.2; mutual conductance, 1.12 mA/volt.

bulb is quite clear and the electrode assembly can be easily examined. Vertical "hairpin" filaments are used, the grid and anode being of the familiar "flattened" type.

# A CONVENIENT EARTH FOR FLAT-DWELLERS.

## Using the Metal Conduit for the Electric Light Wiring.

ACCORDING to the "Regulations for the Electrical Equipment of Buildings," published by the Institution of Electrical Engineers, and adopted as standard by all reputable contractors, the greatest resistance that is permissible between any part of the metal casing through which the wires are run, and earth, is two ohms. This regulation is intended to ensure that if through the failure of the insulation on some part of the wire within the casing, the casing itself becomes momentarily "live," the resulting current to earth shall be great enough to blow the protecting fuses immediately. There is thus no risk of shock to anyone who may touch the casing within the building, while earth leakage, which is one of the bugbears of the power-station engineer, is not permitted to persist.

### Water-pipe Earth Not Always Satisfactory.

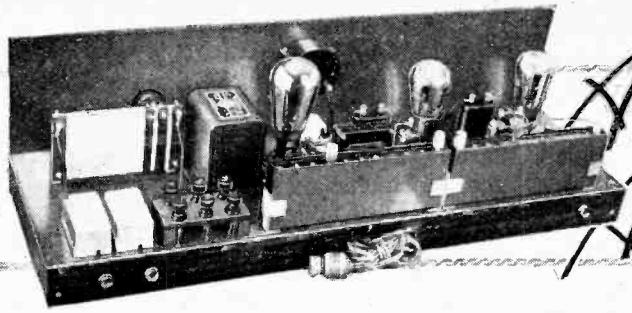
From the point of view of the user of wireless apparatus this careful earthing of the casing also has its merits. Few dwellers in flats can bury large copper plates in the garden for their earth connection, for if they have a garden at all it is usually paved. The usual alternative of a water-pipe is satisfactory enough, provided that the water-pipe chosen goes direct to earth, and not merely to a cistern, but it often involves leads that straggle untidily through several rooms and a landing. There is also the difficulty of making good connection to a water-pipe covered with several coats of paint.

Where electric light is installed it is naturally available in the room which contains the wireless receiver, so that only a comparatively short lead will be necessary if it is decided to earth the set to the casing. Connection may be made to the casing by removing one of the set-screws used at the joints between lengths of the tubing and getting the paint off it by soaking it for a few hours in an egg-cup full of turpentine. It can then be cleaned up with emery-paper and returned to its position, screwing down the earth-wire from the set under its head.

### Freedom from Machinery Noises.

To judge from a limited experience of this method of earthing on a recently installed A.C. system, there are no disadvantages, from a purely wireless point of view, in its adoption; in particular, noises derived from rotating machinery and carried up to the set by the electric light wires do not appear to be accentuated appreciably. As for the D.C. resistance, a measurement between the casing and a water-pipe, both situated on the top floor of a three-storey building, showed it to be only a shade over half an ohm. It may therefore be regarded as a highly satisfactory earth.—A. L. M. S.

# A.C. Eliminator for the All-Electric Amplifier



## Design of Rectifying Equipment, including Field Excitation.

By A. P. CASTELLAIN, B.Sc., A.C.G.I., D.I.C.

ALTHOUGH the " All-electric Amplifier " recently described in this journal [1] was intended for operation from D.C. mains or from batteries, a prophetic instinct on the part of its designer led him to state that with fairly simple modifications the instrument might be run from A.C. mains with a suitable eliminator. Subsequent requests from a large number of readers have shown that there is a strong demand for an A.C. eliminator capable of giving satisfactory service with this amplifier, and the object of this article is to describe two circuits which can be thoroughly recommended.

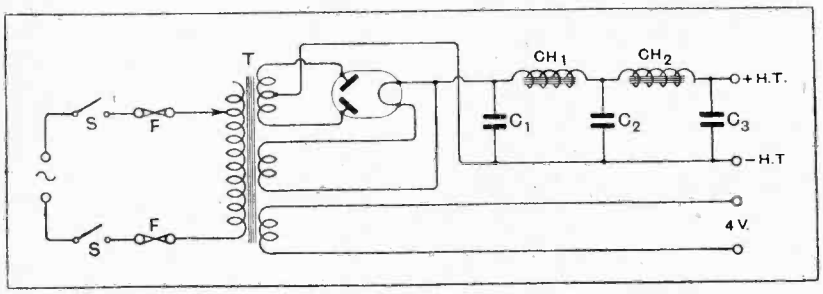



**Fig. 1a.—Eliminator using a single full-wave rectifying valve.**

For normal home use on A.C. supply an amplifier and eliminator using 200 volts H.T. with Mazda A.C. valves (which have indirectly heated cathodes) will give results as to volume and quality exactly equivalent to those obtainable with the all-electric amplifier as described for use on D.C. mains. In the amplifier the valves should be the AC/HL, AC/P, and AC/P1 in the first, second, and third stages respectively. For the eliminator there are two alternatives, depending on whether it is also required to supply the field current for a moving-coil speaker.

Where the amplifier alone has to be considered, the full wave rectifier UU60/250, capable of supplying 60 milliamps. D.C., will be sufficient, while if a 200-volt moving-coil speaker is to be used it will be necessary to use two single-wave rectifiers U.75/300, capable of giving a total D.C. output of 150 milliamps. Since the difference in cost between these two alternatives is so small, the two U.75/300s costing together 30s. as compared with 22s. 6d. for one UU60/250, it is really worth while catering for the greater output, which may come in useful at a later date. The circuits for the two arrangements are shown in Figs. 1a and 1b.

The transformer included in these circuits is the standard Met.-Vic. type AB with a separate 4-volt winding for feeding the heaters of the valves in the amplifier, in addition to the normal 4-volt winding for the rectifying valves. With the two single-wave rectifiers this eliminator will supply a loud speaker with a 20-watt 200-volt field besides feeding the amplifier.

For those readers who desire to use a higher H.T. voltage to obtain a greater power output, an eliminator incorporating a gas rectifier can thoroughly be recommended. Such a rectifier will supply up to 250 milliamps. at 400 volts.

Although it is quite possible to use valves of the L.S.5 class in the first stage of the amplifier, it will probably be found more convenient, in order to obtain an amplifier free from hum on A.C., again to use an indirectly heated cathode valve, such as the AC/HL, for the first stage. Fig. 2 shows the circuit of an eliminator designed with this object in view. The output valve may be an L.S.5a, an L.S.6a, or several of these in

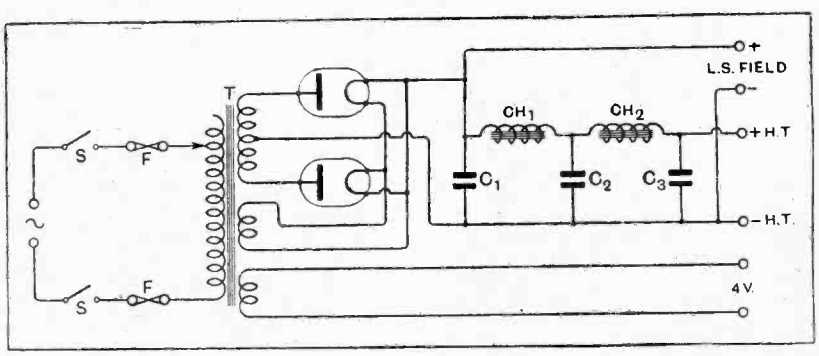



**Fig. 1b.—An A.C. unit with two half-wave rectifying valves for feeding the loud speaker field as well as the valves in the amplifier. $C_1$ is 6 mfds., $C_2$ and $C_3$ 2 mfds., 750 volt D.C. test. $CH_1$ and $CH_2$ are Ferranti B1 chokes. The condenser and choke values apply to Fig. 1a.**

[1] June 19th and 26th, 1929.

**A.C. Eliminator for the All-Electric Amplifier.—**

parallel. The mains transformer is not quite a standard article, but any good transformer manufacturer will be able to make it up at a cost of about £4 or £5.

The gas rectifier requires barretters (*i.e.*, series resistances in the form of spirals of iron wire enclosed in bulbs containing gas) in order to prevent arcing over, and as the filament is very thick and takes some time to come up to its final temperature, a separate switch should be used for connecting up the output to the amplifier. Thus the method of procedure in starting up is to apply the main switch $S_1$ (Fig. 2), which lights the rectifier filament and the filaments of the amplifier valves; after a moment or two the output switch $S_2$ is closed and H.T. and field current are, therefore, supplied.

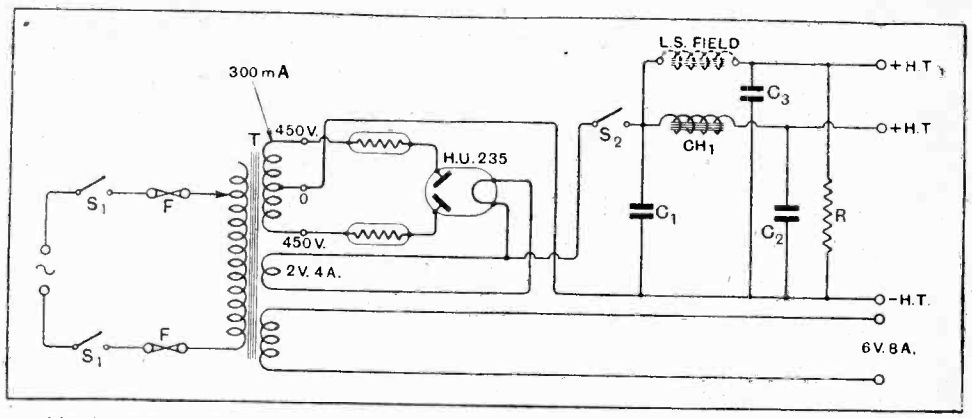



**Fig. 2.—Circuit with provision for supplying the field of a 20 watt 200 volt loud speaker. A gas rectifier is employed. $CH_1$ is an E. 166 Rich and Bundy choke. $C_1$ 6 mfds., $C_2$ 2 mfds., 1,500 volt D.C. test.**

In the circuit diagram, Fig. 2, provision is made for supplying the field of a 20-watt 200-volt loud speaker, the loud speaker field winding being used as an auxiliary choke for the first valve, which was an AC/HL.

**The September "Call Book."**

The Radio Amateur Call Book for September has now been issued. The list of amateur call-signs in all parts of the world, which has been revised and brought up to date, occupies 106 closely printed pages. It includes the latest Australian and New Zealand stations, the Dutch East Indies, and the revised Swedish call-signs.

The publishers earnestly request the help of transmitters in correcting and adding new calls to the list, and amateurs in Great Britain are asked to send particulars of new stations identified or alterations in addresses to Mr. F. T. Carter, Flat A, Gleneagle Mansions, Streatham, London, who is their British representative and from whom copies of the Call Book may be obtained.

Other useful features of the book are the revised "Q" code, International Prefixes, a list of about 1,400 short-wave stations arranged in order of frequencies, and a map of the United States, showing the boundaries of the various Radio districts.

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**Broadcasting in Siam.**

Experimental short-wave broadcasting is being carried out by the Royal Siamese Post and Telegraph Department from their stations in Bangkok. HS1PJ transmits on a wavelength of 16.9 metres with an input of 20 kilowatts on Sundays from 12.00 to 14.30 and 18.00 to 20.00 G.M.T. The low-powered station HS4PJ transmits on 37 metres on Tuesdays from 13.00 to 15.00 and 18.00 to 20.00, and on Fridays from 13.00 to 15.00 G.M.T. Announcements are made in English, French, German, and Siamese, and reports of reception will be much appreciated by the Engineering Service, Royal Post and Telegraph Department, Bangkok, Siam.

## TRANSMITTERS' NOTES AND QUERIES.

**English Amateur in Capetown**

Mr. E. R. Cook (G6UO), whose station near Gainsborough was well known to British amateurs, is now in Capetown, where he intends resuming his experimental transmissions on the 20- and 40-metre wavebands. He will use about 600 volts of rectified A.C. on the plate and raw A.C. on the filament of an LS5 valve, giving an input of about 25 watts, and hopes to get into touch with his friends in the Northern hemisphere.

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**Short-wave Stations.**

We have received, through the courtesy of the Federal Radio Commission, Washington, D.C., a list of radio stations of the world transmitting on frequencies above 6,000 kilocycles (or wavelengths below 50 metres), and comprising about 3,000 stations arranged in order of frequency. The information given includes the call-sign, locality, nature of service and power; also, in many cases, the countries with which any particular station is in regular communication. The nature of service is indicated by letters similar to those used in the "Berne Lists" (e.g., PG=station open to public correspondence, FX=station carrying on services between fixed points), with several additions such as E for Experimental and RBC for Relay Broadcasting. In the case of American stations the name of the company or individual responsible for their working is also given.

The particulars have been compiled partly from the records of the Federal Radio Commission, partly from the lists published by the International Telegraph Union, and from information furnished by the Tropical Radio Telegraph Co., and by various administrations.

The list we have received is in typescript and is, presumably, an advance copy of one to be published by the Radio Division of the Department of Commerce at Washington. If this is the case, we feel sure it will be warmly welcomed by amateurs in this country. It is stated that an endeavour will be made to prepare monthly supplements or correction sheets.

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**Heard in Australia.**

We have received, through the courtesy of G2XV, the following list of the European stations heard by Mr. R. Roberts at his station at Box Hill, Victoria, Australia, during July. The strength of signals is given, according to the "R" code, in brackets:—

G5BY (R4), G2XV (R4), G5BZ (R4), G6NH (R3), G2AX (R2), G6WT (R2), G2BM (R2), G5ML (R3), G5YX (R3), F8FR (R4), F8DA (R3), F8FK (R4), F8RKO (R3), ON4EA (R4), ON4FL (R3), ON4HP (R4), ON4FT (R3), D4YT (R4), OZ7Y (R4), CT1BX (R3).

Mr. Roberts states that during July European signals are best received between 2200 and 2300 and between 0600 and 0700 G.M.T.

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**TRADE NOTES.**

The Marconi's Wireless Telegraph Co., Ltd., Marconi House, Strand, London, W.C., announce a change in their telephone number. This is now Temple Bar 4321.

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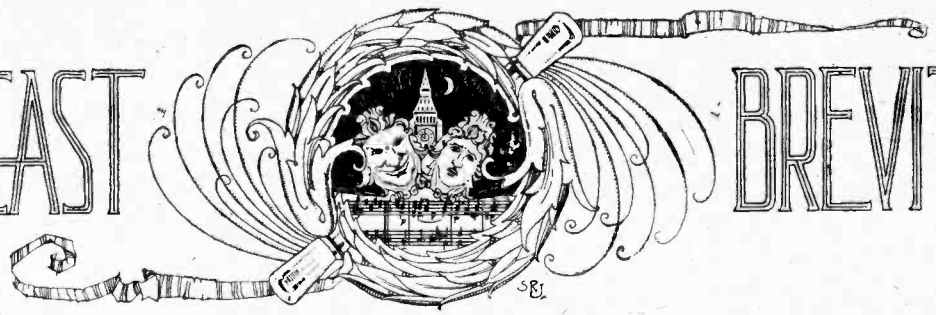
A change has been made recently in the telephone number of Messrs. A. C. Cossor, Ltd. This is now North 5900 (20 lines).

# BROADCAST BREVITIES



*By Our Special Correspondent.*

***Two Important Ceremonies.—2LO's Last Lap.—A Musical Sensation.***

**A Foundation Stone Ceremony.**

Early this year I suggested that the laying of the foundation stone of "Broadcasting House" should be the occasion of a public ceremony. It now seems that the suggestion will be carried out early in the New Year and, although no definite arrangements have been completed, it is not unlikely that the stone will be "well and truly laid" by one of the most popular members of the Royal Family.

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**A Send-off for the Regional Scheme.**

*The Wireless World* has already pointed out that an event of such importance as the inauguration of the Regional Scheme is deserving of more than ordinary publicity. At first it seemed as if the B.B.C. would be content to insinuate the high power transmissions into the ordinary broadcasting periods with an air of apology for disturbing the service. However, some of the old 1922 spirit still bubbles up at intervals, and Savoy Hill has decided that the Scheme is to be given a good send-off in January when the Brookmans Park twins begin simultaneous transmissions. An impressive "S.B." will be staged, in which the inaugural speech will be given by a celebrity of special eminence; indeed, it is hoped that the fateful words will be pronounced by the Prime Minister himself.

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**2LO's Last Lap.**

One of the most surprising phenomena connected with the opening transmissions from Brookmans Park has been the apparent increase of signal strength from 2LO. I have noticed this especially during the transmission of the Promenade Concerts, and others report the same experience.

It would not surprise some of us if the disclosure were made that Brookmans Park is transmitting at periods other than those officially announced. Possibly, of course, the older station is developing a sprint over the last lap.

The Regional Station will take up the entire London programme at the beginning of next week.

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**Unique Newcastle.**

When all six regional stations are functioning listeners in the Newcastle area will possess the unique distinction in the British Isles of still being out of the reliable service range of the new transmitters. So Newcastle will continue to have its own station. For a brief spell in the near future, however, the district will have to forfeit the individuality of local programmes, 5NO being allocated on October 31st next the national common wave of 288.5 metres. From then until the Moorside Edge station is complete (at the end of 1930) Newcastle listeners must submit to a regime of outside programmes.

If they are wise, they will accept the temporary setback in respectful silence, in anticipation of the delights of the future.

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**Personalities at the Microphone.**

Mr. H. G. Wells will be heard by 2LO listeners on October 21st in a contribution to the series of talks entitled "Points of View."

On November 9th the speech of the Prime Minister at the Lord Mayor's Banquet will be relayed by 2LO and 5XX.

**FUTURE FEATURES.**

**London and Daventry.**

OCTOBER 14TH.—"Points of View" (3) by Dean Inge.
OCTOBER 15TH.—Speech by General Dawes at Hull Civic Week Banquet, S.B. from Hull.
OCTOBER 16TH.—"Captain Brassbound's Conversion," by Bernard Shaw.
OCTOBER 17TH.—A Norwegian National Programme.
OCTOBER 18TH.—A Delius Festival Concert.

**Daventry Experimental (5GB).**

OCTOBER 15TH.—Programme of Plantation Songs.
OCTOBER 17TH.—Selections from the Operas.
OCTOBER 18TH.—"Smoke Rings," a bachelor retrospect by Dorothy Eaves.

**Cardiff.**

OCTOBER 14TH.—A Welsh Programme.

**Manchester.**

OCTOBER 14TH.—Gems from Italian Opera.
OCTOBER 16TH.—Speeches at opening of sixth Manchester Radio Exhibition.
OCTOBER 17TH.—Hallé Concert.

**Glasgow.**

OCTOBER 14TH.—An Hour with Tchaikovsky.
OCTOBER 19TH.—"Jinin' the Kirk," a Scots comedy, by T. M. Watson.

**Aberdeen.**

OCTOBER 19TH.—A Gaelic Concert.

**Belfast.**

OCTOBER 19TH.—Speeches at Laying of Foundation Stone of New Law Courts.

**The Manchester Radio Show.**

Speeches at the opening ceremony of the sixth Manchester Radio Exhibition will be relayed from the City Hall for the benefit of Manchester listeners on October 16th, beginning at noon.

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**A Present for "P.P."**

The large-hearted staff at Savoy Hill are now putting their pennies together for a handsome presentation to Captain Eckersley, who terminated his appointment as Chief Engineer on September 30th. There seems to be some doubt as to what would be an acceptable present, but I am authoritatively informed that it will not be a wireless set.

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**A Musical Sensation.**

One of the best indications that the National Symphony Orchestra (which begins broadcasting on October 25th) will aspire to something above the ordinary standard of broadcast orchestras is the news that its leader will be one of the best known solo violinists of to-day. It is rare indeed for a soloist of rank to take up orchestral work, and I am sure that the forthcoming disclosure of the name of this artist will not only cause a lifting of brows among the high brows, but a big advance in the prestige of the National Symphony Orchestra.

The first concert will be given at the Queen's Hall on October 25th, Sir Henry Wood conducting.

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**Football Broadcasts Begin.**

The first running commentary of the season on a soccer match will be heard by 2LO and 5XX listeners on Saturday next, October 12th, when the second half of the Arsenal v. Derby County game will be relayed from Highbury at 4.15 p.m.

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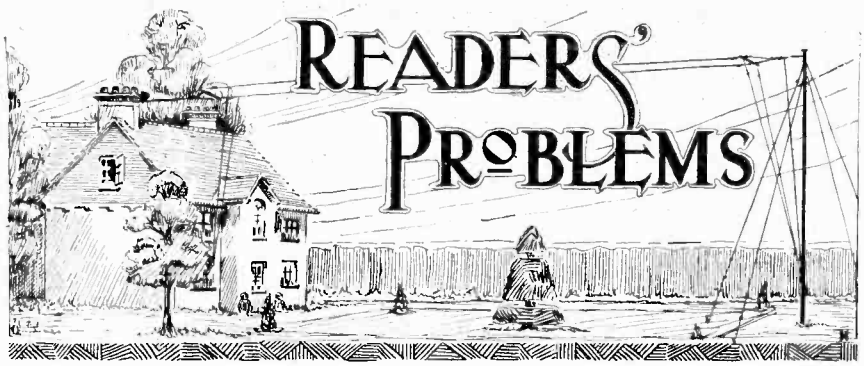
**Archbishop of York and Broadcast Education.**

Public opinion can veer round with surprising rapidity, an instance of this being the changed attitude to broadcast education. Although opposition is still strong, a large section of the public is taking an interest in the plans of the Central Council for Broadcast Adult Education, the new chairman of which is the Archbishop of York. It is hoped that His Grace will be able to preside for the first time at the next Council meeting on Wednesday, October 23rd.




## "The Wireless World" Supplies a Free Service of Technical Information

*The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.*

### Modifying the "Kit Set."

*In this neighbourhod we are not normally troubled by interference, due to the fact that we are remote from any transmitting station. In these circumstances, do you consider that it would be permissible to modify the "Wireless World Kit Set" by omitting the separately tuned aerial circuit, and, if so, will you give me a diagram showing how it can be altered?* T. M. S.

There is no real reason why you should not omit the tuned aerial circuit, but it should be realised that, apart altogether from the question of selectivity, the general performance of the receiver will be adversely affected, but only to a small extent.

We assume that you wish to retain the feature of waveband switching, and give in Fig. 1 a circuit diagram showing how the necessary alterations may be made. A tapping to the aerial connection should be made at the 12th turn from the end, marked x, of the short-wave grid coil L, while a similar connection may be made on the long-wave coil ($L_1$) at the 35th turn.

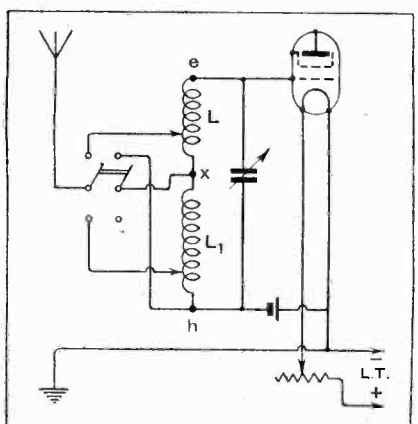



**Fig. 1.—Modified H.F. grid circuit of the "Wireless World Kit Set," showing how provision may be made for an "aperiodic" aerial coupling with waveband switching. Lettering corresponds with that in the original circuit diagram.**



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### Choke Filter or Output Transformer.

*I am building a four-valve set consisting of one H.F. stage, detector, and two L.F. stages. I intend to use an ordinary cone loud speaker, but am uncertain whether it is better to use an output transformer or choke filter output circuit.* D. M. P.

Both of these instruments would give you the same results from the musical point of view, as we assume, in the absence of information to the contrary, that the loud speaker you propose to use is not designed to be employed in conjunction with a step-down transformer. From the point of view of stability, however (more especially if you intend to use a battery eliminator), we think that it would be preferable to use a choke filter output circuit.

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### A Temporary Makeshift.

*I am thinking of building the "Record III" receiver. As A.C. power will not be available for some weeks in my district, would it be possible for me to use battery-operated valves in the receiver for the time being?* H. S. H.

You do not make it quite clear in your letter whether your idea is to use the ordinary type of valves made for battery use, or whether you intend to operate A.C. valves from batteries. If the latter is the case, you can, of course, operate the set entirely from batteries, but it must be pointed out that the filament current taken by the set is naturally very heavy, and therefore it would not be an economical proposition from the point of view of accumulator charging; apart from this, you would have to use an accumulator of generous ampere-hour capacity to enable it to be discharged at a relatively high rate without injury. This would rule out many of the ordinary accumulators now in use.

If you intend to use ordinary battery-operated valves, we would inform you that this plan is quite feasible, but you will have to temporarily alter the filament wiring and probably make some adjustment in the matter of the primary turns on the H.F. transformer. Needless to say, results will be *comparatively* poor to those obtained when using the A.C. valves for which the set is specially designed.

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### Copper or Tin?

*I notice that in many of your set designs published last year copper or aluminium screening boxes were adopted. Am I correct in assuming that these are to be used in the "New Kilo-Mag Four" and the "Record III."?* L. T. P.

It will, of course, be quite in order for you to use copper or aluminium screening boxes, and, indeed, a copper box is the best to use, but tinned iron, which was actually used in one of the receivers to which you refer, is for all practical purposes equally as good.

You must not expect, however, that by using copper you will obtain better results.

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### A Fuse Question.

*I have recently inserted a safety fuse in my "Everyman Four" receiver; this consists of a small flash-lamp bulb connected between H.T.— and L.T.—. Although the set has been functioning well for some time, I find that this lamp speedily burns out.* N. C. J.

The total plate current consumption of this set, if built as described, is well under 20 milliamperes, and the bulb should not, therefore, burn out. We think that you have not provided us with sufficient information, and are possibly using an arrangement of two valves of the LS5A type in the last stage, and in this case it would be perfectly normal for the bulb to burn out, if (as we suppose) it is of the special type now available for use as fuses in sets not employing heavy H.T. current.

If you let us have some more information we will endeavour to assist you further.

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*RULES.*

*(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

*(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

*(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

*(4.) Practical wiring plans cannot be supplied or considered.*

*(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

*(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

*Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.*

### Building an Eliminator.

*Can you give me a circuit diagram for an eliminator which would be suitable for operating a five-valve receiver?* W. M. D. M.

You have omitted to state whether your mains are A.C. or D.C., but we can in either case refer you to an instrument which is quite suitable for your receiver.

In the case of A.C. we should advise you to make the instrument described in our issues dated December 12th and 19th, 1928, and in the case of D.C., we should advise you to construct the instrument described in our issue of August 28th, 1929.

o o o o

### An A.C. "Kit Set."

*Will you please give me a few words of advice as to how the "Wireless World Kit Set" may be modified for use with indirectly heated A.C. valves throughout? I take it that the general design need not be altered; but I understand that it will be necessary to rearrange the filament circuits; it is about this part of the receiver that I should particularly welcome your advice.* S. H. T.

The design of this receiver lends itself readily to modification for A.C. mains operation, and we think that the circuit diagram given in Fig. 2 will convey all the necessary information to you.

You may find it necessary to make a slight adjustment to the number of primary turns of the H.F. transformers—this depends on the characteristics of the valves used—but, apart from this, no basic modification of the design will be necessary. It will be observed that a single cell is connected in the detector-grid circuit in such a way that it provides a positive bias; in this matter you should be guided by the advice given by the makers of the valve.

In cases where an attempt is made to attain the maximum overall magnification, it is sometimes advisable to connect a condenser of about 0.005 mfd. across each half of the potentiometer, which is shunted across the secondary of the heater transformer.

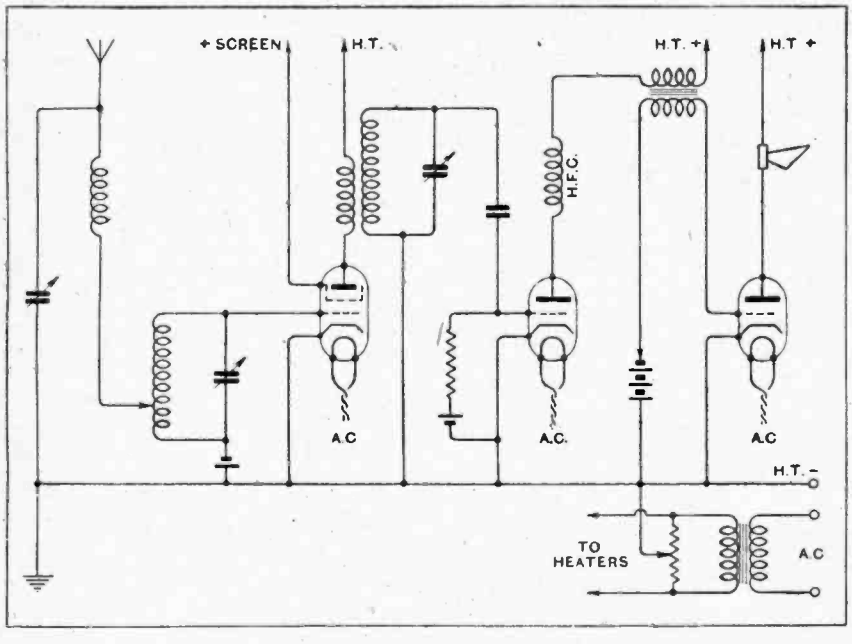


**Fig. 2.—Skeleton circuit diagram (omitting waveband switching, reaction, by-pass condensers, etc.) of the "Wireless World Kit Set," modified for use with A.C. valves.**

o o o o

### A Two-valve Question.

*Hitherto I have not had electric light mains available, but have recently moved into a new house in which D.C. at 110 volts is supplied. My set is a detector and L.F. fitted with a choke filter output circuit, and hitherto I have operated it successfully using 2-volt L.T. accumulator and five 20-volt H.T. units in series. This has given me satisfactory results, the volume being moderate, but ample for my purpose. I obtain the same results using batteries in my present house, but desire to use the household mains for H.T. supply as my H.T. units are now over three years old, and do not hold their charge for as long as they did. I should be glad if you could tell me what precautions I should take in order to avoid "motor-boating." I have already purchased an eliminator.* J. F. J.

You do not give us any technical data concerning the particular eliminator you have purchased, but the type of receiver you have in use will operate with almost any kind of eliminator without giving this particular trouble. We may presume that you have purchased a fairly simple instrument having two tappings, one of which is intended for the detector valve.

We would point out that as your mains are only 110 volts, you will not get enough voltage on your last valve to give you undistorted results unless you are content with comparatively little volume. We should advise you to use one of your accumulator units in series with your eliminator. It should be connected between the H.T.– terminal of the eliminator and the H.T.– terminal of the set. If your existing units do not hold their charge for long, it is advisable to purchase at least one new 20-volt unit to use in this position. If two are purchased you can arrange to charge one while the other is in service.

Naturally, we presume that you have an up-to-date receiver, but if not, you must remember that it is necessary to use fixed condensers in aerial and earth leads.

For further information, we would refer you to an article appearing on page 529 of our May 22nd, 1929, issue.

o o o o

### Special Screening Cabinets.

*Will you please tell me if there is any real reason why conventional screening boxes should not be used in the construction of recent* Wireless World *sets, for which the new design of metal cabinet is specified? I ask the question because I have a large collection of copper boxes with well-fitting lids.* W. M. P.

If the screening provided by your boxes is as thorough as that of the cabinets used in the construction of the sets to which you refer, there is no reason why they should not be used with satisfactory results. All the new sets are on entirely straightforward lines, and, provided adequate means are taken to ensure sufficient isolation of the various circuits, it matters not at all how this end is attained.

o o o o

### The Range of a "1-v-1" Set.

*I live about 160 miles from Daventry, and on account of morse interference depend almost entirely on the long wave station for consistent reception. I am thinking of replacing my det.-2 L.F. set with an H.F.-det.-L.F. three-valve receiver with anode bend detection and transformer coupling. The set will be fed entirely from A.C. mains, and the most efficient modern valves will be used; do you consider that this circuit arrangement should provide really adequate volume with a reasonable margin of safety?* W. J. R.

In answering queries of this sort, we can only assume that your local receiving conditions are not abnormal, and, this being so, it can be stated quite definitely that a well-designed modern three-valve set, with a reasonable aerial and efficient valves, will give an output sufficiently great for average requirements. The efficiency of a modern H.F. stage is so high that it is quite conceivable that you will find it necessary to reduce sensitivity in order to prevent detector overloading.

# The Wireless World AND RADIO REVIEW

(17th Year of Publication)

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## MUST THE REGIONAL SCHEME BE SCRAPPED?

IT was expected that Monday, October 14th, would have seen the eclipse of the old Oxford Street transmitter of 2LO in favour of Brookman's Park, which it was announced officially by the B.B.C. would take over the whole of the London programme transmission from that date; but for some reason which, at the moment, has not been disclosed, the complete transfer of the programme transmissions to the new station has been postponed.

It is natural that after so much expectancy the public should be interested to learn just what is the real reason for the postponement. One can only venture a guess, and since on the engineering side there has already been ample evidence that the quality and the performance of the station is satisfactory, one must look elsewhere for the cause than to any technical trouble. Is it that, judging from reports of listeners, which must already have been pouring into the B.B.C. as a result of the preliminary trials from Brookman's Park, the B.B.C. are not yet prepared to face the deluge of criticism which we feel sure must fall upon them when Brookman's Park takes over? The daily Press, we observe, has awakened to the troubles of listeners who find that the transmission from Brookman's Park deprives them of programmes from farther afield, and if this is the state of affairs to-day, what is going to be the position if a second programme starts up from the same centre?

### Our Views Unchanged.

Our criticism of the power of the Regional stations is not an attitude of recent growth, and we think that the present is a suitable occasion to quote the views which we expressed in our issue of March 2nd, 1927, when, under the title of "The Next War," we wrote:—

"On the face of it the scheme seems to have much to recommend it, provided that one is confident that distribution of programmes over the whole country can be obtained with the four stations (*four or more stations were originally proposed*), but where we find fault with the proposal is in the suggested power of the stations. With many listeners the complaint at present is that it is difficult to cut out the local station if you are anywhere near it, on account of its power. What, then, will be the position when we have two transmissions on 50 kW. in our neighbourhood? Has the B.B.C. quite forgotten its former concern for the interests of the crystal user, for with unselective sets it seems difficult to believe that, close up to a 50 kW. station broadcasting independent programmes on two wavelengths, it will be possible to have a choice of programmes; rather it would seem that two programmes will always be available, but not necessarily as alternatives!

"But there will be a later opportunity for discussing the details of any scheme contemplated. For the moment our desire is to express our disagreement with any proposal which calls for the employment of unnecessarily high power. We believe that in arranging stations and their power to provide for national broadcasting the endeavour should be made to keep down the power so that transmissions do not carry far beyond the frontiers of the country concerned, except, perhaps, in the case of one high-power station for international communication when required.

"As things stand at present the power of stations in Europe is constantly being increased in order to overcome interference from neighbouring stations.

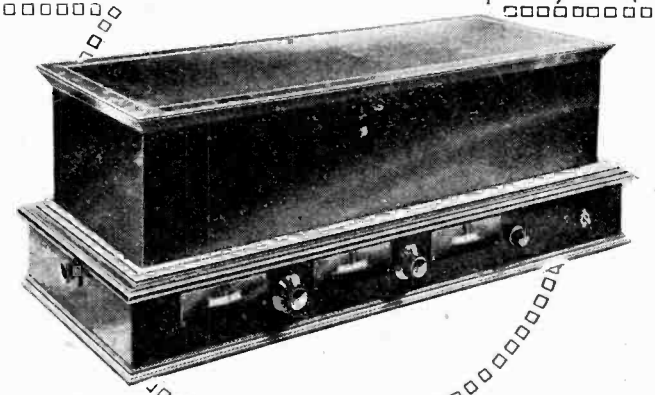
"The first wars of history were almost invariably fought as a result of incursions being made into neighbouring territories; at a later date wars more frequently started because one nation trespassed upon the trade interests of another; to-day we have another possible source of friction between nations to take into account in so far as an invasion of the ether by some foreign nation which may interfere with the broadcasting service of neighbours may at any time excite the indignation of the listening public. We have at the moment the one consolation that, judging from popular views on the programmes, the British nation is not likely to be roused to a high pitch of resentment even if some of our home programmes are overpowered by the programmes from the Continent!"

# THE 1930 EVERYMAN FOUR

## Screen-Grid H.F. Amplification.

## Selective Coupled Aerial Circuit.

By F. L. DEVEREUX, B.Sc.



THERE is much diversity of opinion as to the ideal type of receiver for quality reception of the B.B.C. programmes, with occasional explorations into foreign fields. This is hardly the place to go into the pros and cons of the various circuit arrangements at present in vogue; it is sufficient to state that each possesses definite advantages and enthusiastic supporters. One school of thought favours a four-valve combination comprising H.F., detector, and two L.F. amplifiers, and has recruited a formidable army of adherents as a direct result of the introduction of the "Everyman Four" receiver in 1926.

Since that date many changes have taken place, not only in reception conditions in the ether, but also in the characteristics of valves and components. Many enquiries have been received asking if it is possible to introduce these improvements into the original "Everyman Four" design without sacrificing the essential qualities which so largely contributed to the success of the original design. The design of the receiver about to be described has been governed by these considerations, and most, if not all, the suggestions put forward have been incorporated.

Naturally, the original sequence of valves has been retained, viz., H.F. amplifier, detector, and two low-frequency amplifiers. Other features of the original design which remain substantially the same are the design of the low-wave grid circuit coils, the anode bend detector with resistance coupling to the first L.F. stage,

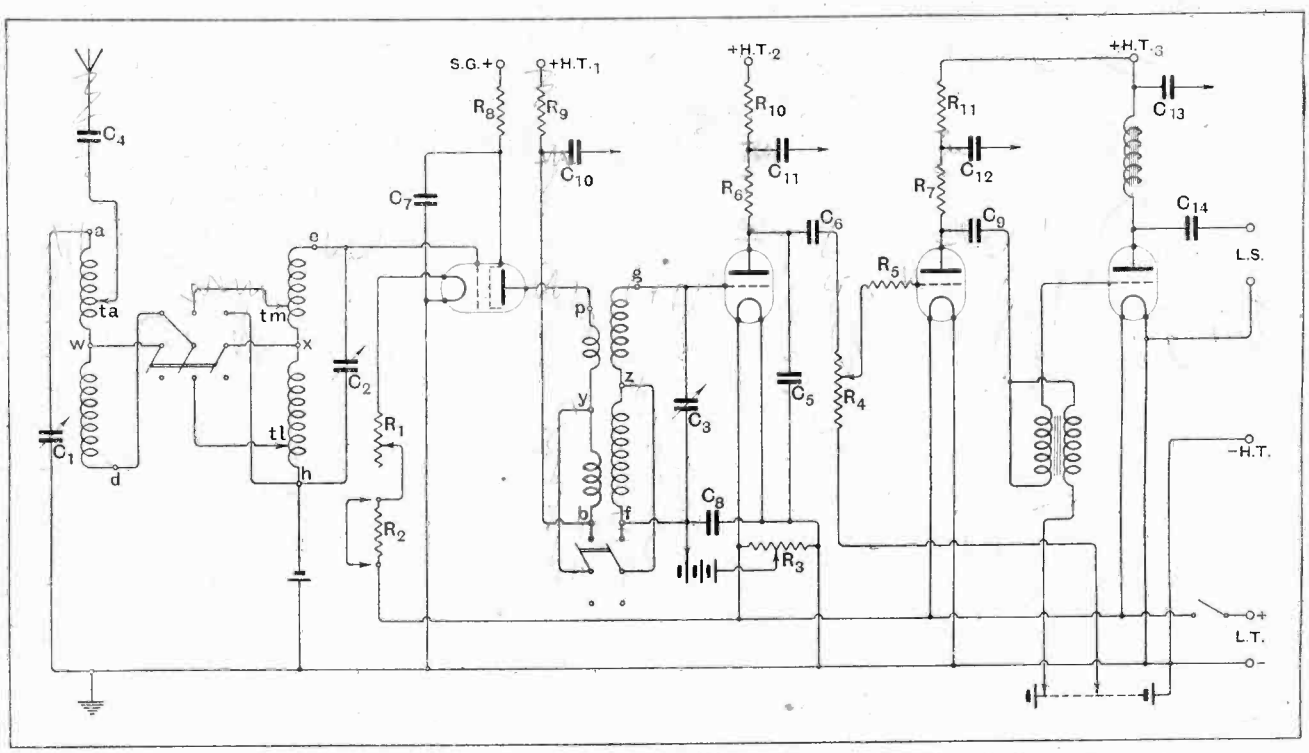


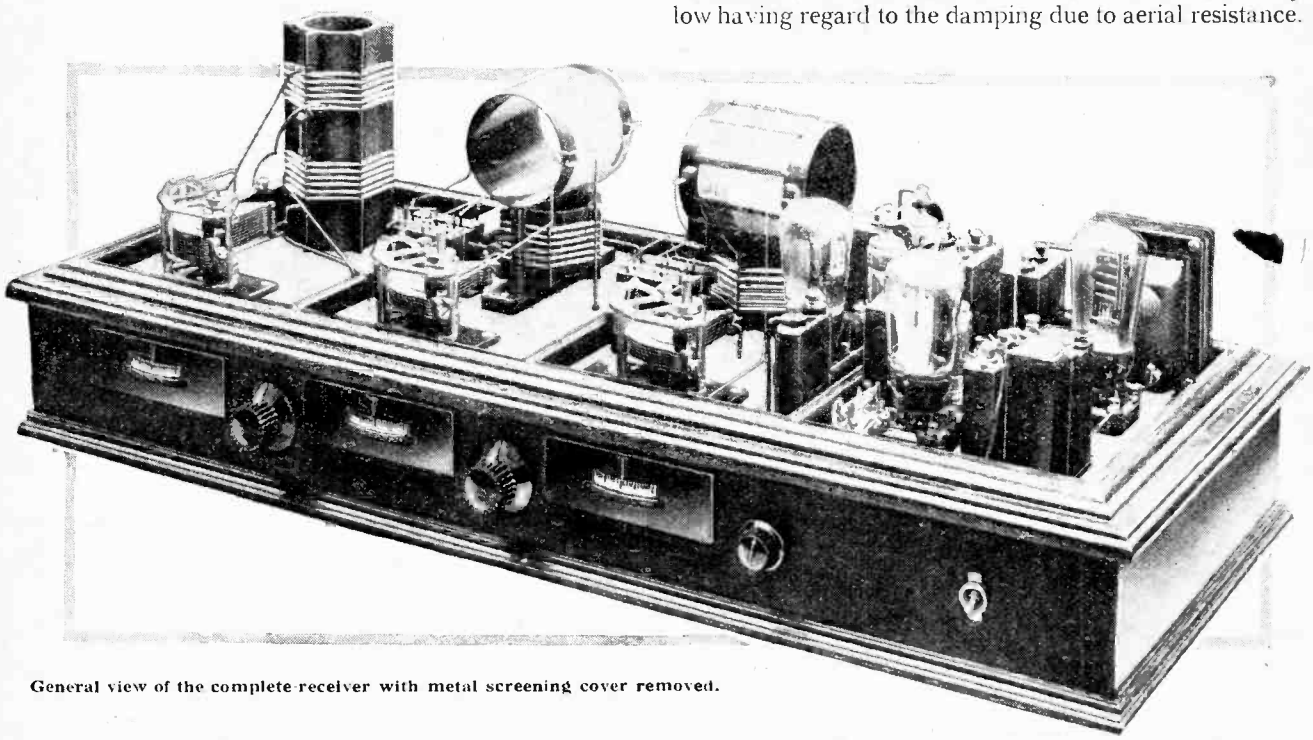

Fig. 1.—The circuit diagram. $C_1$, 0.0005 mfd.; $C_2$, $C_3$, 0.0003 mfd.; $C_5$, 0.0002 mfd.; $C_6$, 0.02 mfd.; $C_7$, 1 mfd (low H.F. resistance type); $C_8$, $C_9$, $C_{10}$, $C_{11}$, 1 mfd.; $C_{12}$, $C_{13}$, $C_{14}$, 2 mfd.; $R_1$, 50 ohms; $R_2$, 0, 12.5 or 25 ohms, depending on filament voltage of valves in last three stages; $R_3$, 400 ohm potentiometer; $R_4$, 1 megohm (variable); $R_5$, 0.1 mehohm; $R_6$, 250,000 ohms; $R_7$, 30,000 ohms; $R_8$, $R_9$, 600 ohms; $R_{10}$, $R_{11}$, 20,000 ohms. The coil connections are lettered to correspond with Figs. 2 and 4.

**The 1930 Everyman Four.—**

and transformer coupling between the first L.F. and the output valve.

Perhaps the most important modification is the introduction of H.F. amplification on long waves. To accomplish this successfully with simple switching arrangements it is necessary, of course, to drop the neutralised triode in favour of the screen-grid valve. This enables us to obtain an amplification in the H.F. stage in excess of the old "Everyman Four" without neutralising; and the change over from long to short waves becomes merely a question of short-circuiting the long-wave windings.

The demand for improved selectivity has been met by the inclusion of a coupled aerial circuit. Unfortunately



General view of the complete receiver with metal screening cover removed.

this introduces a third tuning control, and this is the only feature of the design which compares unfavourably with the original. There can be no doubt that a two-control set possesses many advantages in the matter of easy tuning over the present design with three controls, but conditions in the ether in the near future leave no choice. The coupled aerial circuit, with its extra tuning control, is a necessity if adequate selectivity is to be attained with only a single stage of H.F. amplification.

Two important improvements have been made in the low-frequency part of the receiver, namely, the introduction of a post-detector volume control and a filter-feed circuit in the output stage. The volume control enables the detector to function with an increased H.F. input and greater efficiency without overloading the last stage, while the filter output circuit protects the loud speaker windings and prevents the circulation of strong L.F. currents in the H.T. circuit. A further improvement has been the incorporation of anode feed resistances and condensers which effectively prevent any possibility of "motor-boating."

Finally, the receiver has been assembled in a standard four-compartment metal cabinet of the "Kilo-Mag. Four" type, which not only simplifies the work of construction but provides all the necessary screening for the H.F. and coupled aerial circuits. A further advantage of this cabinet is the provision of a screen between the detector and L.F. compartments, which assists in preventing H.F. straying into the L.F. amplifier.

The foregoing covers the outstanding deviations from and additions to the original design. We may now consider the technical aspects of the new circuit in detail.

The tuned aerial circuit is housed in the compartment at the extreme left of the metal cabinet. The coils are section-wound, and their H.F. resistance is sufficiently low having regard to the damping due to aerial resistance. In order to reduce aerial damping a series condenser is included in the aerial lead, which is connected to a point near the low-potential end of the medium-wave coil. To tap down the long-wave coil also would involve the use of an additional set of contacts on the change-over switch. This is obviated by the arrangement shown, for the tapping reduces the damping to the required figure on low waves while the small series aerial condenser looks after the long waves.

The aerial circuit is coupled to the secondary or tuned grid circuit by including a few turns of the secondary coils in the aerial circuit. A three-pole change-over switch short-circuits the long-wave coils of both aerial and secondary circuits, and also transfers the grid circuit tapping to the appropriate coil.

The secondary circuit is given a compartment to itself (the second from the left). The medium-wave coil follows standard "Everyman Four" practice in that it is wound with 68 turns of 27/42 Litz on a 3in. diameter

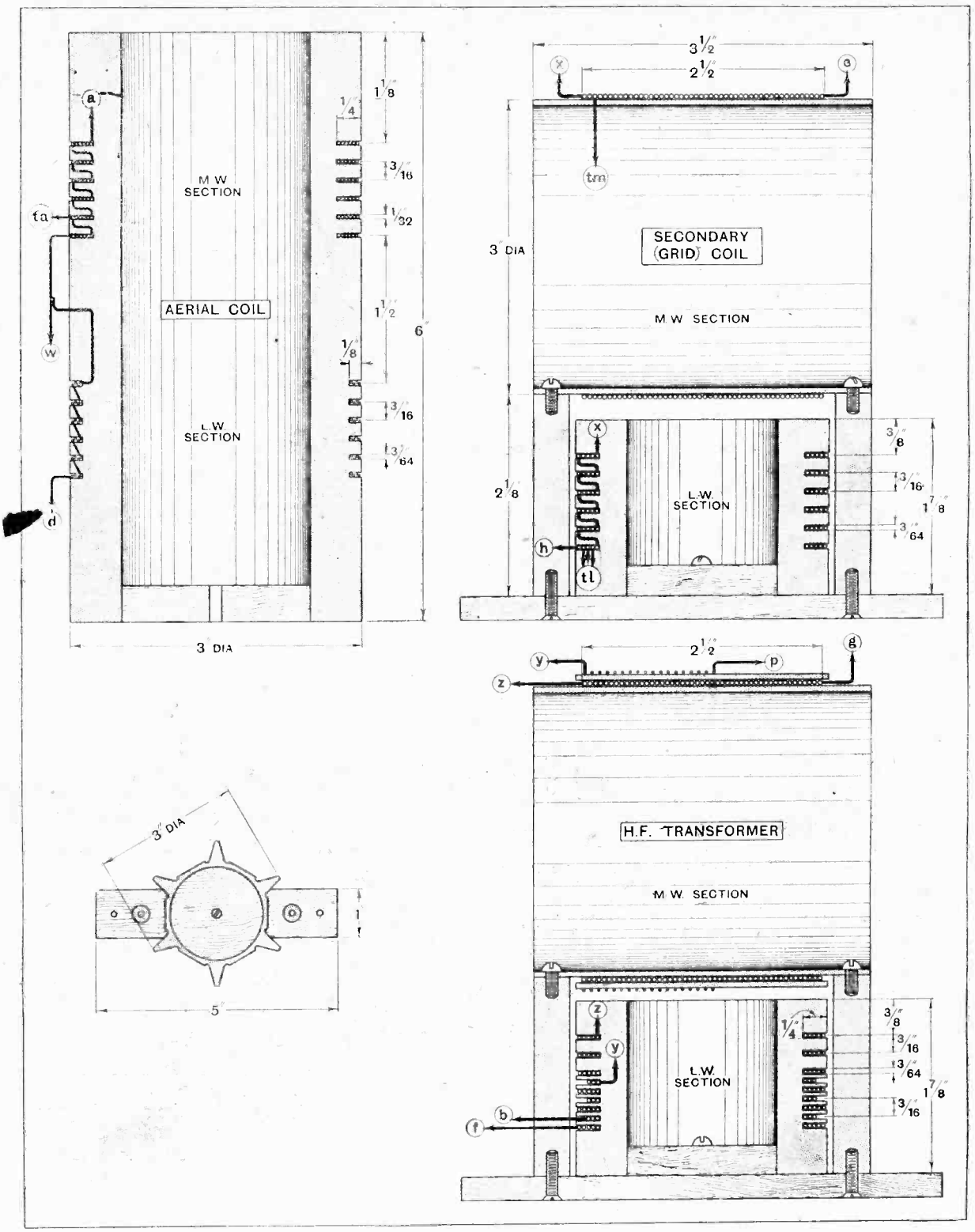



Fig. 2.—CONSTRUCTIONAL DETAILS OF COIL UNITS. The windings require the following turns and tappings. AERIAL COIL, Medium wave: 6 slots, 8 turns per slot No. 26 D.C.C., tapped at 40th turn from start (a), Long wave: 6 slots, 25 turns per slot No. 32 D.S.C. SECONDARY (GRID) COIL. Medium wave: 68 turns 27/42 Litz tapped at 2nd turn from low potential end (X). Long wave: 6 slots, 35 turns per slot No. 32 D.S.C., tapped at 3rd, 5th and 6th turns from low-potential end (h). H.F. TRANSFORMER. Medium-wave primary (for Mazda S.G.215 valve): 30 turns No. 38 D.S.C., spaced 30 turns per inch on 9 ebonite spacing strips. Medium-wave secondary: 68 turns 27/42 Litz. Long-wave primary: 3 slots, 30 turns per slot No. 40 D.S.C. Long-wave secondary: 6 slots. 30 turns per slot, No. 35 D.S.C. All windings are wound in same direction on each former and the lettering corresponds with Figs. 1 and 4.

LIST OF PARTS.

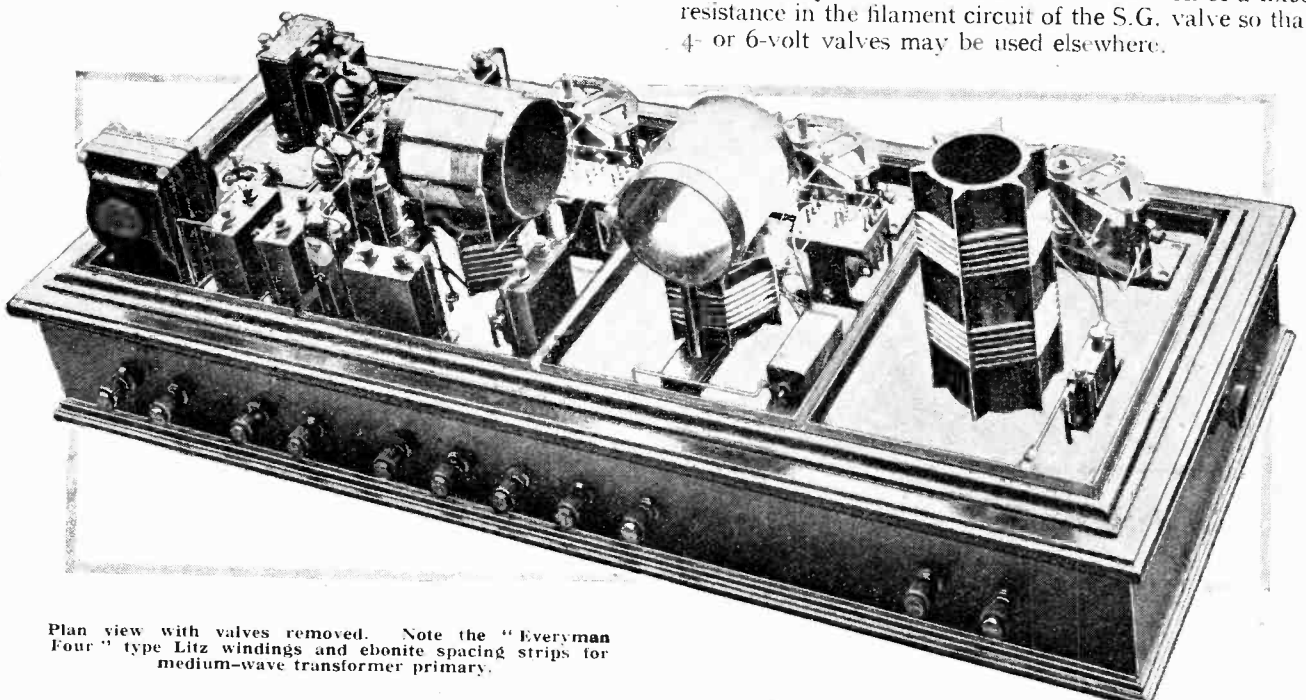
1 *Special metal container (Rigby & Woolfenden, Rochdale).*
2 *Variable condensers, 0.0003 mfd. (J. B. "Universal Log.").*
1 *Variable condenser, 0.0005 mfd. (J. B. "Universal Log.").*
3 *Special dials and escutcheon plates.*
1 *Fixed condenser, 0.0002 mfd. (Dubilier, No. 620).*
1 *Fixed condenser, 0.0003 mfd. (Dubilier, No. 620).*
1 *Fixed condenser, 0.02 mfd. mica (Dubilier, No. B. 775).*
3 *Fixed condensers, 1 mfd. (Dubilier, B.T. type).*
4 *Fixed condensers, 2 mfd. (Dubilier, B.T. type).*
1 *Fixed condenser, 1 mfd. (Dubilier, LAA type).*
3 *Valve holders (Bowyer-Lowe "White Line").*
1 *Valve holder (Aermonic "A" type).*
1 *Switch, 3 pole D.T. (Utility, Lever pattern).*
1 *Switch, 2 pole D.T. (Utility, Lever pattern).*
1 *L.F. transformer (R.I. "Hypermu").*
1 *L.F. choke (Ferranti B.1).*
1 *Special aerial coil.*
1 *Special secondary (grid) coil.*
1 *Special H.F. transformer.*
1 *Resistor holder and shorting plug (Burndept).*
2 *Wire-wound resistances, 20,000 (Varley).*
1 *Wire-wound resistance, 30,000 (Varley).*
1 *Wire-wound resistance, 250,000 (Varley).*
1 *Grid leak, 0.1 megohm (Loewe).*
1 *Porcelain holder for above (Bulgin).*
2 *Decoupling resistances, 600 ohms (Wearite).*
1 *Variable high resistance, 1 megohm (Igranic "Megostat").*
1 *Rheostat, 50 ohms (Ormond).*
1 *Potentiometer, 400 ohms (Ormond).*
1 *G.B. battery, 16½ v. (Siemens).*
1 *G.B. battery, 9 v. (Siemens).*
1 *pr. G.B. clips (Bulgin).*
1 *Cell, 0.9 v. (Siemens).*
5 *Wander plugs (Clix).*
1 *On-and-off switch (Claude Lyons, "Q.M.B." type).*
11 *Terminals, ebonite shrouded (Belling-Lee).*
11 *prs. insulated bushes, 2 B.A. (Igranic).*
*Brass strip, Sistoflex, wire, screws, etc.*

*Approximate cost, including metal cabinet,* £15.

In the "List of Parts" included in the descriptions of *THE WIRELESS WORLD* receivers are detailed the components actually used by the designer, and illustrated in the photographs of the instrument. Where the designer considers it necessary that particular components should be used in preference to others, these components are mentioned in the article itself. In all other cases the constructor can use his discretion as to the choice of components, provided they are of equal quality to those listed and that he takes into consideration in the dimensions and layout of the set any variations in the size of alternative components he may use.

paxolin former. The long-wave coil is designed in accordance with established practice, and is section-wound in a slotted 6-rib ebonite former. The damping on these coils is much less than in the original "Everyman Four," and they therefore contribute considerably more to the overall selectivity of the set.

The screen-grid H.F. valve is mounted underneath the base, out of the field of the tuning inductances, and in this position acts as a link between the two middle screening compartments of the metal container.



**Plan view with valves removed. Note the "Everyman Four" type Litz windings and ebonite spacing strips for medium-wave transformer primary.**

After careful consideration it was decided to specify a Mazda S.G.215 valve for this stage. By making this decision it is possible to specify a definite number of turns for the low-wave primary of the H.F. transformer, giving a well-balanced compromise between amplification and selectivity. It was found that the number of primary turns is somewhat critical when using a Litz-wound secondary of high efficiency, and it would be necessary to specify a different number of primary turns for every make of screen-grid valve on the market. This would involve many difficulties in the production of the coils, so that in the interest of all concerned the obvious step has been taken of recommending a single combination of valve and primary winding which has been found to give very satisfactory results. Considerable latitude is possible in the choice of valves for the remaining three stages, and provision is made for the insertion of a fixed resistance in the filament circuit of the S.G. valve so that 4- or 6-volt valves may be used elsewhere.

A by-pass condenser of low H.F. resistance for the screen-grid is essential, and accordingly a Dubilier type LAA has been specified for this position. The grid is biased by a special 0.9-volt cell, which effects a considerable improvement in the valve characteristics.

We come now to the detector stage, which occupies the third compartment from the left. The assignment

**The 1930 Everyman Four.—**

of suitable values for the components involved in this stage is perhaps the most difficult task which confronts the designer of a receiving set. It is necessary to effect a compromise between the following conflicting factors:—

(1) Detector efficiency, i.e., L.F./H.F. ratio for both large and small inputs.

(2) Grid circuit loading.

(3) High-note loss.

(4) H.F. leakage to the L.F. amplifier.

(5) Post-detector volume control, the operation of which does not affect any of the foregoing conditions.

In order to attain a high detector efficiency, the anode resistance should be large compared with the A.C. resistance of the valve under working conditions, while the by-pass condenser should have a high value to prevent reduction of the H.F. input due to grid circuit

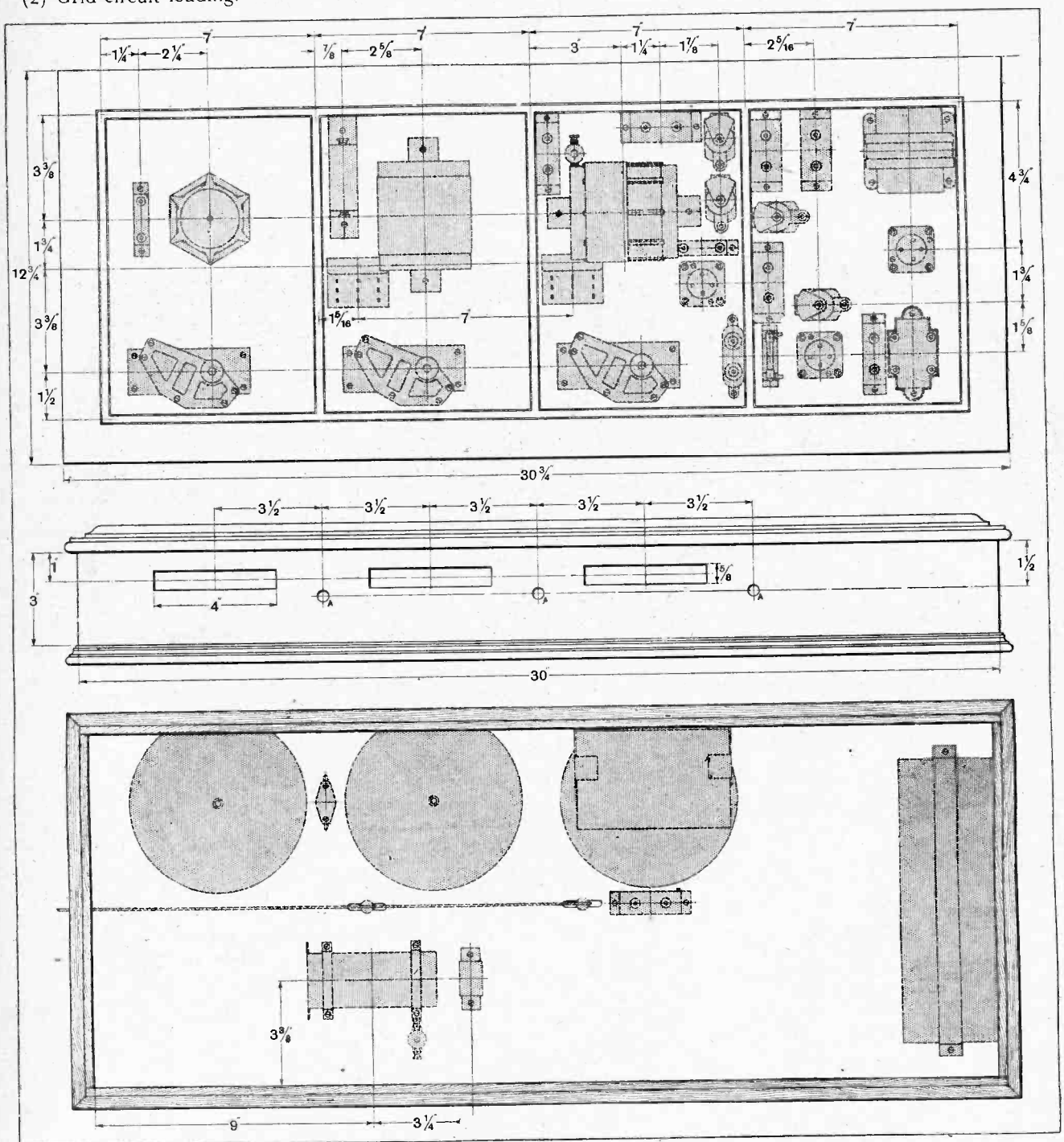



Fig. 3.—Layout of components above and below baseboard. The holes A are ⅛in. in diameter.

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**The 1930 Everyman Four.**

loading. Unfortunately, high note loss sets a limit to the capacity of the by-pass condenser, and it is necessary to steer a middle course between these two conflicting factors. There is little point in using a valve of lower A.C. resistance with a reduction in the anode circuit resistance as a much larger by-pass condenser has to be used to bring the grid current loading to the same figure, and by the time this has been done the high note loss is equivalent to the case of the high resistance valve. In general the high resistance combination is more sensitive to weak signals and has therefore been specified in the design.

### Detector Grid Bias.

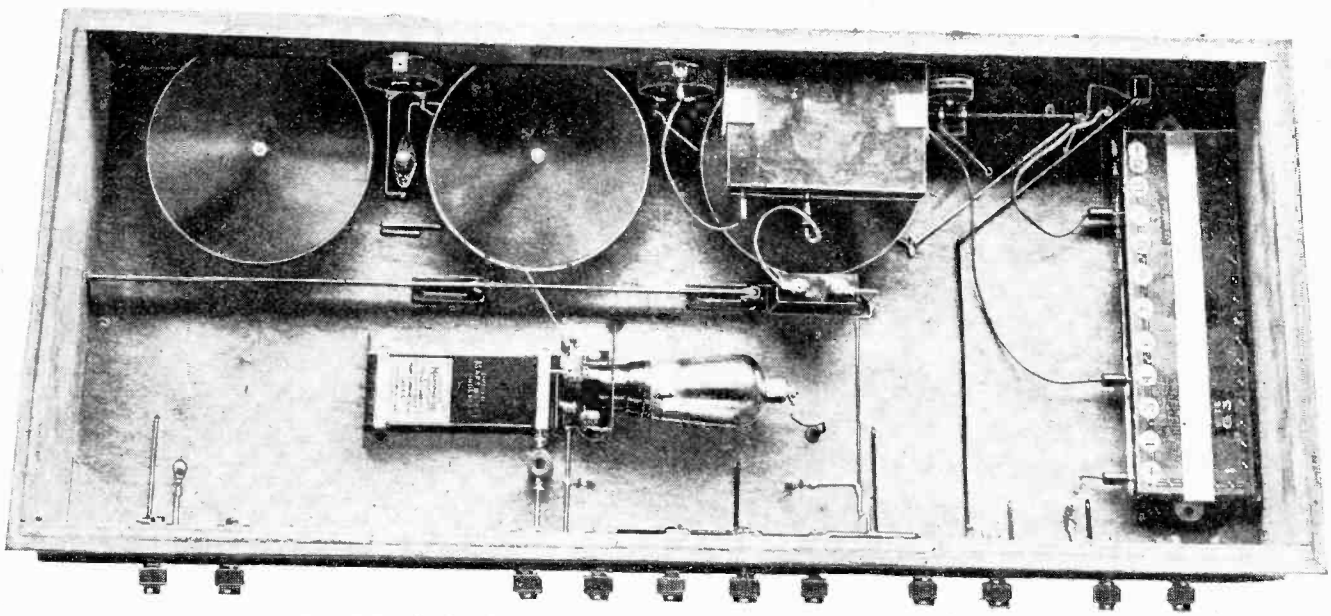
The value of the grid bias and the magnitude of the H.F. input also has some bearing on the grid circuit loading, which is reduced when the negative bias is increased. The introduction of a post-detector volume control permits this adjustment, for the H.F. input can be increased in accordance with an increased negative bias without necessarily overloading the output valve. A potentiometer has been included for critical adjustment of the grid bias.

The values specified in the diagrams are the result of actual measurements on the factors (1) to (4) set out above. An experimental detector stage with a special low-loss tuned input circuit, sensitive to grid damping, was energised by means of a modulated H.F. oscillator. The H.F. input and L.F. (and any H.F.) output could be measured simultaneously. Variations were made in the type of valve, values of anode resistance, by-pass condenser, etc., and for each new set of conditions readings were taken for the detector efficiency with 600 and 6,000 cycle modulation, and the depression of the input circuit volts due to switching on the valve. Tests were also made for H.F. in the L.F. output circuit. The results show that no drastic modification of the original design is necessary at this stage. A slight loss of high notes was permitted in the interest of conditions (1), (2) and (4) above, in view of the fact that the upper frequencies are reinforced in the succeeding stage.

An R.I. "Hypermu" transformer was chosen to couple the first L.F. amplifier to the output valve, since this component, when connected as an auto-transformer and freed from direct anode current by means of a resistance-capacity filter, shows a marked rising characteristic (*vide* N.P.L. curves).

The remainder of the circuit is self-explanatory and does not call for special comment.

The work of assembly and wiring is so greatly simplified by the special form of metal cabinet that detailed description is superfluous; all the necessary information is crystallised in the working drawings and wiring diagram.



View underneath base showing disposition of detector and L.F. grid bias batteries.

It is important that the low-frequency transformer connections should be made exactly as indicated in the wiring diagram, while if the volume control grid leak is of the logarithmic type care should be taken that the end connections are not reversed, otherwise the change in volume will be crowded to one end instead of being distributed evenly over the range of movement of the dial. In the case of the Igranic "Megostat" the red terminal should be joined to grid bias and the blue to the coupling condenser.

### Valves and H.T. Voltages

Suitable H.T. and grid bias values will depend on the valves, and should be fixed in accordance with the maker's recommendations. It has already been stated that a Mazda S.G.215 valve should be used in the first stage. A general purpose (H.L.) valve having an A.C. resistance of about 25,000 ohms and amplification factor

**The 1930 Everyman Four.—**

20 to 25 is suitable for the detector, while the first L.F. amplifier should be a type "L" valve of about 10,000 ohms resistance (amplification factor 10). The output valve may be of the "power" or "super-power" type according to the requirements of the individual.

If 2-volt valves are used throughout a shorting plug must be inserted in the fixed resistor holder $R_2$. With 4-volt valves in the last three stages a 12.5 ohm resistance will be required, and with 6-volt valves 25 ohms.

For the initial tests the following H.T. voltage will be suitable, minor alterations being made by experiment until best results are obtained: H.T.$_1$, 120 volts; H.T.$_2$, 100 volts; H.T.$_3$, 150 volts; Screen, 60 volts.

In conclusion, it can be definitely stated that the H.F. amplification is at least double that of the original "Everyman Four" employing a neutralised three-electrode valve, while tests have proved that the selectivity is more than adequate for long-distance reception under the new Regional conditions.

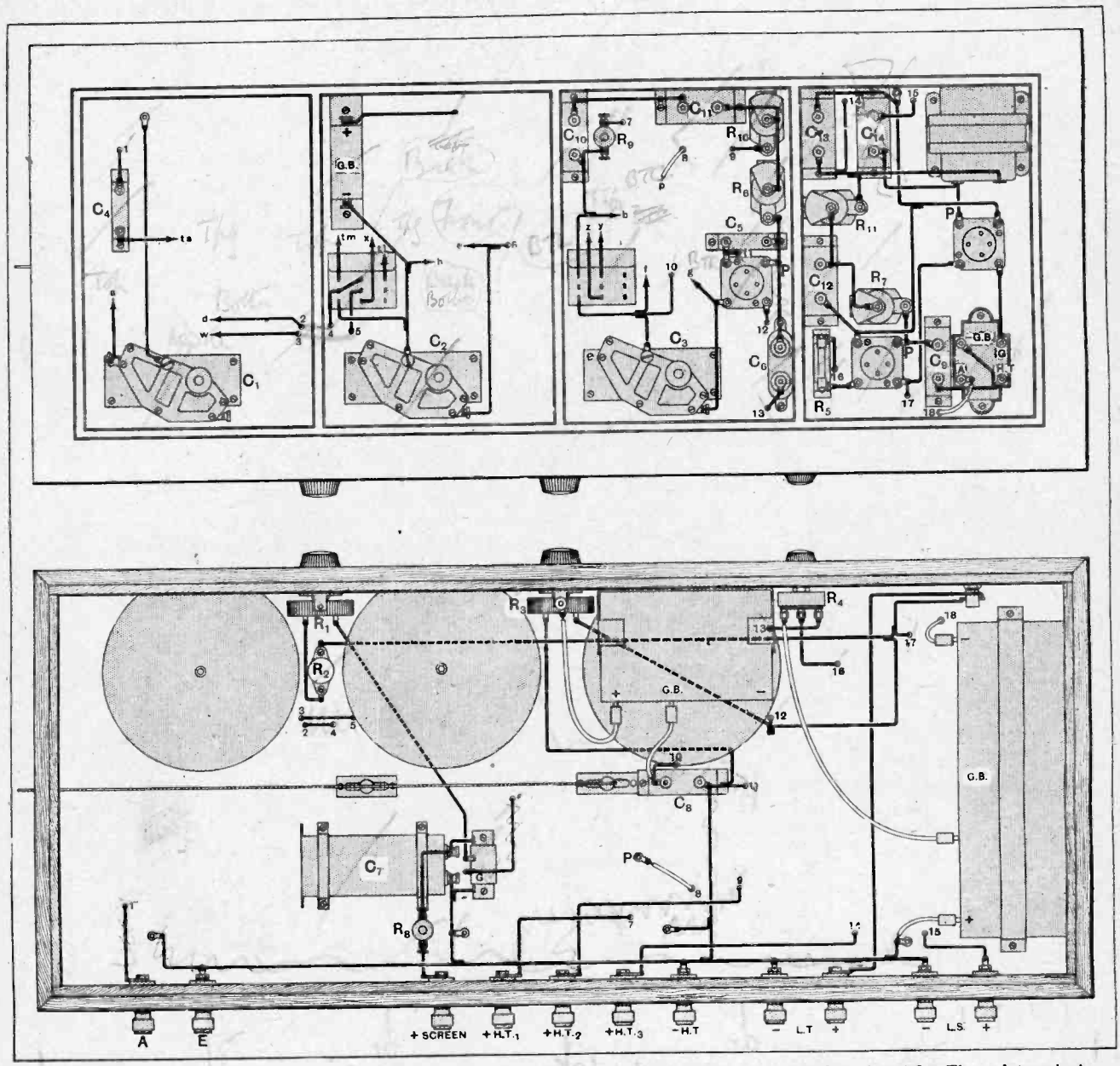


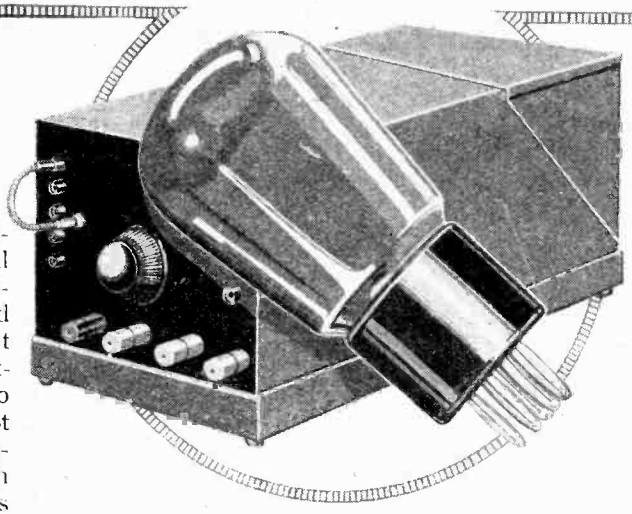

Fig. 4.—Complete wiring diagram. Connections to the coil units are lettered to correspond with Figs. 1 and 2. The red terminal of $R_4$ goes to grid bias and the blue to $C_6$.

*This receiver, together with other sets recently described in these pages, will be available for inspection on* The Wireless World *Stand (No. 34) at the Manchester Radio Exhibition.*

# A NEW HIGH-VOLTAGE PENTODE

## Public Address Volume with 250 Volts.

## Characteristics of the New PM.24A Valve.



ONE of the chief drawbacks to the original pentode valve, introduced by Messrs. Mullard just over a year ago, is that it is rated for an anode voltage not greater than 150 volts. A pentode is not usually incorporated in a receiver for the sake of its high amplification, though this is always very acceptable, but rather because it will give, without overloading, a greater output of signals than can be attained from a triode operated at the same anode voltage. In view of this fact it has always been rather annoying to find that the makers have hitherto restricted us to a maximum of 150 volts on the anode, especially as 200 volts or over is directly available from most D.C. mains, and from many eliminators used on A.C. supply. As there are several triodes on the market capable of standing up to these slightly higher voltages, the restriction has, in the past, seriously curtailed the usefulness of the pentode, for one of these triodes, operated at full voltage, would provide nearly as great an output as the pentode at its maximum rating.

The new Mullard PM.24A is a much more tempting proposition from the point of view of the designer of a set for mains operation. It is rated to withstand up to 300 volts on the plate, with a maximum of 200 volts on the screening-grid. It may, therefore, be put straight into an all-mains receiver and be allowed to operate on the full voltage available from the mains.

In appearance, there is no difference between the new valve and the familiar PM.24, its low-voltage prototype. It is available, however, with the five-pin base recently adopted for indirectly heated mains valves, the screening-grid being, in this case, brought out to the centre pin which is used, in an indirectly heated triode, for the cathode connection.

The makers give the following data for the valve:—

| | | |
|---|---|---|
| Filament Voltage | ... | 4.0 |
| Filament Current | ... | 0.275 amp. |
| A.C. resistance | ... | 53,000 ohms. |
| Amplification Factor | ... | 83 |
| Mutual Conductance | ... | 1.56 milliamps. per volt. |

The conditions in which the figures for A.C. resistance and amplification factor are obtained are not stated; the standard conditions for a triode are anode volts 100, grid volts zero.

### Operating Data.

Since there would be no point in choosing this valve, rather than its less robust brother, the PM.24, unless the use of a voltage higher than 150 were contemplated, the curves for this valve were all taken with the permitted maximum of 200 volts on the screening-grid. With this voltage applied to both screening-grid and anode, the anode currents corresponding to various grid voltages were measured, and are plotted in Fig. 1. The slope of the curve in the neighbourhood of 20 to 25 milliamps., which represents normal operating conditions, is 1.85 milliamps. per volt. It will be seen that this is a little higher than the figure of 1.56 quoted by the makers, and indicates that the valve is conservatively rated. Another curve was also taken, with the same voltage on the screening-grid, but with 300 volts on the plate. At all points this second curve shows about 3 per cent. greater anode current than that of Fig. 1; it is not reproduced on the diagram because the closeness of the two curves would make both difficult to read, while if we allow for permissible variations from valve to valve, that shown may be taken as valid for any anode voltage between 200 and 300. Thus, as might be expected, the screening grid voltage exerts more influence on the anode current than the anode voltage.

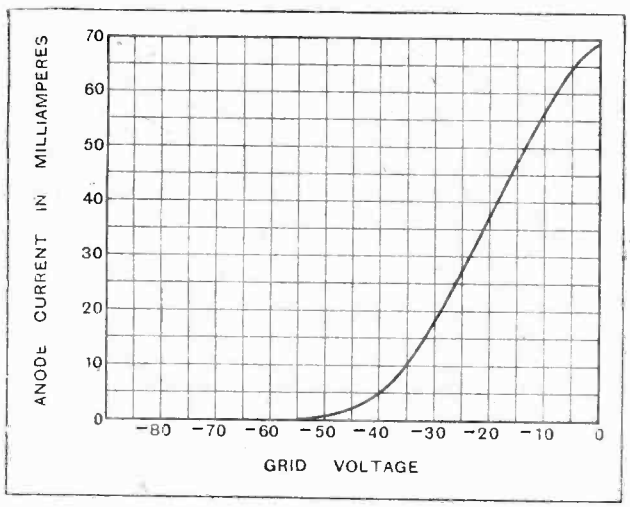



**Fig. 1.—Characteristic of the PM.24A with anode and screen voltages of 200. The curve is little changed by substituting anode voltages from 150 to 300.**

**A New High-voltage Pentode.—**

The operating instructions given with the valve include the following table:—

| | | | | | | |
|---|---|---|---|---|---|---|
| Anode Volts | 100 | 150 | 200 | 250 | 300 | |
| Grid Bias Volts | 9 | 15 | 21 | 27 | 33 | |
| Anode Current | 8 | 11 | 15 | 19 | 23 | milliamps. |

There is also a statement that the screening-grid voltage must not exceed 200 volts, otherwise the emission will be excessive and the valve may be damaged.

**Enormous Power Output.**

Thus, we did not venture to increase the auxiliary grid voltage above 200, but kept it at this value while measuring the anode current at a series of anode voltages. The three curves obtained are given in Fig. 2, the grid voltages adopted being those suggested in the last three columns of the table reproduced above from the makers' instructions. The middle curve of the three, corresponding to a grid bias of 27 volts, would appear to represent the normal working conditions, for the standing anode current at 200 to 300 volts is some 23 milliamps., the highest mentioned in the table. The slope of this curve shows that the valve, under working conditions, has an A.C. resistance of about 60,000 ohms, from which, knowing the mutual conductance, we deduce an amplification factor of 110. Both these figures are rather on the high side, but that is a matter of very little importance with a pentode. If a lower impedance together

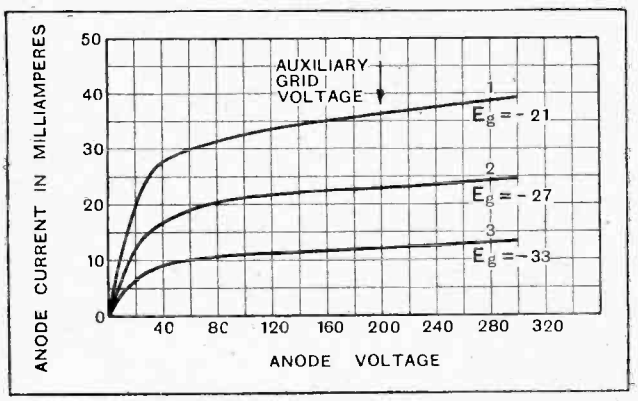



**Fig. 2.—Anode voltage-anode current curves when the screen-grid voltage is 200 and the control grid is biased as shown. In curve 1, $R_0$ is 27,000 ohms and $\mu = 54$; in curve 2, $R_0 = 60,000$ ohms and $\mu = 110$; in curve 3, $R_0 = 80,000$ ohms and $\mu = 130$.**

with a lower amplification factor is desired, it can be had by choosing the lower value of grid bias that corresponds to the uppermost of the three curves, and which is the actual grid bias suggested in the maker's table of data. The anode current rises then to nearly 40 milliamps., while A.C. resistance and amplification factor become about 27,000 ohms and 50 respectively. Neither the available output nor the amplification yielded by the valve are greatly varied by this change; to the ear, the most significant difference is an increase of bass notes with the lower grid-bias voltage.

The maximum power that can be taken from the pentode is not easy to specify exactly, since it depends to a very great extent on the impedance connected in the anode circuit. If we assume this to be a non-inductive resistance of 10,000 ohms, the audio-frequency power that the PM.24A will deliver to it before overloading commences is in the neighbourhood of 2 to 3 watts. Using a moving-coil of 2,600 turns, fifty to sixty ampere-turns are available to move the coil and the cone attached to it. These figures compare well with the output to be had from a valve of the LS5A variety on its maximum rated voltage of 400.

As a final test, the valve was given a practical trial in a receiver. Using a moving-coil speaker fitted with a special "pentode coil" of 2,500 turns, the volume available before overloading began was found to be greater than could be tolerated in any but a very large room. With the lower plate-current (23 milliamps.) corresponding to a high valve impedance it was noticed that the treble was unduly pronounced; this was easily rectified by connecting the loud speaker to a tapping on the choke, as in Fig. 3. No volume appeared to be lost by so doing.

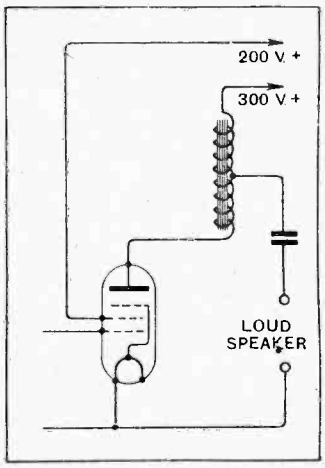
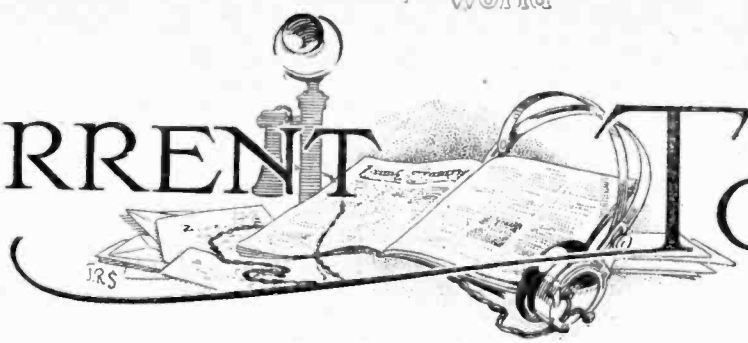



**Fig. 3.—The use of a tapped output choke was found to improve quality.**

Used with a moving armature speaker, overloading occurred at a much smaller signal strength than with the moving coil, as might be expected from the higher impedance and lower sensitivity of this loud speaker. Nevertheless, quite satisfactory volume was to be had, though the introduction of a 2:1 step-down transformer with a resistance of 20,000 ohms connected across its primary resulted in better quality, with less accentuation of the higher frequencies. These practical tests suggest that the pentode, even more than the triode, is best served with a moving-coil speaker.

We understand that the PM.24A is being fitted to all-mains receivers, in which the filament is heated by alternating current. We ourselves have tried this, and find that no noticeable hum is introduced provided that the usual precautions are taken. Pending the arrival of a pentode specially designed for A.C. mains, the present model may be used with complete satisfaction in A.C. sets, while its extreme suitability for use on D.C. mains, where the high voltages normally associated with an output stage of "public address" dimensions cannot be attained, is very evident indeed.

# CURRENT TOPICS



## Events of the Week in Brief Review.

### WHY NOT IN BRITISH TRAINS?

The news that express trains between Paris and Havre are to be equipped with wireless receivers serves to emphasise the lethargy of the British railway companies in regard to the possibilities of broadcast reception on long-distance runs.

### ANXIETY IN GLASGOW.

Known as "The Terror," the Post Office detector van is now touring the Glasgow district in search of oscillators and "pirates." The equipment in the van includes a screen-grid four-valve set with a frame aerial. The receiver covers a wave range from 15 to 2,000 metres.

### THE POPE'S WIRELESS STATION.

It is announced in the Vatican City that the Italian Government has decided to contribute half a million lira towards the expense of erecting the Papal wireless station now under construction. The apparatus is being built by the Marconi Company. The two masts, each nearly 250ft. high, are being made in Italy.

### WHEN IS A WAVE SHORT?

Many arguments will be settled (or started!) by the news that the International Consultative Committee of the Radio-Electrical Conference now in session at the Hague has decided to classify wavelengths as follows:—

Long, 3,000 and upwards.
Medium, 200 to 3,000.
Intermediate, 50 to 200.
Short, 10 to 50.
Ultra-short, below 10.

### PHYSICAL AND OPTICAL SOCIETIES' EXHIBITION.

The Twentieth Annual Exhibition of Electrical, Optical and other Physical Apparatus is to be held by the Physical Society and the Optical Society on January 7th, 8th and 9th, 1930, at the Imperial College of Science and Technology, South Kensington.

### WIRELESS ON TAP AT SING SING.

The many attractions of Sing Sing prison have been added to by the inclusion of a wireless phone "point" in each of the 800 cells in the new block, says a New York message. It is stated that a prison official chooses what programme shall be relayed to the cells, this precaution being necessary to obviate the possibility of prisoners' friends talking to them *via* a night club microphone!

### ALL ROADS LEAD TO MANCHESTER.

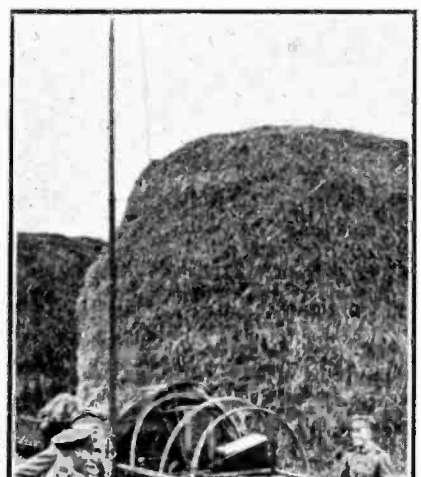
To-day (Wednesday) sees the opening of the Manchester Wireless Exhibition at the City Hall. A guide to the show appears on page 437.

### "TALKIES" FOR THE DEAF.

The Paramount "Talkie" Theatre at Brooklyn, New York, has fitted up a portion of the auditorium with amplifiers and an extensive net of headphones for the use of deaf members of the audience. In order to cope with degrees of deafness, the headphones are equipped with a potentiometer to control the volume of sound according to individual requirements.

### IS YOUR MAST SAFE?

A correspondent in *The Times* has drawn attention to the possibility that many wireless poles erected four or five years ago may now have reached a dangerous condition due to rot at the "wind and water" line, viz., 6in. above and 6in. below ground. *Verb. sap.*



**GERMAN FIELD WIRELESS. A photograph taken during the recent Autumn Manœuvres of the German Army. The portable mast is about 20ft. in height.**

### POLICING THE U.S. ETHER.

The largest radio frequency measuring station in the world is to be opened next December at Grand Island (Nebraska), U.S.A. It is to be used for checking the wavelengths of all United States transmitters. Roughly, six hundred broadcasters, two thousand ship installations, sixteen thousand amateurs, as well as aerodrome, naval and military stations are expected to avail themselves of this service.

### WIRELESS FOR EVERY BLIND PERSON.

The National Institute for the Blind which has just published its sixtieth annual report, has a special Technical Research Committee devoting attention to the upkeep of sets owned by blind listeners. It is hoped that schemes will eventually be evolved which will bring wireless to every blind person in the country.

### NOISY LOUD SPEAKERS.

The Health Committee of the Hull Corporation has requested the Town Clerk to draft a bylaw to stop noise arising from loud speakers which are operated in a manner to cause annoyance.

Simultaneously we learn that an organisation of apartment house owners in Brooklyn, N.Y., have decided to incorporate in leases to new tenants a clause prohibiting the operation of loud speakers after 10.30 p.m.

### PAPER CONDENSER PATENT.

The paper condenser is to be the subject of litigation in America, according to a New York correspondent, who states that the Dubilier Condenser Corporation has brought an action for infringement of patent rights against the Aerovox Manufacturing Corporation in respect of U.S. Patent 1,688,478, which relates to the manufacture of paper condensers.

Large sums of money may be involved, as it is estimated that the cost of such condensers used in radio sets and amplifiers amounts to more than twenty million dollars annually. Many important companies in America and Europe have taken licences on a royalty basis.

# Selectivity in Plain Terms

## A New Unit and its Applications to Practical Circuits.

By R. T. BEATTY, M.A., B.E., D.Sc.

THE opening of the Brookmans Park Station with a power consumption of 30 kilowatts, ten times as great as that of the old 2LO, is bringing to the fore among listeners in the London area the subject of selectivity in receiving sets and the growth of the regional scheme will ultimately compel interest in this topic to extend over the whole country. For, with the realisation of the regional scheme, the local station will become dominant over a wide sector of the tuning dial, and its elimination in favour of distant stations can only be effected by an increase in selectivity.

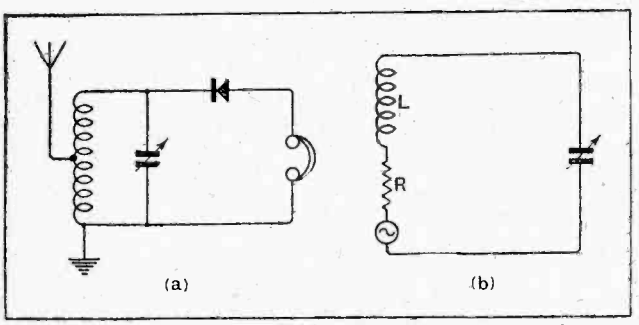



**Fig. 1—Simple crystal set and equivalent H.F. circuit.**

The discussion of selectivity has been hampered in the past by the lack of an exact definition of the term—a definition, in fact, which will allow us to express the selectivity of a set as a numerical quantity from which we can infer its performance both as regards quality of reproduction and power of separating stations of contiguous wavelengths.

This performance can, it is true, be inferred from the resonance curve of the high-frequency stage or stages of the set, assuming that the low-frequency stage is of sufficiently good quality to cause no serious distortion. But we must admit that the formula which gives the resonance curve is a formidable one, and that even when this formula is mastered the numerical work involved in plotting the curve is laborious.

In this article a proposal will be made to express the selectivity of any set as a numerical quantity, and it will be shown that when this number is known it is but a moment's work to draw the H.F. resonance curve.

### Resonance Curves.

A set consisting essentially of a single tuned circuit such as the crystal set shown in Fig. 1 (*a*) is equivalent from the H.F. point of view to the circuit of Fig. 1 (*b*) in which the resistive loads due to the aerial, the crystal and the phones are incorporated as an equivalent series resistance R.

Fig. 2 shows the resonance curve of this circuit: its shape depends solely on the ratio of the reactance of the coil to the series resistance (Fig. 1 (*b*)). This ratio is called the coil magnification. If it is large the curve is steep: if small, the curve is flat.

All these differently shaped curves can, however, be reduced to a single curve by the simple device of plotting them on logarithmic paper. In Fig. 3 the curve corresponding to a single tuned circuit is the same as that of Fig. 2; if now the value of the coil magnification *m* be changed, the shape of this curve is unaltered; it is merely shifted bodily in a horizontal direction (to the right if *m* be decreased, to the left if *m* be increased).

Accordingly, if we copy the curve on a piece of tracing paper and slide the paper horizontally by the requisite amount in any particular case we can obtain immediately the resonance curve for *any* single tuned circuit.

### The Selectivity Number.

In order to decide where to put the tracing paper we must fix on some reference point on the resonance

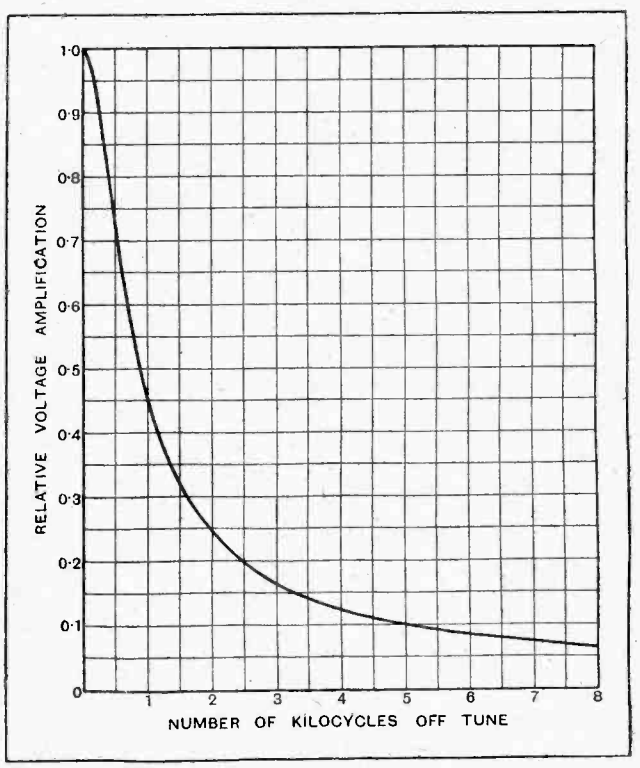



**Fig. 2—Typical resonance curve for the single tuned circuit of Fig. 1.**

**Selectivity in Plain Terms.**—curve; this point we will take to be the intersection of the curve with the cross-hatched horizontal line in Fig. 3, that is, the number of kilocycles by which the circuit must be detuned in order that the ordinate of the curve may fall to 0.1 of its value at resonance. In Fig. 3 this value is 5 kilocycles for all the curves.

The position of this reference point can be found by giving to the single tuned circuit in question a number, called the selectivity number (and this proposal is the kernel of the present article), so chosen that the following statement is true.

*The number of kilocycles by which a single tuned circuit must be detuned to cause the ordinate of the resonance curve to fall to* 0.1 *of its value at resonance is obtained by dividing the frequency of the carrier wave in kilocycles by the selectivity number.*

Thus, if the frequency of the incoming signal is 1,000 kc., and the selectivity number is 200, the resonance curve will cut the cross-hatched line in Fig. 3 at 1,000/200 = 5 kc.: this is the position actually shown.

It has already been stated that the position of this intersection depends only on the coil magnification $m$, so that the selectivity number must depend on $m$.

Actually the relation is very simple: it is shown in the Appendix that for a single tuned circuit the selectivity number is $0.2 \times m$: the example quoted above would consequently refer to a coil with $m = 1{,}000$, which is, of course, much larger than would obtain in a crystal set, where we may expect $m$ to be about 10, and the selectivity number consequently to be $0.2 \times 10 = 2$, so that with a carrier wave of 1,000 kc., the intersection[1] lies at 1,000/2 = 500 kc.

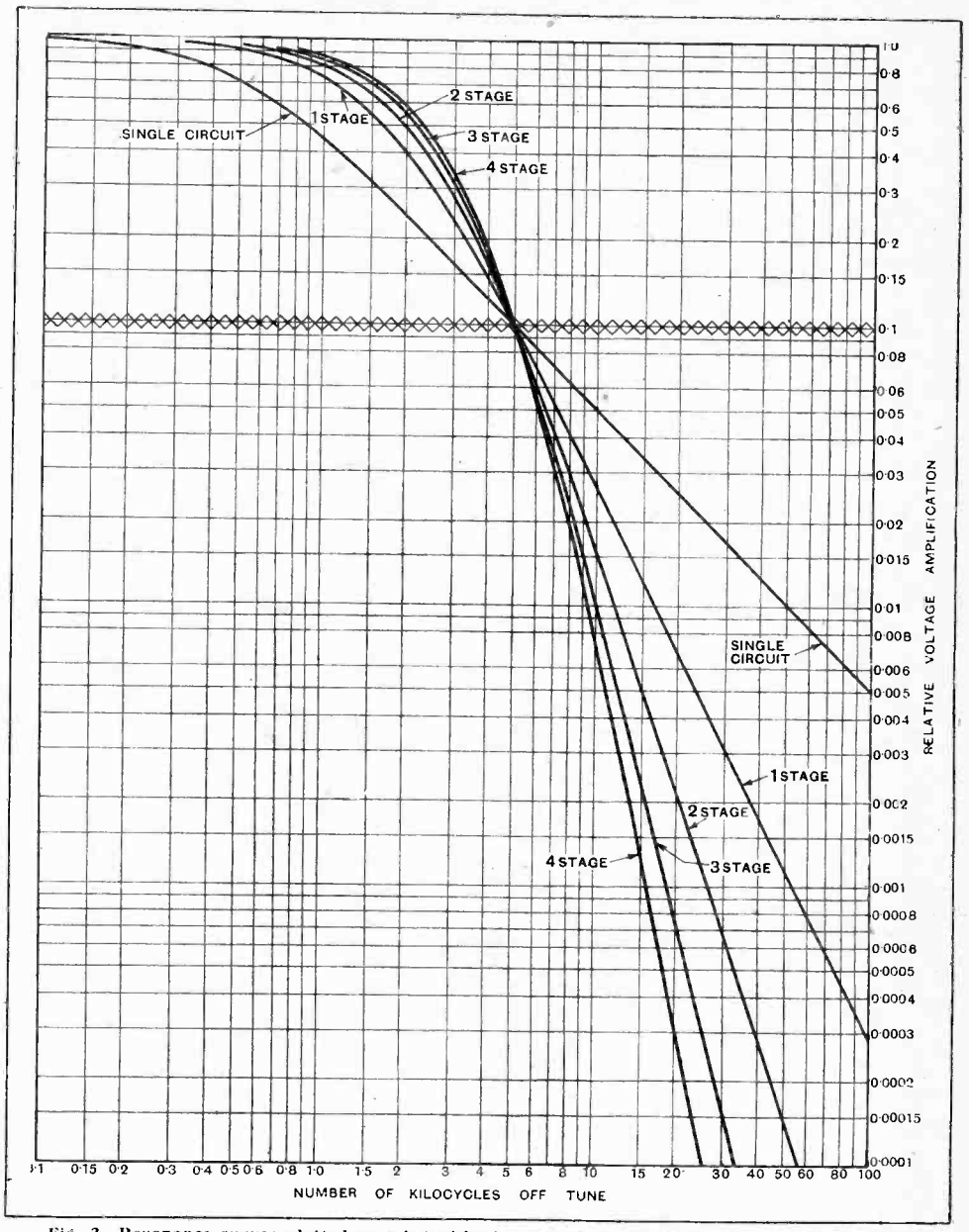



**Fig. 3—Resonance curves plotted on a logarithmic scale. The shape of each curve is unaffected by changes in the value of the coil magnification, which only varies its position on a horizontal axis.**

### Single-stage H.F. Amplifier.

The single-valve H.F. amplifier shown in Fig. 4 (*a*) with tuned grid and plate circuits is equivalent to the scheme in Fig. 4 (*b*) where the equivalent grid circuit contains a series resistance $R_1$, including the aerial load, and the equivalent plate circuit contains a resistance $R_2$, including the load due to the valve resistance.

The resonance curve depends only on the coil magnifications of these two equivalent circuits, i.e., $m_1 = 2\pi L_1 f/R_1$ and $m_2 = 2\pi L_2 f/R_2$, and, to a high degree of approximation, it depends only on the product $m_1 m_2$, provided that $m_1$ does not exceed twice $m_2$, or vice versa.

[1] It should be noted that the resonance curves of Fig. 3 are reliable only up to an amount of detuning not exceeding 10% of the carrier frequency, and so in the example above, although the intersection can be displaced to 500 kc., the useful part of the displaced curve only extends to 100 kc.

**Selectivity in Plain Terms.—**

Thus if we draw the resonance curve for an amplifier whose equivalent grid and plate circuits have $m_1 = m_2 = 100$, then a different amplifier with $m_1 = 71$, $m_2 = 140$, will give practically the same resonance curve, since in both cases $m_1 m_2 = 10{,}000$.

The resonance curve for one stage is given in Fig. 3 and, as in the case of a single circuit, its shape is invariable: it slides right or left as the product $m_1 m_2$ changes.

The selectivity number is $0.2 \times 3.33 \times \sqrt{m_1 m_2}$ as proved in the appendix: thus if the coil magnifications are 225 and 400, the selectivity number is 200, and with a carrier wave of 1,000 kc. the resonance curve cuts the cross-hatched line at $1{,}000/200 = 5$ kc., as it actually does in Fig. 3.

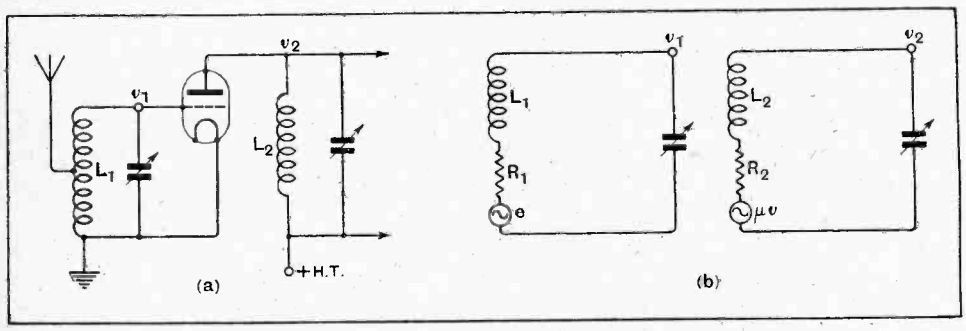



Fig. 4—Single-stage H.F. amplifier and equivalent H.F. circuits.

**Multi-stage H.F. Amplifier.**

Similar reasoning can be applied to H.F. amplifiers with more than one stage, and the results are given in the following table.

| | Selectivity Number. |
|---|---|
| Crystal Circuit .. .. | $0.2 \times 1 \times m$ |
| 1 stage H.F. .. .. | $0.2 \times 3.33 \times [m_1 m_2]^{\frac{1}{2}}$ |
| 2 stages H.F. .. .. | $0.2 \times 5.24 \times [m_1 m_2 m_3]^{\frac{1}{3}}$ |
| 3 stages H.F. .. .. | $0.2 \times 6.80 \times [m_1 m_2 m_3 m_4]^{\frac{1}{4}}$ |
| 4 stages H.F. .. .. | $0.2 \times 8.13 \times [m_1 m_2 m_3 m_4 m_5]^{\frac{1}{5}}$ |

In this table a column of figures occurs which can be replaced by the consecutive odd numbers, 1, 3, 5, 7, 9, with an error not exceeding 11 per cent., and this circumstance allows us to formulate a simple rule for calculating the selectivity number.

*Add the number of H.F. valves to the number of H.F. tuned circuits and multiply this sum by 0.2 times the geometric mean product of the coil magnifications. The result is the selectivity number.*

This statement, in conjunction with the preceding italicised statement, may be taken as a summary of this article.

**Uses of the Selectivity Number.**

Let us take as an example a set with two H.F. screen valves, followed by an anode bend detector, an outside aerial being used. If the tuning coils are wound with solid wire on 2½in. formers and squeezed rather tightly into the screening boxes, the coil magnifications of the equivalent tuned circuits will be about 50 for the aerial circuit, and 100 for each of the tuned anode circuits.

The geometric mean product of these figures is $[50 \times 100 \times 100]^{\frac{1}{3}} = 100[0.5 \times 1 \times 1]^{\frac{1}{3}} = 80$ (approx.).

Hence the selectivity number is $5 \times 0.2 \times 80 = 80$.

When the set is tuned to a 1,600 kc. station the two-stage resonance curve in Fig. 3 must be displaced sideways till it intersects the cross-hatched line at $1{,}600/80 = 20$ kc.

What about the quality of reproduction of this set? Inspection of the displaced curve shows that the relative voltage amplification at 10 kc. is 0.37, and 0.72 at 5 kc. Evidently the sidebands come through quite well, and the quality should be excellent.

Again if two stations 20 kc. apart are of equal strength at the receiver, one of them can be reduced to 0.1 of the strength of the other at the grid of the detector valve. This reduction is just sufficient to swamp the unwanted station.

If the stations are 47 kc. apart, one of them can be cut down to 0.01: hence even if it were originally ten times as strong as the other it can be swamped.

The same set made up with stranded wire coils in roomy screening boxes and provided with a frame aerial might have the coil magnifications somewhere about the values $m_1 = 250$, $m_2 = 200$, $m_3 = 200$. The geometric mean of these is $200[1.25 \times 1 \times 1]^{\frac{1}{3}} = 216$.

Hence the selectivity number is $5 \times 0.2 \times 216 = 216$, and when the set is tuned to a 1,080 kc. station the intersection occurs at $1{,}080/216 = 5$ kc. This is the position of the two-stage curve in Fig. 3.

The sidebands in this case are cut down drastically, and the reproduction is barely tolerable: the separation of stations, however, is good. If two stations are 56 kc. apart, one of them can be cut down to 0.0001 relative to the other, so that even if it were 1,000 times as strong as the other at the receiver it could be cut out.

Since the curves in Fig. 3 have a common point of intersection they refer to sets which have the same selectivity number, namely, (station kc.)/5, which may be taken as the limit of tolerable reproduction.

Tolerable reproduction is given by (station kc.)/10, and good reproduction by (station kc.)/20.

It should be possible for manufacturers to guarantee the selectivity numbers of their sets, and it is quite possible for amateurs to calculate the selectivity number before a set is constructed. All that is required is the coil magnification, i.e., the ratio of coil reactance to coil resistance, of each coil which forms part of a tuned circuit, taking into account the loading due to the aerial in the case of the first coil and that due to the preceding valve in the case of each subsequent coil.

These data are well known, and only require setting out in tabular form to be immediately useful to readers.

**Selectivity in Plain Terms.—**

One striking result follows from Fig. 3. Among a number of sets having equal selectivity numbers, and therefore intersecting the cross-hatched line at the same point, the set having the greatest number of tuned circuits gives the best reproduction and gives the sharpest separation of adjacent stations.

*Several poor coils give better results than a few good ones.* It may be that the realisation of high selectivity combined with good quality is to be found in the employment of a large number of H.F. stages with interstage H.F. transformers with a high step-up ratio to ensure stability.

### Appendix.

The height of the resonance curve (Fig. 2) corresponding to a single tuned circuit (Fig. 1) is given by the expression

$$1/[1+4m^2.\delta f^2/f^2]^{\frac{1}{2}},$$

where $m$ = coil magnification,

$\delta f$ = number of kilocycles off tune,

$f$ = frequency of carrier wave in kilocycles.

This expression is equal to 0.1 when $m.\delta f/f = 5$.

Hence at this point on the curve $f/\delta f = 0.2 \times m$, and this is defined as the selectivity number.

For two tuned circuits (single-stage H.F. amplifier) the expression is

$$1/[1+4m_1^2.\delta f^2/f^2]^{\frac{1}{2}}[1+4m_2^2.\delta f^2/f^2]^{\frac{1}{2}}$$

where $m_1$ $m_2$ are the coil magnifications.

This expression is equal to 0.1 when $[m_1 m_2]^{\frac{1}{2}}.\delta f/f = 1.5$ to within a few per cent., provided that neither $m$ is more than double the other.

Hence the selectivity number $= f/\delta f = 0.2 \times 3.33 \times [m_1 m_2]^{\frac{1}{2}}$.

Similar results can be worked out for multi-stage H.F. amplifiers, and the results are given in the preceding table.

# MANCHESTER RADIO SHOW

## Guide to the Stands.

THE Home Secretary, the Rt. Hon. J. H. Clynes, will to-day open the sixth Manchester Wireless Exhibition, to be held in the City Hall under the auspices of the *Manchester Evening Chronicle*. Unlike its immediate forerunner at Olympia, the Manchester Show is not limited to manufacturers of any particular trade organisation, with the result that the City Hall contains many exhibits which were not shown in London, including apparatus of foreign manufacture. There will be altogether about 170 exhibitors, an increase of forty over last year, and this has necessitated some important structural additions which provide an additional 2,000 square feet of floor space.

As in previous years, visitors will be able to hear various types of loud speakers working from a common amplifier constructed by Messrs. Ferranti, Ltd. An innovation this year is the provision of a number of soundproof cubicles to enable manufacturers to demonstrate their products without interruption.

Of special interest to amateur constructors will be the public tests of home-made apparatus entered for set building competitions.

The Exhibition will remain open until Saturday, October 26th.

ADLEY RADIO, LTD., (91)
99, Mortimer St., London, W.1.

Æonic Radio, Ltd., (87)
90, Regent St., London, W.1.

Atalanta, (122G.)
1-3, Brixton Rd., London, S.W.9.

BAKER'S "SELHURST" RADIO, (111G.)
89, Selhurst Rd., South Norwood, London, S.E.25.

Beardsall & Co., Ltd., W. E., (2)
3-5, Victoria Bridge, Manchester.

Belling & Lee, Ltd., (7)
Queensway Works, Ponders End, Middlesex.

British Ebonite Co., Ltd., (15)
Nightingale Rd., Hanwell, London, W.7.

Brown Bros., Ltd., (56)
265, Deansgate, Manchester.

Brown, Ltd., S. G., (40)
Western Avenue, North Acton, London, W.3.

Brownie Wireless Co. of Great Britain, Ltd., (38)
Nelson St. Works, Mornington Crescent, London, N.W.1.

Burndept Wireless (1928), Ltd., (17)
Eastnor House, Blackheath, London, S.E.3.

Bush House Radio, (90)
23, Corporation St., Manchester.
35, Shudehill, Manchester.
40, Deansgate, Manchester.

CELESTION, LTD., (42)
London Road, Kingston-on-Thames.

Chloride Electrical Storage Co., Ltd. (Exide), (29)
Clifton Junction, nr. Manchester.

Clarke & Co. (M/c), Ltd., H., (41)
Atlas Works, Old Trafford, Manchester.

Climax Radio Electric, Ltd., (20)
Haverstock Works, Parkhill Rd., Hampstead, London, N.W.3.

Cole, Ltd., E. K., (25)
Ekco Works, London Rd., Leigh-on-Sea.

Continuous Gramophones, Ltd., (72)
Continuous Works, Hoe St., Walthamstow, London, E.17.

Corunto Cabinet Co., (60)
122, Leaf St., Stretford Rd., Manchester.

Cossor, Ltd., A. C., (76 & 77)
Cossor House, Highbury Grove, London, N.5.

Crossley & Son, Ltd., Geo., (89)
4, South St., Manchester.

DUBILIER CONDENSER CO. (1925), LTD., (53)
Ducon Works, Victoria Rd., North Acton, London, W.3.

Dulcetto Polyphon, Ltd., (92)
2-3, Newman St., London, W.1.

Dunderdale, Frank (Incorporating Wellworth Wireless Electrical Co.), (65)
8, Withy Grove, Manchester.

Dunhams, Ltd., (128)
Elm Works, Elm Park, Brixton Hill, London, S.W.2.

EASTICK & SONS, J. J., (101)
Eclex House, 118, Bunhill Row, London, E.C.1.

Edison Swan Electric Co., Ltd. (27 & 28)
123-125, Queen Victoria St., London, E.C.4 (Metro-Vick Supplies, Ltd., Trafford Park, Manchester, and British Thomson-Houston Co., Ltd., Rugby.) Manchester office: King's House, King's St. West.

Empire Electric Co., (129)
10, Fitzroy Sq., London, W.1.

Epoch Radio Manufacturing Co., Ltd., (103)
3, Farringdon Av., London, E.C.4.

Ever Ready Co. (Gt. Britain), Ltd., (18)
Hercules Place, Holloway, London, N.7.

**Manchester Radio Show.—**

"Experimental Wireless," Iliffe & Sons Ltd., (34)
Dorset House, Tudor St., London, E.C.4.

FERRANTI, LTD., (52, 53 & 115)
Hollinwood, Lancs.

Fiddian, Bawtree & Co., (124)
Gem Works, Oakhill Rd., Sutton, Surrey.

Fonteyn & Co., Ltd., (130)
2, 4, 5, 6, Blandford Mews, Baker St., London, W.1.

Formo Co. (Arthur Preen & Co., Ltd.), (23)
Crown Works, Cricklewood Lane, London, N.W.2.

Fuller Accumulator Co. (1926), Ltd., (98)
Woodland Works, Chadwell Heath, Essex.

GARNETT, WHITELEY & CO., LTD., (31)
Broadgreen Rd., Liverpool.

The General Electric Co., Ltd., (48)
Magnet House, Victoria Bridge, Manchester.

Gilman, J. S., (113)
63, Basinghall St., London, E.C.2.

Goodmans, (84)
27, Farringdon St., London, E.C.4.

Graham-Amplion, Ltd., (32)
Slough, Bucks. Sales Offices: 25-26, Savile Row, London, W.1.

Gramo-Radio, Ltd., (93)
Commercial Works, Church, Accrington.

HALCYON WIRELESS CO., LTD., (26)
313, Regent St., London, W.1.

Hardman & Co., Ltd., (49)
The Baum, Rochdale.

Harlie Bros., (114)
Balham Rd., Lower Edmonton, London, N.9.

Hart Bros. Electrical Manufacturing Co., Ltd., (64)
4, Queensway, Ponders End, Mddx.

Haw & Co., Ltd., (106)
20, Cheapside, London, E.C.2.

Hollingdrake & Son, Ltd., Henry, (59)
65, Princes St., Stockport.

Holzman, Louis, (57)
37, Newman St., London, W.1.

Houghton-Butcher (Gt. Britain), Ltd., (82)
Manchester Depot: 170, Deansgate, Manchester. Head Office: 88-89, High Holborn, London, W.C.1.

IGRANIC ELECTRIC CO., LTD., (50)
147, Queen Victoria St., London, E.C.4.

Impex Electrical, Ltd., (107)
538, High Rd., Leytonstone, London, E.11.

JUNIT MANUFACTURING CO., LTD., (70)
2, Ravenscourt Sq., London, W.6.

KALISKY (ALDGATE), LTD., S., (68)
75, Aldgate High St., London, E.1.

Kolster-Brandes, Ltd., (74)
Cray Works, Sidcup, Kent.

LECTRO-LINX, LTD., (112)
254, Vauxhall Bridge Rd., Westminster, London, S.W.1.

Lissen, Ltd., (13 & 13A)
Lissenium Works, Friars Lane, Richmond, Surrey, and at Worple Rd., Isleworth, Middlesex.

London Radio Mfg. Co., Ltd., (6)
Trafalgar Works, Station Road, Merton Abbey, London, S.W.19.

Lyons, Ltd., Claude, (95)
76, Old Hall St., Liverpool.

M.P.A. WIRELESS, LTD., (21 & 22)
High Rd., Chiswick, London, W.4. Showrooms: 62, Conduit St., London, W.1.

Marconiphone Co., Ltd., (39)
210-212, Tottenham Court Rd., London, W.1.

McMichael, Ltd., L., (54)
Wexham Rd., Slough, Bucks.

M-L Magneto Syndicate, Ltd., (126)
Victoria Works, Coventry.

Moores & Co., J., (8)
Ravald St. Works, Salford.

Mullard Radio Valve Co., Ltd., (46 & 47)
Nightingale Works, Nightingale Lane, Balham, London, S.W.12.

NEW LONDON ELECTRON WORKS, LTD., (80)
East Ham, London, E.6.

Northern Steel & Hardware Co., Ltd., (104)
1-3, Southgate, Deansgate, Manchester.

OLDHAM & SON, LTD., (43)
Denton, Manchester.

Ormond Engineering Co., Ltd., (66)
Ormond House, Rosebery Av., London, E.C.1.

PARTRIDGE, WILSON & CO., (36)
Offices and Stores: 217a, Loughborough Rd., Leicester. Works: Linford St., Leicester.

Pertrix, Ltd., (37)
Britannia House, 233, Shaftesbury Av., London, W.C.2.

Peto-Scott Co., Ltd., (45)
77, City Rd., London, E.C.1.

Philips Lamps, Ltd., (19)
Philips House, 145, Charing Cross Road, London, W.C.2.

Philipson & Co., Ltd., (123)
Astley Bridge, Bolton.

Potter & Co., Ltd., H. B., (62)
Station Buildings, Rochdale.

Pye Radio, Ltd., (51)
Radio Works, Cambridge.

RADIOVIM, LTD., (94)
Sandford St., Ancoats, Manchester.
24, The Elms, Dingle, Liverpool.

Rawson, H. C. (Sheffield & London), Ltd. (30)
100, London Rd., Sheffield.

Redfern's Rubber Works, Ltd., (24)
Hyde, Cheshire.

Rees Mace Manufacturing Co., Ltd., (61)
59a, Welbeck St., London, W.1.

Rialton Radio, (117)
21a, Barbican, London, E.C.1.

Richardsons, (97)
24, St. John St., Deansgate, Manchester.

Ridged Cone Co., Ltd., (96)
York House, Southampton Row, London, W.C.1.

Ritherdon & Co., Ltd., (108 & 109)
Bolton.

Royal Radio Co., (86)
Dorset Mews North, Upper Gloucester Place, London, N.W.1.

Rumbaken Magneto Co., (127)
Tipping St., Ardwick, Manchester.

SCOTT & CO., LTD., G. L., (102)
Morris House, 60-66, Rochester Row, London, S.W.1.

Selectors, Ltd., (9)
206-207, Bedford Av., Slough Trading Estate, Slough, Bucks.

Siemens Bros. & Co., Ltd., (81)
Woolwich, London, S.E.18.

Sifam Electrical Instrument Co., Ltd., (11)
Bush House, Aldwych, London, W.C.2.

Six-Sixty Radio Co., (55)
122, Charing Cross Road, London, W.C.2.

Squire, F., (116)
24, Leswin Rd., Stoke Newington, London, N.16.

Standard Insulator Co., Ltd., (71)
Winsley House, Wells St., Oxford St., London, W.1.

Standard Wet Battery Co., (63)
184-188, Shaftesbury Av., London, W.C.2.

Stott, J. E., (125)
15, Clare Hill, Huddersfield.

TELEGRAPH CONDENSER CO., LTD., (83)
Wales Farm Rd., North Acton, London, W.3.

Telsen Electric Co., Ltd., (75)
Miller St., Birmingham.

Truphonic Radio, Ltd., (35)
Truphonic House, Hanover Park, Peckham, London, S.E.

Tungsram Electric Lamp Works (Great Britain), Ltd., (10)
72, Oxford St., London, W.1.

Tubills, Ltd., (14)
7-9, Swan St., Manchester.

UNIVERSAL GRAMOPHONE & RADIO CO., LTD., (88)
Kentish Town, London, N.W.5.

VANDERVELL & CO., LTD., C. A., (44)
Wornle Way, Acton, London, W.3.

Varley (Oliver Pell Control, Ltd.), (58)
Kingsway House, 103, Kingsway, London, W.C.2.

WARD & GOLDSTONE, LTD., (16)
Frederick Rd., Pendleton, Manchester.

Watmel Wireless Co., Ltd., (5)
High St., Edgware, Middlesex.

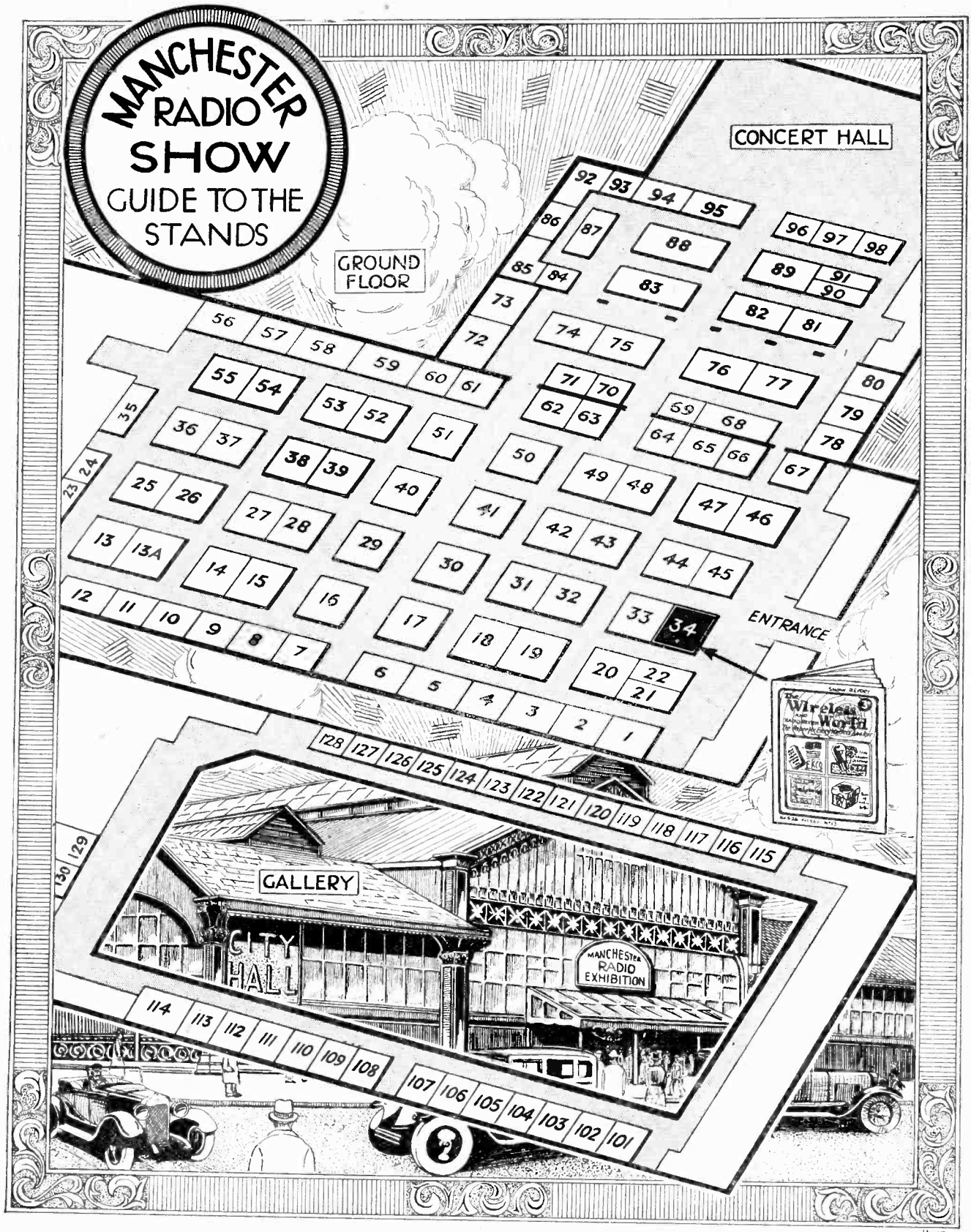
Westinghouse Brake & Saxby Signal Co., Ltd., (78)
32, York Rd., King's Cross, London, N.1.

Whiteley, Boreham & Co., Ltd., (7)
Nottingham Rd., Mansfield, Notts.

"The Wireless World," Iliffe & Sons Ltd., (34)
Dorset House, Tudor St., London, E.C.4.

Wright & Weaire, Ltd., (69)
740, High Rd., Tottenham, London, N.17

YAGERPHONE, LTD., (85)
28, Charlotte St., London, E.C.2.

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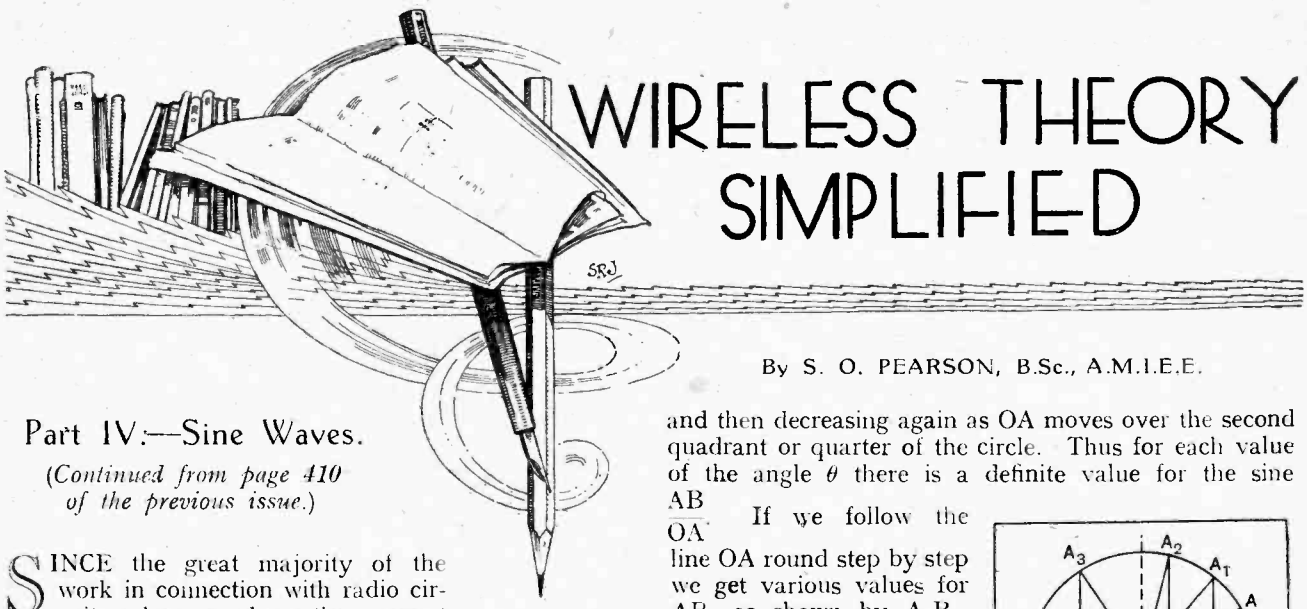

# WIRELESS THEORY SIMPLIFIED

By S. O. PEARSON, B.Sc., A.M.I.E.E.

## Part IV.—Sine Waves.

(*Continued from page 410 of the previous issue.*)

SINCE the great majority of the work in connection with radio circuits relates to alternating current phenomena we shall have a good deal to do with sine waves. It would be a very tedious process if we had actually to draw one or more sine waves every time we had a calculation to make, and fortunately this is not necessary. A sine wave of current or voltage can be represented by a simple straight line, and the method of doing this is explained below.

So far we have referred to a sine wave without giving any explanation as to its nature or how it can be drawn. The term "sine" is simply the name given to the ratio of two sides of a right-angled triangle. For instance, in Fig. 1 we have a right-angled triangle OAB in which the angle at O is denoted by $\theta$ (Greek letter "theta"); the ratio of AB to OA is the sine of $\theta$ or $\sin\theta$. The sine of $\theta$ is the side opposite to the angle $\theta$ divided by the side opposite to the right angle. In any right-angled triangle the side opposite to the right angle is the longest, so that the sine of an angle can never be greater than 1. When $\theta$ is made nearly equal to 90°, OB becomes very short, and AB becomes very nearly equal to OA, and the sine becomes nearly equal to unity. The sine of 90° is actually equal to 1.

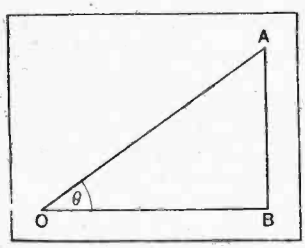


**Fig. 1.—In the right-angled triangle OAB the sine of the angle $\theta$ is $\frac{AB}{OA}$.**

Now suppose that the side OA is of constant length and is slowly rotated about the end O in the opposite direction to that of the hands of a clock, i.e., anti-clockwise, so that the end A moves in a circle as shown in Fig. 2, the other two sides OB and AB remaining horizontal and vertical respectively. It will be seen that the angle $\theta$ gets larger as the line OA pivots round and at the same time the length of the line AB is changing, increasing at first until OA becomes vertical, and then decreasing again as OA moves over the second quadrant or quarter of the circle. Thus for each value of the angle $\theta$ there is a definite value for the sine $\frac{AB}{OA}$. If we follow the line OA round step by step we get various values for AB, as shown by $A_1B_1$, $A_2B_2$, $A_3B_3$, etc., in the diagram. If the rotating line OA is made one inch long, the lengths in inches of $A_1B_1$, $A_2B_2$, etc., give the values of the sines of the corresponding angles. The sine reaches its maximum value when OA becomes vertical, being equal to 1, and begins to diminish again as OA passes through the second quarter of the circle. In the third and fourth quadrants AB falls below the horizontal line, and the sine has a negative value.

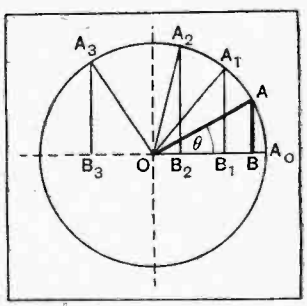


**Fig. 2.—If the side OA of the right-angled triangle of Fig. 1 is rotated about O whilst the other two sides keep their original directions, the relationship between $\theta$ and $\sin\theta$ can be found for all values of $\theta$.**

The connection between a rotating straight line or *rotating vector*, such as OA of Fig. 2 and a sine wave, is shown in the construction of Fig. 3. A circle is drawn and its circumference divided into, say, sixteen equal parts, the sixteen radial lines representing the successive positions of the rotating line or vector. A horizontal line is then drawn through the centre of the circle and extended to the right. Starting from O,

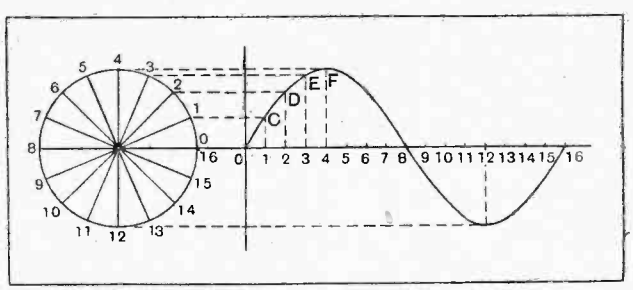


**Fig. 3.—Showing how a sine wave can be projected from a circle. Both the circumference of the circle and the base line are divided into 16 equal parts.**

**Wireless Theory Simplified.—**

sixteen equal divisions are measured off along this line and numbered as shown. If now a horizontal line through 1 on the circle is drawn to cut the vertical line through division 1 on the base line, the point of intersection, shown at C, gives a point on the sine wave being constructed. By proceeding in this way with the remainder of the corresponding pairs of numbers we obtain the points D, E, F, etc., which enable the sine wave to be traced.

### Explaining the R.M.S. Value.

There are two things to be noticed regarding the relationship between the rotating vector and the sine curve constructed from it: (*a*) the maximum height of the sine curve is equal to the radius of the circle or the length of the vector; (*b*) one complete revolution of the vector corresponds to one complete sine wave—one positive and one negative half wave.

We have seen how a sine wave can be obtained from a straight line rotating about one end, and therefore if we have a sine wave to consider showing the relationship between any quantity and time, we can represent it by a straight line rotating continuously about one end with constant speed. For instance, if we have an alternating current whose maximum value is 10 amps. and whose frequency is 50 cycles per second, we can represent it by a straight line 10 cms. long rotating about

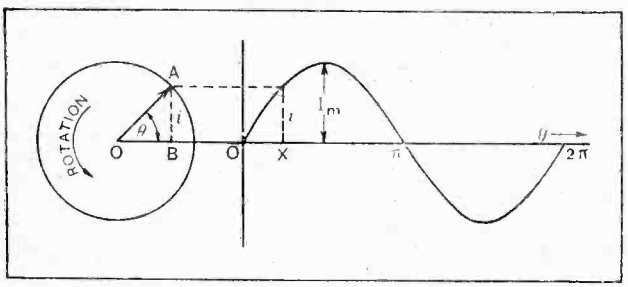


Fig. 4.—Showing how a sine wave of current can be represented by a rotating straight line OA.

one end at a speed of fifty revolutions per second. Actually on paper we draw it in one only of the positions which it is bound to pass through, and have to imagine the rotation—not a very difficult feat.

On the right-hand side of Fig. 4 is a sine wave of current whose maximum value or amplitude is $I_m$ amperes. The rotating vector OA representing it is made equal in length to $I_m$ to the same scale as that to which the wave is drawn. If the frequency of the current is $f$ cycles per second, the vector is assumed to be rotating at a speed of $f$ revolutions per second about one end. At the instant indicated by X, the current has a value of $i = AB$ amperes. But $\frac{AB}{OA} = \frac{i}{I_m} = \sin\theta$. Therefore, $i = I_m \sin\theta$, or, in other words, the current is varying according to a sine law with respect to the angle $\theta$, which is increasing continuously with time.

It will be noticed how very frequently the number $2\pi$ is met with in alternating current work. It is a very important number, and our simple rotating vector enables us to see exactly how it originates. The circumference of a circle is 3.1416 times as long as the diameter, and this number is denoted by $\pi$ (Greek letter "Pi"). Thus the circumference is $2\pi$ times the radius. Now if we mark off on the circumference of a circle a length PQ equal to the radius as in Fig. 5, the angle POQ subtended at the centre is called *one radian*, and there are obviously $2\pi$ radians in a complete circle of 360 degrees. Referring again to Fig. 4, the constantly increasing angle $\theta$ which the vector OA makes with the horizontal line is measured in radians, and in order that the base of the sine wave shall correspond this is scaled to represent the angle passed through by the vector instead of the time in seconds. Since the angle is exactly proportional to time it simply involves a different scale; in other words, the wave is plotted to an angle base instead of a time base as previously. Since one complete wave is represented by one complete revolution of the vector it follows that the base line of one complete wave corresponds to $2\pi$ radians.

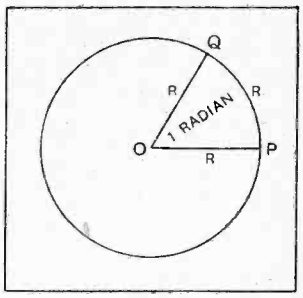


Fig. 5.—When PQ is equal to the radius of the circle the angle QOP is one radian.

It was stated that when the frequency is $f$ cycles per second the rotating vector makes $f$ revolutions per second, and the vector therefore passes through $2\pi f$ radians every second. Thus in $t$ seconds after passing through the starting position the angle $\theta$ will be $2\pi ft$ radians, and therefore at any time $t$ the value of the current is given $i = I_m \sin 2\pi ft$ amps., where $I_m$ is the maximum value, the effective or R.M.S. value being $0.707 I_m$.

### Two Alternating Currents in Phase.

Two sine waves of equal frequency are said to be *in phase* if they are exactly in step, i.e., if they both pass

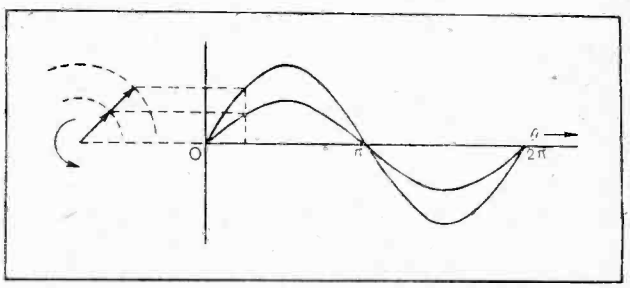


Fig. 6.—Two sine waves in phase with each other. The diagram shows that the vectors representing the two waves coincide with one another.

through their maximum positive values at the same instant. Two waves in phase are shown by the sine curves of Fig. 6, the waves having different amplitudes. Since each reaches its maximum value at the same instant it follows that the respective vectors representing them must pass through the vertical position simul-

**Wireless Theory Simplified.—**

taneously, and therefore must coincide with each other as shown on the left-hand side of the diagram. Their lengths may be simply added together to give the maximum value of the sum of the two currents.

### Sine Waves Out of Phase.

It is only under special circumstances that we find sine waves exactly in phase in A.C. circuits. In the great majority of cases the two or more waves under consideration are out of step or *out of phase*. There is said to be a phase difference between them. In Fig. 7 are shown two sine waves which are out of step by exactly one quarter of a cycle—one of them passes through its zero value just as the other reaches its maximum value. It will be clear that the vector representing the one must be horizontal at the same instant as the vector representing the other is vertical, and so for two waves out of step by a quarter of a cycle, the respective vectors representing them are mutually at right angles. For this reason the two waves are said to be out of phase by an angle of 90°. Note that curve (1) reaches its maximum value before curve (2), and so curve (2)

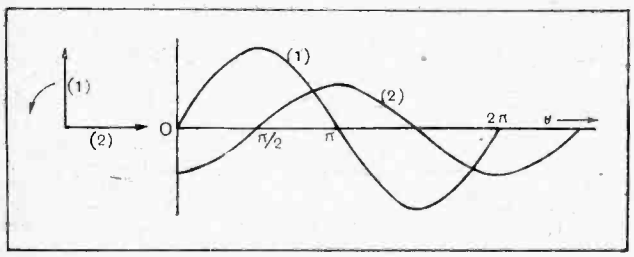


**Fig. 7.—Showing two sine waves 90° out of phase. The vectors representing them are mutually at right angles.**

is said to *lag behind* curve (1) by an angle of 90°. Also since the vectors are assumed to be rotating anti-clockwise, vector (2) is shown lagging behind vector (1) by 90°.

### Adding Currents which are Out of Phase.

Suppose that we have two alternating currents $I_1$ and $I_2$ out of phase by 90°, and that we require to add them together to find the resultant current. They cannot be added numerically because they are out of step. Draw the two vectors $OI_1$ and $OI_2$ representing them, mutually at right angles as shown in Fig. 8. Complete the rectangle $OI_1$ $II_2$. The diagonal OI gives the resultant both in magnitude and phase relationship to the others. This may be done to scale and OI measured, or by calculation, in which case the resultant current is given by $I = \sqrt{I_1^2 + I_2^2}$ amps.

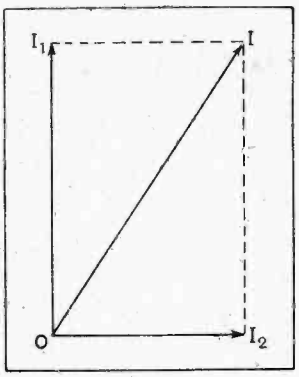


**Fig. 8.—Showing how to add together two alternating currents which are out of step by a quarter of a cycle.**

If the currents (or E.M.F.s) are out of phase by any other angle than 90° the same procedure is adopted, namely—draw the individual vectors to scale at the correct angle to each other, complete the parallelogram and measure the diagonal.

As an example, suppose that two alternating E.M.F.s of 100 volts and 50 volts respectively are out of phase by an angle of 60° and are connected in series. Draw two lines mutually at 60° as in Fig. 9, making one 10 cms. long and the other 5 cms., that is, to a scale of 1 cm. = 10 volts. Complete the parallelogram and measure the length of the diagonal which passes through the intersection of the original vectors at O. The length will be found to be about 13.2 cms., giving a resultant voltage of 132. The value could be calculated, but the process is more complicated.

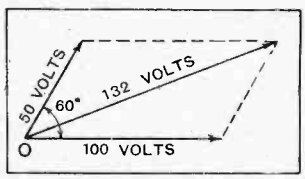


**Fig. 9.—Addition of two voltages by the parallelogram method.**

It is very important to remember that when adding up alternating currents or voltages the phase difference must always be taken into account by using the parallelogram method explained. Ordinary arithmetical addition does not give a true answer when the quantities to be added are out of step. (*To be continued.*)

# CLUB NEWS.

**Club Season Begins.**

The return to G.M.T. has signalised the resumption of club activities all over the country. In the majority of cases programmes for the ensuing months have already been prepared, and it seems likely that the 1929-30 session will equal any of its predecessors in enthusiasm and useful work.

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**A Seven-Year Record.**

An apology is due to the Hackney and District Radio Society in respect of the paragraph in our issue of September 18th, in which it was stated that the Society had "resumed its meetings." To the Hackney and District Radio Society belongs the distinction of having maintained its activities throughout the summer months, and meetings have, in fact, been held every week for seven years. An attractive programme has been prepared for the winter months, and full particulars can be obtained on application to Mr. G. W. Heath, Assistant Hon. Secretary, 61, Lauriston Road, Hackney, E.9.

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**Edinburgh Society's New Headquarters.**

The Edinburgh and District Radio Society now has new headquarters at 16, Royal Terrace, and meetings will be held every Wednesday during the winter months at 8 p.m. Full particulars can be obtained from the Hon. Secretary, Mr. E. I. Robertson, 10, Richmond Terrace, Edinburgh.

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**Institute of Wireless Technology.**

The Annual General Meeting of the Institute of Wireless Technology was held on Wednesday last, October 9th, at the Engineers' Club, Coventry Street, London, W All interested in the activities of the Institute are invited to communicate with the Hon. Secretary, at 71, Kingsway, London, W.C.2.

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**Bringing Olympia to Birmingham.**

Members of Slade Radio (Birmingham) who were unable to visit the Olympia Wireless Exhibition were specially catered for in an interesting summing-up of the Exhibition given by Mr. A. Freeman at a recent meeting. Demonstrations were given of various kinds of apparatus which were on view at Olympia.

The Society will hold its fourth Whist Drive and Dance on October 23rd. On October 24th a lecture on battery eliminators and mains receivers will be given by Mr. Ingham, of Messrs. Clarke and Co. (Manchester), Ltd. Details of these and other activities of the Society may be obtained from the Hon. Secretary, "Enville," Warren Road, Erdington.

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**Newcastle-upon-Tyne Radio Society.**

The Annual General Meeting of the Newcastle-upon-Tyne Radio Society was held in the English Lecture Room, Armstrong College, on October 7th, when the forthcoming lectures of the society were discussed.

Hon. Secretary, Mr. W. W. Pope, 7, Kimberley Gardens, Jesmond, Newcastle-upon-Tyne.

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**Lectures for Beginners.**

Weekly lectures specially for beginners are a feature of the syllabus at the Woolman Radio Society. Meetings are held every Friday at the John Woolman Settlement, 28, Duncan Terrace, London, N.1. Hon. Secretary, Mr. E. Dart, 86, Hampden Road, Hornsey, N.8.

# Broadcast Brevities

## NEWS FROM ALL QUARTERS.

*By Our Special Correspondent.*

***Transatlantic Relay Rivalry.—Prague Plan Fears.—5GB's Wavelength.***

### A Postponement.

For certain domestic reasons, the B.B.C. has decided that the high-power station at Brookman's Park shall not "take over" entirely from the Oxford Street transmitter until Monday next, October 21st, a week later than was originally announced.

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### Free Transmitters for All.

From the Savoy Hill letter-bag :—

"I have a small crystal set and should like a Brookman transmitter, which on my wireless this evening you say is given free of charge."

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### Satanic Interruptions.

Interference with the morning religious service from Daventry has been traced to the Devil's Point station (GYO), Plymouth.

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### A Spaced-Aerial Triumph.

Although the solder on the receiving set had scarcely hardened, the new Tatsfield station of the B.B.C. played a distinguished part in the reception and relaying of the running commentary on the Prime Minister's arrival in New York. Two American short-wavers were picked up, viz., 2XAD (19.56 metres) and 2XK (17.34), which are both at Schenectady.

The Tatsfield station is not yet fully equipped (two of the short-wave receivers have still to be completed), and for this reason the relay was also undertaken by the spaced-aerial receiving plant at Tarling, near Chelmsford, so that both receivers sent signals to the Savoy Hill control room. I am told that the spaced-aerial method has recently been giving a good account of itself.

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### Tarling *versus* Tatsfield.

It will be remembered that the idea of spacing aerials at intervals over several miles arose out of conversations between Captain Eckersley and Dr. Goldsmith, of the National Broadcasting Company of America, when Transatlantic relays were discussed two years ago. Then, to a greater extent than now, fading was the great obstacle to Transatlantic programmes, and it was with the object of obtaining constancy of aerial input that the experiment was tried of feeding one receiver from a number of widely separated aerials, which would not all be subjected to fading at the same moment.

The success of the latest relay shows that the experiment may justify the large expenditure necessary to erect such an elaborate system. But I have no doubt that Tatsfield, when once it is in full working order, will have something to say about this.

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### Is the Prague Plan Good Enough?

Even if it failed as a Transatlantic relay station—and there is nothing to suggest such a possibility—the Tatsfield station would still be fully employed as the B.B.C.'s ether sleuth. More and more the B.B.C. engineers are coming to rely upon the periodical reports from the official receiving station regarding European transmitters which stray from their allotted frequencies under the Prague Plan. During the past fortnight heterodyne troubles have been growing all over Europe, and a significant feature is that in not every case is this due to departure from the allotted frequency.

Savoy Hill is beginning to fear that the separation of 9 kilocycles between transmitters is insufficient during the winter months.

**FUTURE FEATURES.**

**London and Daventry.**

OCTOBER 21ST.—"Point of View (4), by Mr. H. G. Wells.

OCTOBER 25TH.—Orchestral Concert from the Queen's Hall.

OCTOBER 26TH.—Old-time Vaudeville Programme.

**Daventry Experimental (5GB).**

OCTOBER 22ND.—"The Monkey's Paw," a story by W. W. Jacobs, dramatised by Louis N. Parker.

OCTOBER 24TH.—An Edward German Programme.

**Cardiff.**

OCTOBER 22ND.—"Sixty Years of Song," a programme in memory of Fred E. Weatherly.

**Manchester.**

OCTOBER 24TH.—A Musical Comedy Programme.

**Glasgow.**

OCTOBER 22ND.—A Jacobite Concert.

OCTOBER 26TH.—Running Commentary on Wales *v.* Scotland International Association Football Match.

**Belfast.**

OCTOBER 24TH.—"The Faithful Sentinel," an opera, music by Franz Schubert.

### Another B.B.C. Pamphlet.

So many complaints have been received at headquarters regarding interference from Continental stations that the Technical Correspondence Department is seriously considering the preparation of yet another pamphlet, which will tell the listener all he wants to know about heterodyning, and probably a good deal more.

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### New Wavelength for 5GB?

Owing to continued interference by Langenberg, it is rumoured that Daventry 5GB may shortly change its wavelength from 479.2 to 398.5 metres. Such a step would increase the troubles of southern listeners, who already experience difficulty in cutting out Brookman's Park when receiving the alternative programme, and it is to be hoped that 5GB's wavelength change will be deferred until the regional station is sending out twin transmissions.

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### On Armistice Day.

The Cenotaph service will be relayed to listeners on Armistice Day, the transmission being almost exactly the same as last year. All B.B.C. stations will participate, including 5GB and 5SW.

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### A Happy Ending.

An idea is prevalent that the majority of Russian plays are of an unhappy character; in contrast to that view, a play entitled "Michael," which 5GB listeners will hear on October 29, ends on a note of triumph.

"Michael" is a play in three scenes by Miles Malleson; it is an adaptation of Leo Tolstoy's tale, "What Men Live By." The incidental music is by Norman O'Neill.

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### Running Commentary : New Style.

A change from the ordinary running commentary will be broadcast from 2LO, 5XX, throughout the Northern Region and from other stations on Saturday next, October 19. It will be a humorous description by L. T. Whipp, the Lancashire dialect entertainer, of the military band contest which is taking place on that day at Belle Vue, Manchester.

Following Mr. Whipp's efforts, a performance by the winning band will be broadcast.

# LABORATORY TESTS.

## A Review of Manufacturers' Recent Products.

### KESTER SOLDER.

Soldering and its indispensable partner, soldering paste, play an important part in the construction of a wireless set. This, however, is one only of the multitudinous uses to which it is put to-day. Many schemes to render soldering easy have


**Kester rosin-core solder for wireless use. The illustration shows a 4-oz. tin.**

been devised, and one of the latest is the Kester method. Kester radio solder consists of a hollow tube of genuine tin and lead filled with a non-corrosive rosin flux, and can be used to solder the most delicate wires with safety.

This is sold in 4oz. tins at 1s. 6d. for set constructors' use, and in 1lb. spools, at 3s. 4d. per spool, for those requiring larger quantities.

An acid core solder for general domestic use, but not recommended for wireless purposes, is available in 1lb. spools at 3s. 4d. each.

Supplies can be obtained from the Rothermel Corporation, Ltd., 24 and 26, Maddox Street, Regent Street, London, W.1.

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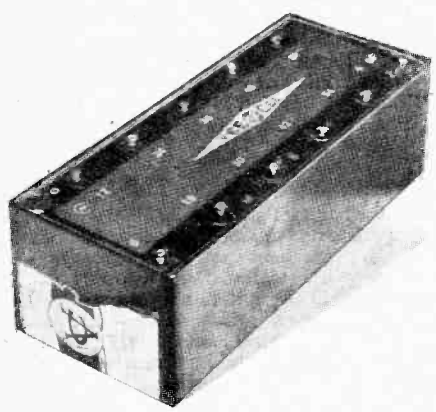
### VEE-CEE DRY BATTERY.

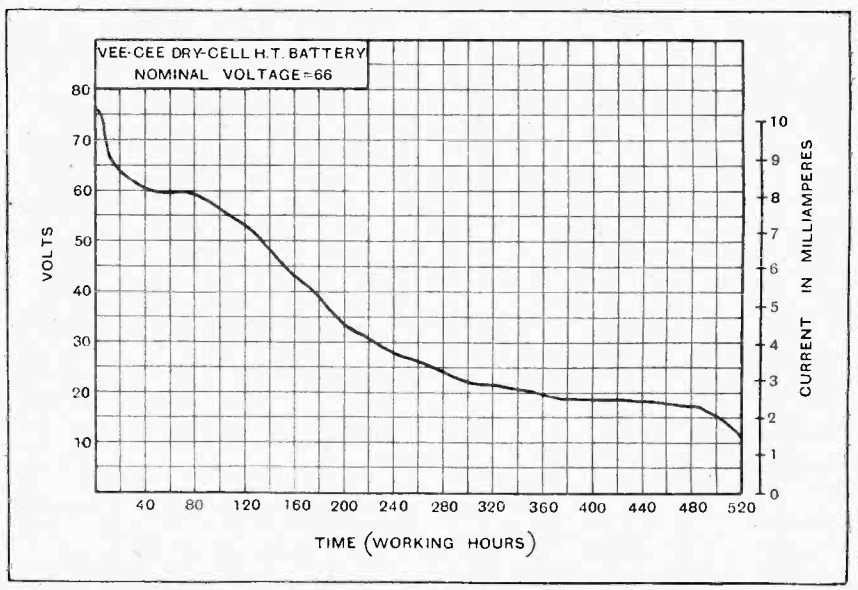
These batteries are made by the Vee-Cee Dry Cell Company (1927), Ltd., 5, Queensway, Ponders End, Middlesex. The sample submitted for test was a standard capacity size, rated at 66 volts, and sells at 7s. 6d. It was decided that about 8 mA would be the normal discharge rate of a battery of this size, so the discharge was commenced at just over 10 mA, which would assure a current of this order after the initial voltage drop.

The terminal voltage at the commencement of the test was 76 volts, but this fell rapidly during the first few hours and soon reached a more steady state at 60 volts. However, this was maintained for about 40 hours only, after which the voltage dropped steadily until the battery was exhausted. There was a slight recovery after 280 hours' discharge, and for the next 200 hours the voltage was maintained at a fair level. It would appear from an examination of the discharge curve that the initial current was on the high side for a battery of this size, and a better performance would have resulted if this had been reduced to between 6 and 8 mA.

The useful life of this particular battery at a discharge of the order of 8 mA would appear to be about 200 working hours, but this figure would be doubled, probably, by limiting the current taken to about 6 mA. Many other sizes of these batteries are available, all having the same capacity, however. A 108-volt size costs 12s. 6d., and the 120-volt model 14s. 6d. Grid batteries, 9 volt size, are marketed at 1s. 3d.



**"Vee-Cee" dry cell battery; 66 volts nominal.**




**Discharge curve of the "Vee-Cee" 66-volt H.T. dry cell battery.**

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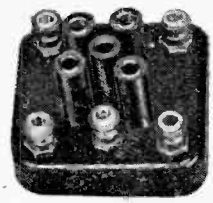
### "TRIX" A.C. VALVE HOLDER.

This valve holder has been designed for the new 5-pin A.C. valves which have recently appeared on the market. It is of the rigid type and consists of a moulded base carrying five insulated pillars with brass insets. Four of these are spaced as in the familiar 4-pin type, the extra socket being placed in the centre. The valve holder is, therefore, of universal application, since it can be used with either the new or the old type of valve fitted with base pins.

The insulating sleeve on the anode socket is coloured red to distinguish it from the others; these are encased in black material. Five small terminals are fitted, four being marked, but the fifth, which connects with the centre socket, is



**"Trix" A.C. valve holder for the new 5-pin A.C. valves.**

not distinguished by any particular marking. The makers are Messrs. Eric J. Lever (Trix), Ltd., 8-9, Clerkenwell Green, London, E.C.1, and the price is 1s. 3d.

## Catalogues Received.

Messrs. Lissen, Ltd., Lissenium Works, Friars Lane, Richmond, Surrey.—Illustrated folders dealing with radio-gramophone sets, portable receivers, the Lissenola three-valve cabinet receiver and new season Lissen components.

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The Peto-Scott Co., Ltd., 77, City Road, London, E.C.1.—Illustrated catalogue of proprietary receivers available under the convenient purchase system arranged by this company.

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Messrs. Wright and Weaire, Ltd., 740, High Road, Tottenham, London, N.17.—Illustrated folder describing some new Wearite components.

# READERS' PROBLEMS.

"The Wireless World" Supplies a Free Service of Technical Information.

*The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.*

### Saving the Batteries.

*In order to reduce the risk of leaving my set switched on all night I should like to fit a warning lamp; will you please tell me how it should be connected? The set is a commercial product, and I do not know its precise circuit arrangement, but imagine that it should be an easy matter to add the lamp.* M. K. W.

The fitting of a lamp to indicate when the filaments are switched on is the simplest possible operation. Having obtained a lamp—a type having a low current consumption should be chosen—and a suitable holder, all you have to do is to wire it directly across the filament terminals of any convenient valve-holder in the receiver.

If your set has provision for gramophone reproduction arranged in such a way that the H.F. valve is automatically switched off, you must take the precaution of seeing that the lamp is operative when the gramophone pick-up is in use.

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### An Indoor Aerial Set.

*Can you refer me to any published description of a receiver designed specifically for use with an indoor aerial?* J. S. P.

It is correct to say that there is no basic difference between a receiver designed for working with a very short aerial and one intended for operation with a collector of the full 100ft. length allowed by the Post Office regulations.

Generally speaking, any of the sets described in this journal are suitable for short aerials; naturally, the more sensitive receivers give better results.

It may be added that where aperiodic aerial coupling or a separately tuned aerial is employed it is generally advised that the aerial connection should be made directly to the grid of the first H.F. valve.

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### Screening Unnecessary.

*I am building a set on the lines of the "Kilo-Mag Four," but with two L.F. stages. Provided all the apparatus associated with the H.F. amplifier and the detector valve is adequately screened, will it be necessary to mount the L.F. portion in a metal box?* C. N. A.

This precaution will be quite unnecessary if the H.F. component in the detector anode circuit is adequately disposed of, and if matters are so arranged that it cannot cause instability through interaction with the input end of the set.

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### An Extra Tuned Circuit for the "Everyman Four."

*My set is an "Everyman Four" constructed in accordance with the instructions given in the revised booklet. With a view to increasing its selectivity still further, I should like to add a loose-coupled and separately tuned aerial circuit, which, it is noted, is included in a number of modern sets.*

*Will you please tell me if this scheme is practicable, and if so, give me a hint as to how I should proceed?* A. C. P.

This set lends itself very readily to your proposed alteration; additions to the present wiring will be made clear, if you consider the circuit diagram given in Fig. 1.

The existing aerial connections on the primary of the aerial-grid transformer should be ignored, and an extra tapping will be made at approximately the second

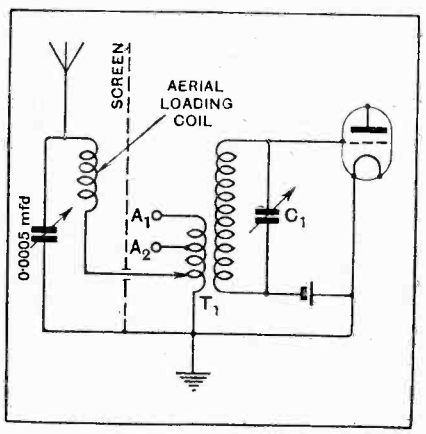


**Fig. 1.—Aerial-grid circuit of the "Everyman Four" receiver modified by the addition of a separately tuned aerial.**

turn from the earthed end of the primary. If the selectivity afforded by this connection is insufficient, it will be necessary to join the loaded aerial to a point still nearer the earthed end.

Needless to say, this extra circuit will not be operative on the long-wave band.

*RULES.*

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

*Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.*

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### Changing Conditions.

*Although the selectivity of my "Megavox" receiver is quite adequate for present requirements, I anticipate that it will be necessary to improve it in this respect in the near future. Have you published any information dealing with this problem?* T. M. S.

We think that we cannot do better than refer you to the "Readers' Problems" section of our issue for May 8th, where a modified arrangement of the aerial circuit of this receiver was suggested.

If you do not wish to make any internal alterations, we would suggest that you should study carefully the article on wave traps and absorption circuits which appeared in the issue of October 2nd.

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### Ample H.T. Voltage.

*I have an H.T. eliminator with a rated maximum output of 120 volts. Would this be suitable for use with the "Record III" receiver?* D. R. S.

Good results would be attainable with an H.T. pressure of about 120 volts, but the performance of the set would be considerably improved by increasing this up to, say, 150 volts. The published figures with regard to measured H.F. amplification were obtained with the full rated voltage applied to the H.F. valve-anode

### Pick-up Connections for the "Foreign Listeners' Four."

*Will you please tell me if it is possible to fit a pick-up to "Foreign Listeners' Four"? If it can be arranged, I should like to retain the feature of "free" grid bias, although if this is inconvenient, I should not object to a bias battery when the set is being used for gramophone reproduction.*

E. N. B.

There is little difficulty in retaining the free grid bias feature when operating this set with a pick-up. We suggest that the detector grid circuit should be connected in the manner shown in Fig. 2, from which you will see that a small resistance is inserted in the detector cathode lead, as in the case of the remaining valves of the set. When the switch is in the "detector" position, the grid is not affected by the potential difference existing across the biasing resistance, as the grid condenser acts as an effective insulator, and the operating conditions of the valve are exactly as before.

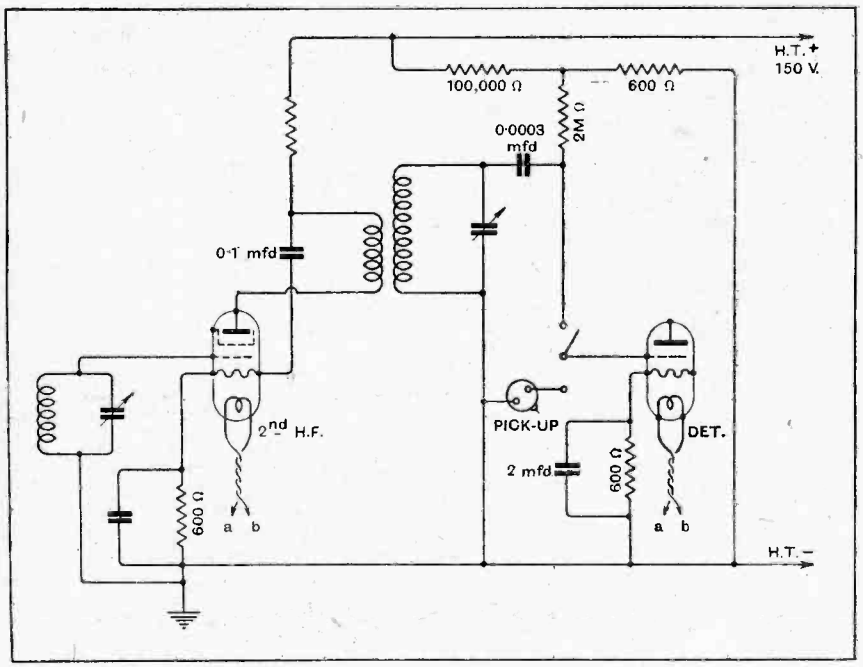


**Fig. 2.—Method of inserting a pick-up in the detector grid circuit of the "Foreign Listeners' Four." Reference lettering corresponds with that of the original circuit diagram.**

For the sake of completeness, we show the grid circuit of the second H.F. amplifier, in order that you may compare the method adopted in providing for the biasing of this valve.

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### On the H.F. Side.

*Will you please examine the enclosed circuit diagram of my receiver and tell me what is wrong with its L.F. amplifier? When the H.T. battery is connected, violent motor-boating is produced when the circuits are brought into tune.*

R. D. G.

The circuit diagram submitted by our correspondent represents a three-valve receiver with transformer-coupled H.F. amplifier and anode bend detector, resistance-coupled to a pentode. A choke-filter device is included. Now, a circuit of this kind is inherently immune from low-frequency interaction troubles, even without the decoupling devices included in the detector anode circuit, and we feel certain that the trouble really lies in the H.F. end of the receiver. It would appear that high-frequency oscillation is produced as the circuits are brought into tune; this may be due either to insufficient screening, or merely to the fact that attempts are being made to attain a greater stage magnification than the valve is capable of yielding.

We think it would be advisable to test the leak resistance associated with the grid circuit of the output valve; it seems probable that choking in this circuit gives rise to an effect similar to that usually described as "motor-boating."

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### External Interference or Internal Fault?

*I am troubled by an intermittent crackling noise from my loud speaker which sometimes lasts for as long as ten minutes, and then suddenly ceases. Can you tell me whether this is due to the receiver, to the eliminator, or to interference from power circuits?*

H. B. B.

From the information given we feel that it is quite impossible to offer a definite opinion, although we are inclined to think that the trouble is due to interference from outside sources.

It would probably be easy enough for you to prove whether the eliminator is at fault by temporarily substituting a set of batteries, and with this form of supply you could ascertain fairly conclusively whether there is a fault in the set by noting whether the interference persists when aerial and earth are removed.

It may be added that in cases of this sort we are always inclined to suspect grid biasing batteries, inductive windings, such as chokes, and more particularly L.F. transformer primaries.

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### An Inevitable Earth.

*I am told that when using D.C. mains for H.T. supply it is possible to earth the receiver through the mains. Will you tell me how this may be done?*

C. S.

It is inevitable that any set deriving its H.T. supply from D.C. mains should be earthed, as without exception public supply mains are connected to earth at the generating station. There is no need for any extra connection, and, although the normal earth terminal of the receiver is left free there will still be an "earth."

It should be pointed out, however, that this form of earthing is not highly effective, and as a general rule another connection is advised.

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### Free Grid Bias Scheme.

*I am thinking of building the "Flat Dwellers' A.C. Three," but should like to include the scheme of "free" grid bias included in the "Foreign Listeners' Four." Is there any reason why this should not be successful?*

D. R. L.

As far as the H.F. and output valves are concerned, it would be quite easy to arrange for free grid bias by inserting resistances in the cathode leads, but it would be almost impossible to apply this simple method to the detector, which, as you will realise, is arranged to work on the anode bend principle.

If you are particularly anxious to proceed with your scheme, we suggest that bias for the detector could best be taken from a resistance inserted in some part of the circuit where current flow is fairly heavy, and not from one of the circuits associated only with this valve itself.

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### Where the Frame Aerial Fails.

*Can it always be assumed that a frame aerial set will be more selective than one with an open aerial? I am considering the design of a new receiver, and, in view of the proximity of Brookman's Park, am wondering which form of collector will be the more suitable.*

J. W. J.

A good deal depends on the purpose for which the set is intended. If it is desired to receive only the two projected alternative transmissions from Brookman's Park, then it may be stated definitely that the frame will contribute nothing towards real over-all selectivity; both stations are on the same site, and its directional properties will serve no useful purpose. If, on the other hand, the reception of other and more distant stations is needed, it will be of the greatest advantage.

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## EMPIRE BROADCASTING.

A NEW and energetic Government,—a new Chief Engineer of the B.B.C. who has, as yet, not curtailed his future activities by compromising utterances on questions of B.B.C. technical policy,—and it would seem that here we have two factors which offer a brighter outlook for the prospects of a new policy in regard to Empire broadcasting.

There has been ample evidence in the past that the B.B.C. will do nothing in the direction of furthering the cause of Empire broadcasting until they are pressed into doing it, and until they are told what course they should pursue. The suggestion that an Empire broadcasting service should be started originated in a contribution in *The Wireless World*, and later, in our issue of April 27th, 1927, we said: "It is a matter for regret that we should so far have neglected to take advantage of the wonderful opportunity which broadcasting provides for communication with the outlying sections of the Empire." By May of the same year the daily Press had taken up the question, and in an article which appeared in the *Evening Standard*, of May 5th, 1927, the comment appeared: "If a foreign station can successfully transmit to the Antipodes on a wavelength of 30 metres there seems to be no logical reason why our own Corporation should not begin to delve a little deeper into the possibilities."

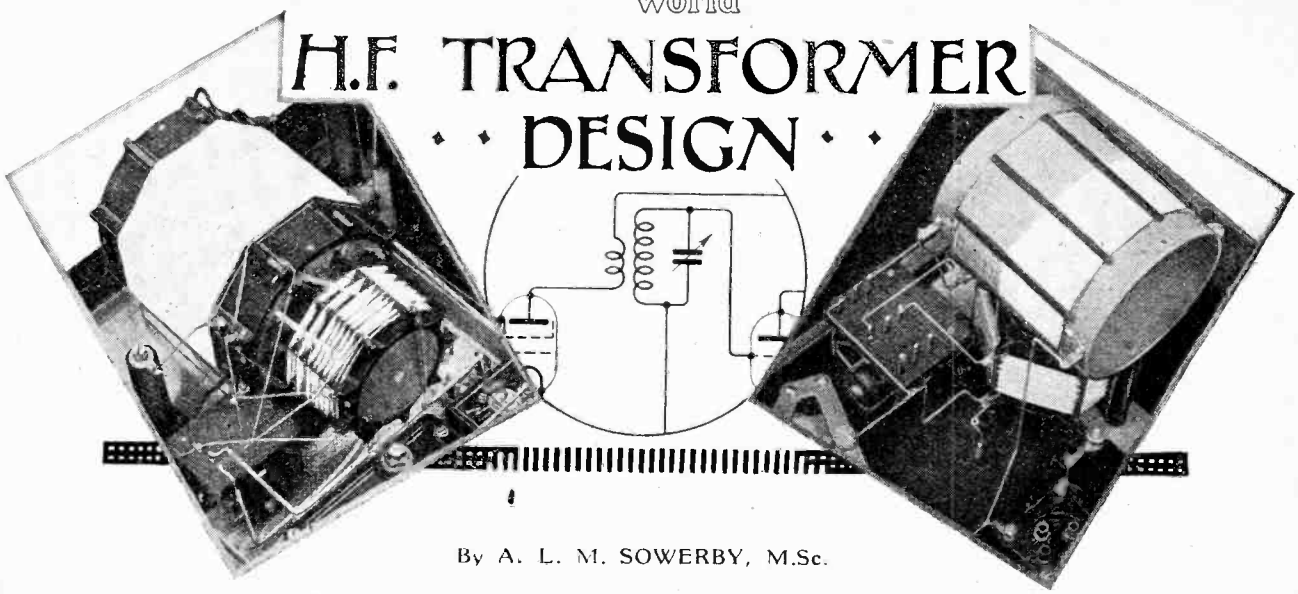
By the end of that month we were able to announce: "The efforts of *The Wireless World* to stir up interest in the subject of Empire broadcasting already show definite promise of bearing fruit in the near future. The daily Press has taken up the subject with interest, and the B.B.C. has issued a statement giving its view of the position." By June 1st, 1927, we were able to state that, "Since the publication of our last issue matters in connection with Empire broadcasting have proceeded apace. The B.B.C. has made an announcement to the effect that they are undertaking the erection of a short-wave station at Daventry."

### How 5SW Started.

In our issue of June 29th, 1927, we criticised the delay in proceeding with an Empire short-wave station and suggested a remedy. The B.B.C. had stated that they were erecting a short-wave station for experimental work at Daventry, but we drew attention to the fact that "The preliminary work of an experimental kind before the first B.B.C. stations were established was undertaken by the big wireless companies, and when a long-wave station (Daventry 5XX) was decided upon it was first established, and all experiments conducted in connection with it, at the Marconi Company's Works at Chelmsford," and we continued: "We sympathise with the attitude of the B.B.C. that it is not justified in incurring heavy expenditure on experimental work; but such experimental work, we believe, would readily be incurred by one of the big commercial companies if the station, when established in going order, and after having passed specified tests, could be handed over to the British Broadcasting Company at an agreed price."

As we know, our advice that the technical development of the Empire short-wave station should be initiated by the Marconi Company on behalf of the B.B.C. was adopted, and we still have, to-day, 5SW located at the Marconi Works at Chelmsford. But there matters have stood still, and we would now urge Capt. Eckersley's successor and his staff to show the same degree of enthusiasm for achieving results with a short-wave Empire broadcasting service as, on other wavebands, has already resulted in a success which has earned for British Broadcasting a reputation second to none.

# H.F. TRANSFORMER DESIGN



By A. L. M. SOWERBY, M.Sc.

## Adjusting Ratio to Compromise between Amplification and Selectivity.

WHEN using a triode as a high-frequency amplifier in conjunction with any reasonable tuned circuit it is quite essential, as has many times been pointed out in the pages of this journal, to use a high-frequency transformer with a secondary winding containing several times as many turns as the primary. Even apart from the question of stability it will be found that a tuned anode circuit or its equivalent provides both lower amplification and worse selectivity than a properly designed transformer.

When using a screen-grid valve with a tuned circuit of normal losses the best number of turns for the primary of the transformer is very nearly the same as the number of turns on the secondary. For example, using a screen-grid valve of A.C. resistance ("impedance") $R_0 = 200{,}000$ ohms before a tuned circuit of dynamic resistance $R = 250{,}000$ ohms, the optimum ratio, as given by the formula $n = \sqrt{\frac{R}{R_0}}$ comes out at 1.11. Thus if the secondary contains 70 turns there should be $\frac{70}{1.11}$ or 63 turns on the primary.

Now, in many cases the use of the tuned anode circuit, or its close equivalent, the tuned grid circuit (Fig. 1), would be preferred to a transformer for the sake of greater ease in wave-band switching or coil-changing. Using a transformer, there are two coils, primary and secondary, that have to be changed in passing from one wave-band to another, so that a four-connection mount is needed if the transformer is to be changed, while if switching is adopted a two-pole switch is required, as in Fig. 2, to short out the long-wave primary and secondary when receiving on the broadcast band. With either the tuned anode or the tuned grid circuits, on the other hand, the same end is achieved by a two-connection coil or, as in Fig. 1, by a single-pole switch.

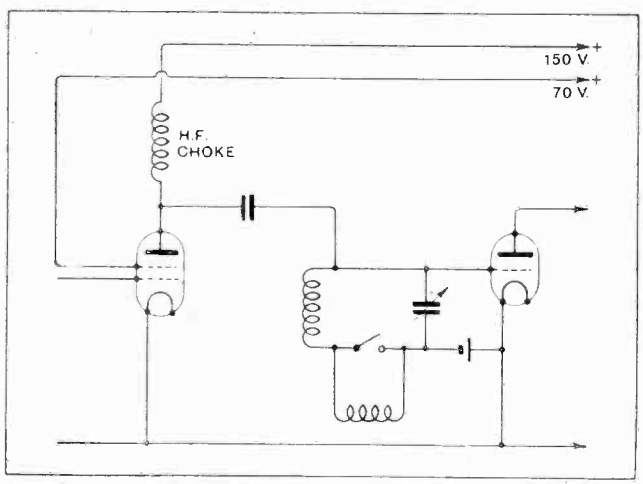



**Fig. 1.—The tuned grid circuit, showing simplicity of waveband switching. Range-changing can also be achieved by changing one coil.**

### Tuned Anode *versus* Transformer.

If, in the interests of simplicity, either of these more convenient circuits is adopted, it becomes pertinent to enquire how much of the possible amplification will be sacrificed by employing what is, in effect, a 1 : 1 transformer (since the same coil now does duty both as primary and secondary) in place of a transformer of the correct step-up ratio.

The appendix contains a calculation that leads to a formula, applicable to all cases, for comparing the amplification yielded by the tuned anode circuit with that given by a theoretically perfect transformer. For greater convenience in reference there is plotted in Fig. 3 a curve from which the desired numerical result can be read off at a glance for any case for which the best transformer ratio is known. In the case taken as an example, and for which the best transformer ratio was found to be 1 : 1, the curve shows that the

**H.F. Transformer Design.—**

amplification attained if a tuned circuit were substituted would be 99 per cent. of that to be expected from the transformer. Even the most enthusiastic efficiency hunter would hardly be appalled at the prospect of sacrificing one per cent. of his amplification for the sake of the extra convenience of the simpler circuit! If, however, the correct transformer ratio had been 2, implying a primary with half as many turns as the secondary, the amplification with the tuned anode circuit would be 80 per cent. of the highest attainable with the valve and tuned circuit to be used, while selectivity would also suffer by the change.

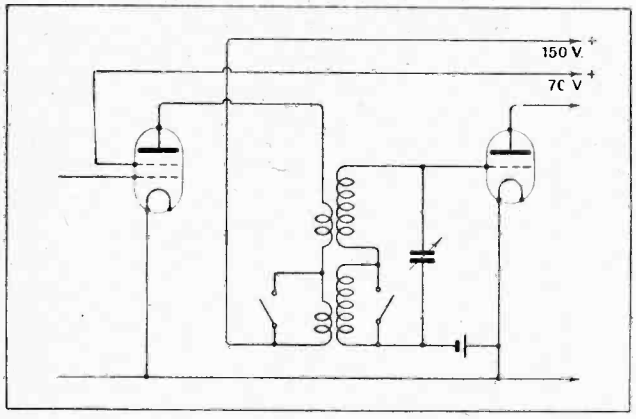



**Fig. 2.—Waveband switching with a transformer. The separate switches shown would in practice be combined into a single two-pole switch.**

There are, however, some other factors to be taken into consideration. With a transformer having a ratio in the neighbourhood of 1 : 1 the amplification, though theoretically the same as that yielded by tuned anode, is in practice found to be lower by some five or six per cent., owing to the slightly incomplete coupling between the two windings, and to the losses introduced by the wire of the primary. As a result of this, the theoretical losses due to replacing by tuned anode of a transformer of ratio anywhere between 1 to 1 and about 1.4 to 1 do not appear in practice, so that a tuned circuit having a dynamic resistance anywhere between double and half the value of the A.C. resistance of the valve will yield, with tuned anode coupling, the highest amplification that can be extracted from that particular combination of coil and valve.

**Tuned Grid Coupling.**

If the receiver is to be used with an eliminator it will usually be preferred, for several excellent reasons connected with decoupling, to use the tuned grid circuit of Fig. 2 in place of tuned anode. Although this may theoretically be considered as an equivalent of tuned anode, it is in practice a little inferior owing to the high-frequency losses introduced by the choke. As a first approximation, we may set this off against the small losses that are equally inevitable in the transformer, so that if it is desired to compare the probable performance of the tuned grid circuit with that of a transformer with a primary designed to suit the valve and coil to be used the curve may be taken as it stands, without the small correction suggested for tuned anode. Unless some care is expended in the selection of a choke a correction in the other direction may be necessary, for the loss in amplification in such circumstances will be a good deal greater than the curve would suggest.

In the formula from which the curve was computed no restrictions were made confining the conclusions to step-up transformers. In terms of receiver design this implies that the curve covers cases such as arise with some of the very high-impedance screen-grid valves now produced, where theory indicates that a step-*down* transformer should be employed. Suppose we propose to follow a Cosmos AC/S valve, of nominal A.C. resistance 800,000 ohms, with a tuned circuit of dynamic resistance 250,000 ohms. Here $\sqrt{\frac{R}{R_0}} = \frac{250,000}{800,000} = 0.56$. The secondary must have 0.56 times the primary turns, which is a step-down ratio of $\frac{1}{0.56}$ or 1.79 to 1. Referring to the curve, we find that the tuned anode (or a 1 to 1 transformer) will give 85 per cent. of the amplification that would be attained if the practical difficulties of using a transformer with so large a primary had been satisfactorily overcome. While one may hanker after the lost magnification, one may at least feel consoled that the loss is not, perhaps, so great as one had thought, especially as some of the loss will be made up automatically when, in choosing the best screen-grid voltage, the A.C. resistance of the valve is adjusted to the best compromise with the coil used.

**Poor Selectivity with Screen-grid Valve.**

Those who read the appendix will notice that the expression obtained is symmetrical in $m$ and $n$. This fact further extends the applicability of the curve to cover the inverse problem, which also has considerable practical interest, of finding the loss in amplification incurred through using a step-up transformer when a tuned-anode circuit is theoretically correct. We have all discovered, through practical experience, that the

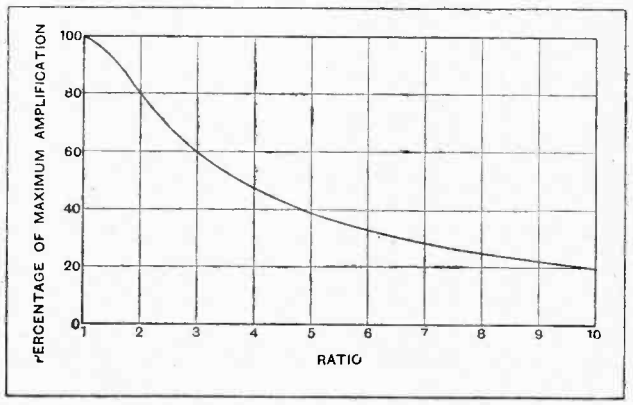



**Fig. 3.—(a) When a transformer of ratio $m$ is correct, and tuned anode is to be used, the percentage amplification yielded is read from the curve against $m$ on the "Ratio" scale. (b) When tuned anode is theoretically correct, the curve gives the percentage amplification for a transformer of any ratio. (c) When a transformer of ratio $m$ is correct, and one of ratio $n$ is to be used, the percentage amplification yielded is read from the curve against $n/m$ (or $m/n$) on the "Ratio" scale. (See Appendix.)**

**H.F. Transformer Design.—**

screen-grid valve, used with a tuned-anode circuit or its approximate equivalent, makes for a receiver of very poor selectivity, though the theoretical basis for this would appear at present to be obscure. This poor selectivity is usually combated by using a step-up transformer with a primary a good deal smaller than theory, directed towards maximum stage again, would demand. The gain in selectivity is undoubted—but how about the loss of amplification?

### Combating Loss in Amplification.

Provided always that the optimum ratio, as calculated from the formula, is 1 to 1, the curve will give straight away the loss of amplification incurred by using a step-up transformer of any ratio that the needs of selectivity may prescribe. To take an example, a 200,000 ohm tuned circuit after a 200,000 ohm valve needs a 1-to-1 transformer if we are legislating for amplification only, and with this transformer the amplification of the stage will be exactly half the "$\mu$" of the valve. If we decide that a 3-to-1 transformer is necessary to provide the selectivity we require, the stage gain will be reduced, as the curve shows, to 60 per cent. of the possible value, or with a 4-to-1 transformer to 47 per cent., making the actual figure for amplification 60/200ths or 47/200ths respectively of the amplification factor of the valve.

Even when the theoretically correct ratio is not 1 to 1, this remarkably versatile curve does not admit its inability to deal with the problem reasonably simply. Instead of looking up directly on the horizontal scale the transformer ratio that we propose to use, we divide the proposed ratio by the theoretical ratio, and look up the result as before. Two cases are needed to illustrate this point fully.

First let us take the case of a valve of $\mu=200$, $R_0=200{,}000$ ohms, used with a tuned secondary of dynamic resistance 300,000 ohms, and a primary which, for the sake of selectivity, shall only contain one-fourth as many turns as the secondary. How much amplification do we sacrifice to selectivity, and what will be the actual amplification of the stage when set up?

The theoretically correct ratio for the transformer is not 4, but $\sqrt{\frac{R}{R_0}}=\sqrt{\frac{300{,}000}{200{,}000}}=1.23$. With this an amplification of $\frac{1}{2}\mu n=\frac{1}{2}\times 200\times 1.23=123$ times would be expected. To find what percentage of this we shall attain with the 4-to-1 transformer, we divide proposed ratio by theoretical ratio, getting $\frac{4}{1.23}=3.25$. Looking up 3.25 on the curve, we find that this figure corresponds to 56 per cent. of maximum amplification, showing that, even with the 4-to-1 transformer, more than half the maximum attainable amplification is still to be had. The stage as planned will amplify 56 per cent. of 123, or 69 times.

For our second example we will take the AC/S valve again, and assume that we propose to use with it a 2-to-1 step-up transformer having a secondary of 200,000 ohms dynamic resistance. Here the valve characteristics are $\mu=1{,}200$ A.C. resistance $=800{,}000$ ohms. Optimum ratio $n=\sqrt{\frac{R}{R_0}}=\sqrt{\frac{200{,}000}{800{,}000}}=0.5$ (primary twice as many turns as secondary). This would give an amplification of $\frac{1}{2}\mu n=\frac{1200}{4}=300$ times. But we propose, for the sake of selectivity, to use a 2-to-1 step-*up* transformer, with half as many turns on the primary as on the secondary. Dividing proposed by theoretical ratio we get $\frac{2}{\frac{1}{2}}$ or 4, which corresponds on the curve to 47 per cent. of maximum amplification. We shall therefore achieve a magnification of 47 per cent. of 300, or 141 times, in our receiver.

### Incidental Reaction.

In any case where a step-up transformer of comparatively high ratio is chosen, for the sake of enhancing selectivity, to follow a screen-grid valve, the incidental reaction due to the incomplete screening within the valve will also be reduced, as is evident from the fact that set designers often use step-up transformers for the purpose of ensuring stability. This effect, though perfectly amenable to calculation if the necessary data are to hand,[1] cannot be expressed in a simple curve, and is therefore not treated quantitatively in the present note. It is thought, however, that the curve given will be found useful in obtaining a rapid solution to some of the problems incidental to the design on modern lines of a stage of high-frequency amplification.

### Appendix.

For two transformers, of ratio $n$ and $m$, but otherwise identical, we have

$$A_1=\frac{n\mu R}{R+n^2R_0}$$

and

$$A_2=\frac{m\mu R}{R+m^2R_0}$$

$$\therefore\ \frac{A_1}{A_2}=\frac{n}{m}\cdot\frac{R+m^2R_0}{R+n^2R_0}=\frac{n}{m}\cdot\frac{R/R_0+m^2}{R/R_0+n^2}$$

if the ratio $m$ is the optimum, $R/R_0=m^2$

For any value of $n$,

$$\frac{A_1}{A_2}=\frac{n}{m}\cdot\frac{2m^2}{m^2+n^2}=\frac{2mn}{m^2+n^2}=\frac{2m/n}{(m/n)^2+1}$$

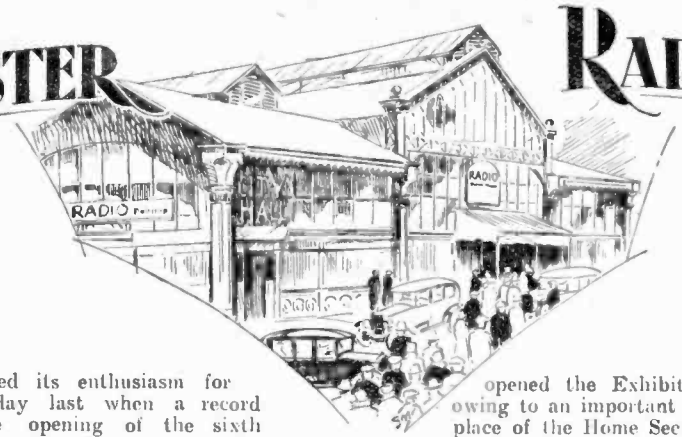
$$\frac{A_1}{A_2}=\frac{2}{m/n+n/m}$$

In the curve of Figure 3, $\frac{100A_1}{A_2}$ is plotted against $m/n$ (or $n/m$) from the above expression.

[The formula for amplification upon which this calculation is based will be found in "Radio-frequency Transformers," by N. W. McLachlan, *Experimental Wireless*, October, 1927, p. 597.]

[1] See R. T. Beatty, *Experimental Wireless*, Jan, 1928, p. 3.

# MANCHESTER RADIO SHOW



## New Items of Interest — Seen at the Stands.

MANCHESTER reaffirmed its enthusiasm for wireless on Wednesday last when a record crowd attended the opening of the sixth annual *Evening Chronicle* Wireless Exhibition in the City Hall.

In a speech which must have reassured many anxious listeners, Mr. Gladstone Murray, of the B.B.C., declared that the opening of the Moorside Edge Regional Station in a year's time would provide the North with a much better broadcasting service than at present. Referring to criticism of the use of the microphone by cabinet ministers, Mr. Gladstone Murray said that neither the present nor the previons Government had misused the microphone, nor was the slightest pressure brought to bear upon the B.B.C. in the conduct of its services.

Mr. J. R. Clynes, the Home Secretary, who was to have opened the Exhibition, was unable to be present owing to an important Cabinet Meeting. In taking the place of the Home Secretary, the Lord Mayor of Manchester (Colonel Westcott) delivered a rousing speech, in which he congratulated the organisers on the large attendance at the opening of the Exhibition, and referred to the now recognised fact that Manchester is in the forefront of radio development.

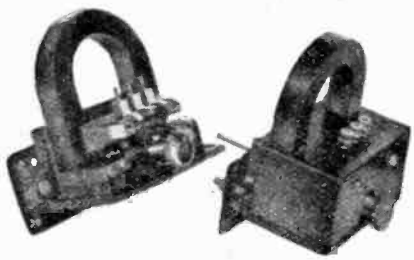
Other speakers included Captain P. P. Eckersley and Mr. Edward Liveing, Regional Director for the Northern Group of B.B.C. stations.

The following review of the Show forms a comprehensive survey of the "Olympia of the North." The Exhibition will remain open daily until Saturday next, October 26th. Admission is 1s. 2d., including tax.

*Apparatus exhibited at many of the stands has already been described in detail in the recent report of the Olympia Show. To avoid repetition, attention has been devoted in particular to sets and components now shown for the first time.*

### AMPLION. (32)

In addition to the new apparatus described in our Olympia Show Report, an Amplion balanced armature loud speaker drive unit—Type B.A.2—has just been



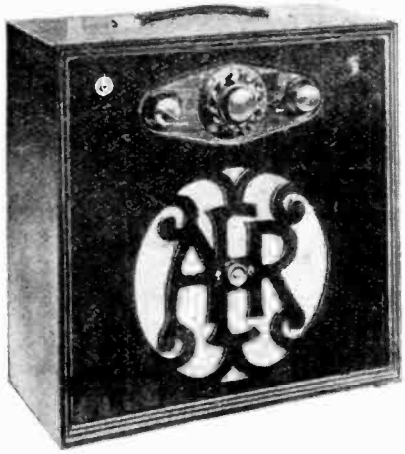
**New Amplion balanced armature loud speaker unit, with and without cover.**

introduced. This component will be examined with more than usual interest, as it embodies features not to be found (the writer believes) in any other unit yet available. In the first place, there are three input terminals, so arranged that the user has a choice of three distinct resistance values of 500, 700 and 1,200 ohms, corresponding to impedances at 1,000 cycles of, respectively, 4,500, 6,500, and 20,000 ohms. The high-resistance winding is stated to be specially designed for use in conjunction with a pentode output valve.

The vibrating reed is held in position between two restraining springs, one of which is adjustable, while the other is normally fixed. When sent out from the works, this is set so that the sensitivity of the unit is fairly high, but its capabilities in the matter of power handling is not in excess of normal requirements; where exceptionally great outputs from the receiver are available, this second spring may be easily adjusted, so that the unit will be capable of delivering greater volume without "chattering"; at the same time, sensitivity will be reduced.

A removable back plate is supplied with the unit, in order that it may be mounted on a cone chassis drilled in accordance with several standard arrangements.

*Graham-Amplion, Ltd., Slough, Bucks. Sales Offices, 25-26, Savile Row, London, W.1.*



**Aconic portable receiver.**

### ATLAS. (41)

The new Clarke Atlas H.T. eliminator, Type A.C.15, seems to be admirably suited for supplying anode current for any of the more popular circuit arrangements of the present day. It is for use


**Atlas H.T. eliminator with outputs arranged to suit the most popular modern circuits.**

with an alternating current supply, includes a valve rectifier, and is mounted in the neat type of olive green finished metal container which is always associated with the products of this firm.

Three voltage outputs are provided; the first, variable up to 100 volts, is regulated by means of a potentiometer, so it is quite suitable for supplying the screening grid of an H.F. amplifying valve. A fixed output of 120 volts is obtained through a series resistance, which can be

**Manchester Radio Show.—**

pressed into service for preventing anode circuit interaction when suitably connected to the receiver. Lastly, there is a main output tapping rated at 150 volts, 25 mA.

This eliminator costs £4 10s.; a similar model for D.C. mains, with the same arrangement of output terminals, is sold at £3 10s.

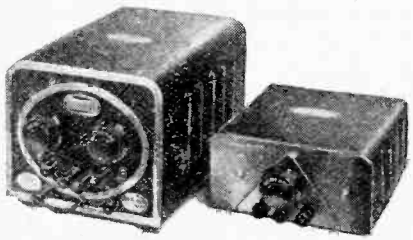
Atlas plug-in coils and Pirtoid coil formers are again exhibited, together with a new compression-type variable resistance, having a continuous adjustment between about 200 ohms and 1 megohm. This latter component is stated to be capable of dissipating 10 watts.

*H. Clarke and Co. (Manchester), Ltd., Atlas Works, Old Trafford, Manchester.*

### BEARDSALL. (2)

This company act as agents for Regentone products, well known for "radio-from-the-mains" components and accessories.

A large number of A.C. and D.C. eliminators are being shown, also combined chargers. For those who have replaced their ordinary filamented valves by the type with indirectly heated cathodes and who already have an H.T. eliminator, there is a filament transformer available at 12s. 6d., giving an output of 4 amps. at 4 volts. Separate filament and anode mains transformers have a certain amount to be said in favour of them, on the score of regulation.



**Two Regentone eliminators. (Left) W2A type. (Right) WIC type. Exhibited by Beardsall.**

The Regentstat is a British-made non-wire-wound continuously variable resistance with a dissipation not to exceed 10 watts. It does not contain graphite and mica, and it is claimed that it does not "pack"; the price is 7s. 9d.

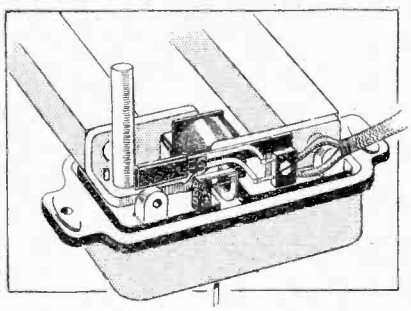
The W.I.C. eliminator for A.C. mains at £3 15s. represents good value for money. A Westinghouse copper-oxide rectifier and liberal filtering equipment are included. The total output at 120 volts is 18 mA., which is delivered from two tappings, the first of which is variable, allowing for the feed to a screen-grid valve. The W.2A eliminator is an elaborate unit, selling at £7 15s., and capable of giving 50 mA. at 160 volts. There are three tappings, two of which are variable; the unit is thus suitable for feeding a set having an S.G. valve and an anode bend detector.

A range of power chokes and mains transformers is being shown.

*W. E. Beardsall and Co., Ltd., 3-5, Victoria Bridge, Manchester.*

### BLUE SPOT. (30)

The Blue Spot loud speaker unit is too well known to require description here.



**Interior of the new Blue Spot movement.**

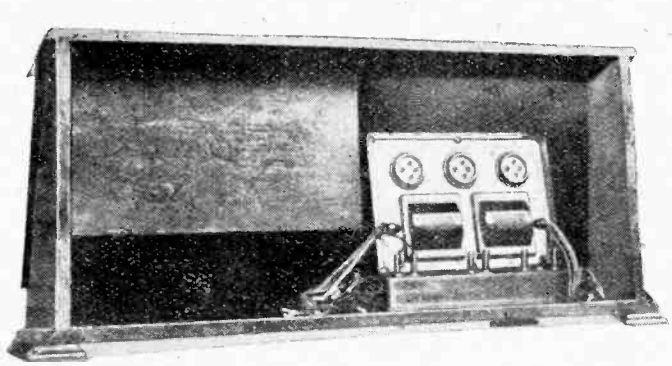
It is to be noted at the stand that a new model has made its appearance, known as the Type 65K. While externally resembling previous models, it has been modified to handle more input. The differential armature assembly provides for generous displacement and the winding has a resistance of 1,500 ohms. The impedance is given as 10,000 ohms at 1,000 cycles, and the winding has a mean D.C. current-carrying capacity of 25 mA. One appreciates the concise information given in the four-page pamphlet which accompanies the unit. This describes in a very practical way the building of two forms of cone loud speaker.

*H. C. Rawson (Sheffield and London), Ltd., 100, London Road, Sheffield. (F. A. Hughes and Co., Ltd., 204-206, Great Portland Street, London, W.1.)*

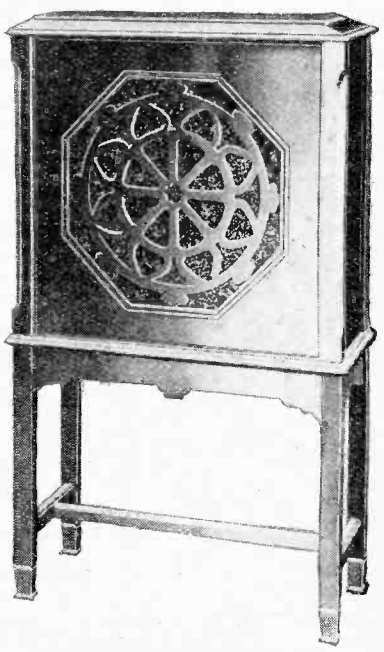
### BROWNIE. (38)

A three-valve receiver that is proving popular is the Dominion Console which, complete with self-contained loud speaker but without valves or batteries, is priced at £9. The three-valve receiver amplifier is built as a single moulded unit carrying three terminals for aerial and earth connections, terminals for gramophone pick-up, as well as a pair of terminals for connecting an external loud speaker. As the components are completely protected the back of the instrument is left open, which probably gives an advantage as regards the performance of the loud speaker, this being a 12in. cone driven by an adjustable 4-pole balanced armature.

*Brownie Wireless Company of Great Britain, Ltd., Nelson Street Works, Mornington Crescent, London, N.W.1.*



**Interior view of the Brownie Dominion Console receiver showing the unit construction of the amplifier.**



**The Celestrola loud speaker. A moving-coil model, manufactured by Celestion.**

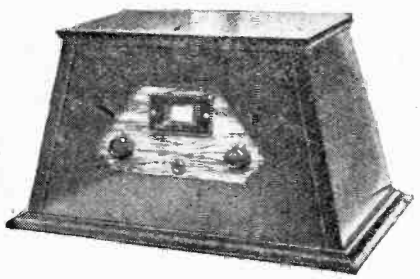
### CELESTION. (42)

The loud speakers made by this firm need little introduction to readers. The well-known "C" type have been reduced in price; the "C12," for instance, is now £5 12s. 6d. A new series has been introduced this season, known as the "Z" class; the reinforced diaphragm is retained, but there is a new electro-magnetic movement which it is claimed gives an even wider frequency response than that in former models. The "Celestrola" (erroneously called the "Celestroda" in our Olympia report) is a moving-coil instrument capable of

**Manchester Radio Show.**—

giving a very large acoustic output. There are a number of models with suitable field design for D.C., A.C., or battery operation, and in each case the speech coil is centred by three flexible metal strips.

*Celestion, Ltd., London Road, Kingston-on-Thames.*

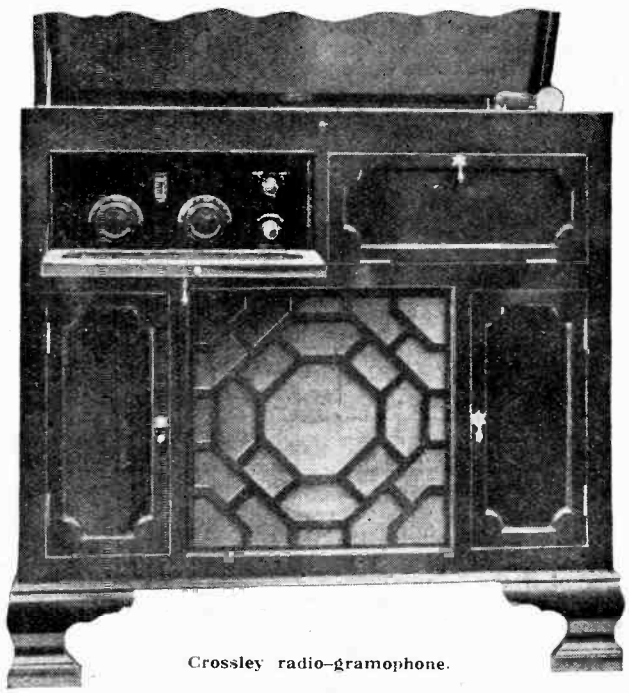


**The new Climax Chelloset. A two-valve all A.C. mains-operated receiver.**

### CROSSLEY. (89)

The Crolectro 4-valve radio-gramophone, besides being a beautifully finished piece of furniture, will delight the heart of the student who follows the latest trend in radio technique. The gramophone equipment includes a B.T.H. electric motor and pick up, the latter being switched into the detector grid circuit. The whole set derives H.T., L.T., and bias from A.C. mains, and, except for the output stage where raw A.C. is used (a common practice to-day), valves with indirectly heated cathodes are employed. The outside aerial is coupled by a double circuit to a Mazda AC/SG valve, which in turn is coupled to the anode bend detector (a Mullard 164 V.) by a Litz 3in. transformer with a small step-up ratio. No reaction is employed, and the screening in three planes is very complete. The volume control for both radio and gramophone is a variable resistance across the primary of the input push-pull transformer which directly follows the detector. Two Mazda P.650 valves are coupled to a Rice-Kellogg moving-coil speaker by means of an output push-pull transformer. A separate Westinghouse metal oxide rectifier provides grid bias and avoids the necessity of elaborate anti-motor-boating devices. The instrument is built on sound lines and contains those fine points in design which make for high sensitivity and good quality of reproduction.

*Geo. Crossley and Son, Ltd., 4, South Street, Manchester.*



**Crossley radio-gramophone.**

### DUBILIER. (33)

Practically every component necessary for the construction of a wireless receiver is manufactured by this company. In addition to the well-known comprehensive range of condensers with both mica and paper dielectric, also anode resistances, R.C.C. units, chokes and grid-leaks, there is being marketed this season a series of dry-cell H.T. batteries known as the "Superior" and "Supreme" types. The recommended load for the former is 6, and the latter 16mA. The life curve submitted by the makers shows a drop to only 0.8 volts per cell after 1,000 hours. The 108-volt battery of the "Superior" series, for instance, costs 12s. 9d., whilst the 60-volt "Supreme" model is 13s. 6d.

The new all-mains 3-valve receiver can be obtained for D.C. or A.C. supplies at £25. The aerial and interstage inductances are toroidal transformers, and although the detector works on the anode bend principle, reaction is used and applied to the interstage coupling. The valves in order are AC/SG, AC/HL, and AC/P, and the rectifier is a U.30/250. A purchaser of the D.C. model can have it converted to A.C., when his mains supply is changed, for the sum of £6.

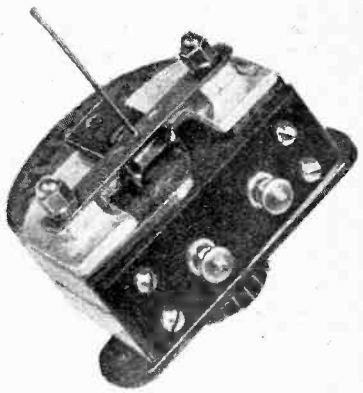
**Dubilier 3-valve receiver for A.C. mains.**

*Dubilier Condenser Co.* (1925), *Ltd., Ducon Works, Victoria Road, North Acton, W.3.*

### DYNOMAG UNITS. (121)

Among the components shown is a new cone unit working on the balanced-armature principle, and a large range of Mansbridge condensers of high-voltage test for eliminators.

A series of well-designed permanent magnets made by Swift Levick are exhibited. There are also a number of grid leaks and anode resistances, having wire end-connectors, thus enabling these components to be suspended in the wiring without the use of holders and clips.



**Cone unit shown by Dynomag Units, Ltd.**

*A. M. E. Sherwood, 68, Hatton Garden, E.C.1.*

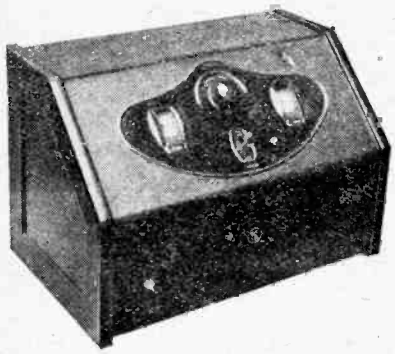
### EDISWAN. (27 and 28)

(Incorporating B.T.H. and Metro-Vick.)

In view of the fact that this stand contains the radio products of three well-known firms, there are such a large number of sets and components that space

**Manchester Radio Show.**—forbids the description of more than a few. The reader is referred to the Olympia Stand-to-Stand report. The new Mazda valves, which have remarkable characteristics, are being exhibited. Perhaps the most striking member of this series is the AC/SG valve, in which the inter-electrode capacity has been lowered to what would appear to be the irreducible limit of 0.0045 mmfd. Such minute feed-back occurs through the valve that the coils on either side of it (i.e., grid and anode) can be made of so small a high-frequency resistance that the valve does not oscillate until a stage amplification of about 250 times is attained. This figure, when compared with a maximum of about 60 with screened valves of last year, is very striking.

The 215 S.G. is a battery-fed screened valve with which it is possible to obtain a stage amplification of about 150 with stability if the external screening is carried out with great care.



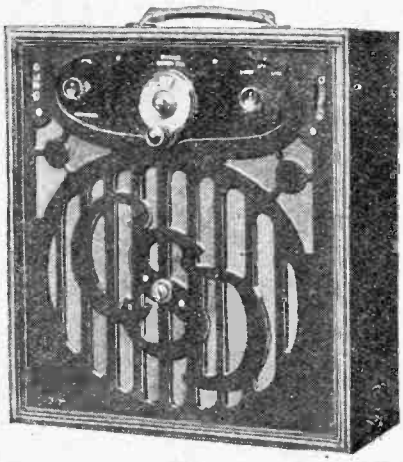
Ediswan 3-valve battery receiver.

The two-volt battery valves, one of which has a mutual conductance approaching 4 mA. per volt, should prove popular both for the portable set and for the man who has to carry his L.T. accumulator any distance to the charging station. There are new Mazda pentodes and a range of indirectly heated cathode valves for every position in a receiver.

The all-mains receivers merit the careful attention of prospective set buyers, as their design is the result of the combined resources and experience of the Ediswan Company, the B.T.H. Company, and Metro-Vick Supplies. A three-valve battery-operated receiver, selling at the popular price of £9 12s. 6d., has interesting points in design and incorporates the Mazda 215 S.G. valve.

*Edison Swan Electric Co., Ltd.*, 123-125, *Queen Victoria Street, E.C.*4.

Ediswan 3-valve all-electric receiver.

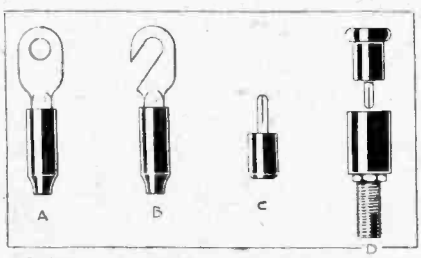


Dunham transportable receiver.

## EELEX. (101)

Besides distributing the products of well-known radio manufacturers, this company exploits a number of components of their own. A shock-proof eliminator terminal in which contact is made within a countersunk insulator should find considerable application now that so much attention is being paid to all-mains equipment.

There is a treble-duty terminal to take every variety of spade and pin connector; also a series of split-eyelet connectors so




Eelex connectors. (A) Eyelet type. (B) Slotted eyelet. (C) Midget wander-plug. (D) Shock-proof eliminator terminal.

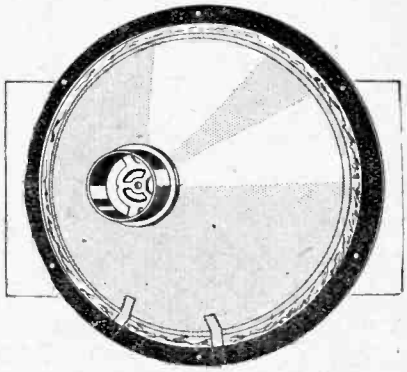
fashioned as to make it difficult for the terminal and the wire leading to it to part company, even if the holding-down screw has become loose.

For portable sets, where space is limited, a midget wander plug being shown should prove useful.

*J. J. Eastick and Sons, Eelex House*, 118, *Bunhill Row, E.C.*1.

## EPOCH. (103)

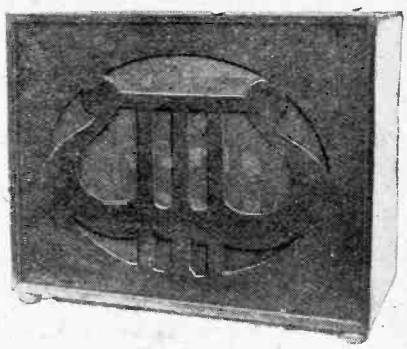
Since the Olympia Show an addition has been made to the range of Epoch loud speakers by the production of the Model 99. The usual form of edge suspension is here dispensed with, and instead locating pieces are provided. The freedom thus obtained largely removes resonances within the cone itself. The surround is, however, effectively sealed



The new Epoch free-edge cone as fitted in the Model 99 loud speaker.

to prevent air leakage between the two faces of the diaphragm.

Moving-coil loud speakers of the permanent magnet type and remarkable for



A popular priced loud speaker cabinet with grille at back and front (Epoch).

their high flux density are attracting the attention of those who seek quality but have no mains supply

The well-arranged interior of the Metropolis portable. It is a five-valve super-heterodyne produced by the Empire Electric Company.

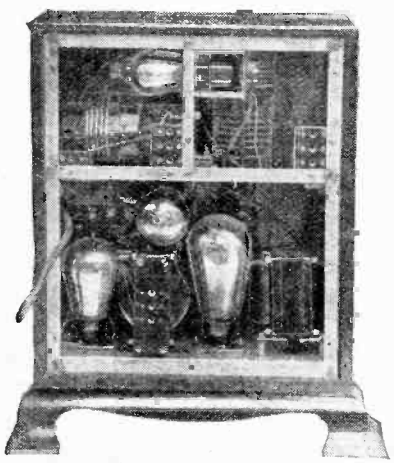
**Manchester Radio Show.—**

Loud speaker cabinets in various grades with or without loud speaker are available in a wide range of prices covering all requirements.

*Epoch Radio Manufacturing Co., Ltd., 3, Farringdon Avenue, London, E.C.4.*

### FERRANTI. (52, 53 and 115)

In view of the recent detailed description given in respect of the range of Ferranti products shown at Olympia, mention need only be made here of new items of interest.

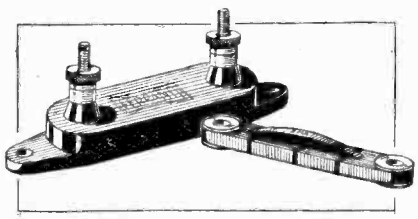


**Interior view of the new Ferranti mains-operated receiver.**

The Ferranti A.C. mains receiver Model 31, while now being shown in a new and attractively finished form of cabinet, may be carefully inspected as to its interior make-up. Liberties have not been taken in the direction of cheapening the construction of this complete receiver, and the specialised Ferranti components are of standard form. In the tuned circuits associated with the indirectly heated screen-grid valve we find coils carried on slotted ribbed formers. An interesting detail is the adoption of a Bowden wire coupling to rotate the reaction coil. As a long-range receiver leaky grid detection is provided, maximum amplification being produced by the use of the newly introduced AF6, an intervalve transformer with a 1 to 7 ratio, and which is actually larger than the well-known AF5. The output valve is a P.625, and is associated with a double ratio transformer permitting of the use of loud speakers having either high or low resistance windings. Grid biasing is obtained by an independent Westinghouse rectifier, the H.T. supply being provided by a valve rectifier, the U.5. Volume control is by adjustment of grid bias of the H.F. valve. A safety switch disconnects the current when the instrument is opened. The consumption from the mains is about 80 watts, and the undistorted signal output rating is 700 milliwatts.

Small mica condensers and high resistances of the grid-leak type now make their first appearance. The leaks, which are made of high resistance material, have a current-carrying capacity up to about 5 mA., and are available in the resistance values of 20,000 ohms to 5 megohms. These resistances, which are not easily broken, are accurately adjusted by reducing the cross section. Their price is 1s. 6d.

Apart from the new 1 to 7 intervalve transformer, which is specially intended



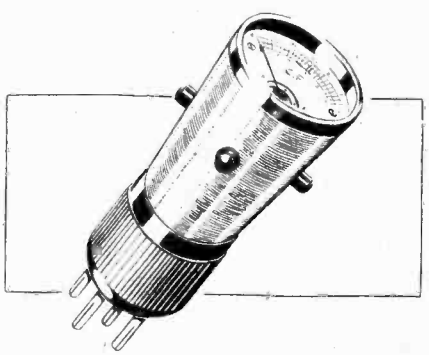
**Ferranti grid condenser and leak.**

for use following leaky grid detection, there are four eliminator transformers. Type P.10 gives (*a*) 4 volts 4 amps., (*b*) 6 volts 3.2 amps., (*c*) 45 volts at 5 milliamps. This transformer meets the popular demand for converting a set for mains operation. Price 32s. Type E.V.4, giving 250 volts at 50 milliamps when used with the U.5 rectifier. Price 25s. Type P.9, which, with a Westinghouse rectifier type A.3, will give a battery charging rate of 1 ampere, and is suitable for energising the field coil of a moving-coil loud speaker. Type M.3 has been introduced to suit the Westinghouse rectifiers types H.T.3 and H.T.4, and in connection with the condenser voltage doubling arrangement gives respectively 120v. 20 mA. and 180v. 30 mA.

*Ferranti, Ltd., Hollinwood, Lancashire.*

### FONTEYN. (130)

This firm are agents for several French and Belgian manufacturers, and are showing a quantity of apparatus which is of interest as being representative of present-day practice in those countries. The "Radio Controller" is a neat two-range voltmeter mounted on a standard valve base, the pins of which can be inserted in any of the valve sockets of a receiver.



**Fonteyn's "Radio Controller": a 2-range voltmeter with valve socket fitting.**

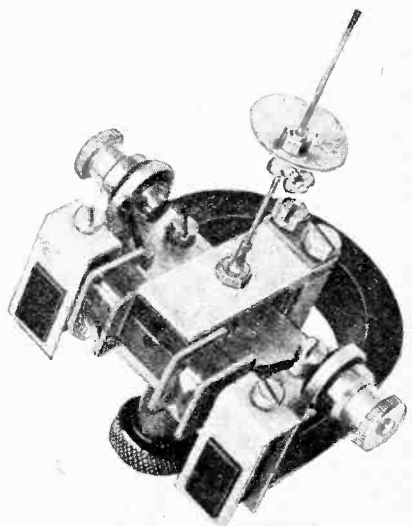
Push-button switches are so arranged that low-tension or high-tension voltages may be checked: of course, the reading of the latter will be affected by the ohmic resistance of whatever coupling component may be connected in the anode circuit, and will only be correct when dealing with a high-frequency amplifier. Nevertheless, any deflection of the needle will show continuity, and an accurate indication of voltage can readily be obtained if the anode coupling component is temporarily short-circuited, should it be of sufficiently high resistance to warrant this course.

A number of inexpensive low-frequency transformers, sold under the trade name of "Cifel" at prices between 3s. 6d. and 8s. 6d., are also exhibited, together with ebonite panels, also exceptionally low in cost.

Messrs. Fonteyn are agents for meters made by the firm of Guerpillon and Sigogne, of Paris, and show a number of these instruments, both of the moving-iron and moving-coil type. There is also a gramophone pick-up supplied complete with adaptor for insertion into a detector valve socket: this instrument is provided with a variable damping control.

Other exhibits include a trickle charger with an indicating lamp acting as a fuse, in which a Westinghouse metal rectifier is used, and also a larger model for service stations. There is also a combined H.T. and L.T. charger with valve rectification, selling at £4 10s. complete.

*Fonteyn and Co., Ltd., 2, 4. 5 and 6, Blandford Mews, Baker Street, London, W.1.*



**G.E.C. Stork loud speaker unit.**

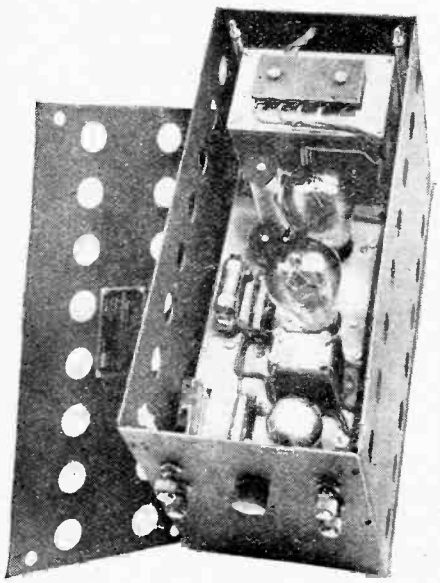
### G.E.C. (48)

Apart from the new Osram valves which have recently been described in detail in these pages, the principal exhibit is the Screen-Grid Four Portable. The model shown is finished in Cambridge blue, and its equipment includes the use

**Manchester Radio Show.—**

of both screen-grid and generous output valve. This portable is priced £24 3s.

For those wishing to build an inexpensive loud speaker there is the Stork loud speaker unit as fitted in Gecophone loud speakers. An interesting device shown is a power amplifier unit for use with A.C. supply. This is intended for connection to the radio receiver in lieu of an existing amplifier or, alternatively, it will convert a standard gramophone to one of the electrically reproducing type. It is all-metal enclosed and has a particularly generous output valve, the LS6A, while its rectifier is the U.8. This mains-operated amplifier is intended for operating a moving coil loud speaker.



**Mains-operated amplifier for use following a detector valve or gramophone pick-up (Gecophone).**

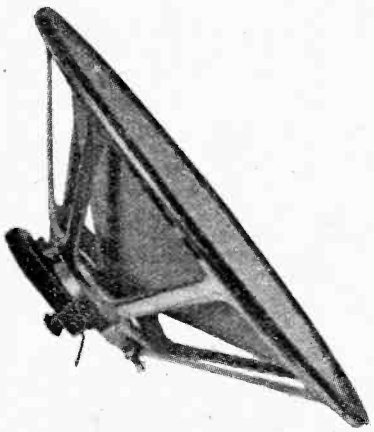
Home constructors are showing a keen interest in the Music Magnet receiver, a detailed description of which recently appeared in these pages.

*General Electric Co., Ltd., Magnet House, Victoria Bridge, Manchester.* (*Magnet House, Kingsway, London, W.C.*2.)

### GILMAN. (113)

With the help of such labour-saving components as are shown by this company, it is possible for the home-constructor to make a complete loud speaker in a comparatively short time and for a small outlay. There are available two aluminium chassis, one with an 18in. "Power" cone, and another with the standard 11½in. cone, to which can be fixed by three-point suspension a plate so shaped as to be attached easily to all the well-known cone units on the market. The three-point attachment allows perfect centring. The periphery of the metal chassis is drilled to enable the complete unit to be screwed to a baffle or cabinet, and a felt washer is interposed to reduce the chances of resonance. The edge of the cone floats on a supple fabric suspension. The smaller cone unit with adjustable plate sells at 15s. 6d., and the large power model at 22s. 6d.

*J. S. Gilman*, 63, *Basinghall Street, E.C.*2.



**Gilman 18-inch cone assembly.**

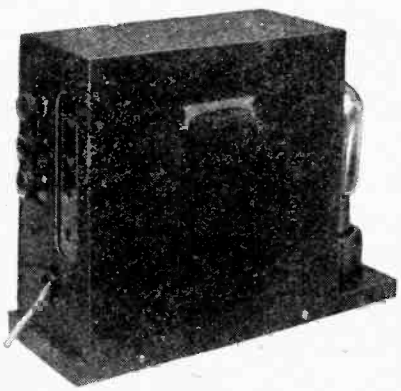
### GOLTONE. (16)

As in previous years, a large part of this stand is devoted to radio wire and battery cord assemblies; among the latter is a connecting cable just produced for the Mullard "Orgola" receiver.

The Goltone five-valve portable set embodies a fairly conventional 2-v-2 circuit, but its frame aerial is built into a hinged flap forming a rear cover, so that it can be set for direction without swinging the receiver as a whole.

A combined H.T. and L.T. eliminator has just been introduced. This instrument, which is for operation on A.C. mains, makes use of a Philips double-wave rectifying valve, and has rated filament and anode supply outputs of, respectively, 2½ amps. at 4 volts, and up to 150 volts at 35 milliamperes.

The Goltone radio-gramophone includes a Mullard "Orgola" receiver (A.C. mains model), an electric turntable motor,



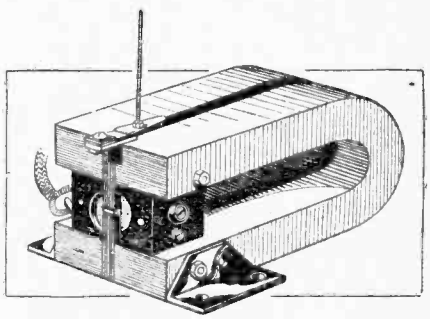
**Goltone H.T. and L.T. battery eliminator.**

B.T.H. pick-up, and Mullard loud-speaker. There is an extra control for regulating the volume of gramophone reproduction.

*Ward and Goldstone, Ltd., Frederick Road, Pendleton, Manchester.*

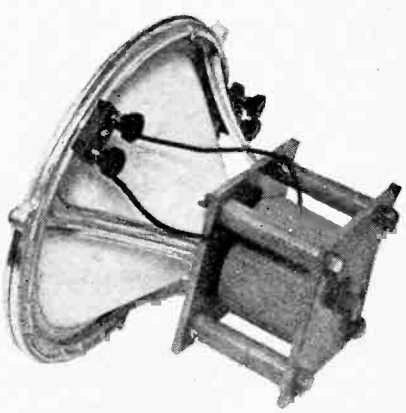
### GOODMANS. (84)

Several entirely new models are to be seen, in particular the "Invincible" moving coil loud speaker which follows the end-plate form of construction. By this means it is all-steel built, permitting of high flux density, while the winding is well ventilated. With the use of a particularly small gap and positive centring adequate flux density is obtained when a winding requiring only 50 mA. at 100 volts is used. Such a winding may serve as a smoothing choke.



**Goodman balanced-armature loud speaker movement. The adjustable feet provide an easy fixing.**

The Goodman differential loud speaker movement is unique in the use of a pair of particularly large magnets of generous cross-section. Four extension poles are presented to the neutral armature, which is surrounded by a 2,000-ohm bobbin. The drive is transmitted to an auxiliary reed. Adjustable and reversible feet



**New type Goodman moving coil speaker.**

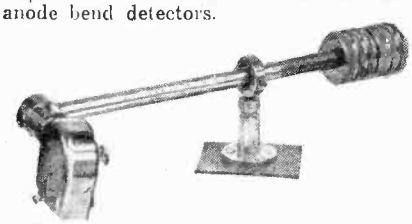
permit of the unit being mounted in a variety of positions to suit most requirements. The price is 29s. 6d

*Goodmans*, 27, *Farringdon Street, London, E.C.*1.

### GRAMO-RADIO. (93)

The chief exhibits on this stand, besides a series of radio gramophones, are

**Manchester Radio Show.**—a range of "Coruso" reed-driven cone loud speakers built into attractive cabinets. There are also a number of eliminators for A.C. mains, provided with voltage tappings suitable for the critical requirements of screened valves and anode bend detectors.



**Gramophone tone arm with adjustable balance weight, shown by Gramo-Radio Co.**

A gramophone pick-up and tone arm with adjustable balance weight which can be locked, should assist in reducing record wear.

*Gramo-Radio, Ltd., Commercial Works, Church, Accrington.*

### GREEN and CO. (75)

A range of Sure-a-lite dry batteries is shown on this stand. High-tension units are made in four capacities, the largest being capable of supplying currents up to 25 mA. Grid bias batteries of conventional dimensions are manufactured, as well as units with voltages up to 30, in square form, which are more economical of space, and consequently suitable for mounting inside the cabinet of receivers with high-power output valves demanding a considerable negative bias.

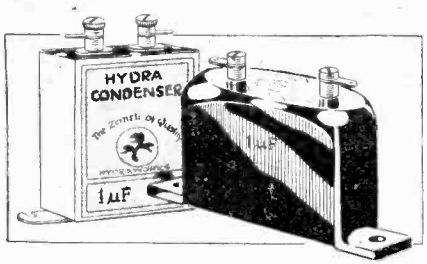
The new Telsen L.F. transformers, described in our Olympia Show Report, are also exhibited, as are several well-known sets in which these components are included as standard.

There is also a display of the new Cleartron valves with improved coated filaments.

*Green and Co., 94-96, Hurst Street, Birmingham.*

### HOLZMAN. (57)

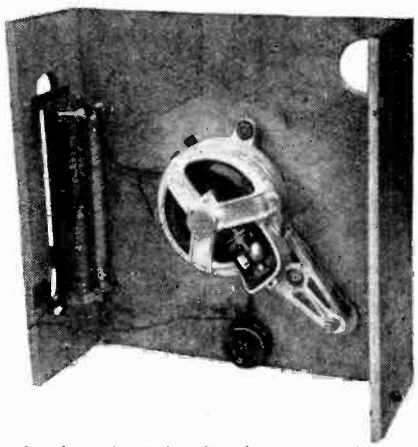
With the large stage amplifications now obtainable with screen-grid valves, it is becoming more and more evident that con-




**(Left) One mfd. Hydra condenser in metal case. (Right) Non-inductive condenser in bakelite case (Holzman).**

densers to be used in decoupling schemes must have a low high-frequency resistance, that is to say, a good power factor. Thus, it is interesting to note that this firm are showing a range of Hydra paper-dielectric condensers with capacities from 0.001 to 4 mfd. with non-inductively arranged foil. In bakelite cases and with a working voltage of 240 D.C., the price of the lowest capacity condenser already referred to is 1s. 6d., while the 4-mfd. type is 5s. Where surge voltages considerably greater than the nominal voltage of the supply mains are encountered, particularly in D.C. eliminators, the Hydra series of condensers tested at 1,000 volts D.C. for an A.C. working voltage of 300 should find considerable application. The 2-mfd. condenser of this type retails at 4s. 9d.

There is being shown a vertical scale double-reading volt-milliameter. It is a moving coil instrument with a resistance of 250 ohms per volt and the scale readings are 0-240 volts and 0-60 mA. Besides having a minimum projection from the front of the panel, the meter should harmonise with thumb control tuning dials. The price is 22s. 6d.



**Insol universal electric gramophone motor, shown on Holzman's Stand.**

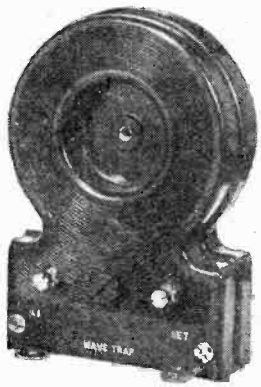
The Insol gramophone motor and turntable for A.C. mains contains a squirrel-cage motor which runs at 1,750 r.p.m. The drive is by rubber belt from a tapered spindle, and the speed is made variable by ±6 r.p.m. by means of a control which causes the belt to run on a larger or smaller diameter of the taper. It is claimed that the running is particularly silent. The price is £6. There is also a universal model for D.C. or A.C. supplies

Besides tapped condenser blocks, which it is now appreciated are more economical where eliminator smoothing filters are concerned, there is being marketed a double buffer condenser of 2×0.1 mfd. for shunting across the secondary of a mains transformer. Tested at 1,000 volts A.C., this component sells at 3s. 3d.

*Louis Holzman, 37, Newman Street, W.1.*

### IGRANIC. (50)

New components introduced since the opening of the Olympia Exhibition include a wavetrap, of which the coil and variable condenser (the latter of the compression type) are built into a brown bakelite moulding provided with feet so that it may be secured to the baseboard of an existing receiver.

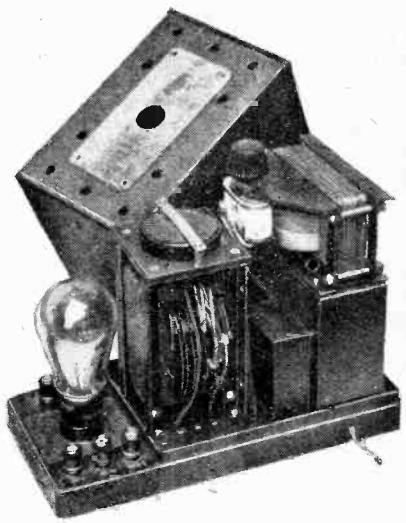



**Igranic wavetrap.**

The "Megastat" variable high resistance has been modified to render it more suitable for mounting in radio gramophones or for controlling volume in sets fitted for gramophone reproduction; it is now available in types having maximum values of 50,000 ohms, 500,000 ohms, 1 megohm, and 5 megohms.

Indigraph vernier dials are now fitted with a reduction gear giving a ratio of 15 : 1; the 4in. pattern has a slightly higher ratio.

A new battery charger, incorporating the Igranic-Elkon metal rectifier, has been introduced; it delivers current up to 3 amps. The same rectifier, working in conjunction with an electrolytic condenser, is used in an L.T. supply unit, which is suitable for supplying up to seven valves rated at 4 or 6 volts. Valve rectification is included in the new Igranic H.T. unit, which also supplies



**Igranic H.T. eliminator, which also supplies current for the heating elements of A.C. valves.**

**Manchester Radio Show.—**

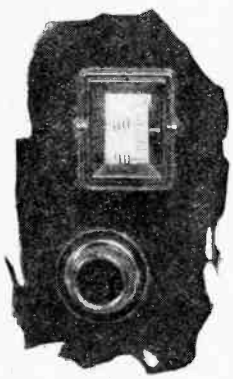
raw A.C. at 4 volts for feeding the heaters of A.C. valves.

The "Q.M.B." switch is intended for mains-fed receivers; it has wide-break contacts, heavy insulation, and an ebonite control knob.

*Igranic Electric Co., Ltd., Elstow Works, Bedford.*

### ISOMONO. (106)

A wide range of "Iso" dials are exhibited on this stand, including several new models. Some are provided with a catgut band drive, and several patterns have an illuminated scale; in one case the lamp is controlled by a neat and inconspicuous switch forming part of the



A neat Isomono drum dial with knob control.

escutcheon plate. These dials are manufactured in both drum and disc types, double and single, and their appearance when fitted is in keeping with modern tendencies.

There is also a very wide selection of imported components at most attractive prices. One of the most interesting is a wire-wound potentiometer of 30,000 ohms resistance, selling at 6s. 3d. This should be most useful in regulating eliminator voltage output, particularly for screen-grid valves.

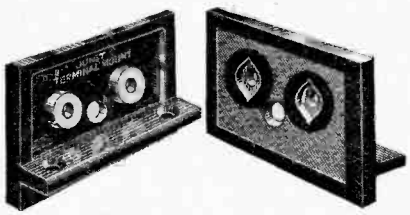
Wave traps are coming into prominence, and for the more efficient type it is customary to use a small inductance and a comparatively large value of tuning capacity. As variable condensers of more than 0.0005 mfd. are not readily obtainable, it is convenient to add a fixed shunt capacity, and the air dielectric components shown by this firm would appear to meet the case admirably. They are made in capacities of from 0.00005 to 0.001 mfd., and are extraordinarily compact and but little more expensive than the better type of mica-dielectric condensers.

Other components on show are chokes, power transformers, very small condensers, both with air and paxolin dielectric, fixed condensers, and trickle chargers with Kuprox rectifiers selling at 3Cs.

*Haw and Co., Ltd., 20, Cheapside, London, E.C.2.*

### JUNIT. (70)

A neat push-pull switch for metal panels is being shown. The spindle contains two bow-springs, which ensure good electrical contact without unduly impeding the movement of the plunger. There is another model available, in



The Junit vertical terminal mount with horizontal fixing flange.

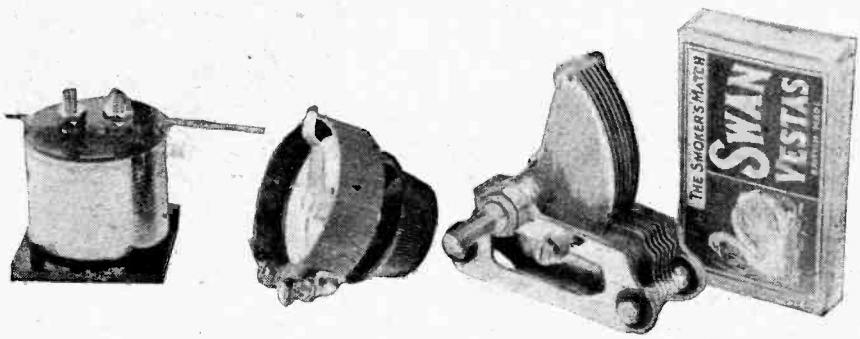
which all contact points are insulated from the spindle and fixing bush. The price of these switches, one of which is specified for the Mullard Orgola set, is 1s. 6d. A vertical terminal mount, sold at 8d., which has a right-angled drilled flange, is arranged to screw into the horizontal surface of a baseboard, and thus the danger of splitting is avoided.

There is also a universal 5-pin valve holder and a multiple contact switch.

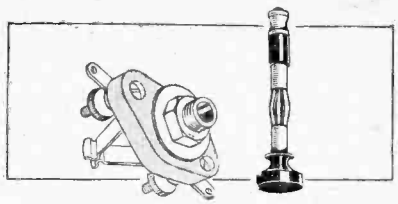
*Junit Manufacturing Co., Ltd., 2, Ravenscourt Square, W.6.*

### KOLSTER-BRANDES. (74)

For the new season this company has embarked upon the manufacture on a large scale of popular-priced receivers. As an example, the K-B 161 can be said to give good value for money. It is a 3-valve receiver entirely driven from

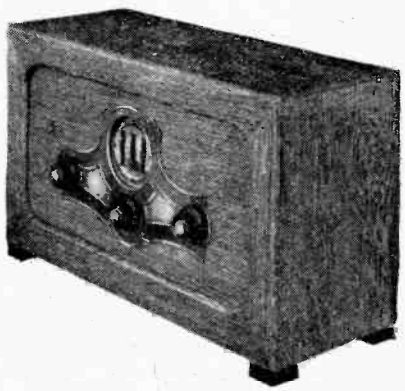



Some compact components shown by Haw & Co. From left to right: air-dielectric fixed condenser, 30,000 ohm potentiometer, and 0.0003 mfd. variable condenser.



Junit push-pull switch. Note the bow-springs on the spindle.

A.C. mains. A double-tuned circuit is employed, which makes for good selectivity, and greater sensitivity is obtained by the use of reaction on to the secondary of the high-frequency transformer, which links the AC/SG valve to the leaky grid detector. On the low-frequency side there is a transformer coupled pentode, the filament of which is hearted by raw A.C. The set is well screened and decoupled. The feed to the screen of the SG valve is through a potentiometer, which is in keeping with the best practice. A valve rectifier is used for the anode supplies and the "free" positive grid bias is obtained from a potentiometer across the H.T. Thumb controls are used and the receiver is housed within a well-finished oak cabinet. The price is £17 10s., including valves and royalties.



K-B 163 receiver; a Kolster-Brandes product at a popular price.

A battery model (the K-B 163), on the same lines, sells at the moderate figure of £10 15s. complete.

*Kolster-Brandes, Ltd., Cray Works, Sidcup, Kent.*

### LOTUS. (31)

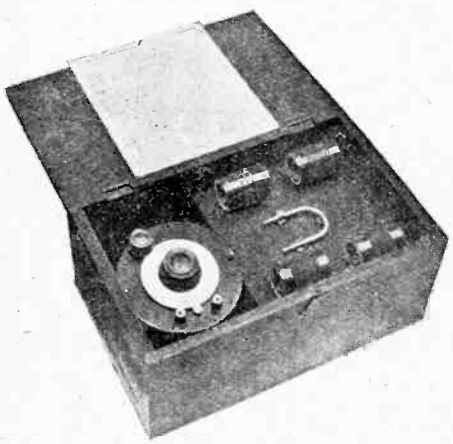
A carefully prepared folder showing the construction of the Lotus S.G.P. receiver is attracting interest. Its large constructional drawings show in precise detail the building of a well designed three-valve set. Wiring is simplified by full scale drawings showing the bending of every lead. The circuit is in every way up to date, including all those refinements appreciated by the enthusiast.

*Garnett, Whiteley and Co., Ltd., Lotus Works, Mill Lane, Liverpool.*

**Manchester Radio Show.—**

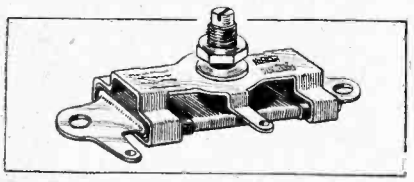
**CLAUDE LYONS. (95)**

The products exhibited at this stand principally include specialised components for the transmitting amateur, practical laboratory test gear for the manufacturer as well as generous amplifier equipment. The apparatus is mainly that of General Radio, together with a selection of components from the American market.



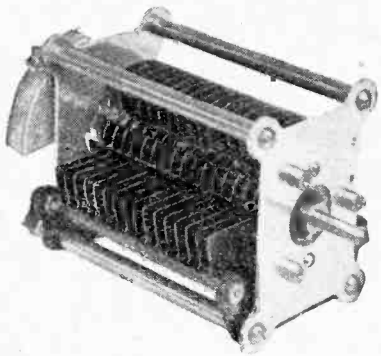
General Radio frequency meter on the stand of Claude Lyons, Ltd. This model has been specially introduced to meet the Post Office requirements governing the issue of transmitting permits.

For the transmitting amateur faced with the difficulties of conforming to Post Office requirements a special type of absorption wavemeter has been introduced. This instrument, type 558P, has

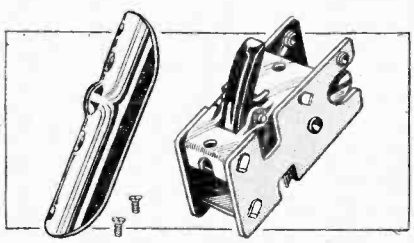


The "Hum Dinger" an adjustable potential divider for use in the construction of mains-operated sets. Shown on the stand of Claude Lyons, Ltd.

been approved by the Post Office, and will, in use, permit of an accuracy greater than the stipulated ±0.25 per cent. Its five scales have optimum frequencies of 5, 10, 20, 40 and 80. The price is £5. This instrument includes a special condenser which is also available as a component. By arranging for only a few of the plates of this condenser to produce a change of capacity it gives a particularly open scale over a limited range while maintaining a suitable L/C ratio. For the transmitting enthusiast also special condensers are shown primarily designed to



General Radio transmitting condenser. The losses have been reduced to a minimum to permit of its use on very short wavelengths. (Claude Lyons, Ltd.)



A useful catch switch for breaking the supply circuit on opening a mains connected receiver. (Claude Lyons, Ltd.).

possess minimum losses at the ultra high frequencies. These are specially intended for use in transmitting circuits, and are available in three capacities, 0.00005 mfd., 0.0001 mfd., 0.00025 mfd., the last mentioned selling at 35s.

Small components include Centralab and Clarostat products, while among bigger equipment is a specimen Pam speech amplifier.

*Claude Lyons, Ltd.*, 76, *Old Hall Street, Liverpool.*

**M.P.A. (21 and 22)**

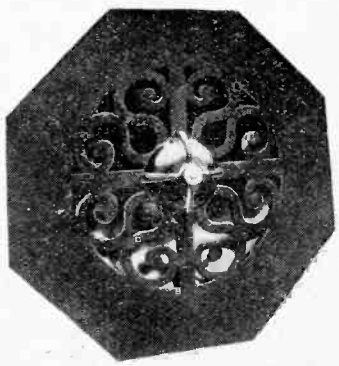
The "Ethatrope Exchange," an ambitious radio-gramophone combination, may perhaps best be described as a "next year's set." It includes an ingenious arrangement whereby a series of circuits tuned to any one of four stations—chosen by the purchaser—may be put into operation by manipulation of the appropriate switch. There is clear evidence that this simplified method of tuning already appeals to many listeners, and it is bound to be still more popular when the new scheme of alternative programme transmissions comes into being. It may be urged that the buyer of a comparatively elaborate set will think himself justified in demanding a wider choice of stations; this objection is adequately met, in the case of the receiver in question, by providing a switch for disconnecting the automatic tuning device, thus allowing of operation in the normal manner.

Indirectly heated valves are fitted in this set, which is intended for an A.C. supply; the variable condensers tuning the circuits associated with its two H.F. couplings and the frame aerial are completely "ganged." The detector is followed by two L.F. stages, with parallel output valves. A moving coil loud speaker is built into the base of the large gramophone-style containing cabinet, which also accommodates the medium- and long-wave frame aerials; these are mounted at right angles, the whole assembly being rotated by means of an edgewise drum protruding through the side.

Provision is made for connection of one or more external loud speakers, and a microphone can be used for addressing large audiences.

The new A.C. transportable sets are completely self-contained except for a connection to an electric supply. Four indirectly heated valves, including one high-frequency amplifier, are used.

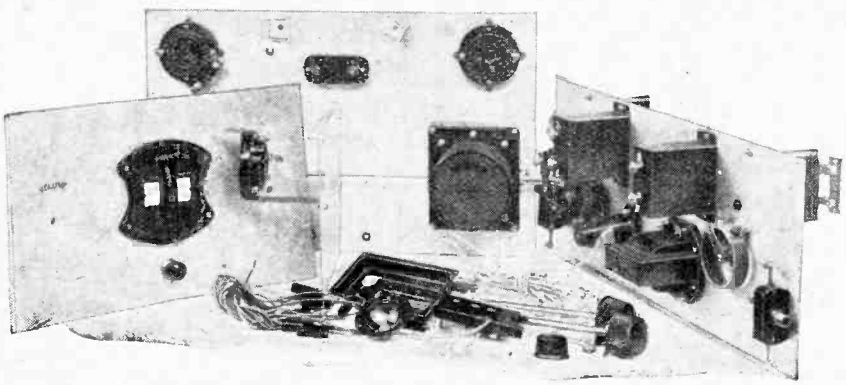
*M.P.A. Wireless, Ltd., High Road, Chiswick, London, W.4.*



New Marconiphone Octagon cone loud speaker.

**McMICHAEL. (54)**

As at Olympia the McMichael "Super Range Portable Four" is the principal



Garnett Whiteley Kit Set. The components are supplied assembled as shown here so that the constructor is only required to carry out the wiring.

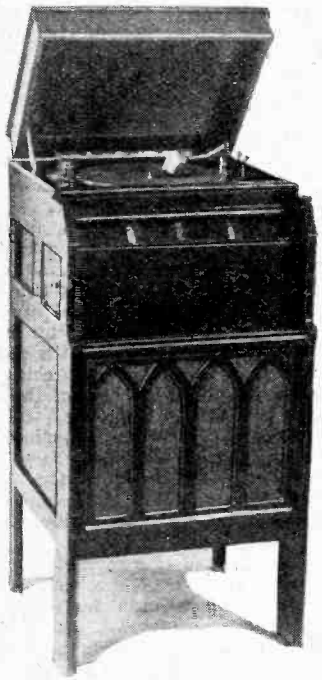
**Manchester Radio Show.—**

exhibit here. An exposed chassis shown at this stand reveals the interior construction which, to those who are acquainted with the performance of this set, satisfies the inducement to carefully study the principles involved.

*L. McMichael, Ltd., Danes Inn House, 265, Strand, London, W.C.2.*

### MOORES. (8)

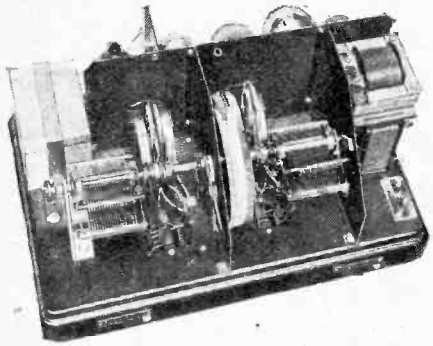
An interesting exhibit on this stand is a radio-gramophone including a Philips Type 2514 receiver—an H.F.-det.-pentode all-mains set for operation on an A.C. supply, with which many readers will be



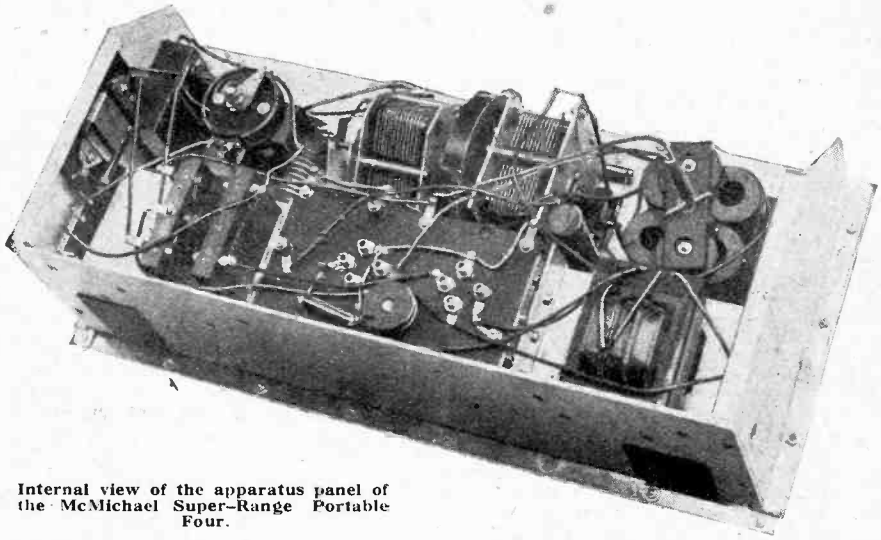
**Moores' radio-gramophone cabinet, which includes a Philips set.**

familiar. The gramophone turntable is rotated by a Garrard double-spring motor, and an external volume control is provided. A cone loud speaker is built into the base of the cabinet; an Ormond instrument is customarily fitted, but any other pattern can be supplied to order.

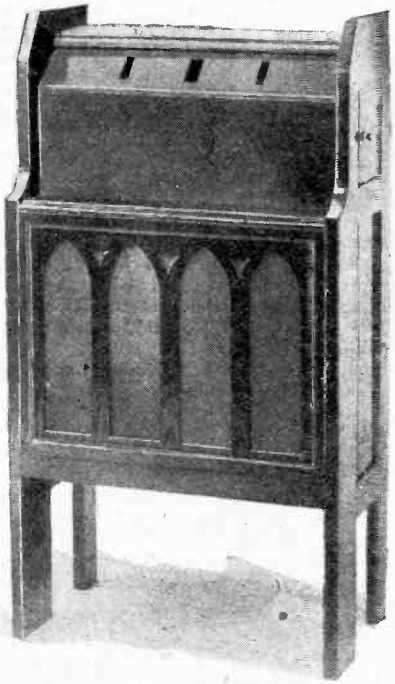
This instrument is sold complete at £45; those who already own a Philips set may obtain the cabinet ready wired and fitted in such a way that the receiver may be mounted in position and connected up by the veriest novice; this fitted gramophone cabinet costs £22 complete—except, of course, for the receiver itself.



**Pressed metal chassis of the Marconiphone Model 47 A.C. receiver.**



**Internal view of the apparatus panel of the McMichael Super-Range Portable Four.**



**Upright cabinet for Philips' 3-valve A.C. set shown by J. Moores and Co.**

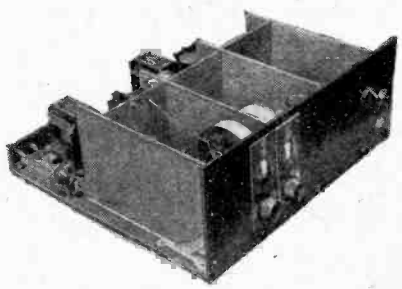
Another upright cabinet, of similar design but of reduced depth, is arranged to take the above-mentioned Philips set, but has no gramophone turntable. There is ample room in the base for any make of cone loud speaker.

*J. Moores and Co., Ravald Street Works, Salford.*

### NORTHERN STEEL and HARDWARE CO., LTD. (104)

Wholesale distributors to the trade of the products of well-known manufacturers such as Philips, Marconi, Mullard, Amplion and Cossor. A representative range of receivers, loud speakers, and eliminators is to be seen on this stand.

*Northern Steel and Hardware Co., Ltd., 1-3, Southgate, Deansgate, Manchester.*



**Mullard Orgola Senior receiver.**

### OLDHAM. (43)

While having been described in detail when they were exhibited at Olympia, mention might again be made of the Oldham auto-power units. These instruments function as L.T. and H.T. battery eliminators, but are, in fact, batteries that are automatically recharged. They can, therefore, be used with any receiving set without trouble or complication. Units are available for use with A.C. or D.C. supply, and their adoption renders a set virtually all-mains operated.

*Oldham and Sons, Ltd., Denton, Manchester.*

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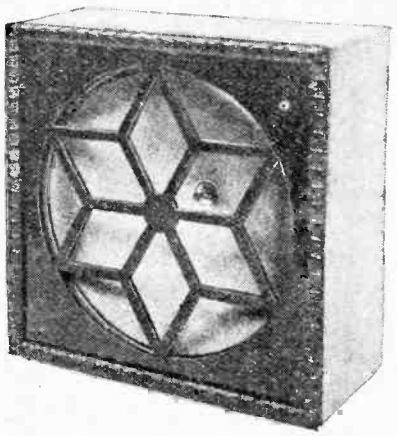
### ORPHEAN. (6)

The chief products of this company are cone loud speakers. The smaller speaker, housed within a cabinet 11in. square, contains a 9in. cone partly concealed by an oak grille; it is marketed at the popular price of 30s. Another model embodies a 9in. cone attached at its periphery to a square bakelite plaque with a burr walnut finish. The whole speaker is so constructed that it can hang from the picture rail or stand on the table. The price is 29s. 6d.

A plug and jack connector for loud speaker connection in a house wiring scheme is exhibited; it has the advantage that the insertion and withdrawal of the plug is nearly parallel and not at right-angles to the wall of the room. This renders the whole component inconspicuous.

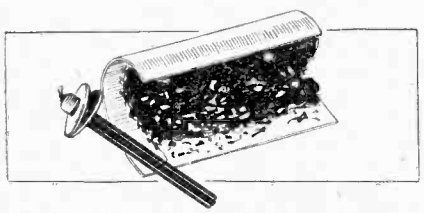


**Orphean popular cone speaker. (London Radio Manufacturing Co.).**

*London Radio Mfg. Co., Ltd., Trafalgar Works, Station Road, Merton Abbey, S.W.*19.

### PERTRIX. (37)

It can safely be said that the percentage of listeners who have an electric lighting supply in their houses is below 25; the number of sets, therefore, still relying on batteries for their anode supply must be exceedingly large. The special depolariser and electrolyte used in the Pertrix batteries is said to prevent chemical action from continuing after the load is removed; furthermore, it is claimed that as the cells drop in voltage the internal resistance does not rise, this state of affairs being brought about by the hardening of the depolariser, which does not increase its resistance with age.



**Pertrix battery cell showing the grooved carbon and sacless depolariser.**

There is a representative range of radio batteries exhibited from the 9-volt bias type to the heavy-duty H.T. batteries capable of giving a 30 milliamp. discharge. The 60-volt battery of the popular type, selling at 8s., has been tested in *The Wireless World* laboratories and found to have a useful life of about 470 working hours when the initial discharge is 8 mA.

A feature of interest, especially in connection with portable sets, is the provision of a number of 1½-volt tappings at the negative end to enable grid bias to be taken from the H.T. battery.

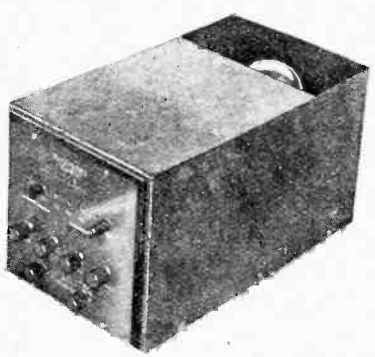
*Pertrix, Ltd., Britannia House, 233, Shaftesbury Avenue, W.C.*2.

### PETO-SCOTT. (45)

This firm, which specialises in the supply of complete sets, kits of parts, and accessories, either for cash or on the deferred payment system, are showing a singularly well-chosen assortment of the better makes of apparatus.

There is also to be a kit of parts for an ambitious six-valve receiver with three tuned H.F. stages. Although a complete model had not arrived at the time of visiting the stand, the chassis assembly of four variable condensers for this set was examined with great interest. Each condenser is rotated individually by means of its own control knob, but all are coupled together through worm gearing so that they may be operated simultaneously; there is a slipping clutch fitted to each condenser spindle. This is a promising development of the semi-gang control principle, and is obviously applicable to any set with two or more tuned circuits.

*Peto-Scott Co., Ltd., 77, City Road, London, E.C.*1.



**Philipson A.C. battery eliminator. It has a valve rectifier, while terminals are provided for supplying current to indirectly heated valves.**

### PHILIPSON. (123)

The activities of this company are devoted exclusively to the production of H.T. battery eliminators for use with A.C. and D.C. supply. It is understood that the various voltages are obtained by the potential dividing method, while the A.C. models adopt valve rectification. These eliminators are well finished and all-metal enclosed and sell at popular prices.

*Philipson and Co., Ltd., Astley Bridge, Bolton.*

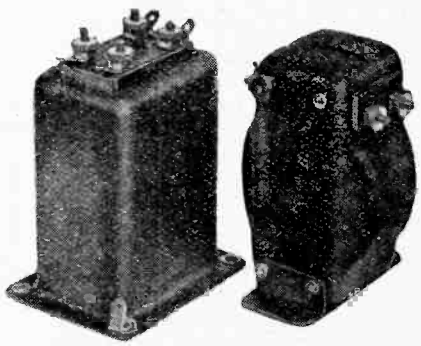
### POTTER. (62)

Manufacturers and wholesalers of ebonite sheet, known as "Parfait." Moulded ebonite to various requirements can now be undertaken on a new plant just installed. Ebonite sheet is being shown with six different surfaces, namely, matt, black, polished various mahogany finishes, and a cube surface.

*H. B. Potter and Co., Ltd., Station Buildings, Rochdale.*

### PYE. (51)

The Pye radio-gramophone, of which details were not available for our Olympia Show Report, is an interesting example of modern practice. It is an A.C. mains set with two H.F. stages (one tuned and one aperiodic), and a detector followed by resistance- and transformer-coupled L.F. amplifiers. The apparatus is completely self-contained (except for a mains connection), the internal frame aerial being rotated by a knob mounted near the record turntable. There is a "local station damper," and the built-in loud speaker is of the moving coil type.



**New Pye L.F. transformers.**

Pye receivers, Type 460 and Type 350—the first for batteries or D.C. mains and the second for A.C. supplies—have already been described, and are well worth examining, if only because they go to prove that up-to-date high-efficiency circuit arrangements can be embodied in sets produced on a manufacturing basis.

A National Physical Laboratory curve is issued with respect to the new low-priced Pye L.F. transformer, and shows an exceptionally good performance for a component sold at only 12s. 6d. Another transformer with a mu-metal core, has a shroud of the same material which, it is stated, is effective in preventing induction troubles, particularly in all-mains receivers.

*Pye Radio, Ltd., Paris House, Oxford Circus, London, W.*1.

### RADIOVIM. (94)

This company operates a battery hire and maintenance service, and delivers low- and high-tension accumulators to residents within ten miles of either Manchester or Liverpool. Full details of the service are given in a booklet issued on the stand; as an indication of cost, it may be stated that a freshly charged 30

**Manchester Radio Show.—**

ampere-hour two-volt cell is supplied once a fortnight for a shilling.

*Radiovim, Ltd., Sandford Street, Ancoats, Manchester, and 24, The Elms, Dingle, Liverpool.*

### REDFERN. (24)

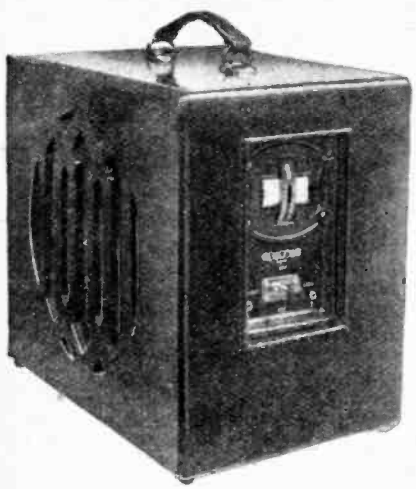
Two new types of ebonite coil formers have been introduced since the Olympia Exhibition. One of these has a mean external diameter of 3in. with nine deep ribs (approximately ½in.), and, as in the case of the earlier 6-ribbed product of this firm (which, by the way, is still available), is particularly suitable for use in the construction of section-wound coils of almost ideal proportions; the extra ribs make for easier winding and for a better looking and slightly more efficient coil.

There is also a new former with a diameter of 2½in. and six ribs.

*Redfern's Rubber Works, Ltd., Hyde, Cheshire.*

### RIALTON. (117)

The Melva transportable 5-valve receiver contains an interesting and unconventional circuit. There are three



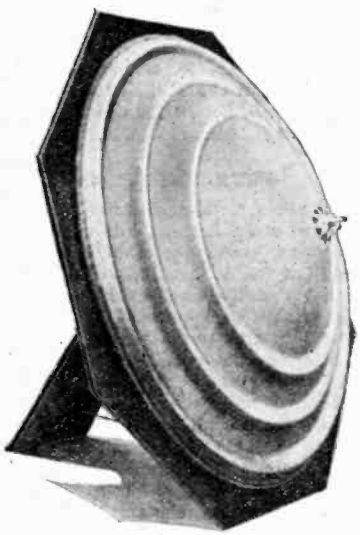
Rialton 4-valve S.G. portable.

screen-grid valves in a modified superheterodyne arrangement, whereby a good measure of H.F. amplification is got without the necessity of elaborate screening. The first screened valve acts as a separate oscillator and the second and third valves are coupled as intermediate frequency amplifiers with aperiodic transformers. There is only one detector, which is coupled to a pentode output valve. The S.G. portable set, selling at 19 guineas, is extremely compact, and is one of the smallest 4-valve sets on the market. Its dimensions are 15in. × 9in. × 10in. The first valve—a screened valve—is aperiodically choke-coupled to a triode which in turn is aperiodically coupled to the leaky grid detector. There is one L.F. valve—a pentode. The set is well finished in polished grained oak, and has a small recess on one side in which the drum dials are placed.

*Rialton Radio, 21A, Barbican, E.C.1.*

### RIDGED CONE COMPANY. (96)

A complete reed-driven cone loud speaker at 25s. and its two essential components—the magnetic unit and the fabric cone—are being exhibited on this stand. The cone, which is seamless and sells at 3s., has three prominent ridges, which it is claimed assist in strengthening and allow the cone to vibrate as a whole over the normal range of frequencies.



Cone assembly by the Ridged Cone Co.

The "R.C." unit, selling at 13s. 6d., has four large magnets with laminated poles and an adjustable reed. The D.C. resistance is 2,000 ohms. The twin-transmission regional scheme will demand the cutting down in length of outside aerials; in fact, in a great many cases it will probably be necessary to use indoor aerials. With this in view the Ridged Cone Company have produced a number of complete indoor aerial equipments with insulators, etc., selling at popular prices.

*Ridged Cone Co., Ltd., York House, Southampton Row, W.C.1.*

### RITHERDON. (108 and 109)

Metal cabinets constructed on the lines suggested by contributors to these pages are exhibited by this firm. A container for *The Wireless World* Kit Set is a replica of that used in the original model, and is of suitable size to accommodate any of the conventional H.F.-det.-L.F. circuits. Channels are provided along the lower edges of the metal cover, and are arranged to engage with strips forming part of the base. This affords a good electrical joint, as, thanks to careful workmanship, all clearances are small. Sealing should be sufficiently good for any type of circuit likely to be set up in this size of cabinet.

A similar method of construction is employed in building the larger type of cabinet used for the Kilo-Mag Four, Record III, and 1930 Everyman Four sets. Due to the fact that the screening cover is considerably larger, and has three crosswise partitions, clearances of the base joints are of necessity somewhat larger, and in cases where an exceptionally high magnification is aimed at it might be necessary to provide additional sealing, say by placing lengths of springy metal braid in the channels.

These cabinets are thoroughly well made, and the metal work is nicely finished in rosewood, walnut, dark oak, or imitation leather.

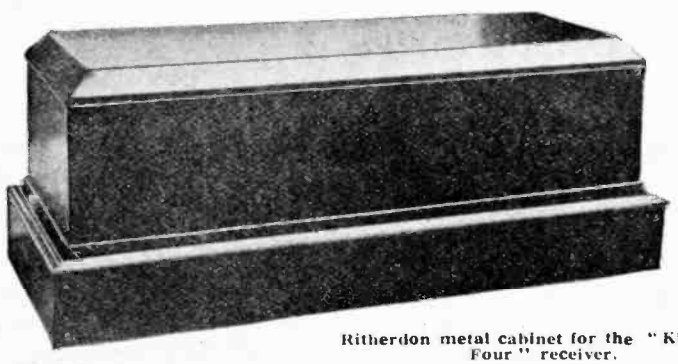
The large and small containers cost, respectively, £2 6s. 6d. and £3 in wood finish, and a few shillings less in imitation leather.

A large number of other metal containers are exhibited, including a neat inexpensive box with a horizontal partition, which would be suitable for a two-valve all-mains receiver.

*Ritherdon and Co., Ltd., North Bridge Mill, Deansgate, Bolton.*

### ROYAL RADIO. (86)

A mains-operated three-valve transportable receiver (H.F.-det.-L.F.) has been introduced since the Olympia Show.



Ritherdon metal cabinet for the "Kilo-Mag Four" receiver.

This set includes a built-in loud speaker and frame aerial, and has provision for a gramophone pick-up. An external aerial may be used if desired. Models for A.C. or D.C. supplies are each priced at 28 guineas.

All the receivers shown at Olympia are available, and the radio-gramophone has been improved by fitting a moving coil loud speaker.

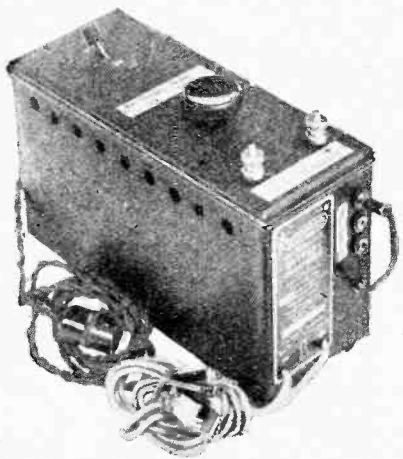
*Royal Radio Company, 4 and 5, Dorset Mews North, Upper Gloucester Place, London, N.W.1.*

Manchester Radio Show.—

### RUNBAKEN. (127)

In view of the increasing interest in radio-from-the-mains, the series of automatic and semi-automatic battery chargers and testers exhibited should have considerable appeal.

The Ardwick charger contains a vibrator rectifier and, for H.T., sells at 49s. 6d. A charging rate as high as 350 mA. can be maintained. The combined L.T. and H.T. instrument is marketed at 95s., and is capable of giving 3 amps. at 6 volts. It should find application to car as well as radio accumulators. The automatic charger for A.C. is designed to remain permanently in circuit with the mains supply, the set and the L.T. accumulator. As soon as the radio set is switched off, the charger automatically comes into



Runbaken automatic charger.

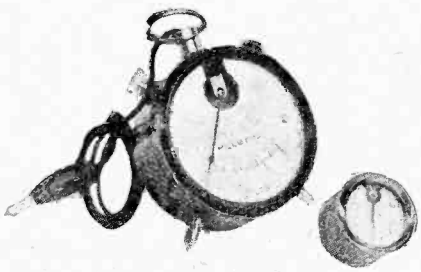
action, and vice versa. The battery is thus kept in a healthy condition by reason of the taper charge given to it. The price is 75s. A semi-automatic type, which is not interposed in the L.T. switch circuit of the set, costs 65s. There is a variety of chargers with dry copper-oxide rectifiers.

An unbreakable hydrometer in which the float-spindle is guided by a thin horizontal drilled washer to prevent surface tension effects with the inside wall, should provide a means of measuring specific gravity accurately. Battery testers to give reliable results should first place a load across each cell before reading voltage. In fact, the best indication of the state of charge is obtained by noting the no-load to full-load voltage ratio. With the Runbaken tester a 12-amp. load is taken from small accumulator cells, whilst for car starting batteries experience shows that a cell is in good condition if it reads 1.5 volts at a load of 200 amps. This company is also showing loud speaker and telephone magnetisers.

*Runbaken Magneto Co., Tipping Street, Ardwick, Manchester.*

### SIFAM. (11)

A new pocket volt-milliammeter with ranges suitable for the average domestic receiver and selling at 10s., should prove of interest to readers. The 15-volt range is for L.T. and bias measurements, while the 150-volt and 50 mA. scales will cover normal anode requirements. There is available a new range of baby meters for

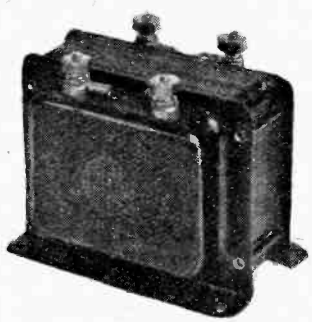


(Left): New Sifam pocket volt-milliammeter. (Right): Miniature milliammeter measuring only 1in. diameter.

flush mounting, which measure in diameter only one inch. It is remarkable that such a large amount of material can be got into such a small space. There are only ammeters and milliammeters in this series with centre-zero marking for charging purposes. The price of each model is the same, namely, 7s. 6d.

A new moving coil meter, with knife edge pointer, is being put on the market, and there is also available a hot wire instrument especially suitable for measuring heater voltages for indirectly heated cathode valves. For valve filament protection a new type of radio fuse is being shown. The fusing points are from 150 mA. to 6 amps.; they are sold at 1s. 3d. and 1s. The eliminator voltmeter with a resistance of 100,000 ohms, and known as the "Elimeter," is being retained for the coming season.

A 3 to 1 L.F. transformer, called the "Hevicore," and selling at 17s. 6d., is among the exhibits; it is stated to be suitable to follow valves having an impedance not exceeding 25,000 ohms.



Sifam "Hevicore" L.F. transformer.

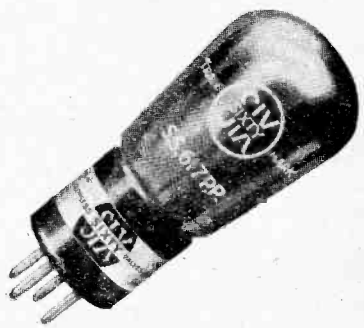
Besides the special meters referred to, there is a comprehensive display of moving coil and moving iron meters with conventional scale readings; there is, in fact, on this stand a meter for every radio purpose.

*Sifam Electrical Instrument Co., Ltd., Bush House, Aldwych, W.C.2.*

### SINQUERS. (124)

Long life from accumulators is only obtained if careful attention is paid to maintaining the specific gravity of the electrolyte at the correct value. Charge indicators showing a rough value of the acid density are provided by specially constructed pellets known as "Sinquers," the red and blue coloured varieties of which sink at different states of discharge of the cell into which they are dropped. A pellet of each colour dropped into a fully charged accumulator will float on the surface of the acid, but if the cell is half discharged the red ball only will float, while the blue will sink. Should both balls sink the battery requires an immediate charge.

*Fiddian, Bawtree and Co., Gem Works, Oakhill Road, Sutton, Surrey.*



Six-Sixty power output valve.

### STANDARD INSULATORS. (71)

A new material for panels has just been introduced by the Standard Insulator Company. It consists of a bakelite base coated on each side with a veneer of wood—birch, walnut, or mahogany—the whole being subjected to a bakelising process which imparts a highly finished glossy surface, and, what is perhaps more important, improves its electrical properties. It is stated that panels can easily be drilled, tapped or machined, and specimens on the stand show that it can be engraved in the ordinary manner.

In appearance, these panels are indistinguishable from real wood—indeed, there is no reason why they should be, as the visible part is actually wood. The new material is known as Hivoltsit Veneer Bakelite, and is stated to withstand an average pressure of 13,000 volts per millimetre thickness. Its resistance per cubic centimetre is given as $1.48 \times 10^{12}$ ohms. It seems probable that these panels will find a ready application, particularly in the construction of high-grade receivers where good appearance is considered to be essential.

*The Standard Insulator Co., Ltd., Winsley House, Wells Street, Oxford Street, London, W.1.*

### STOTT. (125)

The "Pegasus-Scout" portable receiver, of more or less conventional design, should have a performance well above the average; its layout is exceptionally neat

**Manchester Radio Show.—**

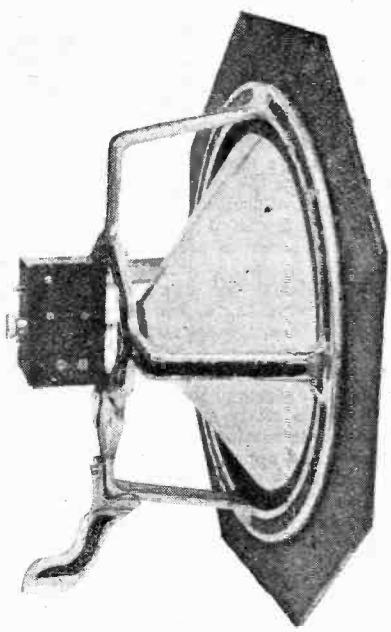
and workmanlike, and all the components used in its construction are of high grade. Its anode circuits are decoupled—a refinement not yet by any means universal in sets of its class—and in consequence there is but a single positive lead to the H.T. battery.


**The Pegasus portable receiver with back cover removed.**

Provision for a gramophone pick-up is included, and an upright cabinet with grille front, turntable, pick-up arm, and space for the receiver is also supplied, in order that the set may be converted into a radio-gramophone. The fitted cabinet costs 13 guineas, while the receiver itself is priced at 17 guineas.

This firm are Northern agents for the Mic Wireless Co., of Wellingborough, and are showing specimens of the new "Zampa" components and accessories described in our Olympia Show Report.

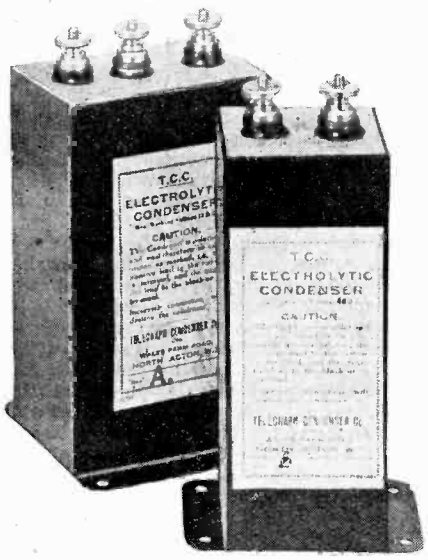
*J. E. Stott*, 15, *Clare Hill, Huddersfield.*



**The Squire aluminium cone cradle. This is exhibited as an octagonal hanging lamp shade with bead fringe.**

### T.C.C. (83)

In addition to the wide range of fixed condensers for every purpose in a radio set, there has been introduced this season a single type electrolytic condenser for a maximum working voltage of 40; the minimum capacity is 500 microfarads, and the price £1. The electrolytic condensers shown are of the dry polarised type, and must be connected to the correct poles. The importance of good power factor, especially in condensers which have to by-pass H.F. energy in a divided circuit, is not being overlooked by this company, who are spending much time in research on non-inductive connection of condenser foils.



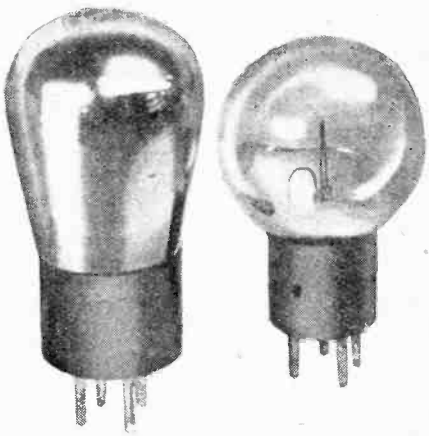

**T.C.C. electrolytic condensers for L.T. eliminators.**

A range of tapped condenser blocks for eliminators is to be seen on this stand. The company are to be congratulated on having been chosen by the B.B.C. to supply a number of high-voltage smoothing condensers for the new station at Brookman's Park.

*Telegraph Condenser Co., Ltd., Wales Farm Road, North Acton, W.3.*

### TUNGSRAM. (10)

Pamphlets available at the stand give complete technical data of the valves made by this well-known lamp manufacturing concern. Among the details given it is interesting to note the inclusion of anode conductance (reciprocal of impedance) as well as power output in milliwatts. While the range of valves is very extensive, it does not, as yet, include the screen-grid and pentode types. As a gauge to the performance of these valves one might take a typical L.F. type such as the P.215. Passing 0.15 ampere at 2 volts it has an amplification factor of 5 with an impedance of 3,300 giving a mutual conductance of 1.5 mA/v. Among 6-volt power valves there are the P.615 and P.614. The former has an amplification factor of 10 with an impedance of



**Specimen Tungsram power valve and photocell.**

3,300 ohms, and the latter an amplification of 6 with an impedance 1,900, so that the mutual conductance in each case reaches the high figure of about 3 mA/v. These valves are priced at 7s. 3d. and 8s. respectively. The range includes directly and indirectly heated valves for use with A.C. supply. As an example in this class we might take the general-purpose valve A.G.4100. Like other valves the heater unit takes 1 ampere at 4 volts, and the amplification factor is 16 with an impedance of 8,000 ohms, giving a mutual conductance of 2 mA/v. The price of this valve is 8s. 6d.

Much interest is now being taken by amateurs in the experimental use of photocells, and shown at the stand is the Tungsram "Nava" cell. It is a sodium cell of the hard variety, and is therefore stable. An interesting feature is the provision of a filament within the cell. This is used in the process of forming the sodium coating, though in normal use the filament is not heated, but is used as an anode. The wavelengths of light to which this cell responds represent a band between violet and orange, while another cell is available covering the spectrum from the blue to the red. The prices of these cells are 50s. and 57s. 6d. respectively.

*Tungsram Electric Lamp Works (Great Britain), Ltd., 72, Oxford Street, London, W.1.*

### TUTILL. (14)

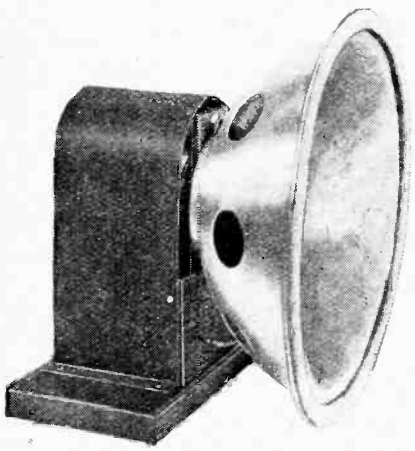
There are several new and interesting products to be seen on this stand. Perhaps the most ambitious is the "Tinol" radio-gramophone, which is supplied for operation on A.C. or D.C. mains. It includes a five-valve receiver working with an external aerial, with one high-frequency valve, detector, and two L.F. stages with push-pull output. The two circuits are tuned by a Utility balancing condenser, reaction control is on the differential principle, and there is

**Manchester Radio Show.**—a volume control operative on both radio and gramophone reproduction.

An unusual refinement is the provision of a tone control; with the regulating lever at the normal position no correction is applied to the amplifier, but movement to either side introduces a degree of attenuation of the bass or treble as may be desired.

This instrument is fitted with a moving coil loud speaker, and is supplied either in a walnut or mahogany cabinet at £65 for A.C. and £55 for D.C. supplies. Extensive precautions are observed towards the prevention of low-frequency reaction.

In spite of its extremely low price—the battery and D.C. models cost but £2 19s. 6d.—the Liberty moving coil loud speaker is well constructed and designed on sound lines. An easily adjusted paper "spider" is provided for centring, and the cone is supported by a surround of closely woven fabric, stated to be unaffected by climatic changes. As a step-down transformer is mounted in the base the instrument as supplied is complete and ready for mounting in a cabinet or on a baffle board. An A.C. model, with Westinghouse rectifier and electrolytic smoothing condenser, is sold for £5 15s.



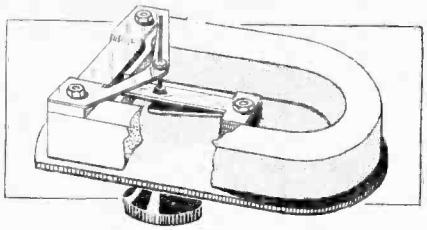
**The Liberty moving coil loud speaker.**

The "Kukoo" loud speaker drive unit, manufactured by the Sheffield Magnet Co., is also exhibited. This promising component is of exceptionally heavy and solid construction, and employs two large cobalt steel magnets.

*Tutills, Ltd.*, 7-9, *Swan Street, New Cross, Manchester.*

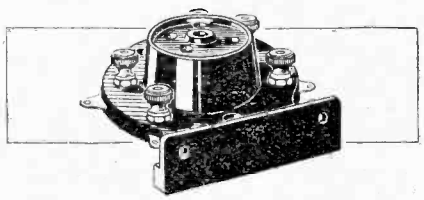
### W.B. (7)

While the mounting of loud speakers in large moulded bakelite housings is a common practice, the new W.B. cone speaker, which is built in a bakelite case, is distinctive. It is probably the only bakelite mounted loud speaker of the "clock" design and its grained moulding gives a finish superior to that of polished wood, and is, of course, infinitely more durable. The bakelite back plate supports the adjustable differential reed movement. In spite of the generous use of bakelite the price of the complete speaker is 42s.



**Interior of the W.B. balanced-armature loud speaker movement. The cover is of moulded bakelite.**

For the home construction of an inexpensive cone loud speaker the balanced-armature movement is available for 12s. 6d. Double-ended extension shoes are attached to the poles of a cobalt steel magnet, and the armature is neutrally set through the axis of the bobbin.



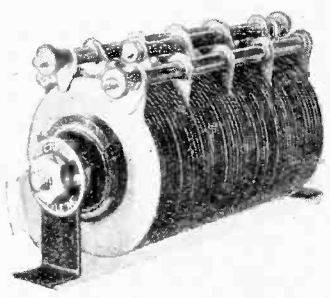
**The new W.B. valve holder for side or baseboard mounting.**

W.B. five-pin valve holders are well known to readers, and a modified pattern has now been introduced which, by means of a side plate, provides for horizontal or vertical mounting. The feature of W.B. valve holders is the expanding nickel-silver leg sockets. Like the circular pattern valve holder the price is 1s. 3d.

*Whiteley, Boneham and Co., Ltd., Nottingham Road, Mansfield, Notts.*

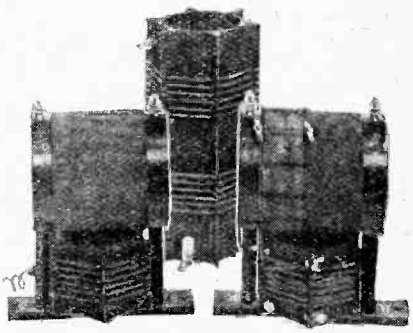
### WESTINGHOUSE. (78)

Besides the H.T.1 and H.T.2 metal rectifiers, which have been reduced in price and the L.T. chargers and trickle chargers, there have been introduced for this season two new units for H.T.



**Westinghouse A.4 rectifier, giving 2 amps. at 9 volts.**

The H.T.3 is a half-wave instrument giving a voltage of 120 when the maximum load of 20 mA. is applied. Such a rectifier is useful for kit sets having a screened valve followed by leaky grid detector and triode output. The transformer feeding the H.T.3 should not give more than 140 volts on open circuit. The H.T.4 rectifier is designed to be used in a voltage doubling bridge circuit with two 4 mfd. condensers (if the capacity is less the output is considerably reduced). Although the transformer for use with this rectifier must not develop more than 135 volts, the D.C. output is about 180 volts 30 mA. There is thus a step-up irrespective of the transformer. The H.T.4 gives full-wave rectification and sells at 37s. 6d.



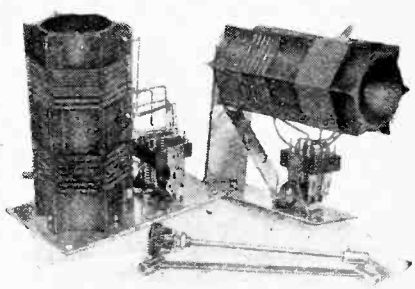
**Coils for the 1930 Everyman Four (Wright & Weaire).**

The A.4 unit, giving 2 amps. at 9 volts, is capable of charging large wireless batteries and is quite useful for car batteries.

*Westinghouse Brake and Saxby Signal Co., Ltd.*, 82, *York Road, King's Cross, N.1.*

### YAGERPHONE. (85)

Portable receivers and radio-gramophones are the chief products of this firm. The majority of these instruments are for all-mains operation, as much attention being paid to D.C. as A.C.



**Coils with switches incorporated for "The Wireless World" Kit Set. (Wright & Weaire).**

As an example of a moderately priced radio-gramophone for use with an outside aerial, mention should be made of the "Popular" model for battery operation, at £28 10s. There are three valves, arranged as two L.F. resistance stages following a regenerative leaky grid detector. This circuit allows of simple one-dial tuning. A cone speaker is built into the base of the cabinet and is hidden by an ornamental grille. There is a spring-driven Garrard gramophone motor with automatic stopping device. The cabinet work of the radio-gramophones exhibited is superb.

*Yagerphone, Ltd.*, 28, *Charlotte Street, E.C.2.*

# RADIO in the FAR WEST

By OUR CANADIAN CORRESPONDENT.

"RADIO" and "The Air" are our names for the broadcast transmissions, and I should say they are as good as any; although it is said by some that, in the late presidential election in the U.S.A., Governor Smith, the unsuccessful candidate, lost a number of votes because he spoke of the "*Raddio*"!—so powerful is the influence of the ether.

Here in British Columbia, away up country, we are within reach of a really large number of broadcasting stations both Canadian and American; but our mountain ranges and our lakes run for the most part north and south, so it is the American stations that come in best. Our Canadian stations lie east and west of us. Calgary, in the province of Alberta, comes in fairly well; Vancouver only sometimes. If, therefore, we want an evening's straightforward radio, we switch on to one of the American stations; and that means Salt Lake City, Seattle, San Francisco or Los Angeles.

We are a very English community here in the Okanagan Valley, so that if you know anything at all of English people out of England you will know that we are very strong in our likes and dislikes, and when we have been listening, say, to a whole winter's programme from these American stations, it will be readily understood that "things are said" I think we are very grateful for the really marvellous range of programmes provided for us, and I have never once heard anything from any of the big American stations that could cause a moment's discomfort or uneasiness to the man who listens-in this side of the border. The programmes are arranged by the various mercantile corporations, and they are essentially a means of advertisement. The nature of the broadcast and the amount of advertising matter will therefore vary according to the character of the firm or the corporation.

Some of the best things are put on by the banks and by the powerful oil companies; and a very few words about the bank's business, or about the advantages of the oil, are all that accompany the symphony concerts which are the speciality of these institutions.

But they all have their turn, even down to So-an-So's pickles, a particular line of underclothing, or the This-and-That washing machine. Quite a small experience of radio will make you wary! You are listening, may be, to the "Venusberg" music from "Tannhäuser," beautifully rendered; the "Pilgrim's Chorus" is to follow; but before that begins the announcer must give you a cute little dissertation on the merits of X's soap, taking it for granted that there is no other kind of soap in the world, and that you certainly have never enjoyed a decent "wash" unless you have come across this particular brand. This is quite legitimate advertising, no doubt; but you listen to the "Pilgrim's Chorus," when it does come on, with a vague feeling that you have got a dirty neck.

The kind of English spoken by the American announcers is not of the quality which you hear from 2LO. If not exactly infinite in their variety, the voices are greatly diversified, and we all have our favourites. There is the voice with a smile, that is cheering to hear for a few nights, but which palls dreadfully after a time. There is the pained, hurt and aggrieved voice, as of a man having to read his own death sentence; and there is a voice for every stage between these extremes. Only very rarely do we hear the soft Southern drawl which in itself is perfect music.

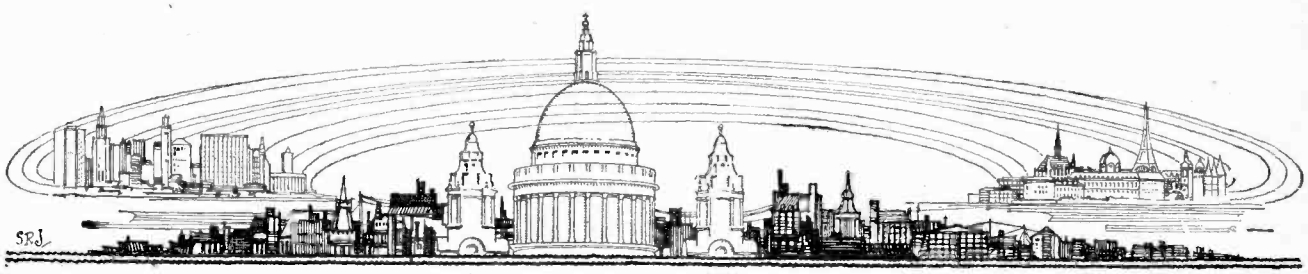
This past season we have suffered from a superfluity of soprano singers. Some are good and worth listening to; others, many others, are neither good nor worth listening to; and it is sad to hear courtly and gallant old gentlemen switching off in disgust and muttering threats and slaughterings against "these squawking females." Indeed, these sopranos are so rife that many of us would prefer a saxophone, than which no more powerful indictment could be framed.

But our greatest grumble is that the announcer will not leave our poor intelligence alone. We are not allowed to listen to a Chopin's Nocturne without being told who Chopin was (presumably it *is* he who is meant by "Show-pang"), and we must be informed what a nocturne is. And then, perhaps, we are told that we are to hear "Nocturne," by Chopin—as though he wrote one only!

To have our intelligence improved in this way is bad enough; it is worse when our emotions are got hold of and straightened out. For instance, they are going to play a Minuet of Beethoven's, but before we get to it we are told what our reactions should be to "this piece," and so stereotyped is this kind of advice that in nine cases out of ten a man may safely wager that he will hear, at least once, phrases such as "delicate cadences," "swinging lilt," "felicitous movement," "swaying rhythm," "charm," "romance," "quaint." These grumblings, after all, amount to very little in comparison with the abundance of the musical feast provided by the many stations we tap here in the North-West.

The most impressive broadcast I ever heard was late on the last night of the Old Year, when New Year messages were being sent out from the Edmonton Station to listeners-in away up among the isolated settlers and officials in the Yukon and the North-West Territories, close by the Arctic Circle. Many a heart-ache must have been lifted that night when those lonely people heard over the radio the names of their home-folk who remembered them.

The Spirits of the Air fulfil their kindly mission nowadays, not only in fairy-tales but in real life.



# CURRENT TOPICS

## Events of the Week in Brief Review.

### HIGH POWER BROADCASTING IN IRELAND.

Following the B.B.C. example, the Irish Free State Postal and Finance Departments are considering the erection of a high power broadcasting station in Athlone. It is not yet clear whether the Athlone station will supersede those at Dublin and Cork, but it is certain that it will be designed to include practically the whole of the Irish Free State in its service area.

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### MOTOR CAR WIRELESS.

A time when every car will carry a receiver, if not a transmitter, is suggested by the news that the Radio Corporation of America and General Motors have organised a new concern, known as General Motors Radio Corporation, for the manufacture of motor car wireless sets.

Wireless may soon be an indispensable "gadget."

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### WHY CRIMINALS HATE WIRELESS.

The increased use of wireless by Scotland Yard has been carefully watched by the French police. In the coming Budget funds will be specially allocated for the erection of a wireless station in Paris to link up with the frontiers, ports and provincial police stations.

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### THE STORY OF THE VALVE.

A talk on "The History of the Thermionic Valve" will be given from the Dublin broadcasting station at 10.30 p.m. on October 30th by Mr. H. A. Donisthorpe, of the General Electric Co., Ltd.

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### RADIO BEACON'S SUCCESS.

The new Air Ministry rotating wireless beacon at Orford Ness, Suffolk, has proved so successful that, as from Sunday last, October 20th, the beacon works continuously throughout the 24 hours instead of from 6 a.m. to midnight. The revised timing will continue for two months.

The Trinity House observers state that out of 21 observations only five showed an error of 1 degree. In tests as to the accuracy of its time-keeping, the National Physical Laboratory found that the accuracy was well beyond the limit of accuracy of the ordinary chronometer or stop-watch.

Practically correct results have been obtained on a vessel off Beachy Head, 100 miles distant.

### BRITISH GEAR FOR SPANISH-ARGENTINE SERVICE.

The new Spanish-Argentine radio telephone service recently opened from Seville by General Primo de Rivera is the only service of its kind in the world, with the exception of that between Great Britain and America, in which subscribers are connected at each end by means of the ordinary telephone service. Complete secrecy is obtained by transmitting in a distorted form unintelligible to ordinary receiving stations. The transmitters and receivers for this new radio link were manufactured by Standard Telephones & Cables, Ltd., in their factories at Woolwich and Hendon.

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### MORE LISTENERS IN GERMANY.

Registered listeners in Germany now number 2,843,569, an increase of 16,941 in three months.

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### SAD CASE.

The pirates' repertoire of excuses has been added to by a Doncaster delinquent who pleaded last week that he thought the second-hand receiver he had purchased was already licensed, like a car.

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### RADIO IN RANGOON.

To popularise wireless in rural India the Burma Legislative Council has voted 3,000 rupees for the installation of receiving sets in twelve villages within 100 miles of Rangoon. The Rangoon broadcasting station is operated by the Burma Radio Syndicate on a wavelength of 398 metres.

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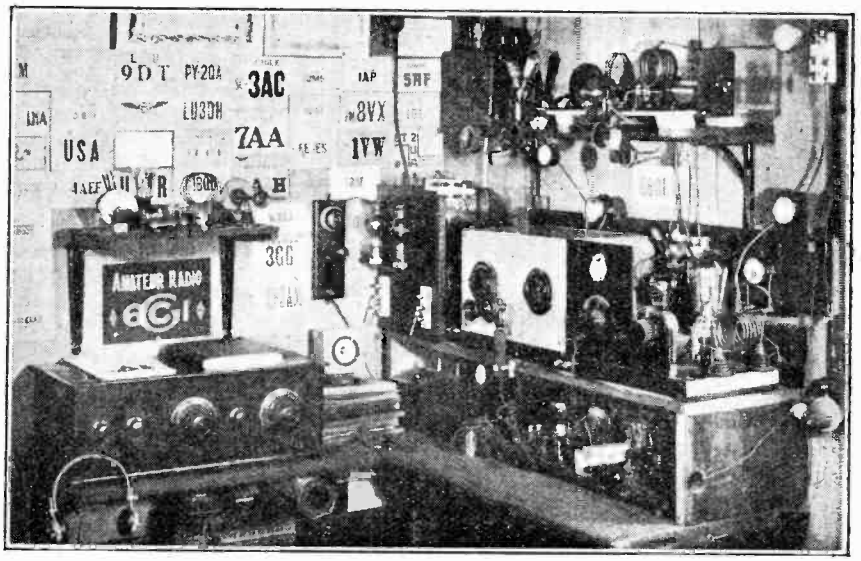
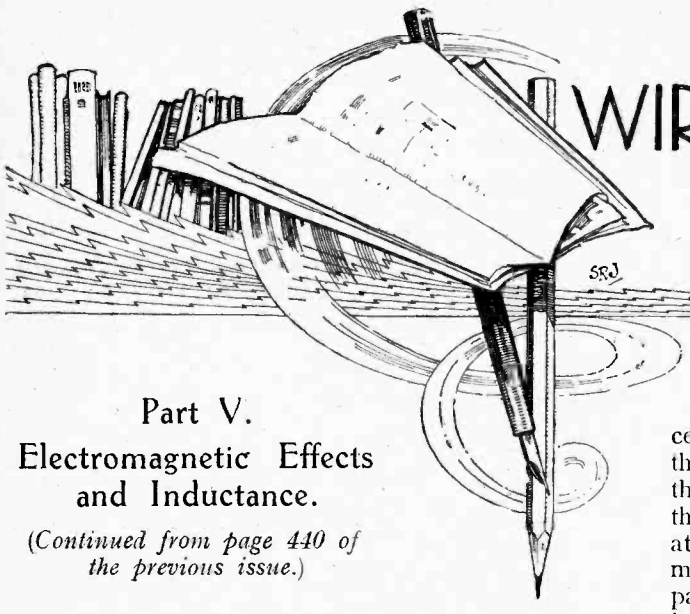
### LECTURES FOR RADIO-GRAMOPHONE DEALERS.

Under the auspices of the Gramophone Co., Ltd., a special course of sixteen lectures in radio-gramophone re-production is being given at the London Polytechnic, Regent Street, by Mr. S. T. Short, A.M.I.E.E., for the benefit of dealers, salesmen, service staff and others engaged in the radio-gramophone industry. Similar courses are to be given in various provincial centres. Particulars of the courses and of a special correspondence course for those unable to attend the lectures, are obtainable from The Gramophone Co., Ltd., 363, Oxford Street, London, W.1.




**A MODERN AMATEUR STATION. The transmitting and receiving apparatus of G 6CI, owned by Mr. B. W. Warren, of Coventry. As the QSL cards indicate, G 6CI has practically a world-wide "service area."**



# WIRELESS THEORY SIMPLIFIED

By S. O. PEARSON, B.Sc., A.M.I.E.E.

## Part V.
## Electromagnetic Effects and Inductance.

(*Continued from page 440 of the previous issue.*)

BEFORE we can proceed further with A.C. theory it will be necessary to know something about that type of circuit in which considerable magnetic effects are produced when a current of electricity flows through it. It will be seen later what a very important part inductance plays in A.C. circuits.

Whenever a current of electricity flows through a circuit a magnetic field is set up in the vicinity of the conductors. With the aid of a miniature compass needle, lines of force can be detected and the directions in which they act determined. The intensity of the field depends on the nature of the circuit and the strength of the current flowing through it. For instance, if a long insulated wire is wound into the form of a coil or solenoid, a relatively powerful magnetic field is produced when a current is passed through it. The lines of action of the forces pass through the coil parallel to its axis at the centre, and spread out brush-wise at the ends.

If such a coil could be arranged so that its axis lies on a plane surface, as shown in Fig. 1, the lines along which the magnetic forces act could be traced out with the aid of the little compass needle. If any one line is followed completely round, it is found to be a closed loop, so that we have in a magnetic field a large number of closed loops of magnetic force linked with the turns of the coil.

The total magnetic influence passing through the centre of the coil parallel to its axis is referred to as the *magnetic flux*, and the amount of flux which passes through one square centimetre of area at right angles to the lines of force represents the field strength or intensity at that point. It is expressed in lines per square centimetre or *gauss*. If a current of I amperes could be passed round a single circular wire loop one centimetre in radius, the field strength at the centre of the loop would be $0.2\pi I$ lines per square centimetre or *gauss*.

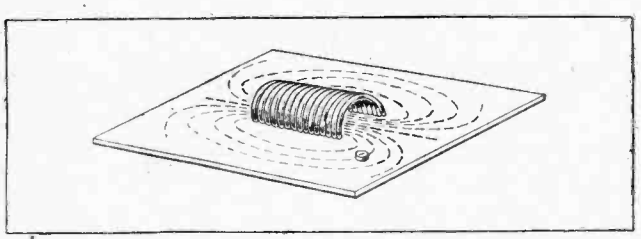


**Fig. 1.—Showing how the lines of magnetic force produced by a coil can be traced by means of a miniature magnetic compass.**

### Electromagnetic Induction.

If the current flowing through the coil is varied, the magnetic flux linked with the coil varies in direct proportion, and this changing of the flux has a peculiar effect on the circuit. It actually causes an electromotive force to be *induced* in the turns of the coil, this being the property known as *self-inductance*.

The explanation of self-inductance will be made simpler if we first consider the action of a permanent magnet on a coil of wire. In Fig. 2 is shown a permanent magnet of the horseshoe pattern with lines of magnetic force passing between the poles from N to S. Close to the magnet is a coil so placed that one pole of the magnet can be lowered into it, and across the ends of the coil is connected a sensitive galvanometer or millivoltmeter. When the magnet is lowered, the lines of force passing between the poles are "cut" by the turns of the coil, and just as this is happening a reading is obtained on the millivoltmeter, showing that an E.M.F. is being induced in the coil. This is Faraday's original experiment, and explains the principle of electromagnetic induction.

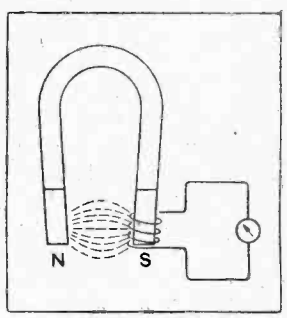



**Fig. 2.—Faraday's experiment for demonstrating the principle of electromagnetic induction.**

The important feature is that the E.M.F. is induced in the coil only so long as the magnet is moving relatively to the coil; as soon as the magnet comes to rest the E.M.F. disappears, no matter what the relative positions of the magnet and coil are. The value of the induced E.M.F. is exactly proportional to the rate at which the lines of force are being cut, i.e., to the

**Wireless Theory Simplified.—**

number of lines being cut per second, and therefore *to the rate at which the flux linked with the coil is changing*.

Reverting to the case in which the magnetic flux linked with a coil is produced by a current in the coil itself, it will be clear that an E.M.F. will be induced in the coil whenever the current is changing, because the magnetic flux is proportional to the current. In any circuit where the changing of the current causes an E.M.F. to be induced into the circuit itself, self-inductance is said to be present.

From the foregoing it follows that inductance will be present in any circuit where a magnetic field is produced by a current passed through the circuit.

### Unit of Self-inductance.

The practical unit of self-inductance is the *henry*, and a circuit is said to have a self-inductance of one henry if one volt is induced in it when the current is changing at the rate of one ampere per second. The self-inductance expressed in henrys is called the *coefficient of self-induction* of the circuit, and is usually denoted by L.

Suppose that in a circuit where the inductance is L henrys the current is changing at a steady rate and increases from $I_1$ to $I_2$ amperes in $t$ seconds. Then the rate of change of current is $\frac{I_2-I_1}{t}$ amperes per second, and the self-induced E.M.F. will be $e = L \times \frac{I_2-I_1}{t}$ volts.

### Electrical Inertia.

Before we can make full use of this expression it is necessary to know in what direction the induced E.M.F. acts. Lenz's law states that the induced E.M.F. always acts in such a direction as to oppose the changing of the current. This means that if the current is increasing, the induced E.M.F. will be opposing the applied E.M.F. actually producing the current, and when the current is falling in value the self-induced E.M.F. acts in such a direction that it tends to maintain the current. The self-induced E.M.F. is very often referred to as a *back E.M.F.* or counter electromotive force when it acts in opposition to the applied E.M.F.

A similar law exists in ordinary mechanics—a heavy body resists the taking up of motion when a force is applied to it on account of its *inertia*; there is a back pressure proportional to the mass of the body and the rate at which its velocity is changed. Once the body is set in motion, it tends to continue moving even after the original driving force has been removed. A railway wagon on a level track could be taken as an example.

Owing to the similarity of the laws of an inductive circuit and those of inertia, self-inductance is very often referred to as "electrical inertia." Since the induced E.M.F. is proportional to the rate of change of current and acts in opposition, it follows that in a circuit possessing self-inductance the current can never be changed instantaneously. If the E.M.F. applied to the ends of the circuit is suddenly changed, the current will *gradually* acquire its new value just as, if the throttle of a motor car running at slow speed is suddenly opened wide, the car does not attain its full speed instantaneously, but gradually accelerates.

### Energy Stored in a Magnetic Field.

If an electromotive force is suddenly applied to the ends of an inductive circuit, power is expended not only in heating the circuit through the medium of its resistance but also in overcoming the back E.M.F. during the time that the current is building up. When the current has reached its final steady value, the back E.M.F. disappears, and the whole of the in-going energy is being converted into heat. It is clear then that just as the current is building up, a certain amount of energy is put into the magnetic field. When the current is reduced to zero again, the induced E.M.F. of self-induction acts in the same direction as the falling current, and hence the stored energy is given back again to the circuit. In the case of a very powerful field such as that of a large dynamo, the stored energy is so great that it is positively dangerous to switch off the magnetising current suddenly. Even in the case of the pot magnet of a moving-coil loud speaker precautions are usually taken to dissipate the stored energy gradually when switching off.

### Calculation of Stored Energy.

Suppose that we have a coil whose inductance is L henrys and that a current is caused to build up in it from zero to I amperes in $t$ seconds. The average rate of growth of the current will be $\frac{I}{t}$ amperes per second, and, since the induced E.M.F. is equal to the product of the inductance and the rate of change of current, the average back E.M.F. during this time will be $e = L \times \frac{I}{t}$ volts. Now, the power consumed in building up the magnetic field is given by the product of back E.M.F. and current at any instant. But the current is varying from zero up to I amperes, and therefore its *average* value during the time of growth is $\frac{1}{2}I$ amperes (see Fig. 3). Thus the average power expended on the field whilst it is being built up is

$$e \times \tfrac{1}{2}I = L\frac{I}{t} \times \tfrac{1}{2}I$$
$$= \tfrac{1}{2}\frac{LI^2}{t} \text{ watts.}$$

The time during which this power acts is $t$ seconds, and so the energy put into the field is

$$W = \tfrac{1}{2}\frac{LI^2}{t} \times t = \tfrac{1}{2}LI^2 \text{ watt-seconds or } \textit{joules}$$

(the energy represented by a power of one watt expended for one second is called one *joule*).

The energy stored in the field at any instant is thus seen to be proportional to the inductance of the circuit and to the *square* of the current at that instant. It is assumed that the energy thus stored takes the form of a sort of strain in the ether in which the magnetic field is situated.

### Mutual Induction.

Sometimes two circuits are so arranged that when a current in one of them is varied it causes an electro-

**Wireless Theory Simplified.—**

motive force to be generated in the other. Under these conditions *mutual inductance* is said to exist between the circuits. It should be fairly obvious then that if a current in one circuit causes lines of magnetic force to be linked with a second circuit, mutual inductance will be present, because any variation of current in the one will result in an induced E.M.F. in the other.

As an example, we may consider two coils $L_1$ and $L_2$ arranged as shown in Fig. 4. When a current is passed through $L_1$ from a battery B it will produce a magnetic field, part of which links itself with the turns of $L_2$. If the current is varied by changing the value of the regulating resistance R, the flux linked with $L_2$ will be altered, and an E.M.F. is induced in it during the process.

The mutual inductance between the coils is said to be one henry if one volt is induced in one of them when the current in the other is changing at the rate of one ampere per second. The mutual inductance in henrys is usually denoted by M, and is sometimes called the coefficient of mutual induction. The coil $L_1$ in which the current flows is called the primary (coil), and $L_2$ is called the secondary. The mutual inductance between the two coils is the same, no matter which is used as the primary; its value depends only on the dimensions of each coil and their relative positions.

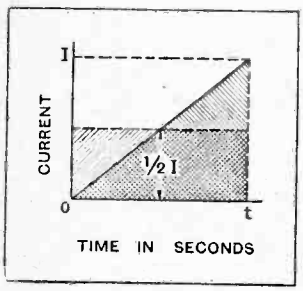



**Fig. 3.—When a current is increased from zero to I amperes at a uniform rate the average value is ½I amps.**

When the mutual inductance is M henrys, the E.M.F. induced in the secondary coil is given by

$e_2 = M \times$ (rate of change of primary current).

If an alternating current is passed through the primary coil, an alternating magnetic flux will act upon the secondary coil, and so induce in it an alternating voltage of the same frequency as the primary current. When two coils are used in this way they are said to be magnetically coupled together, and the combination is known as a transformer, a subject to be dealt with separately at a later date.

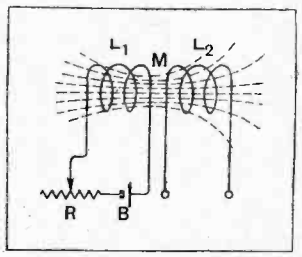



**Fig. 4.—Mutual inductance exists between two coils if a current in one affects the other magnetically.**

**Degree of Coupling.**

The two coils are said to be tightly coupled when they are brought close together so as to obtain a relatively high mutual inductance, and *vice versa*. The degree of coupling is expressed as the ratio of the mutual inductance to the square root of the product of the separate self-inductances, this ratio being known as the coefficient of coupling,

i.e., $$\text{coefficient of coupling} = \frac{M}{\sqrt{L_1 L_2}}$$

In theory the coupling coefficient can never be greater than unity, and in practice never reaches this value. The coupling would be unity if the whole of the magnetic flux produced by a current in one coil linked itself with the whole of the turns on the other. In low-frequency transformers the coupling is made as great as possible by winding the two coils on a common iron core so that the total flux is constrained as far as possible to be fully linked up with both windings. That fraction of the total flux which fails to link with both coils is termed leakage flux.

*(To be continued.)*

# CLUB NEWS.

**Peckham Radio Society.**

Many South London amateurs have derived benefit from the Peckham Radio Society, which has now opened the winter session with meetings on Thursday evenings at 7.30 p.m.

Hon. Secretary, Mr. A. E. Pettet, 192, Hollydale Road, S.E.15.

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**Informality in Wireless Meetings.**

A request that the informal nature of its meetings should be maintained was made by members of the South Croydon and District Radio Society at the recent Annual General Meeting. It was felt that the ordinary owner of a wireless set derived most benefit when he could discuss his radio troubles and experiments with a minimum amount of formality. A feature of the new session is the arrival of a large contingent of new members. More vacancies still exist, however, and the Hon. Secretary, Mr. E. L. Cumbers, 14, Campden Road, South Croydon, will be glad to receive applications.

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**A Topical Lecture.**

"Mains Apparatus—Its Design and Operation" was the title of a lecture given by Mr. Garside, of Messrs. Ferranti, Ltd., at a recent meeting of the Kensington Radio Society.

The Society's meetings are held at 136, Holland Park Avenue, W.11. Hon. Secretary, Mr. G. T. Hoyes, 71a, Elsham Road, Kensington, W.14.

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**Bec Radio Society.**

The programme of the Bec (Streatham-Tooting) Radio Society, which has commenced the new session, includes weekly lectures and demonstrations, visits to places of wireless interest, and tests with members' sets and apparatus. Meetings are held every Tuesday, from 7.30 to 9.30 p.m., at the Literary Evening Institute, Bec School, Beecheroft Road, S.W.17. Hon. Secretary, Mr. A. L. Odell, 171, Tranmere Road, S.W.18.

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**Meetings Twice Weekly.**

The Alma Radio Society, which recently opened a new session, holds meetings twice weekly, on Tuesdays and Thursdays, from 7.30 to 9.30 p.m., at the Bermondsey Men's Evening Institute, Southwark Park Road, S.E.15, under the direction of Mr. S. F. Harris (G5SH). The club possesses a good collection of tools and wireless apparatus. An attractive syllabus has been prepared, and full particulars can be obtained from the Hon. Secretary, Mr. A. J. Hopkins, 41, Trafalgar Road, S.E.15.

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**Wireless in the Isle of Wight.**

Readers in the Isle of Wight will be interested to learn that the Ryde Radio Society has resumed meetings, its headquarters being Mount House Hall, George Street, Rye. An interesting programme has been prepared and includes lectures by representatives of leading radio manufacturers. There will also be a "query" night and a "surprise" night.

The meetings take place every Tuesday at 8 p.m. Applications from prospective members will be gladly received by the Hon. Secretary, Mr. Ivor Goddard, "Brinkcliffe," Sandown.

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**For Muswell Hill Readers.**

One of the most active of the London Societies last year was the Muswell Hill and District Radio Society, which has resumed meetings at Tollington School, Tetherdown, Muswell Hill, N.10, on Wednesday evenings at 8 o'clock. Hon. Secretary, Mr. C. J. Witt, 39, Coniston Road.

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**A Refractory Receiver.**

A unique set, the circuit diagram of which puzzled even the veterans present, was demonstrated by Mr. Newington at the last meeting of the South Croydon and District Radio Society. Piquancy was added by the fact that the set at first refused to function, but after an animated discussion it was discovered that by changing the position of two variable condensers the trouble was overcome!

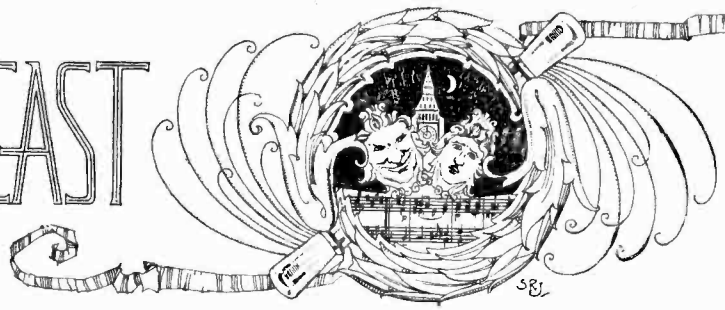
Hon. Secretary, Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.

o o o o

**An October Field Day.**

Six members of Slade Radio (Birmingham) succeeded in tracking down a hidden transmitter on the occasion of the Society's field day on October 13th. Thirty-five members and friends took part in the hunt. After the test the company enjoyed an alfresco tea, which was followed by the distribution of prizes. Full particulars of the Society's activities will be gladly supplied by the Hon. Secretary "Enville," Warren Road, Erdington.

# BROADCAST BREVITIES



*By Our Special Correspondent.*

***What of the Twin Transmitter ?—Continental Relays.—B.B.C. Finance.***

### The Sleeping Partner.

Despite rumours to the contrary, I understand that it is extremely unlikely that London Regional No. 2 will have anything to tell the world until mid-December. Why there should be such a delay is rather difficult to fathom, for the second station is already in working order, and the B.B.C. has the Postmaster-General's permission to go ahead with alternative transmissions.

One would have thought that even the cautious conservatism of the B.B.C. engineers would have been outweighed by their anxiety to discover as soon as possible whether twin-wave working from the same site can be a practical success. So far, its practicability is only theoretical.

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### Weekly Relays from the Continent.

Those long-distance listeners who are threatened with a curtailment of their activities owing to the enormous power of the new regional stations will wonder whether there is any special significance behind the fact that the B.B.C. is urgently negotiating for a series of regular relays from Continental stations.

I hear that present plans provide for a weekly "Continental" evening during the coming winter. The new La Panne-Thanet cable will form the connecting link with the Continent. It is hoped that programmes will be available from Belgium, Holland, Germany and France.

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### The Money Question.

Tales have been going the rounds that the B.B.C. is desperately "hard up." It would be doubtful policy for Savoy Hill to contradict such statements, but I can definitely say that it is not money troubles that loom largest in the official mind at the present moment. At the end of next year, however, some heavy calls will be made on the exchequer, including the cost of the Moorside Edge Regional Station, and it would not be surprising if the B.B.C. were then to demand an enquiry into the existing system of allocating licence moneys whereby both the Post Office and the Treasury reap more than an adequate profit.

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### Work Begins at Moorside Edge.

The contract for the erection of the station buildings at Moorside Edge has been secured by the Anglo-Scottish Construction Co., Ltd., of Victoria Street, Westminster. Work on the site will begin almost immediately.

It is hoped that the station will be ready to start exactly a year hence.

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### The B.B.C.'s Chief Spokesman.

Mr. Gladstone Murray, who poured oil on the troubled waters of political broadcasting at the opening of the Manchester Show, is becoming recognised as one of the leading spokesmen of the B.B.C. Since 1927, when he was appointed Assistant Controller of Broadcasting at the age of 34, Mr. Gladstone Murray has been the close assistant of the Director-General, an experience which has given him a probably unrivalled insight into the countless problems affecting the control of a monopolistic broadcasting service.

I venture to suggest that before long we shall hear a good deal more of Mr. Gladstone Murray.

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### Sir Oliver Lodge's Point of View.

Sir Oliver Lodge will give listeners his views on passing events in a broadcast from a London studio on November 1st. This is the sixth half-hourly talk in the "Points of View" series, which has aroused so much discussion, favourable and unfavourable, amongst the public.

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### Dilemma in Belfast.

Belfast listeners are still wondering what actually happened at 2BE on a recent Sunday. I can now tell the story, which must surely rank as a broadcasting epic. Owing to heavy rains the land lines connecting the studio with the transmitter were put out of action shortly before the Sunday afternoon programme was due to begin. As all S.B. lines terminate at the studio it was impossible to broadcast the London programme as announced. But all Belfast was waiting for a programme.

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### Rehearsing in a Power Station.

Nothing daunted, the engineers transported a gramophone to the transmitter, together with two large amplifiers and 500 volts of high tension, and in an amazingly short time an impromptu programme was being radiated. While this was going on a "studio" was hastily rigged up in a small office in the adjoining power station, and at 8 o'clock it was possible to transmit a religious service with gramophone records of hymns, and later a programme by the Whiteway String Quartet. I am told that it was one of the sights of the century to see this hurriedly assembled combination rehearsing in the power station, surrounded by huge turbo-generators, switchboards and rotary converters! Normal working was not resumed until Tuesday.

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### Copyright Music at Cenotaph Service.

The B.B.C. issues a hint to those persons who may be arranging for the re-diffusion of the Cenotaph broadcast on Armistice Day ("re-diffusion" is a word commonly used at Savoy Hill in reference to loud speaker reproduction in public places). Whilst it is felt that no action would be taken for infringement of copyright, the B.B.C. disclaims all responsibility in the matter. But we may assume that no copyright holder would assert his claims on such a special occasion, and organisers of public gatherings on November 11th would be well advised to proceed with loud speaker arrangements without worrying themselves with questions of copyright. Far more important is the question of good reproduction.

### FUTURE FEATURES.

**London and Daventry.**

OCTOBER 30TH.—"Aïda" (Verdi).
OCTOBER 31ST.—Hallé Concert from Manchester.
NOVEMBER 2ND.—A Burlesque Talkie.

**Daventry Experimental (5GB).**

OCTOBER 27TH.—"The Golden Legend," an oratorio by Sullivan.
OCTOBER 29TH.—"Michael," a play by Miles Malleson adapted from "What Men Live By" (Tolstoy).

**Cardiff.**

NOVEMBER 2ND.—Popular Concert relayed from National Museum of Wales.

**Manchester.**

OCTOBER 28TH.—"Establishing Relations," a comedy by W. W. Jacobs.
OCTOBER 31ST.—Hallé Concert relayed from Free Trade Hall.

**Glasgow.**

OCTOBER 29TH.—"The Jolly Beggar," a Cantata, words by Robert Burns, music by W. A. Henderson.

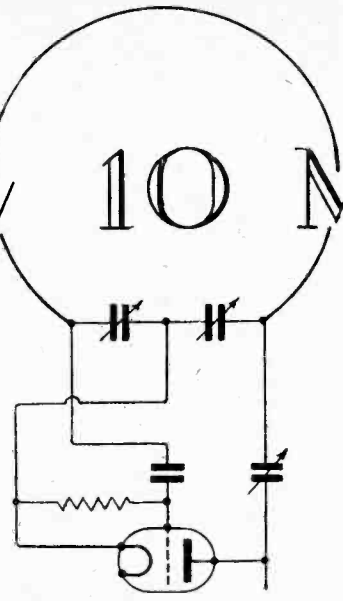
**Aberdeen.**

OCTOBER 30TH.—Scottish Instrumental Concert and Songs.

**Belfast.**

OCTOBER 28TH.—"At the Sign of the Tabard," a Song and Story Programme.
NOVEMBER 2ND.—"Sax Appeal," a saxophone musical programme.

# Below 10 Metres



## Some Experimental Receiving Apparatus for Ultra-short Waves.

By R. L. SMITH-ROSE, D.Sc., A.M.I.E.E., and J. S. McPetrie, B.Sc.

APPARATUS characteristic of the latest practice in the transmission of ultra-short waves has already been described[1]; it remains to deal in this article with the methods adopted for their reception.

There is nothing radically new in the design of receiving apparatus for use on very short wavelengths, the main difference from receivers suitable for longer wavelengths being a general reduction in inductance and capacities. Stray capacities become very important at frequencies of the order of 50 million cycles per second, and very careful layout of the components is necessary. Before describing in detail any specific receiver it will be useful to review the various types of receiver which have been used with success on longer wavelengths. The simplest type of receiver which has found widespread use on wavelengths below 100 metres is that employing a single-valve detector with variable capacity retroaction. For the reception of modulated continuous waves this retroaction can be set critically at a point just below that at which the valve oscillates, while at a point just above this the receiver is in a very sensitive condition for the reception of continuous waves. Any valve circuit, therefore, which will oscillate freely at the working frequency and can be controlled by suitable adjustment of the retroaction may be made to serve for reception purposes. Where additional sensitivity is required the possibilities of direct radio-frequency amplification immediately arise. Considerable experience with various types of radio-frequency amplifiers has shown that it is extremely difficult to obtain any appreciable amplification on wavelengths shorter than about 15 metres.

In receivers using one or more stages of amplification at these high frequencies, it is usually found that any amplification obtained is got at the expense of the retroaction setting of the detector, and that if the high-frequency stages are removed this retroaction can be increased so that there is little overall loss in sensitivity. To avoid this decrease in available retroaction when using high-frequency stages, certain investigators have developed the super-regenerative type of circuit. In this arrangement it is possible to use more retroaction as the valve is prevented from dropping into oscillation by the quenching action of a supersonic oscillation at a lower frequency than that of the signals to be received.

Little work has been done on the development of the supersonic heterodyne receiver for wavelengths less than 10 metres, although this would appear to offer the greatest possibilities. It is a comparatively simple matter to obtain considerable voltage amplification at an intermediate frequency of the order of 100 kilocycles per second (3,000 metres). In order to use such an intermediate frequency amplifier in a short-wave receiver, it is necessary merely to precede it by a frequency changing unit, which generates oscillations of such a frequency as to heterodyne that of the incoming signals. By the substitution of different frequency-changing units it would appear possible to extend the range of such a receiver down to the shortest

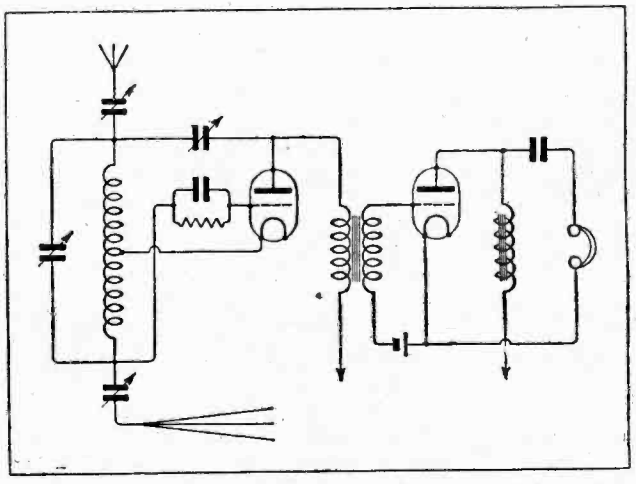


Fig. 1.—Circuit diagram of a two-valve short-wave receiver using a centre-tapped input coil capacity-coupled to aerial and counterpoise.

[1] *The Wireless World*, Oct. 9th, 1929, p. 398.

**Below 10 Metres.—**
wavelengths at which receiving valves may be made to oscillate.

### A Receiver for Use with Aerial and Earth Connections.

The two receivers described below were developed by the authors to meet the requirements of the simplest type of receiver which could be used in a study of the propagation of very short waves. For these receivers the single-valve retroactive detector has been employed, followed by one stage of transformer-coupled low-frequency amplification.

The circuit diagram of one of these receivers is given in Fig. 1. In this the tuning inductance is centre-tapped, as at this point there is no alternating potential, and by connecting the centre of the coil through a suitable battery to the negative end of the filament any required bias may be applied to the grid of the detector valve without interfering with any alternating electromotive forces in the tuned circuit. An open aerial can be coupled to one end of the coil by a variable condenser having a capacity of about 50 micro-micro-farads. If a definite earth connection is employed, this should be made to the centre of the coil for the same reasons as given above for the centre-tapping. If, on the other hand, an insulated counterpoise system is preferred, this may be coupled to the other end of the coil from the aerial through a condenser of similar dimensions to that used for the aerial.

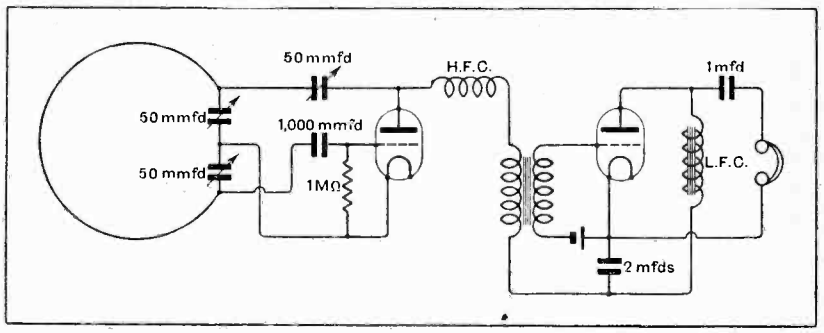



**Fig. 2.—Circuit diagram of a two-valve short-wave loop receiver for field-strength measurements and direction finding. The wavelength range is from 4 to 10 metres.**

It is important to observe that in this circuit both ends of the inductance coil are at high alternating potentials, and the aerial and counterpoise connected to them should be so adjusted that they have potential variations impressed by the incoming signals at the ends coupled to the tuning inductance. It is important, therefore, that the length of either should not be an odd multiple of a quarter of the wavelength, since this would provide a potential node at the receiver. The condition for optimum reception with this type of circuit involves the adjustment of the length of the aerial and all the controls of aerial coupling, retroaction, and, of course, tuning. The correct adjustment of aerial coupling is particularly important since, if it is too great the radiation resistance of the aerial, which at these short wavelengths is high (of the order of 50-80 ohms), will prevent the detector from oscillating, while if it is too small a loss in sensitivity will result.

### Variable Condensers for Short Waves.

For wavelengths between 5 and 10 metres a condenser having a maximum capacity of 50 micro-micro-farads is suitable for the main tuning condenser. This condenser should have reasonably small linear dimensions, as at this short wavelength the inductance of the plates themselves becomes important. Another advantage of such a small condenser is that there is usually less stray field to create losses in the insulators supporting the plates. A condenser of similar capacity and design is suitable for retroaction purposes and for coupling the aerial and counterpoise to the coil. The grid condenser should be fairly large as it was found that it tended to stabilise the oscillations: a fixed condenser having a capacity of about 1,000 micro-micro-farads will be found suitable. The grid leak should have low self capacity, and have a resistance of between 0.5 and 2 megohms according to the valve used. The time an electron takes to travel from the filament to the anode should always be small compared with the period of the wave which the valve is receiving: for this reason it may be found necessary to use short-path valves for wavelengths below about 5 metres. Small diameter wire has an appreciable inductance, and so to avoid unnecessary reactance in the leads at very high frequencies all wiring should be made in reasonably thick wire, say, No. 16 S.W.G. Such wire has the additional advantage of rigidity, an essential feature at these high frequencies. Suitable coils may be made from $\frac{1}{8}$in. or $\frac{1}{4}$in. aluminium or brass tubing. With $\frac{1}{4}$in. tubing and components complying with the above conditions it was found that with a centre-tapped 4-turn coil with internal diameter of 1in. and 2in. long, the wavelength range extended from 4.7 to 7 metres, while with another 4-turn coil of equal axial-length but having a diameter of $1\frac{1}{2}$in., the available range was from 5 to 12 metres. It is advisable to mount such coils on ebonite or American whitewood to prevent change in shape which, of course, alters the inductance of the coils.

### Frame Aerial Reception.

For measurement purposes, it is essential to cut down the number of variables involved in the transmission and reception of the waves and, for this purpose, a small loop receiver was designed in order to do away with the necessity for an aerial. This loop is mounted directly on a screened box measuring 20in. × 10in. × 8in., which contains all the receiving apparatus. In this way everything except the pick-up loop and the telephone leads is screened, a distinct advantage when measurements are required. For wavelengths below 10 metres the product of area and turns of the receiving loop is comparatively small, and it was decided to construct the loop of single turns of brass tubing. With single-turn coil receivers a centre tapping on the tuning

**Below 10 Metres.**—

coil is objectionable, and, to avoid this, the circuit arrangement shown in Fig. 2 is adopted for the detector.

The tuning adjustment is effected by two variable condensers of maximum capacity, 50 micro-microfarads, each mounted in series on a common spindle, the tapping to the filament being taken from their common connection. Latterly this connection has been omitted, the centre of the double condenser being allowed to take up its own "earth" point. By omitting this connection the capacity across the tuning loop is effectively decreased, and the range of the receiver is thus extended in the direction of shorter wavelengths. A photograph of a complete receiver built on the above lines is shown in Fig. 3. The front lid of the box has been removed to show the internal arrangement of the components. The diagram of connections and the dimensions of the principal components are given in Fig. 2. The details in design emphasised in the description of the previous receiver obviously apply in this case also. In order to make the whole receiver as symmetrical as possible about the loop, and also to shorten the lengths of wires in the detector stage, the apparatus is arranged within the box in three tiers, as indicated in the photograph. The top tier contains the tuning condensers, the reaction condenser, the grid condenser and leak, along with the first valve and a radio frequency choke. The loop is held rigidly to an insulating strip on the top of the box by two terminals to the underside of which is attached the tuning condenser. This tuning condenser, and also the reaction condenser, are mounted on a panel which, when in position, lies about 1½in. from the back of the box. This mounting is necessary in order to keep stray capacities at a minimum. Extension handles pass from the condensers through the box and are connected to dials at the back.

### H.F. Chokes.

It is advisable to be able to change the choke and grid leak, so these were arranged to fit into sockets provided on the top platform. Little systematic investigation has been made into the working of choke coils at very high frequencies, but a design which the authors have found fairly satisfactory consists of a solenoidal coil of No. 47 S.W.G. insulated copper wire wound uniformly on a 3in. × ½in. ebonite former. A range of chokes may be made by varying the number of turns from about 50 to 200. The ends of the wires are soldered to two valve pins screwed into the ends of the ebonite, and, by keeping the distance between these pins the same for all chokes, it is a simple matter to make them easily interchangeable. It is desirable in fixing the positions of the pins to remember that the farther they are apart the less will be the self-capacity of the choke.

A single audio-frequency amplifying stage is mounted on the middle platform of the box, while the necessary filament and high-tension batteries are placed at the bottom of the box. The screening box is used as the lead to the negative end of each filament, as this decreases the number of wires necessary in each compartment. The output terminals for the telephones are placed as a shunt across an audio-frequency choke in the anode circuit of the second valve. By this means the telephones and, therefore, the observer are maintained at the potential of the screening box (see Fig. 2). This design diminishes certain difficulties due to capacity changes while tuning, and also prevents the high-tension battery being short-circuited when the telephone terminals come accidentally into contact with the box. In order that the screening may be efficient, the box and lid are bolted together when the receiver is in use.

### Wavelength Range of Loop Receiver.

Using single-turn loops constructed of ⅛in. diameter copper tubing, the following wavelength ranges are covered with a tuning condenser, of which the minimum and maximum capacities are 2 and 25 micro-microfarads

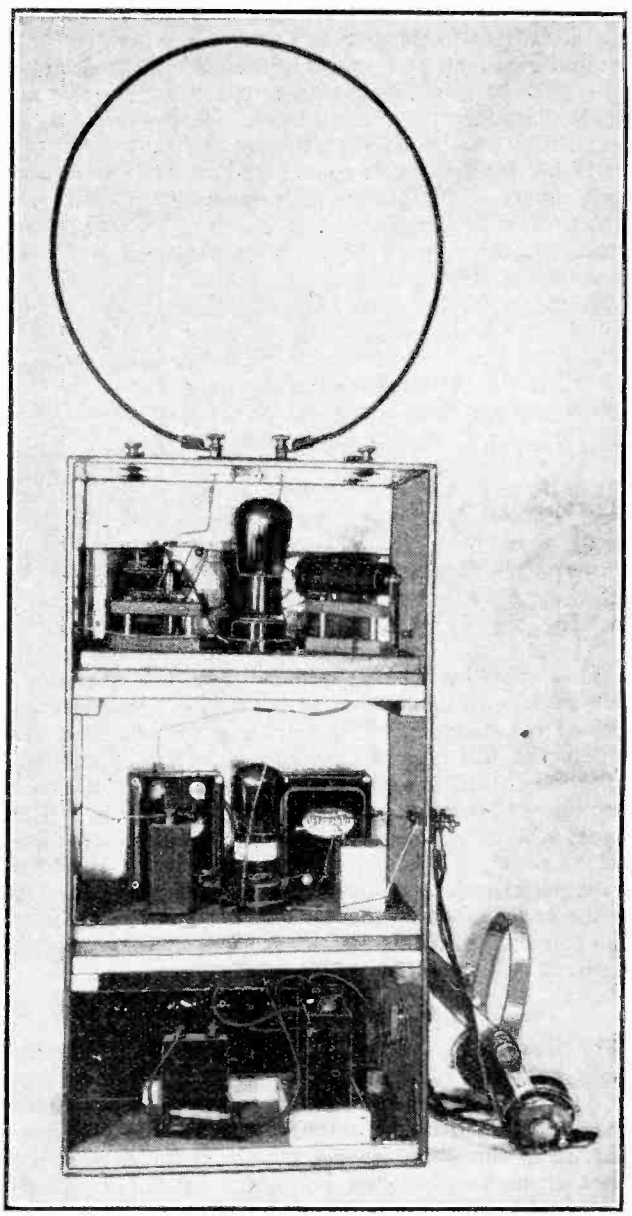


Fig. 3.—The loop receiver using the circuit shown in Fig. 2.

**Below 10 Metres.**—

respectively (i.e., two condensers in series, each having minimum and maximum of 4 and 50 micro-microfarads).

| Diameter of loop in inches. | Wavelength range in metres. |
|---|---|
| 5 | 4.8-6.9 |
| 8 | 5.5-8.8 |
| 10 | 6.2-9.5 |
| 12 | 6.7-10.8 |

In order to ascertain the possibility of reducing the minimum wavelength by a reduction in the stray capacity of the first stage, some measurements were made of the capacity between the coil terminals and the effect of various components upon this capacity. The measurements were made by a substitution method using a standard variable air condenser and a wavelength of about 17 metres. With both tuning and retroaction condensers set to their minimum positions, the capacity between the coil terminals with the first valve in its socket was 9 and 12 micro-microfarads with the current on and off respectively. To this amount the base of the valve contributed 1 micro-microfarad, while the capacity of the valve itself in between its grid and anode was about 1.5 micro-microfarad, leaving about 7.5 micro-microfarads to be attributed to the wiring connections and their capacity to the screening box. The alteration of the retroaction condenser from its minimum to maximum position increased the capacity between the coil terminals by 5 micro-microfarads. The substitution of various grid leaks and choke coils in the detector valve circuit made no appreciable alteration to this capacity. It will be seen that the minimum capacity that can be obtained is limited by the capacity of the valve and its connections, and little reduction can be obtained by omitting the valve holder or by using a tuning condenser with a still lower minimum capacity than that at present in use (2 micro-microfarads).

The chief disadvantage of this limitation in the minimum capacity of the main tuning condensers is that the maximum must also be small, as no suitable condenser has yet been designed which incorporates both a small minimum and a relatively large maximum capacity. This limitation in capacity restricts the range of wavelengths which it is possible to cover with any one coil, but the above table indicates that there is no difficulty in making the receiver operate at wavelengths down to about 4 metres. When it is desired to proceed to still shorter wavelengths, it is an advantage to remove the stray capacity due to the screened box. In this way the same receiver, with the inductance coil reduced to a straight wire of No. 16 S.W.G. 2in. long, has been made to operate at 2.9 metres.

# CORRESPONDENCE.

The Editor does not hold himself responsible for the opinions of his correspondents.

**Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.**

### *EMPIRE BROADCASTS.*

Sir,—Having read in your columns so many denunciations of the B.B.C.'s short-sighted short-wave policy, one finds it increasingly difficult to produce further arguments in the hope of persuading an early improvement in the situation. Apparently neither the B.B.C. officials nor the engineers responsible for 5SW have any sense of shame or interest in the station, otherwise 5SW would be proclaiming itself to the world at large as the short-wave unit of the richest broadcasting combination in the world, and proclaiming itself in no small voice. Several people already have shattered the excuse that 5SW is experimental. When one thinks of the number of stations that have started since 5SW came on the air, and have been immediate successes, one cannot but feel that the B.B.C. is letting us down rather badly. Anyway, how can a station pretend to be experimental which does not experiment with the most important item, the wavelength? Strangely enough, the engineers are so proud of its puny performance that they never bother to ask for listener's reports.

In my humble opinion the B.B.C. would do well to tell the Marconi Company that they have no use for such a poor effort as 5SW, and ask the Philips Radio people to build a permanent station, it would need no months of experiment! Any fool can see that a truly Empire station must broadcast simultaneously on two wavelengths, neither of which would be that used at present. I would suggest wavelengths of around 32 and 16 metres.

And now, you folks at home, are you in sympathy with the B.B.C.'s plea that they are not justified in spending your money on an Empire broadcaster? Of course you aren't! Then let us have a good lusty demand from you for a station you can be proud of. You are our only hope now. "CROWSER."

R.A.F. Base,
Calafrana, Malta.
September 9th, 1929.

### *WIRELESS THEORY.*

Sir,—May I say how I appreciate the articles in *The Wireless World* on "Wireless Theory Simplified," by S. O. Pearson, B.Sc. I do not think that the subject could be treated in a simpler and more attractive manner. May there be many more of a similar nature.

I am one of that small number of readers who find your paper slightly too technical, but who, nevertheless, can find no other wireless periodical to come anywhere near to taking its place.

You will understand, therefore, how valuable a series of articles on the above subject will be to a

NON-THEORETICAL READER.

### *B.B.C. TRANSMISSIONS.*

Sir,—I should like, if I may, to submit one or two observations about the quality of B.B.C. transmissions.

For at least one provincial listener, all the special occasions which the B.B.C. are in the habit of heralding with preliminary programme-puffs and pamphlets—the promenade concerts, symphony concerts, operatic performances—serve merely to mark so many *dies non* or rather "blank" nights; and this not because a plebeian ear disqualifies him from appreciating what the best people like, but because the quality of the transmission makes it impossible to listen to it with pleasure.

This state of affairs gives him a sense of grievance at all times. But what moves him to public complaint about it at this moment is his recent very keen enjoyment of "local" transmissions of orchestral music from the Festival Hall at the North-East Coast Exhibition. He has experienced wireless at or approaching its best for a few brief hours. And, naturally enough, he asks himself—and any-one else better able to supply an answer—why he can't be given the genuine thing always.

I believe that neither the engineer nor the musician would

question the practical accuracy of some such classification of B.B.C. transmissions as follows :—

(a) First-rate. Direct or "local" transmissions.

Only those within "local" range of London receive transmission wholly of this quality. Provincial stations, other than Daventry, give only about 25 per cent. direct transmission.

(b) Second-rate. Daventry transmissions.

These suffer deterioration through the use of 70 miles of land-line.

(c) Third- to fifth-rate. Land-line relays.

The land-line may be anything from 100 to 400 miles in length, of varying character, and inadequately corrected. Besides the prime defect of frequency distortion and/or attenuation, these transmissions are vitiated also by background noise. It is impossible, even in the case of any one particular provincial transmitter, to set them down as being all of level merit. Relays by Newcastle, for instance, from the London Queen's Hall, seem, as judged by ear, to be inferior for some reason or other to those from the London studios.

Sixty per cent. of provincial transmissions of music come under this head.

(d) Sixth- to tenth-rate. Wireless relays.

These are re-transmissions by provincial transmitters of Daventry 5XX picked up by wireless. They combine, therefore, the defects of a short land-line, one receiver, and two transmitters, with the addition in varying degrees of atmospherics. Some 15 per cent. of provincial musical transmission is of this sort.

The conclusion to be drawn is that the majority of listeners receive as a rule third- to tenth-rate transmission.

Until a majority at least enjoy for the most part first-rate transmission it would seem premature to accept wireless as an authentic medium either of musical entertainment or of musical education. There is at present a case rather for denouncing it as de-sensitising the collective musical ear.

And can it be possible that the efforts of designers and manufacturers to provide sets giving straight-line reproduction have been so far and remain for the time being so much energy misdirected?

K. McCORMACK.

Newcastle-on-Tyne.

### *HIGH SPOTS.*

Sir,—The *Humorist* recently had a radio article whose writer says that last year screen-grid valves and pentode coils (*sic*) were the "high-spot" of interest, and asks what it will be this year. I can tell him : it was the drum-controlled loud speakers.

H. E. ADSHEAD.

### *IDENTIFYING STATIONS.*

Sir,—I have been much amused at the various efforts of broadcasting authorities and others to make the identification of stations an easy matter. All broadcasting stations are given a call-sign consisting of a combination of letters and figures, or letters only. Why not use them? and in this manner : Each station to send its call-sign three times in morse, slowly and distinctly, in the intervals. Listeners will not need to learn the code as, if sent in a proper manner, it would be an easy matter to copy the dots and dashes on paper and look up the code afterwards and at leisure.

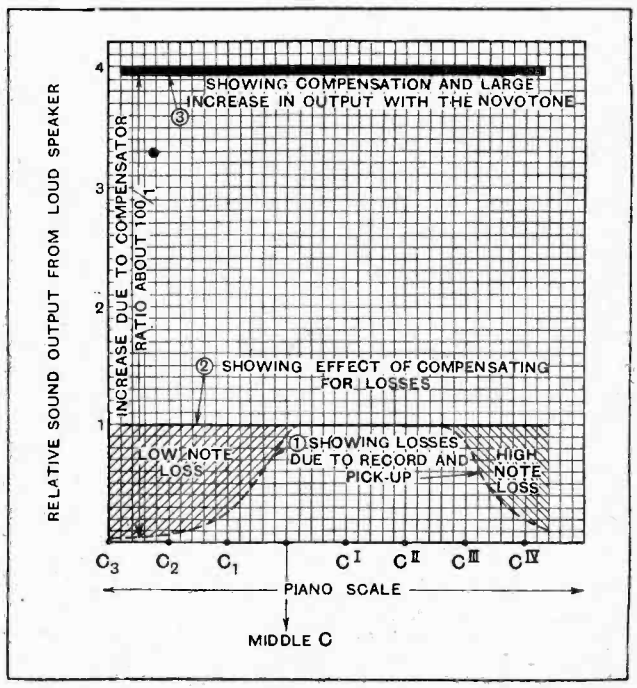
I claim that this simple and very obvious system would obviate all the various phonetic languages—hoots, whistles, ticks, gongs, and so forth—which each station now employs in a vain effort to make itself known.

S. W. CUTLER.

Ealing, W.5.

### *THE NOVOTONE.*

Sir,—I should like to amplify your remarks on the above device which appeared in *The Wireless World*, page 380, October 2nd, 1929. The apparatus is termed a "filter" and it is also implied that a good pick-up requires no correction. The Novotone is in no sense a filter. It increases the voltage from the pick-up below 250 cycles and above 2,000 cycles. If the groove width below 250 cycles is constant (as it is in practice), it is necessary—even with a perfect pick-up—to compensate for the corresponding reduction in low frequencies. The Novotone gives accurate compensation from 250 cycles to 50 cycles. The requisite compensation above 2,000 cycles depends upon the pick-up, etc., and can be varied by means of a rheostat of 30 ohms or more.




The accompanying diagram shows precisely what happens when the Novotone is connected between the pick-up and the amplifier. With M.C. speakers having pronounced resonances below 100 cycles the Novotone causes a startling effect, which I leave the experimenter to discover for himself.

N. W. McLACHLAN.

## BOOKS RECEIVED.

*First-Year Electrical Engineering*, by D. J. Bolton, M.Sc., M.I.E.E.—An elementary text-book of electrical engineering, including Ohm's law, electrical units, primary batteries and accumulators, magnetism, motors and generators, electrostatics, instruments, lighting, telegraphy and telephony, with a few notes on the elements of wireless telegraphy. Pp. 260, with 118 illustrations and diagrams. Published by Edward Arnold and Co., London. Price 5s.

o o o o

*Electrical Wiring and Contracting.*—A practical and authoritative work dealing with all branches of the trade, written by experts for electricians, contractors, and all engaged on installation work, and edited by H. Marryat, M.I.E.E., M.I.Mech.E. To be completed in about thirty weekly parts. *Part I* includes workshop science and the beginning of an article on drawing. Subsequent parts will include electricity and magnetism, A.C. and D.C. generators and motors, practical wiring, testing, heating and cooking, estimating and many other kindred subjects. Published by Sir Isaac Pitman and Sons, Ltd., London. Price 1s. each part (64 pages, with numerous illustrations and diagrams).

*The "Motor Cycle" Diary for* 1930, including, in addition to the usual diary memoranda, speed records, with space for amendments; monthly summary of running expenses; principal hills in Great Britain, with remarks on their special features. Published by Iliffe and Sons Ltd. Price, bound in leather with pencil, 1s. 6d. net or 1s. 7d. post free.

o o o o

*Fenomeni Radioatmosferici*, by Prof. Piero Ilardi.—A study of the nature and character of atmospherics, from observations recorded in various meteorological and geophysical observations (in Italian). Pp. 28, with 5 diagrams. Issued by the Servizio Radioatmosferico Italiano, Montecassino and Rome.

# READERS' PROBLEMS ANSWERED

*The Service is subject to the rules of the Department, which are printed below; these must be strictly enforced, in the interest of readers themselves.*

*A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.*

"The Wireless World" Supplies a Free Service of Technical Information.

### Converting a Portable.

*I should like to convert a commercial portable 5-valve battery receiver with two aperiodic H.F. stages into an A.C. mains set for operation where a source of current is available; will you tell me if it is likely that any special "snags" are to be guarded against in converting the set, and if it is necessary to do anything beyond making the usual alterations to the low-tension circuits?* J. L. P.

We would hesitate to offer any definite advice on this matter, but we cannot help thinking that you would find it extremely difficult to overcome the natural tendency towards instability which would manifest itself on replacing the existing valves by indirectly heated types, having a much better "figure of merit." It seems almost certain that the H.F. amplifier will lack stability, and that motor-boating will be produced unless elaborate decoupling devices are included in the low frequency anode circuits.

o o o o

### A "Regional" Crystal Set.

*I often use a crystal set for listening to the local station when loud speaker reception is not required, and after hearing the test transmissions from Brookman's Park have come to the conclusion that my present arrangement will be hopelessly lacking in selectivity when the twin stations start operations. I take it that a two-circuit aerial tuner will be the best, and should be greatly obliged if you could suggest any improvement to the conventional arrangement, bearing in mind the fact that I have a number of spare components, including variable condensers of 0.0003 and 0.0005 mfd. capacity, which I should like to use if possible.* K. D.

We think you will find it difficult to better the arrangement shown in Fig. 1, which is an improvement over that usually suggested, in that it makes provision for reducing the damping effect of the crystal; this is achieved by joining the detector and phones across a portion only of the secondary inductance coil.

Strictly speaking, the best connection for the crystal tapping can only be determined by trial and error, as its position depends entirely on the characteristics of the detector. It will therefore be obvious that a simple single-layer winding, or perhaps a section-wound coil would be best for this circuit, but in practice good results are often afforded by the use of an efficient commercial

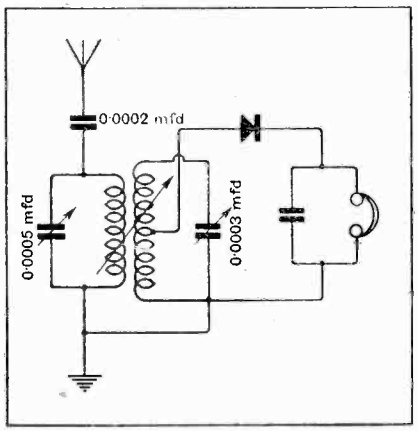



**Fig. 1.—Highly selective circuit arrangement for a crystal receiver.**

centre-tapped plug-in coil; of course, the crystal connection is made to the mid-point.

*RULES.*

*(1.) Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

*(2.) Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

*(3.) Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

*(4.) Practical wiring plans cannot be supplied or considered.*

*(5.) Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

*(6.) Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

*Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.*

Results comparable with those yielded by this step-down auto-transformer can be obtained by using an exceptionally large capacity for tuning the secondary circuit, but this is not usually convenient, particularly if it is desired to receive both of the twin stations, which will naturally transmit on wavelengths differing as much as possible.

o o o o

### Tapping Litz Wire.

*I am building a two-circuit aerial tuner similar to that included in several recent "Wireless World" sets, and have encountered a difficulty in making tapped connections to the secondary winding, which is of Litz wire. It would simplify matters greatly if it were permissible, instead of making connections to all the strands of the cable, to effect a junction to but a few of the conductors; would this course be permissible, or would it be better in the interests of efficiency to cut the wire at each point and to make a soldered connection to each and every strand?* O. C. B.

In circuits of the kind under discussion—and, indeed, in most arrangements for which tapped Litz coils are used—it is is quite unnecessary to make connection with all the strands. In a tuned open aerial circuit where losses are bound to be fairly heavy, there is no point in taking special precautions, but you should be very careful not to break any strands.

o o o o

### 'Kit Set" Modifications.

*Is there any reason why the "Wireless World Kit Set" should not be modified by the use of anode bend detection? It is realised that this alteration would entail one or two minor modifications; for instance, the detector-grid would be connected directly to the high potential end of the H.F. transformer secondary.*

*If you approve this alteration, I propose to abandon the use of reaction.* P. A.

With the alterations you specify, the set should work quite well, with its detecting circuits altered for anode bend rectification. It must not be forgotten, however, that in its existing form it is essentially designed for grid detection, and we cannot help thinking that it would be rather a pity to alter it.

### Eliminator for the "Foreign Listener's Four."

*I already have an H.T. eliminator capable of supplying approximately the voltages specified for the "Foreign Listener's Four." Do you think that it would be safe to use it, or would it be better to make up a special unit as described?*

M. T. E.

The circuit of the set in question is such that it is not prone to interaction troubles, and, if your eliminator delivers sufficient current at approximately the right voltage and includes reasonably adequate smoothing arrangements, there is no reason why it should not be used with complete satisfaction.

oooo

### "Kilo-Mag Four" Pick-up Connections.

*Will you please give me a circuit diagram showing how a pick-up may be fitted to the "Kilo-Mag Four" receiver? If possible, I should like to make the change-over by means of a single-pole switch mounted through the base of the screening compartment, and operate it through a rod by a knob mounted on the front panel. In addition, I should like to arrange matters so that the H.F. valves are switched off when the waveband switches are in the "off" position.*

A. G. C.

This method of fitting a pick-up is to be recommended, and it is not difficult to devise a suitable method of connection. A recommended arrangement is shown in Fig. 2, which is drawn on the assumption that the switches at present used for waveband changing are so made that they have a definite "off" position.

You will see from the diagram that the extra switch is so arranged that it changes over the low-potential end of the detector grid circuit from its normal bias connection to the pick-up, which will naturally be connected to a less negative point on the common bias battery. An extra pole is added to the waveband switch $S_3$ (reference lettering corresponds with that in the original circuit diagram, Fig. 2), and is arranged so that the filament connections of the H.F. valve are broken when its arms are in a position intermediate between the sets of contacts.

oooo

### Potentiometer or Variable Resistance.

*By mistake I recently purchased a ¼-megohm potentiometer instead of a variable resistance of that value; will you tell me if it is possible to alter the internal connections to the terminals, so that the device may be used as a plain variable resistance?*

R. T. C.

Unless a definite "off" position is required for your purpose, it is quite unnecessary to alter the component, and, to use it as a variable resistance, it will only be necessary to connect the external circuit to the terminal in contact with the movable brush contact (generally the centre terminal) and to either one of the other terminals—it is really immaterial which, but it is usual to choose the one which gives a decrease of resistance with clockwise rotation of the knob.

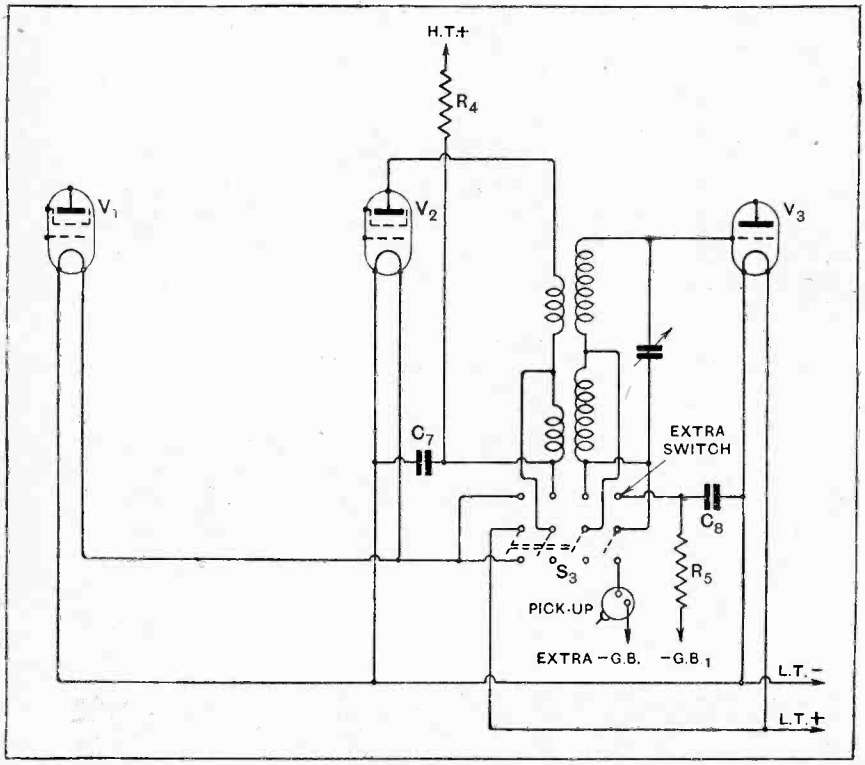



**Fig. 2.—Method of connecting a gramophone pick-up to the "Kilo-Mag Four": an extra contact on the wave-change switch $S_3$ is arranged to break the H.F. valve filament circuits.**

oooo

### Built-in Transformer Condensers.

*For the "Kilo-Mag Four" I am using a transformer with a built-in condenser across the primary windings. Would it be best to remove it, or, alternatively, do you advise me to leave it in position and to omit the by-pass condenser connected between anode and filament of the detector valve?*

C. N. S.

To be on the safe side, we think it would be as well to remove the condenser. Unless steps are taken to by-pass H.F. currents in the detector anode circuit, instability may be encountered, and it is hardly wise to omit the anode by-pass condenser, as you suggest.

oooo

### Testing in Safety.

*My "Record III" receiver is nearing completion, and I should like to know what alterations are necessary to enable me to test the receiver with battery feed before connecting my mains unit.*

R. P. C.

This receiver may be fed from a battery supply without any alteration whatsoever. The leads provided for connection to the low voltage A.C. input are connected across a 4-volt low tension accumulator; polarity is immaterial. You should assure yourself that this battery is capable of delivering a current of 3 amperes.

oooo

### Leave Well Alone.

*Do you consider that it would be worth while modifying the "New All-Wave Four" by substituting a screen-grid valve for the present neutralised triode H.F. amplifier? If so, will you please give me a few hints as to how to proceed, bearing in mind that, as the set works very well as it is, I do not propose to make any change unless it is possible to do so satisfactorily without radical structural alterations?*

C. R. G.

If you are using an efficient modern three-electrode valve in the H.F. position, it can safely be assumed that a magnification of at least forty times is being attained; unless comparatively elaborate screening arrangements are added, you are hardly likely to better this appreciably by fitting a screen-grid high-frequency valve; unless you are willing to make these alterations, we can hardly advise you to change your existing arrangements.

oooo

### The "Kilo-Mag Four": A Correction.

In the practical wiring plan of this receiver, the reference lettering on the two H.F. valve-holder filament terminals should be reversed; it will be obvious that the terminals "earthed" to the metal work should be lettered *r* and *t* to correspond with their connecting wires, which lead to L.T. negative. The valve-holder positive filament terminals, which are connected to the rheostat, should of course be lettered *s* and *u*.

# The Wireless World AND RADIO REVIEW

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CONTENTS OF THIS ISSUE.



## THE REGIONAL SCHEME.

OUR editorial in the issue of October 16th, under the title "Must the Regional Scheme be Scrapped?" has aroused some of our readers to wrath, whilst others are whole-hearted in their endorsement of our criticism of the power of Brookman's Park. The letters which we are receiving can, with very few exceptions, be divided into two classes; those whose receivers have hitherto been outside the range of efficient reception from the lower-powered 2LO transmitter in Oxford Street and who now get a satisfactory service on account of the higher power of Brookman's Park, and are enthusiastic in their support of the station; and those who have the misfortune to live nearer to Brookman's Park and find that much that they were hitherto able to listen to by way of a choice of programme is now denied to them because of the "wipe out" effect of the new station. These unfortunates look forward with apprehension to the commencement of the dual transmissions from the regional station.

Several letters have commented on the fact that the receivers described recently in *The Wireless World* have been designed so as to be sufficiently selective to overcome the disadvantages of the high power transmitter and that therefore there should be no occasion for worry. We agree that selective sets will go a long way towards solving the problem for those who want to listen to alternative stations, but the vast majority of the public are to-day using sets which are not sufficiently selective to give them, under the regional scheme, freedom to receive transmissions from abroad which they have hitherto enjoyed.

### B.B.C. Programmes Only.

We know that those who have been responsible for developing the regional scheme hold the view that the listener should have the choice of two B.B.C. programmes from his local regional transmitter, and that he should neither be encouraged nor even permitted to receive any other station, but that from time to time the B.B.C. will put on for his benefit selected portions of the programmes of some of the foreign stations. Now the listener has, we feel, a right to say whether he endorses this policy or not, and whether he is content that his receiver should, by the action of the B.B.C., be rendered virtually incapable of receiving anything beyond the two programmes which the B.B.C. will provide. Our own conception of wireless does not, we fear, harmonise with this policy; the principal fascination of wireless, as we see it, lies in the ability to reach out and pick up programmes of all countries and all languages at will.

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## OLYMPIA SHOW COMPETITION.

IN this issue we are able to announce the result of the voting of our readers in the Competition which we conducted in connection with the Olympia Radio Show, and we give the names of the receivers and other apparatus gaining the largest number of votes in each of the classes into which the exhibits as a whole were divided.

We are not yet in a position to announce the names of the winners of the cash and other prizes, offered by *The Wireless World* to those competitors whose votes agree most nearly with the views of the majority, but the task of arriving at these totals is a formidable one and some little delay is inevitable. Last year the total of entries was not so great, and it was then possible to make both announcements at the same time.

In our issue of November 13th we propose to illustrate and describe the winning apparatus in the Competition, and we feel sure that these descriptions will be of interest to all our readers.

# SELECTIVITY AND QUALITY

## Using Band-pass Filters to Avoid Interference and Side-band Cutting.

By W. T. COCKING.

WITH the opening of the first Regional Station at Brookman's Park the problem of obtaining adequate selectivity has become greater than ever before. A method of tuning which of recent years has been somewhat neglected is that employing coupled tuned circuits, which in pre-broadcasting years was often used under the name of the three-circuit tuner. The use of this method, however, has been revived in a few modern receivers, a notable example being the "Wireless World Record III" set; it is also used by the B.B.C. in the transmitting circuits of the Daventry Experimental station.

The reason for its lack of popularity is due to the fact that in its old form it was very difficult to tune, there being three variable controls. Properly designed, however, as in the "Record III," it is no more difficult to handle than more conventional arrangements, and it offers several important advantages.

The great fault of all ordinary tuned circuits is that they reduce to a large extent the strength of the high notes in the received speech and music. This effect is well known, but the amount of the reduction is not so generally realised. The H.F. circuits of a receiver using a Mazda AC/SG valve as the H.F. amplifier will, under certain conditions, reduce a 5,000 cycle note by 89 per cent., when the carrier wavelength is 500 metres, and both the grid and tuned anode coils have inductances of 240 mH. and H.F. resistances of 5 ohms. On the lower wavelengths the loss is not so great, but it is still so serious that it will completely overshadow any normal loss in the L.F. portion of the set.

The selectivity of the arrangement is quite high, the strength of a signal at 40 k.c. off resonance will be only 1/500th of that at resonance; that is, the selectivity ratio is 500 : 1. Throughout this article the selectivities of different circuits will be compared by the ratios of the voltage on the grid of the valve at resonance and at a frequency differing from resonance by 40 k.c. The variation in strength over the side-band range (taken as the carrier frequency plus or minus 5,000 cycles) is expressed as a loss in percentage.

With the usual method of tuning by circuits in cascade no improvement in quality is possible without a corresponding reduction in selectivity, unless both the number of the circuits and the H.F. resistance of each are increased. While this is quite effective, it is not very economical, for the resistance of each coil has to be so high that the sensitivity of the receiver is very much reduced.

With coupled tuned circuits, or as they are more usually called, band-pass filters, high selectivity with a good measure of amplification and a high note loss of only about 10 or 20 per cent. can be readily attained. There are three methods of coupling the two halves of these filters, (*a*) by inductance, (*b*) by mutual inductance, and (*c*) by capacity, and the connections for such filters used in the aerial circuit are illustrated in Fig. 1.

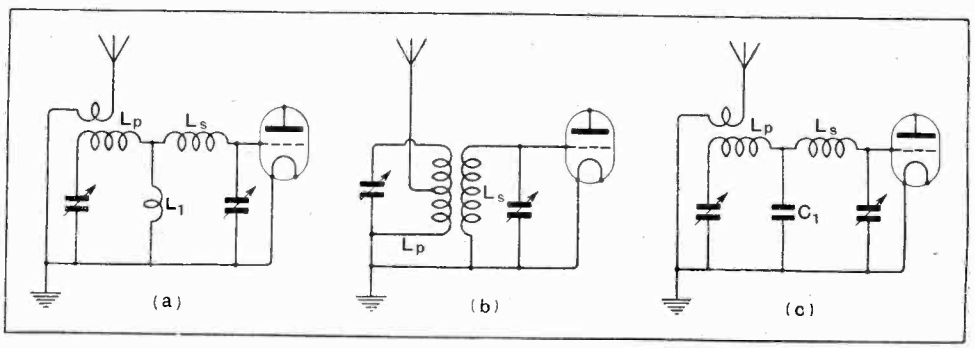



Fig. 1.—Three band-pass filter arrangements. (a) Coupled by inductance; (b) coupled by mutual inductance; (c) capacity-coupled.

Now it is a peculiarity of filter circuits of these types that they are tuned to two different frequencies at the same time. With inductance coupling, one of these frequencies is the same as the normal resonance fre-

**Selectivity and Quality.**

quency of either primary or secondary circuit alone, while the second resonance frequency depends upon the value of the coupling inductance $L_1$. Expressed algebraically,

the normal resonance frequency $f = \frac{1}{6.28\sqrt{LC}}$

the second resonance frequency $f_1 = \frac{1}{6.28\sqrt{C(L+2L_1)}}$

With mutual inductance coupling, there are still two resonance frequencies, but neither of these occurs at the normal resonance frequency. One is at a higher, and the other at a lower frequency as follows:—

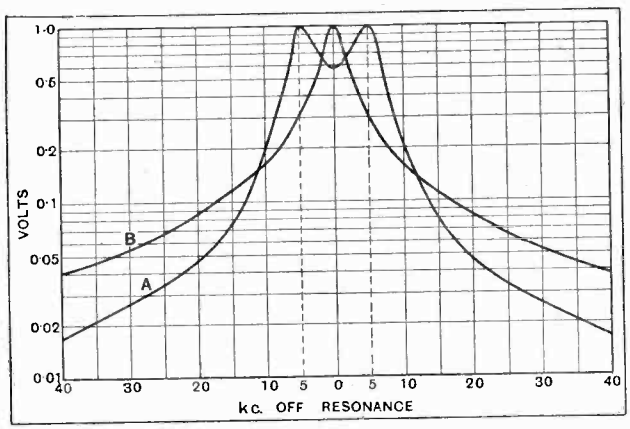



**Fig. 2.—Curve A, filter in aerial circuit at 500 metres, 5 ohms coils. Curve B, single coil aerial tuned circuit at 500 metres, 5 ohms coil.**

one resonance frequency $f_1 = \frac{1}{6.28\sqrt{C(L+M)}}$

the second resonance frequency $f_2 = \frac{1}{6.28\sqrt{C(L-M)}}$

It is this possession of two resonance frequencies which makes the filter so valuable; for the resulting tuning curve shows two peaks, the distance apart of which depends principally upon the value of the mutual inductance M, and to a smaller degree upon the resistance of the coils. See formula given in Appendix (1).

The results calculated from the formula show that the shape of the tuning curve is the same for both inductance and mutual inductance couplings. The chief fault of both types of inductance coupling, however, is that the peaks get further apart as the wavelength decreases, and, neglecting the effect of the resistance, the distance between them at 250 metres will be double that at 500 metres. Thus the selectivity on the lower wavelengths is reduced. With capacity coupling, on the other hand, the reverse takes place; and the distance between the peaks is less on the shorter wavelengths.

Curve A, Fig. 2, shows the resonance curve for a mutual inductance-coupled (or inductance-coupled) filter, where each coil has the same constants—240 mH., 5 ohms, the value of mutual inductance being 4 mH.—and the wavelength is 500 metres; while curve B is for an ordinary tuned coil in the aerial circuit, having the same constants. The curves in Fig. 3 are for the same circuits, but for a wavelength of 250 metres, at which the coil resistance is 10 ohms.

An inspection of these curves shows that with a wavelength of 500 metres (Fig. 2) at a frequency 40 k.c. different from the carrier the selectivity with the filter is much better than that with the ordinary tuned circuit. At frequencies nearer to resonance the filter is not quite so good; but the variation over the side-band range is 42 per cent., as compared with 69 per cent. for the single coil. The efficiency, however (see Table) is only about one-third.

**The Intervalve Coupling.**

The curves of Fig. 3 for the same circuits at 250 metres show that here again the filter is the better, but that the differences between the two circuits are less at this shorter wavelength. At 40 k.c. from resonance the selectivity with the filter is only slightly greater than that with the ordinary circuit, but the shape of the curves shows that at frequencies further from resonance than this it will be by far the more selective. The side-band variation is also less, being only 18 per cent. as compared with 15 per cent. for the single coil. The only fault of this curve (A) is that there may be a danger of receiving stations adjacent in wavelength to that of the desired station, as the peaks coincide with their wavelengths. This fault may be eliminated, as will be shown later.

The behaviour of a filter used as an intervalve coupling in place of the more usual tuned anode or tuned transformer will now be considered. In the Appendix is given the necessary formula (2) for calculating the amplification possible at any frequency.

Since the curves for a filter used in the anode circuit of a valve such as the Mazda AC/SG are very similar to those for the same filter used in the aerial circuit, it is unnecessary to give a series of curves, but Fig. 6, Curve A, shows one for an inductance-coupled filter at

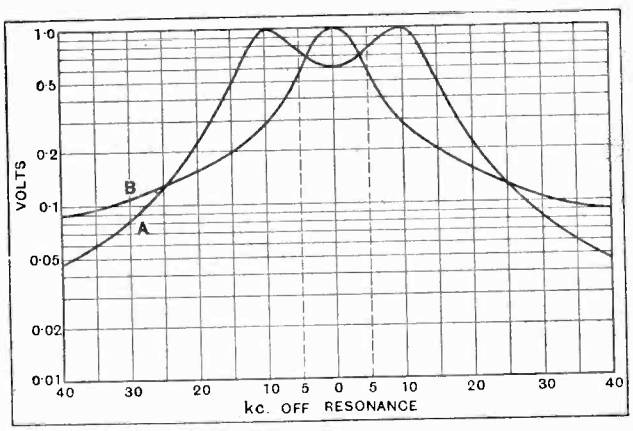



**Fig. 3.—Curve A, filter in aerial tuned circuit at 250 metres, 10 ohms coil.**

500 metres. The essential characteristics are given in the table, and it is curious that the selectivity is actually higher than when the same filter is used in the aerial circuit.

A comparison of the results for the filter used in the aerial circuit with those for it in the anode circuit shows

**Selectivity and Quality.**—

that there is little difference as regards selectivity and efficiency, but that in the anode circuit it gives a smaller side-band variation.

Now, it will be observed that all these filters give a double-peaked curve, with the result that the high notes in the reproduced speech and music are accentuated. This is not undesirable, since most loud speakers are somewhat deficient in the upper register. There is no base cut-off, for the effect is similar to that obtained

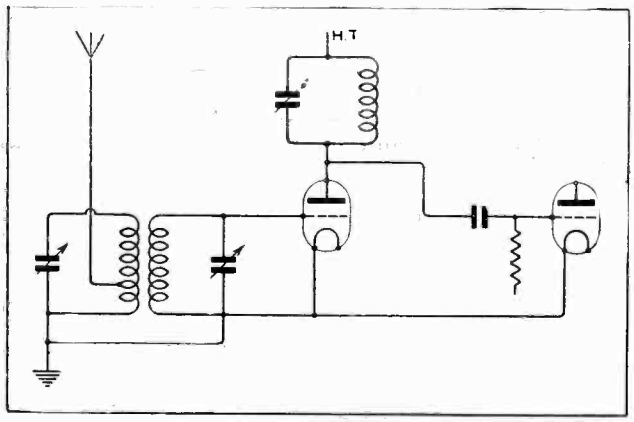



**Fig. 4.—A curve with a single peak is obtained when using this circuit.**

with an L.F. transformer having a rising characteristic. If this were the whole story it would be advantageous to use suitably designed filters in order to compensate for the loud speaker deficiencies. Unfortunately, however, such an arrangement would be difficult to handle, for it would be necessary to tune, not for maximum strength, but for a minimum occurring between two maxima. For ease in tuning, therefore, the overall curve must have only a single peak, and this can easily be obtained by using a tuned-anode intervalve coupling with a filter in the aerial circuit.

### Avoiding Interference from Brookman's Park.

A circuit of this nature is shown in Fig. 4, and the overall tuning curve is the product of the individual curves for the filter and tuned-anode. Overall curves are given in Fig. 5 for the case when the components have the values given earlier; curve A is for a wavelength of 500 metres, and B for 250 metres; the figures for selectivity and amplification are given in the table.

At this point it is of interest to note a few characteristics of the filter circuit. When the H.F. resistance of the coils is raised sufficiently, the value of the mutual inductance being unaltered, the double-peaked curve will disappear and be replaced by a single very flat peak; and although the efficiency and selectivity are slightly lowered the amount is by no means as great as one would expect. This is shown in Fig. 6, where curves A and B are for identical circuits in the anode of an AC/SG valve, but the coil resistances are 5 and 10 ohms respectively. The figures for amplification are 71.5 and 56.7, for selectivity 54.5 and 41.5, and for side-band variation 34.5 per cent. and 2 per cent.! The improvement in the side-band variation is so enormous that in many cases the slight loss in amplification and selectivity is well worth while, particularly as the former is only low when compared with the results obtainable from the same valve and low-loss coils. In actual fact, it is rather higher than that obtained with the screen-grid valves of only a year ago.

An increase in the resistance of the coils of a filter in the aerial circuit gives similar results, but the alteration in side-band variation is not so marked. The effect of increasing the mutual inductance between primary and secondary circuits is to increase the distance between the peaks in the curve, and in many cases to decrease the side-band variation and efficiency. Lowering the value of the mutual inductance will increase both the selectivity and efficiency up to the point where the single-peaked curve is obtained; it will, however, introduce more high-note loss.

When designing any receiver it is advisable to make the aerial circuit as selective as possible, otherwise jamming of a peculiar kind may be obtained. When listening to a weak signal on a wavelength quite different from that of the local station, no matter how selective the intervalve couplings may be, if the aerial circuit is unselective the local station may cause considerable jamming. This is a rather neglected side of the selectivity question, but one which may be of particular interest to those living near a high-power station. Jamming of this kind is due to the H.F. valve. If the valve is overloaded, or its characteristic curved, it will rectify the voltages produced by the strong local station,

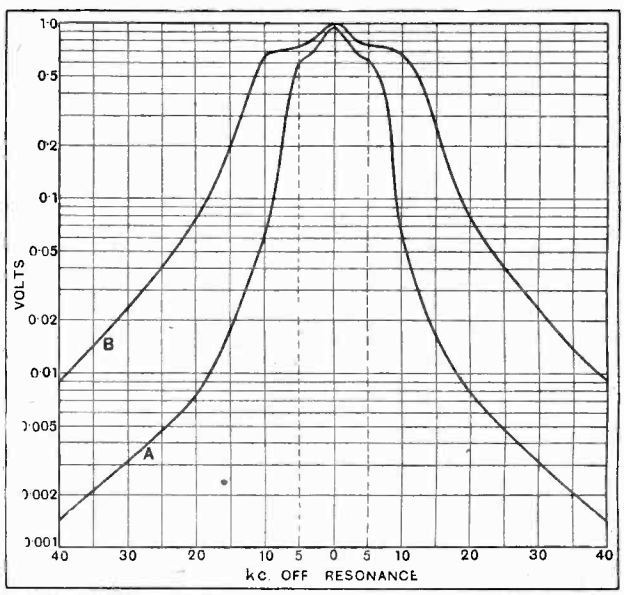



**Fig. 5.—Curve A, filter in aerial circuit followed by tuned anode, 5 ohms coils at 500 metres. Curve B, as curve A, but 10 ohms at 250 metres.**

and the resulting low-frequency currents will modulate the carrier of the desired station. The result is that the local station is heard, for it will actually pass through the following tuned circuits as a signal of the wavelength to which they are tuned.

A similar form of jamming is obtained under the same conditions if the aerial tuning is very flat. Suppose that the set is tuned to 1,500 k.c. and that the aerial tuning is so flat that it allows a fair proportion

**Selectivity and Quality.**—

of the voltage set up by the signals of two stations working at 700 k.c. and 800 k.c. to reach its grid. These voltages will be rectified by the H.F. valve and will produce a variety of beat frequencies, one of which will be equal to the sum of the two original frequencies.

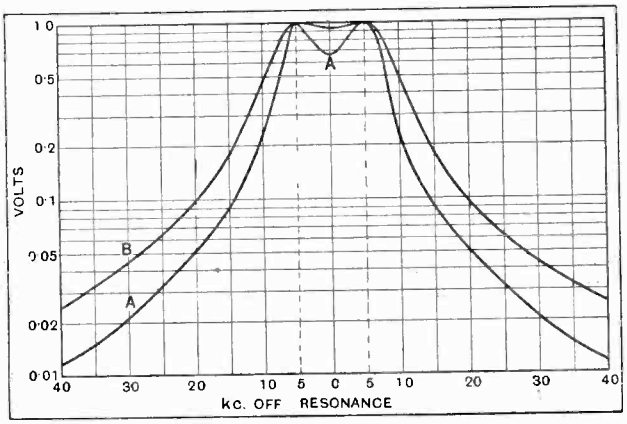



**Fig. 6.—Curve A, filter with 5 ohms coils at 500 metres in anode of AC/SG valve. Curve B, as curve A, but 10 ohms coils.**

that is, 1,500 k.c. Thus, not only will the desired station be heard, but in addition a jumble of two other stations; and this no matter how selective the tuned intervalve couplings may be.

Jamming of this character is frequently obtained, and blamed upon the unselective properties of the set, whereas the fault lies rather in the characteristics of the H.F. valve. The cure is always to work the H.F. valve upon the straight part of its curve, and to provide as selective an aerial tuning circuit as possible. The former necessitates a fairly high H.T. voltage and the correct negative grid bias, and the avoidance of those forms of volume control which alter the characteristics, such as filament control, control by alteration of the anode, screen-grid or control grid voltage.

A selective aerial circuit necessitates some form of band-pass filter if excessive side-band variation is to be avoided. For this reason, therefore, it is recommended that if tuning by a combination of filters and single-tuned circuits be used a filter should always be included in the aerial circuit. For volume control a high-resistance potentiometer shunted across the tuned input circuit is probably the best, as used in the "Megavox" receiver.

Coming now to practical considerations, the great fault of both inductive and capacitative couplings is that each coil in the filter must be completely screened. With mutual inductance coupling, however, it is only necessary to screen the filter as a whole, but it is a little more difficult to obtain the correct degree of coupling between primary and secondary circuits. A very good approximation to the correct coupling can be found as follows: Tune both primary and secondary circuits to a fairly weak station with very loose coupling between the coils; then increase the coupling just beyond the point at which the signals are at their loudest. If low-resistance coils are used a double tuning peak should be just obtained as the ganged tuning condensers are rotated; but if this is found with high-resistance coils the coupling is too tight. Ganging the condensers is quite easy, and is essential to the proper operation of the filter; the initial adjustments are best carried out with very loose coupling between the coils.

### The Use of Solid Wire Coils Preferable.

If desired, reaction may successfully be applied to the secondary coil of a filter. It affords a useful increase in both the amplification and selectivity, and it does not seem to cause nearly so much distortion as with ordinary circuits. The effect is to decrease the coil resistance, and, in theory, this should actually increase the strength of the high notes!

In the accompanying table will be found the essential figures for magnification, selectivity, and side-band variation for all the circuits mentioned earlier; and, in addition, those for an H.F. amplifier at a wavelength of 500 metres, in order to show the possibilities of the filter circuit in a multi-stage amplifier. The circuit diagram of such an amplifier is shown in Fig. 7, from which the method of connecting a filter as an intervalve coupling can be seen. A receiver built in accordance with normal present-day practice would have only three tuned circuits, and, as a consequence, not only would the selectivity be much less, but the high-note loss would be very high indeed.

Lest the filter be condemned on the grounds of expense, it is worthy of note that this need be no higher than that of a Litz wound coil tuned by a single high quality condenser. Coils of this type are usually unsuited to the filter characteristics, and small solid-wire coils which can be made for a few shillings are often the most satisfactory. As highly efficient coils are not used, the small variable condensers of the type made for portable sets are admirably adapted for tuning. Certain of these can be obtained in a form eminently suitable for ganging for about 5s. each.

| Circuit. | Wavelength. | Magnification. | Selectivity. | Side-band Variation. |
|---|---|---|---|---|
| Filter in aerial circuit, 5 ohm coils | 500 | 53.8 | 36.7 | 42% |
| Single tuned aerial, 5 ohm coil .. | 500 | 178 | 25 | 69% |
| Filter in aerial circuit, 10 ohm coils .. .. .. .. | 250 | 53.6 | 12.9 | 18% |
| Single tuned aerial, 10 ohm coil .. | 250 | 180 | 11 | 52% |
| Filter in anode of AC/SG, 5 ohm coils .. .. .. .. | 500 | 71.5 | 54.5 | 34.5% |
| Filter in anode of AC/SG, 10 ohm coils .. .. .. .. | 500 | 56.7 | 41.5 | 2% |
| Filter in aerial, followed by tuned anode, 5 ohm coils and AC/SG valve .. .. .. .. | 500 | 11,100 | 740 | 39% |
| As above, but 10 ohm coils .. | 250 | 19,000 | 108 | 25% |
| Anode filter and tuned anode with 10 ohm coil, aerial filter with 5 ohm coils. Two H.F. with AC/SG valves .. .. .. | 500 | 340,000 | 17,500 | 29% |

**Selectivity and Quality.—**

In conclusion, the writer would say that, in his opinion, anyone once using properly designed filters for tuning will never go back to the ordinary cascade tuning circuits. Not only is the selectivity greater, but the improvement in quality is so great that it must be heard to be realised; and, in practice, the loss in amplification is not so noticeable as the figures would indicate. To those troubled by interference from the powerful transmissions of Brookman's Park the trial of one of the band-pass filters already described is suggested.

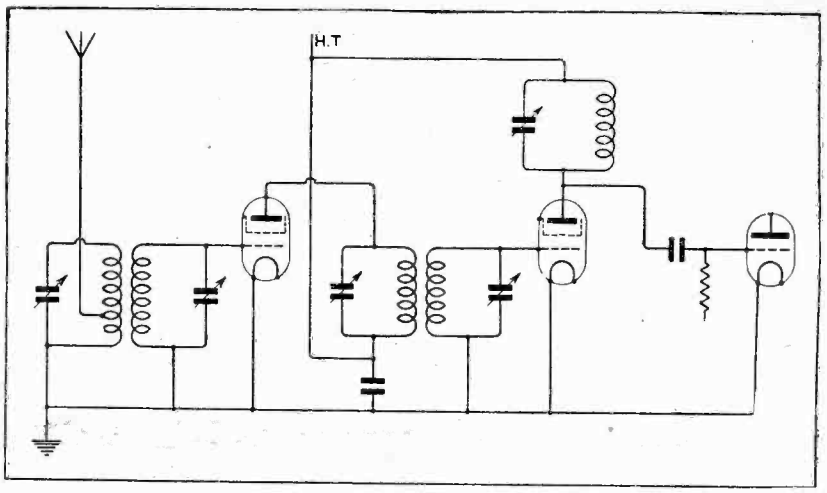



Fig. 7.—A high-frequency amplifier having aerial and inter-valve filters.

APPENDIX.

(1) The following formula may be used to calculate the voltage $e$, impressed upon the grid of a valve at any frequency for a given voltage E, applied in series with the primary circuit.

$$e = \frac{EM}{C\sqrt{\left[\left\{R^2+\omega^2M^2-(\omega L-1/\omega C)^2\right\}^2+4R^2(\omega L-1/\omega C)^2\right]}}$$

where M = mutual inductance in henrys.
L = inductance of one coil in henrys.
C = capacity of one condenser in farads.
R = effective H.F. resistance of coil in ohms.
$e$ = voltage developed across secondary tuning condenser.
E = voltage applied in series with primary circuit.

For inductance coupling the above formula is modified by substituting $L_1$, in henrys, for M; and the value used for L should be the inductance of one tuning coil plus the inductance of the coupling coil $L_1$.

It should be noted that this formula is accurate only when both primary and secondary circuits are identical; that is, when $L_p = L_s$, $C_p = C_s$, and $R_p = R_s$.

(2) Formula for calculating amplification possible at any frequency with filter used as intervalve coupling. The symbols have the same meanings as before, and $\mu$ and $R_a$ are, of course, the amplification factor and anode A.C. resistance of the valve, respectively.

$$A = \frac{M}{\omega C^2\sqrt{\left[\left\{R_a(R^2+\omega^2M^2-(\omega L-1/\omega C)^2)+\frac{LR}{C}\right\}^2+\left\{(\omega L-1/\omega C)\left(2RR_a+\frac{L}{C}\right)-\frac{\omega M^2}{C}\right\}^2\right]}}$$

# "THE WIRELESS WORLD" OLYMPIA SHOW COMPETITION.

**Results of the Ballot.**

WE are now in a position to announce the results of *The Wireless World* Competition arranged in connection with the Olympia Radio Show, in so far as giving the names of the winning sets and other apparatus in the various classes into which the exhibits at Olympia were divided.

We shall not be able to announce the names of the winners of the cash and other prizes until a little later, as the task of arriving at the totals for this purpose has not yet been completed.

It will be remembered that, in connection with the voting, we divided apparatus into various classes, which were defined as follows:—

(1) Complete receivers of five valves or more—that is to say, receivers exclusive of loud speaker and batteries—unless these should happen to be incorporated as part of the receiver.

(2) Complete receivers of four valves or less, similarly defined.

(3) Batteries of all kinds, including accumulators for both high tension and low tension.

(4) Mains supply units, both D.C. and A.C., and including those which provide filament heating circuits.

(5) Loud speakers of all types.

(6) Valves.

(7) Other apparatus not classified above, also amplifiers, component parts, such as transformers, condensers, tuning coils, resistances, etc., etc.

In addition, readers were asked to vote for what was considered to be the single outstanding exhibit at the Show. In our issue of November 13th we are arranging to illustrate and describe the winning apparatus in the various classes.

## OUTSTANDING SINGLE EXHIBIT AT OLYMPIA.

"Mazda" Screen Grid A.C. Valve.
The Edison Swan Electric Co., Ltd.

## WINNING CLASSIFIED EXHIBITS.

***Class 1.***
A.C.7 Receiver.
Burndept Wireless (1928) Ltd.

***Class 2.***
Four-valve Receiver, All-electric, No. 2511. Philips Lamps Ltd.

***Class 3.***
Type WY.10 Exide H.T. Accumulator.
The Chloride Electrical Storage Co. Ltd.

***Class 4.***
Ecko Combined A.C. Eliminator, Type C2A. E. K. Cole, Ltd.

***Class 5.***
Moving Coil Loud Speaker.
Ferranti, Ltd.

***Class 6.***
"Mazda" Screen-Grid A.C. Valve.
The Edison Swan Electric Co. Ltd.

***Class 7.***
The Novotone. Gambrell Radio Ltd.


# Factors in Design.

By F. L. DEVEREUX, B.Sc.

MANY methods, widely divergent in principle, have been suggested for converting the mechanical energy from a gramophone record into electrical energy in a suitable form for amplification; but, for various reasons which need not receive our consideration at the moment, only one type has survived commercially, viz., the electromagnetic pick-up. Fig. 1 shows the principle of an early form of electromagnetic pick-up which may be referred to as the "single-acting" type in which a vibrating reed varies the magnetic flux between two pole pieces *situated at one side only of the reed*. The single-acting pick-up has, however, given place to the differential or "double-acting" type shown diagrammatically in Fig. 2 in which the reed is placed symmetrically between pole-pieces *situated on either side of the reed*.

The advantage of the latter arrangement will be better appreciated if we first study the disadvantages of the single-acting principle. In the first place, serious amplitude distortion is caused by the fact that the flux varies as the square of the distance of the reed from the pole pieces. Secondly, the whole of the flux passes through the reed and may cause saturation, and, thirdly, as the attractive force is exercised in one direction only, a heavy reed with a powerful restoring force is necessary to prevent it falling on to the pole pieces.

### Principle of the Balanced Armature.

In the case of the differential movement, the flux in the armature at rest is zero as the diagonal fluxes from the pairs of opposite pole-pieces cancel out (see Fig. 3(a)). When the armature is displaced (Fig 3(b) and (c)) the greater part of the flux flows in one direction, thus inducing an E.M.F. in the coil C (Fig. 2), but a certain residue still flows in the reverse direction, and this tends to annul the square-law effect mentioned in connection with the single-acting pick-up. The cancellation is, however, incomplete, and amplitude distortion still persists. Fortunately, it is now reduced to the degree where it becomes useful in compensating for the restriction in amplitude of the low notes on the average record.[1] The tendency for the armature to stick over on the pole pieces is also present in the differential movement but to a much smaller extent. There is no necessity to strengthen the reed to combat this force, and the necessary restoring force can be applied by the rubber damping pads (D in Fig. 2).

The differential movement, then, provides a practical method of reducing *amplitude* distortion to a manageable quantity. A much more difficult problem is that of *frequency* distortion. This resolves itself largely into a question of resonance in the reed itself. Now any vibrating system involving mass and a restoring force will resonate at one frequency, possibly more than one if harmonics are present. The frequency of the principal or fundamental resonance will be inversely proportional to the mass and directly proportional to the restoring force. In order to produce a pick-up of good characteristics this principal resonance should lie outside the range of fundamental frequencies used in speech and music. It is impracticable to arrange for the resonance to occur below, say, 30 cycles, therefore we must endeavour to raise it above 3,500 cycles. To do this the mass of the moving parts must be reduced to a minimum and/or the restoring force increased. The restoring force generally takes the form of rubber pads (D in Fig. 2), which also absorb a certain amount of energy, and thus damp down the resonance peak in the response curve. Record wear, however, limits the restoring force and degree of damping we can employ.

### Reed Resonance.

The correct procedure, then, in raising the principle resonance above 3,500 cycles is to start with the reed and to reduce its mass to the lowest possible figure, and then to add just sufficient restoring force in the form of rubber damping to raise the frequency to the required value and to hold the reed symmetrically between the pole pieces. When dealing with the reed it must not be forgotten that the needle holder and set-screw are an integral part of the vibrating system and must be made as light as possible. In the B.T.H. pick-up, for instance, the set-screw coincides with the pivot axis (P in Fig. 2) thus reducing its moment of inertia about the point P.

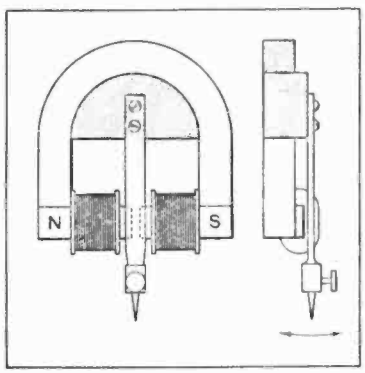



Fig. 1—Single-acting or unbalanced armature pick-up.

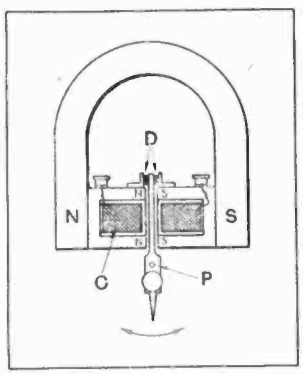



Fig. 2.—Differential or balanced armature pick-up.

[1] See p. 177 of the August 21st issue.

**Gramophone Pick-Ups.—**

The lightening of the moving parts has been carried to its logical conclusion in the new Burndept and Lissen pick-ups in which the needle itself forms the vibrating armature and carries the magnetic flux. Naturally, the characteristics of such pick-ups must depend on the type of needle employed, but in the ordinary balanced-armature instrument the effect on the characteristic is small, though the general level of the output may be

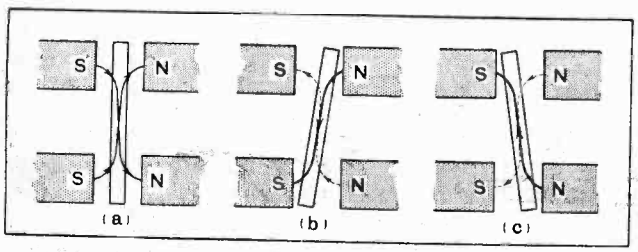



**Fig. 3.—Illustrating the principle of the differential or balanced armature.**

considerably modified. This is illustrated by the curves in Fig. 4, which are the result of actual measurements on an experimental pick-up with two different types of needle. The general form of the curve remains unchanged, but the resonance in curve A is about 400 cycles lower than in curve B, while the general level of output is nearly doubled. The lowering of the resonance in curve A is due to the extra mass of the thick Tungstyle needle.

As a guide to the relative outputs to be expected from various types of needle the following figures, the results of some measurements with H.M.V. needles, are given.

| Needle. | Relative Output. (Per cent.) |
|---|---|
| Tungstyle Extra Loud Tone .. .. | 100 |
| „ Loud „ .. .. | 90 |
| „ Soft „ .. .. | 80 |
| Steel Extra Loud Tone .. .. | 85 |
| „ Loud „ .. .. | 80 |
| „ Half „ .. .. | 75 |
| „ Soft „ .. .. | 45 |

Although the Tungstyle needles give a good output and will play up to 250 records without renewal, their comparatively high mass tends to bring the armature resonance within the range of audibility. The steel " Half Tone " needle is a good compromise for all-round use with electrical pick-ups; its weight is not excessive, yet there is little loss of energy in transferring the record vibrations to the armature.

The three factors most essential to the successful design of an electromagnetic pick-up may therefore be summarised as follows:—

(1) A symmetrical arrangement of the magnet pole pieces to give differential vibrations of flux in the reed or armature. Provided the armature is accurately centred, amplitude distortion will be reduced to a level at which it can be turned to a useful purpose, while the restoring force required to hold the armature in a central position will be small.

(2) An armature of the smallest possible dimensions in which the best distribution of mass to give a small moment of inertia has been attained without appreciably affecting the efficiency of the magnetic circuit.

(3) The restoring force and damping must be adjusted to compromise between record wear, the frequency of the principal reed resonance, and the peak value of this resonance.

Numerous minor problems follow in the train of these three indispensable conditions. For instance, the small reed demands a large and heavy permanent magnet if an adequate voltage output is to be maintained, and this means increased record and needle wear. Actually, record wear is more a question of the mass and damping of the reed than of the downward pressure of the needle. In fact, damage to the record groove is more likely to occur with a light pressure due to the tendency of the needle to jump the groove. Wear of the *bottom* of the groove due to pressure is unimportant compared with damage to the *sides*, which do the work of transferring the sound energy to the needle. In the writer's experience too little weight on the needle point is a prevalent source of distortion, and where the tone arm is fitted with

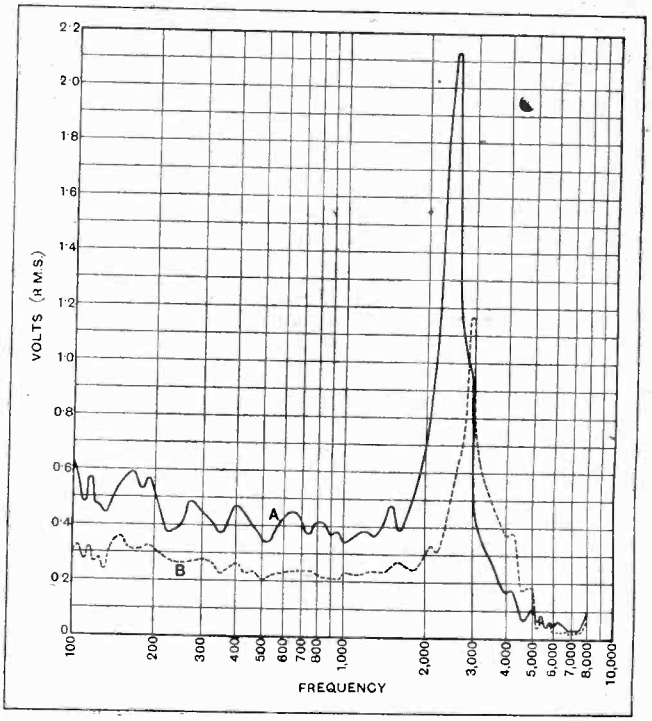



**Fig. 4.—Output characteristics of experimental pick-ups, (A) with Tungstyle soft tone needle, (B) with steel soft tone needle.**

an adjustable counterweight, best results are almost invariably obtained with the maximum available pressure.

Tone arm resonance should also be taken into account, though its effect on the output characteristic will not be appreciable until the pick-up movement itself is well-nigh perfect.

Now that standard frequency records are available to the public all the foregoing points can be investigated experimentally, and there is no longer any excuse for the manufacturer who continues to market an inferior product.

# NEW YORK RADIO SHOW

## Impressions of the Radio World's Fair.

By OUR SPECIAL CORRESPONDENT.

*In the following report readers will be able to draw some interesting comparisons between the latest British and American practice in receiver design. U.S. broadcasting conditions have hitherto given manufacturers across the Atlantic unrivalled experience in producing selective receivers, but their lead in this direction is now being seriously challenged by the British-made article.*

THAT the American broadcast receiver has almost become a standardised article was the impression gained by a visit to the sixth annual Radio World's Fair, held at Madison Square Garden, New York City, at the end of September.

Just as different makes of car now differ only in comparatively minor details, so with the American broadcast receivers of the different manufacturers. The screen-grid tetrode is almost universally used for the radio frequency amplifier stages. There are usually four tuned circuits, including the input stage. All the sets have single tuning control with an additional knob for controlling volume and usually a third control for adjusting the input circuit, which contains the antenna. This adjustment is not only necessary to cater for different antenna structures, but also to a small extent for different wavelengths.

### Ganged Tuning in Evidence.

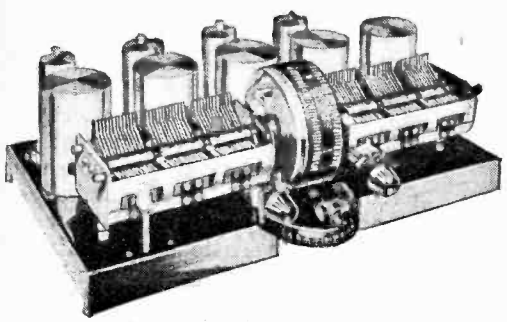
The tuning of the stages is carried out by means of a gang condenser. Components of this kind can be manufactured by mass-production methods, so that individual condensers do not differ from one another by more than one or two micro-microfarads on any part of the scale. Using a condenser aerial the step-up obtained by turning the induced E.M.F. into a potential difference across a tuned circuit will depend on the value of the capacity across the aerial. In order to eliminate this effect, a variometer tuning is employed by some manufacturers on the input circuit. There are a number of other different types of input circuits which endeavour to correct this inherent defect of gang condenser tuning, but none gives perfect tuning of the input circuit over the whole wavelength range. This difficulty could be overcome by employing an

**New York Radio Show.—**

untuned input, but in such a case the amplification of the set would be considerably reduced, and if this were compensated for by the insertion of another valve the ratio of valve noise to signal noise would be very considerably increased.

The concert-hall "Grebe," one of the best-known American receivers. Three S.G. valves are employed, but only one stage of L.F. amplification. A gramophone pick-up is included.

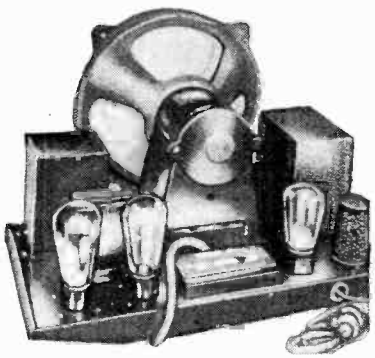
All the sets on view at the Show were very compact, and each stage was carefully screened. *In American receivers reaction control is absolutely taboo.* The sets contain five to seven valves, often using separate heaters in order to reduce the A.C. hum of the supply, practically all the sets being fitted with a power pack suitable for A.C. mains. In such conditions, of course, it is not necessary to economise in filament voltage and most valves work on a five-volt filament. Many sets are fitted with automatic volume control, an arrangement by which, if the carrier amplitude is large, the overall amplification of the set is automatically reduced. If such an arrangement were perfect, all stations transmitting with the same percentage modulation would produce the same output intensity for a given setting of the volume control. In practice, the arrangement is not perfect, but is very convenient.



The "Grebe" receiver contains no fewer than six tuned circuits all controlled by a single knob.

### Automatic Tuning.

Although the space available in the exhibition was not so large as that at Olympia, there was a comprehensive display of sets and components fully representative of the latest practice in American radio. About 300,000 people visited the Show during the week it was open, an increase of 50,000 over last year.



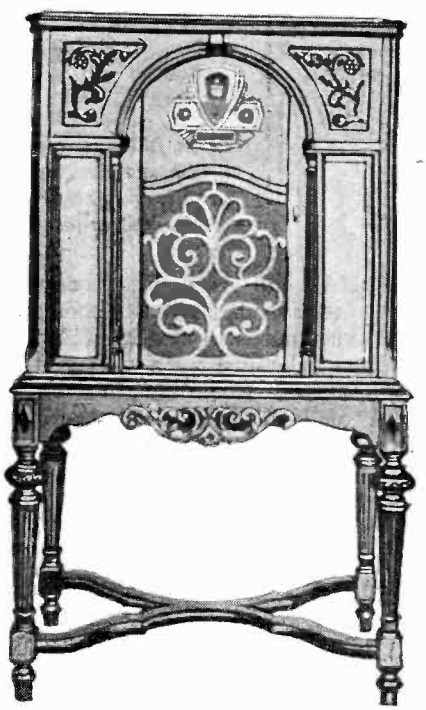
The moving-coil loud speaker fitted as standard in all the "Grebe" models.

The fact that orders were booked for no less than six million pounds sterling is sufficient indication that radio in the U.S. is in a flourishing condition.

The genius of the American manufacturer in the production of labour-saving devices was strikingly exemplified in nearly all of the well-known models. Knobs and dials, switches, etc., were conspicuous by their absence, two small controls harmonising with the general ensemble of the set being sufficient for tuning and control of volume. Many sets have automatic tuning, such as the Zenith and the Earl receivers. The latter is fitted with a device which enables the listener to choose a number of stations by first tuning them in in the ordinary way; by pressing a knob at each point of tune the mechanism is locked to that particular station. This knob moves in a horizontal slot under the tuning device, whilst above the slot are a number of name plates for logging the particular stations chosen. When a certain number have been tuned in and locked, it is merely necessary to slide the lever along the slot to register with the station logged there, and pull out the knob, when the required station is perfectly tuned in, no further adjustment being necessary.

The Edison receiver possesses another automatic tuning device which gives out a flash of light when the desired wave is obtained. Other receivers are fitted with automatic volume controls, automatic voltage regulators, and other details making for easy operation and fool-proof working.

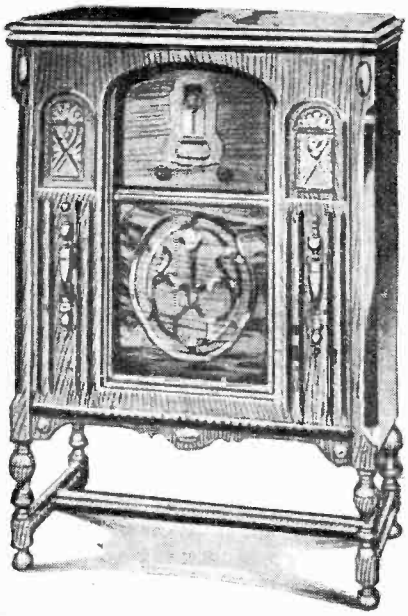
Screening in practically all the American sets has reached a high state of perfection. There is no wire to be seen, all the connections



A home edition of the "Grebe" receiver.

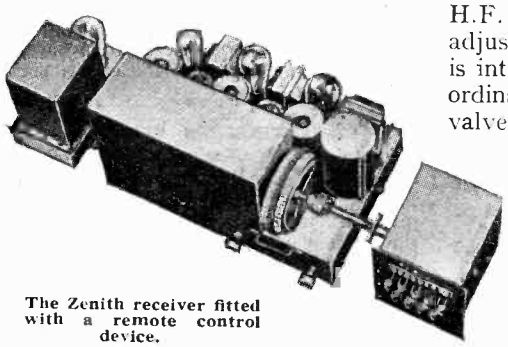
**New York Radio Show.**—

being made by "bunching" leads under sub-panels and double base plates (one cannot say "boards"



The eight-valve Zenith instrument, incorporating three S.G. valves, anode bend detector and double push-pull output. Full power equipment is included.

as there is practically no wood or ebonite to be seen otherwise than in the actual cabinets). Every component is encased in a metal cover, excepting perhaps the valves, and the appearance of the chassis is extraordinarily neat and business-like. In several sets even the valves are covered. The "First National" receiver, for instance, suggests an armoured car. Its chassis is built of cold rolled steel,

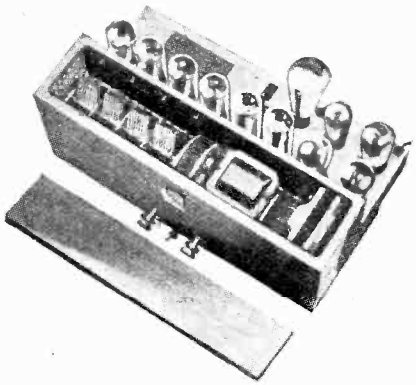


The Zenith receiver fitted with a remote control device.

silver-plated, and not a connection is visible. The four S.G. H.F. amplifiers are all covered with metal frames.

In the realm of loud speakers the moving coil type reigns as practically standard. One departure from this type at the Show was the "Kylectron" instrument with a rather large chassis of the condenser type carrying a grid of aluminium sheet covered on one side with tin-foil. This speaker is supplied as standard with the "Peerless" receivers, which are of the luxury class, selling at between £40 and £120 without valves. Several "balanced armature" loud speakers were on view, besides all shapes and sizes of exponential horns. One of the largest had an air column of 10 feet and weighed 45 lb.

Component parts were noticeably few, and even separate battery eliminators were rare, these being



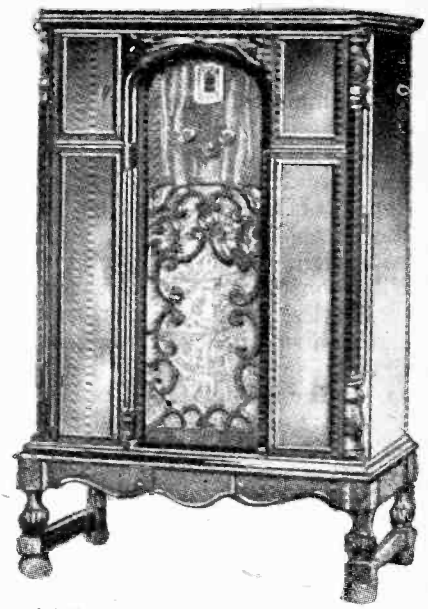
The "Peerless" receiver as incorporated in the most expensive models.

included in the majority of the receivers exhibited.

An interesting item among the "gadgets" was described as "a built-in high impedance link circuit H.F. coupler, with automatic self-adjusting grid bias." The device is intended for the conversion of an ordinary receiver to screen-grid valve working and consists of an external filament transformer, resistances, etc., together with a perforated metal cover for the valve.

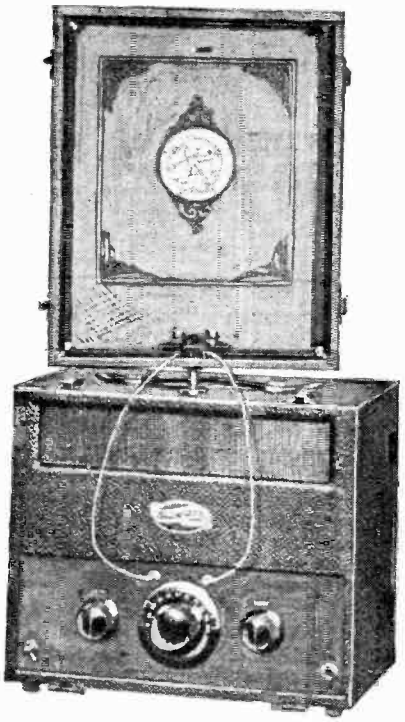
The astonishing paucity of portables was a subject of comment at the Show. The "Trav-Ler," one of the few exhibited, included a loud speaker of the horn type.

The lower floor of the Exhibition was devoted to numerous scale models of transmitting and receiv-



A "Peerless" receiver, one of a range of luxury sets, some of which embody a loud speaker of the condenser type known as the "Kylectron." Three screen-grid valves are used, with anode bend detection.

ing stations. A full size studio was in use and visitors were able to watch the performance of broadcast programmes which were sent out over the networks of the National Broadcasting Company and the Columbia system. Picture trans-



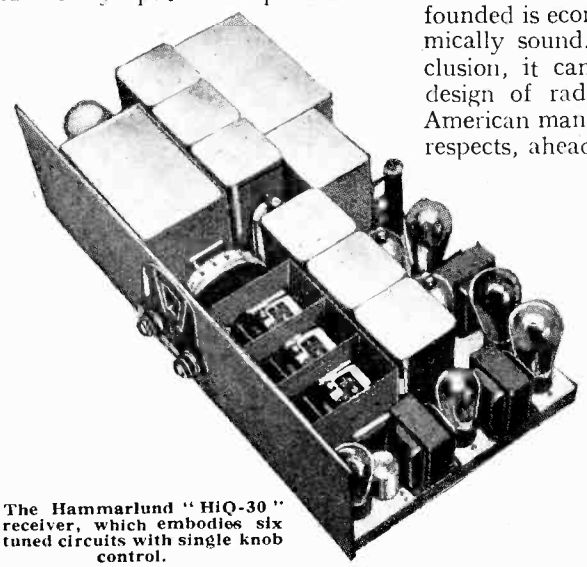
The "Trav-Ler," one of the few portables at the Show. Although five valves are included, the price is just under £10.

**New York Radio Show.—**

mission and reception was well demonstrated.

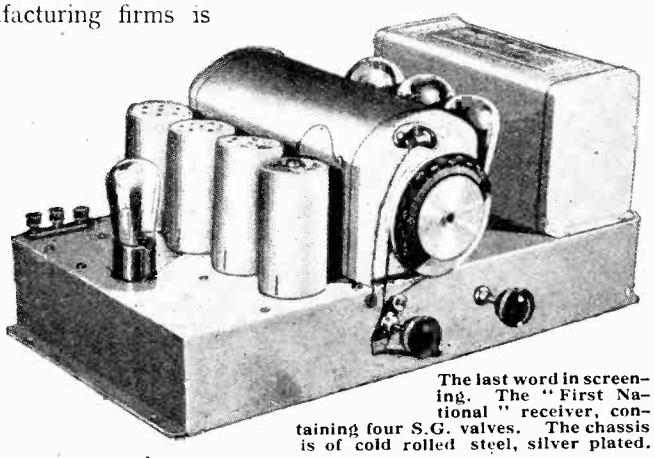
One exhibit which deserves special mention was that of the Radio Frequency Laboratories, who showed a large number of sets divested of their cabinets so that visitors could easily examine their construction.

This concern, Radio Frequency Laboratories, carries out research work for the benefit of its licensees, providing designs for set manufacture. The engineers of the licensees may alter the designs as they think fit for the purpose of facilitating production. The sets are then tested in the laboratories and finally put into production.



**The Hammarlund "HiQ-30" receiver, which embodies six tuned circuits with single knob control.**

The licensees can call on the Laboratories at any time for any consulting and engineering service. In this way the research work of a number of manufacturing firms is concentrated at one point, and can consequently be carried out more satisfactorily and at a cheaper price than if each firm had its own research organisation. The success of the undertaking shows that the basic idea on which it was founded is economically sound. As a general conclusion, it can be said that in the design of radio receiving sets, the American manufacturers are, in some respects, ahead of the British. They have been working under different conditions. The enormous market open to the American manufacturer has been the chief reason of his rapid progress, and he has not found it worth while to economise on research. Moreover, the generally high level of wealth in the United States has permitted the manufacturer to neglect the very cheap set and concentrate all his energy on the reproduction of a higher quality product. Sets such as described above range from about £25 up, a price which could not be approached unless a very large market were available. In another respect the conditions in America and England differ. Instead of the well ordered state of affairs existing in England regarding the erection of broadcast stations, there are innumerable stations in America. This necessitates the construction of highly selective receiving sets, and a very cheap set cannot be highly selective. That is the reason why four tuned circuits are used in most sets, and perhaps also why the manufacturers do not cater for the cheap product.



**The last word in screening. The "First National" receiver, containing four S.G. valves. The chassis is of cold rolled steel, silver plated.**

# CURRENT TOPICS.

### THE NEW CALL.

The expression "London Regional Station calling" seems to have been misheard in France. A Paris wireless journal states that the new 2LO comes on the air with: "London Bridge calling!"

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### A SCOTTISH COINCIDENCE.

Since the Post Office direction-finding van arrived in Glasgow a fortnight ago it is reported that the number of wireless licences taken out during the period has shown an increase above the average of over a thousand.

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### BEIRA TELLS THE WORLD.

The erection of a short-wave station has placed Beira (Portuguese East Africa) in touch with practically the whole world. During the past year, says *The African World*, the station has been in communication with Tokio, Cachila (Chile), Torrensville (Australia), Pasa de Toros (Uruguay), Santos (Brazil), and Karachi (India).

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### PORTRAIT UNVEILING BY WIRELESS.

Pressing the key of his short-wave transmitter at Little America Camp, in the Antarctic, Commander Byrd blew a motor horn and drew aside curtains covering his enlarged portrait at the recent National Radio Exposition at Los Angeles.

The pre-arranged signal from Byrd's camp was picked up by KPH, San Francisco, and relayed by wireless to KSE, Torrance, twenty miles from Los Angeles. From Torrance the impulse travelled by land line to the exposition hall, where a crowd of 10,000 watched the experiment.

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### I.E.E. WIRELESS SECTION.

Captain C. E. Kennedy-Purvis, R.N., chairman of the Wireless Section of the Institution of Electrical Engineers, will give an inaugural address at a meeting of the Section on Wednesday next, November 6th, to be held at the Institution, Savoy Place, W.C.2, at 6 p.m.

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### FRANCO-NORWEGIAN BROADCASTING EXCHANGE.

An exchange of broadcast programmes between Norway and France is being sought by the *Service de la Radiodiffusion Française*, which is negotiating with the Norwegian Broadcasting Company at Oslo

for land line relays. In a few days' time it is hoped that the Oslo evening programme will be relayed to all the State transmitters in France. Later a symphony concert from Paris will be relayed to Norway.

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### WIRELESS FOR JAPANESE TIME-SERVERS.

Following America's example, the Japanese prison authorities have decided that convicts shall enjoy special radio concerts. They must also listen to educational talks.

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### INTERMEDIATE WAVES FROM FRANCE.

Gramophone transmissions on 175 metres (coming within "intermediate" waveband of the Hague Conference) are given on Tuesdays and Fridays between 21.30 and 22.30 G.M.T. from a small experimental station at St. Quentin. The call-sign is F8GM.

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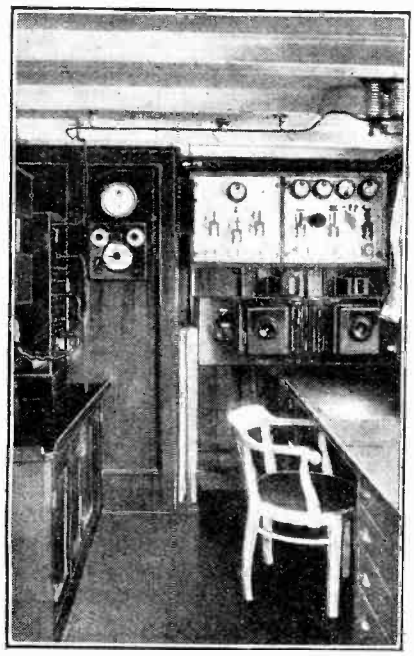
### A RUM-RUNNERS' WIRELESS STATION.

The discovery and seizure by the U.S. Government of an unlicensed wireless station operated by rum-runners is described by the New York correspondent of *The Times*. The capture resulted from preparations extending over six months, which culminated on October 16th in a series of police raids along a front of 100



**THE PERFECT YACHT. The wireless cabin on the motor yacht "Orion," stated to be the biggest privately owned yacht in the world. Built at Kiel with a tonnage of 3,000, the "Orion" has just been delivered to her owner, Mr. Julius Forstmann, a New York millionaire.**

miles from Atlantic City, New Jersey, to Sag Harbour, Long Island.

The campaign started in April last, when an inspector for the Federal Wireless Commission reported the existence somewhere near New York of an unlicensed wireless station which habitually sent out its messages in code. The messages were deciphered and the code learned, and the Treasury Department was informed of the discovery. Thereafter, every message this station sent out was recorded.

The information secured by the Treasury through these wireless messages was invaluable in its preparations for its attack on the "ring."

On the day of the raid, the police came upon the station in the Atlantic highlands, close to New York, at the very moment when the operator was sending out one of his code messages. Before he could give a warning he was thrust from his seat and a Government expert, using the same code, sent out messages which brought one of the largest of the expected rum-running ships into the reach of a Revenue cutter.

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### LIFEBOAT WIRELESS.

The Plymouth lifeboat is the latest to be equipped with wireless telephony.

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### INVESTIGATION INTO PATENT LAW?

The committee, which was set up under the chairmanship of the Right Hon. Sir Charles Sargant to consider whether any amendments in the Patents and Designs Acts, or any changes in Patent Office practice, were desirable, are continuing their meetings at the Board of Trade for the purpose of hearing evidence from interested persons and associations.

Those who desire to submit any suggestions, or to give evidence, are invited to communicate with the secretary, Mr. R. W. Luce, Industrial Property Department, Board of Trade, 25, Southampton Buildings, W.C.2.

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### CHICAGO AS U.S. BROADCASTING CENTRE.

Complete plans for "the world's most pretentious broadcasting quarters" have been prepared by the National Broadcasting Company of America. These will be the new Chicago studios on the roof of the Merchandise Mart, in the heart of the city.

It is hoped that January 1st, 1930, will be the opening date, when six studios should be ready for use. Studio "A," it is stated, will be the largest radio theatre in the world, with standing room for more than a thousand persons. (The biggest "studio" in "Broadcasting House," Portland Place, will provide seats for this number!)

The Chicago headquarters of the N.B.C. will be larger and more imposing than those at New York, Washington, and San Francisco.

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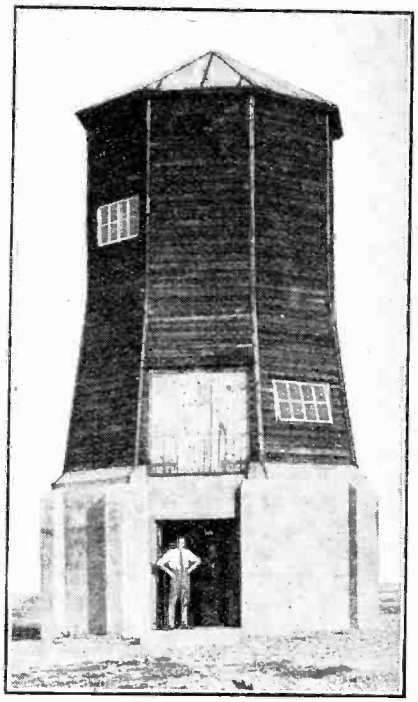
### MAKING SPANISH WIRELESS HISTORY.

By the opening of a new group of beam stations at Aranjuez by the King of Spain last week, Madrid is now placed for the first time in direct wireless telegraphic communication with both North and South America. In addition, a Marconi short wave beam installation included in the equipment provides a regular commercial telephone service between Spain and the Argentine Republic.

The supply of this apparatus to Transradio Espanola is the second big order for British wireless equipment recently received from Spain, the Marconi Company having also supplied a short-wave station to the Spanish Government to establish



**RADIO "LIGHTHOUSE" FOR AIRMEN. An experimental beacon at Orfordness, Suffolk, operating with a rotating frame aerial. Continuous-wave signals are transmitted for five minutes at a time, with alternate five-minute periods of silence. The apparatus, which is automatic, changes hourly to interrupted C.W.**

a direct wireless service between Madrid and the Spanish colony at Fernando Po, in Equatorial Africa.

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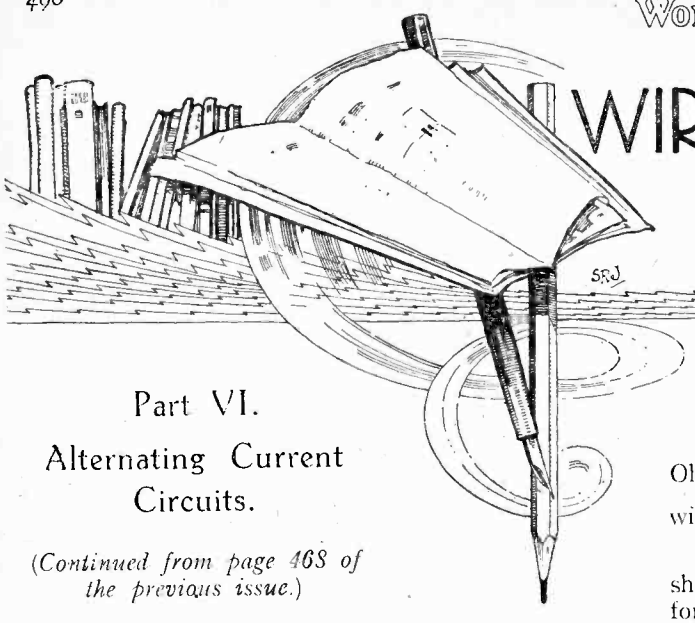
### NEW EMPIRE BROADCASTING SCHEME?

In the Editorial of Wednesday last, *The Wireless World* criticised the B.B.C.'s policy in regard to Empire broadcasting and urged the new Chief Engineer and his staff to show the same degree of enthusiasm for achieving an Empire short-wave service as on other wavebands, has already won for British broadcasting a reputation second to none.

Subsequently a note appeared in the daily Press suggesting the strong possibility that the present Empire experimental short-wave broadcasting service from 5SW, Chelmsford, will shortly be superseded by regular Empire transmissions from a new B.B.C. short-wave station.

A statement was made to *The Wireless World* by the B.B.C. at the time of going to press to the effect that the Corporation is considering the future of short-wave broadcasting from this country and is already negotiating on the question, but that no decision has been taken to build a station at Daventry or elsewhere.



# WIRELESS THEORY SIMPLIFIED

## Part VI.

## Alternating Current Circuits.

(*Continued from page 468 of the previous issue.*)

By S. O. PEARSON, B.Sc., A.M.I.E.E.

HAVING learned a little about inductance and its effects we are in a position to proceed with the discussion of alternating current circuits. In dealing with a steady direct current, the relationship between the current and the voltage can be determined if we know only the resistance of the circuit, by the application of Ohm's law. With alternating currents, however, the other constants, namely, inductance and capacity, must be taken into account. For the time being we shall consider one or two circuits possessing resistance and inductance both singly and together, and assume that no capacity is present.

### Simple Circuit with Resistance Only.

For the moment let us consider the simplest A.C. circuit imaginable, namely, a straight piece of resistance wire connected to a source of A.C. supply, or to the terminals of an alternator as shown in Fig. 1. We can treat such a wire as a pure resistance of R ohms possessing neither inductance nor capacity, and apply Ohm's law in the ordinary way. If a sine wave of alternating voltage is applied to its ends, the current taken will be at every instant proportional to the voltage and will, therefore, also vary according to a sine law.

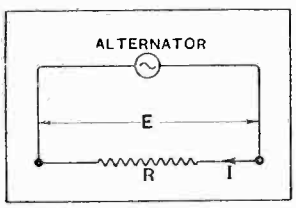



**Fig. 1.—Simple A.C. circuit with resistance only.**

When the voltage reaches its maximum value the current will be greatest, and when the voltage is passing through one of its zero values the current will be doing likewise. *Hence for a pure resistance the current and voltage waves are exactly in step or in phase.* These conditions are clearly shown by the curves and vector diagram of Fig. 2.

### Relationship Between Current and Voltage.

Let $E_m$ be the maximum or peak value reached by the alternating voltage every half cycle. Then by Ohm's law the maximum value attained by the current will be $I_m = \frac{E_m}{R}$ amperes.

The effective or R.M.S. value of a sine curve was shown to be 0.707 of the maximum value and, therefore, if we multiply each side of the above equation by 0.707 it will give the relationship between the R.M.S. values of the current and voltage, namely, $I = \frac{E}{R}$ amperes, where I and E are the effective values as indicated by an ammeter and voltmeter respectively.

The conclusions are then that for a simple A.C. circuit with resistance only, (*a*) Ohm's law may be applied as in the case of a direct-current circuit; and (*b*) the current and voltage waves are exactly in phase.

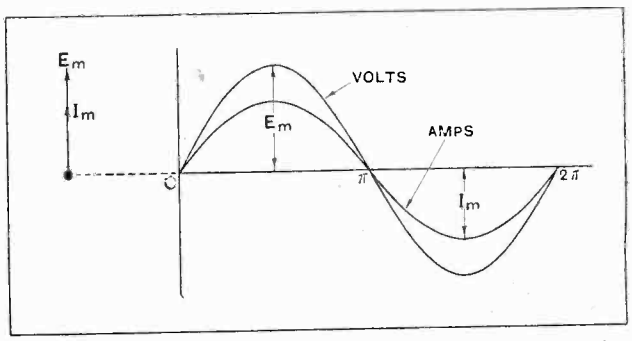



**Fig. 2.—For a simple resistance the current and voltage are in phase and the corresponding vectors are parallel with each other.**

Frequency plays no part whatever providing the resistance remains constant. When we come to consider high-frequency effects it will be seen that the resistance of a conductor actually increases as the frequency is raised, but for the present we shall assume that we are dealing with low-frequency currents only and that the resistance remains constant.

### Power in Simple A.C. Circuit.

Since the effective value of an alternating current was defined as the value of the direct current which would have the same heating effect in the resistance, it follows that the average power expended in the resistance R is given by $P = I^2R = IR \times I$ watts. But we have just seen that $E = IR$ for a pure resistance and, therefore, the power is given by $P = E.I$ watts, just as though we were dealing with a direct-current circuit.

**Wireless Theory Simplified.—**

It will be shown presently that this is not true if the circuit contains inductance—it only applies to a pure resistance.

### The Effect of Inductance.

In an A.C. circuit the current is changing at all times, except during the minute fraction of a second every half-cycle when it ceases to increase and begins to fall again. In the last part it was explained how

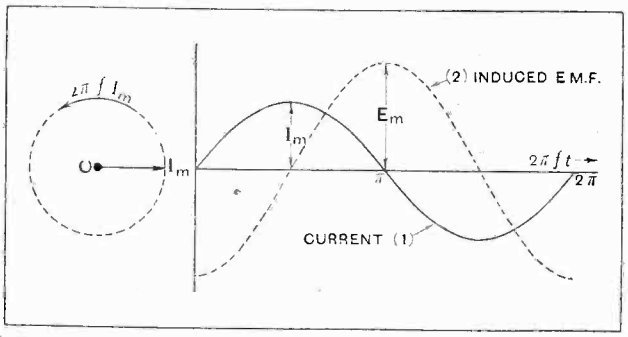



**Fig. 3.—The speed of the end of the vector $OI_m$ gives the maximum rate of change of current. The induced E.M.F. is out of step by a quarter of a cycle, with respect to the current.**

the changing of a current in a circuit containing inductance caused an E.M.F. to be generated in the circuit, and it was shown that the magnitude of this induced E.M.F. was given by the product of the inductance in henrys, and the rate at which the current is changing in amperes per second.

Now suppose that we cause a sine wave of alternating current, whose maximum value is $I_m$ amperes, to flow through a coil having an inductance of L henrys. The resulting magnetic flux linked with the coil will also vary according to the sine law, being at every instant proportional to the current producing it, and this varying magnetic flux will generate a sine wave of E.M.F. in the coil. The sine wave of current is shown by curve (1) of Fig. 3.

Our immediate task is to find out the magnitude of this induced E.M.F. and its phase relationship to the current, that is, whether it is in step with the current or not, and in the latter event, how far out of step it is. In the first place we do know that the induced E.M.F. always acts in such a direction that it tries to prevent the changing of the current (Lenz's law as explained in the previous part), and we shall make this our starting point.

Just as the current is passing through its maximum value, it is neither increasing nor decreasing—its rate of change is zero—and therefore at these instants the back E.M.F. will be zero. Thus the induced E.M.F. wave must be exactly a quarter of a cycle out of step with respect to the current wave. Now when the current is increasing from zero to the maximum positive value the induced E.M.F. will be negative, because it is opposing the growth of the current. Thus the induced E.M.F. wave will be in the position shown by the dotted curve (2) of Fig. 3. A glance at the curves will show that the current reaches its maximum positive value a quarter of a cycle *before* the induced E.M.F. wave, and therefore that the current leads the induced voltage by an angle of exactly 90 degrees.

### Magnitude of the Back E.M.F.

Obviously the current is changing at its greatest rate just as it passes through its zero values, because the slope of the current curve is steepest at these points. The curves of Fig. 3 confirm that the E.M.F. is a maximum when the current is zero. Now if the maximum value of the current is $I_m$ amperes, and its frequency $f$ cycles per second, it can be represented by a vector whose length is $I_m$ to some suitable scale, rotating about one end with a speed of $f$ revolutions per second, or $2\pi f$ radians per second (*see* Part IV, October 16th issue). The actual speed of movement of the extremity of this vector round the circle of radius $I_m$ will be represented by a distance equal to $f$ circumferences every second. But the circumference is $2\pi$ times the radius, and therefore, the speed of the end of the vector $OI_m$ is $2\pi I_m \times f$, and since the vertical scale of the current curve is in amperes, this speed will represent amperes per second. This value then gives us the maximum rate of change of current, being $2\pi f I_m$ amperes per second.

The induced E.M.F. is equal to the product of the rate of change of current and the inductance (explained in Part V). Hence the induced or back E.M.F. will have a maximum value of $E_m = 2\pi f I_m \times L$ volts, where L is in henrys; or $E_m = 2\pi f L \times I_m$ volts.

### Coil with Inductance Only.

We shall first assume that the coil of inductance L henrys under consideration has no resistance whatever. Hence to drive a current through it there is only the back E.M.F. of self-induction to be overcome by the

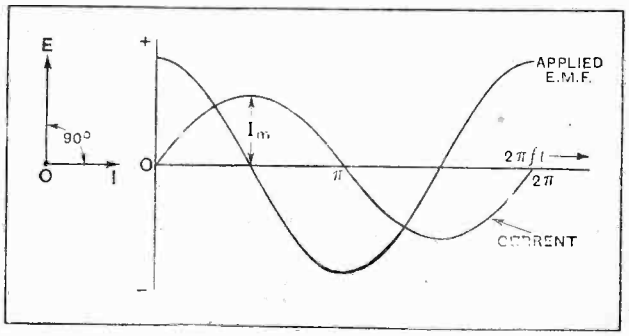



**Fig. 4.—For a pure inductance the current lags by 90 degrees behind the supply voltage.**

supply voltage, and therefore the maximum value of the applied E.M.F. will also be given by $E_m = 2\pi f L \times I_m$.

The applied E.M.F. or supply voltage must exactly neutralise the induced E.M.F. at every instant, and is, therefore, represented by another sine wave in exact opposition to the wave of induced E.M.F. The phase relationship between the applied voltage and the current is shown by the curves of Fig. 4.

Note that the current curve reaches its maximum value a quarter of a cycle later than the applied E.M.F. and therefore *for a circuit possessing inductance only, the current lags behind the supply voltage by exactly*

**Wireless Theory Simplified.—**

*90 degrees*. Also note that the vectors on the left of Fig. 4, representing the current and voltage, are drawn at right angles to each other. In future we shall dispense with curves as far as possible and use the vectors only.

### Reactance.

So far we have found the relationship between the maximum values or amplitudes only of the current and voltage for a pure inductance. If we multiply each side of the last equation by 0.707 we obtain the R.M.S. value of the voltage, viz.: $E = 0.707E_m = 2\pi fL \times 0.707.I_m$; or $E = 2\pi fL \times I$ volts, where $I = 0.707.I_m$ is the effective value of the current. This result may be rewritten thus $I = \frac{E}{2\pi fL}$ amps.

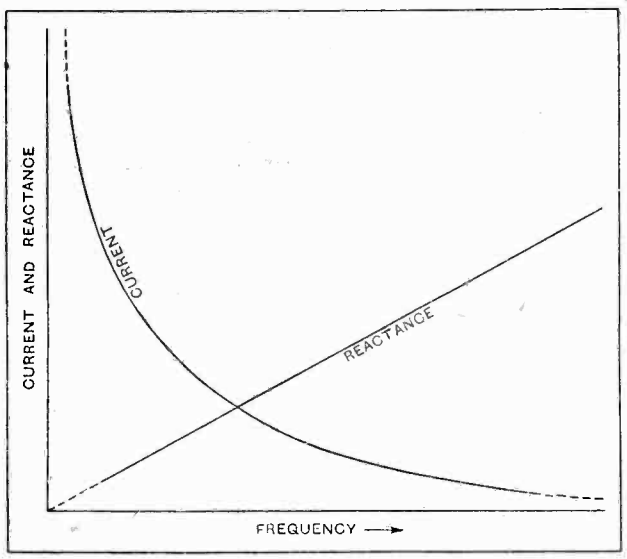



**Fig. 5.—Curves showing how reactance and current vary with frequency for a coil having inductance only.**

We have here an extremely important result. It is a relationship of the same kind as Ohm's law, the only difference being that in place of the resistance R we have the quantity $2\pi fL$. This is called the *reactance* of the coil and is expressed in ohms. It is usually denoted by X and so for a coil with inductance only the current is given by $I = \frac{E}{X}$ amperes, and lags behind the voltage by 90 degrees. Expressed in words the inductive reactance of a circuit may be defined as the opposition set up to the passage of an alternating current by the induced E.M.F. of self-induction. This definition is of fundamental importance.

It should be noted that the reactance of the coil is directly proportional to the frequency of the current, so that at very high frequencies such as those met with in radio work even a coil of a few turns and low inductance will have a comparatively high reactance. Suppose that a voltage of constant R.M.S. value is applied to a coil of L henrys inductance and that the frequency is gradually increased from a very low value upwards. The reactance will increase in direct proportion, and if plotted as a graph against the frequency will give a straight line passing upwards from the origin O as shown by the curve of Fig. 5. The current, being inversely proportional to the reactance, will vary in inverse proportion to the frequency, and the curve showing their relationship will be of the form indicated in the figure, the curve being a hyperbola.

### Numerical Example.

Consider a coil of negligibly small resistance having a self-inductance of 20 henrys. We shall calculate what current will be passed if 10 volts (R.M.S. value) are applied to the terminals when the frequency is (a) 50 cycles per second and (b) 2,000 cycles per second. At 50 cycles the reactance will be $X = 2\pi fL = 2\pi \times 50 \times 20 =$ 6,280 ohms, and at 2,000 cycles X works out to 251,200 ohms. The currents will thus be (a) $I = \frac{10}{6,280} = 0.00159$ amp. or 1.59 milliamps. and (b) $I = \frac{10}{251,200} = 0.0000398$ amp. or 0.0398 milliamp. Figures of this order are encountered in connection with low-frequency chokes in receiving circuits.

### Choking Coils.

The property of an inductance coil of opposing the passage of an alternating current through it is used to a very large extent. A coil without any resistance whatever, if such were possible, would allow a direct current to pass through it unimpeded, although choking back alternating currents to an extent depending on the frequency. An actual coil with low resistance has approximately the same effect. Such a coil is usually referred to as a *choking coil* or *choke*. To produce a desired choking effect or reactance, the value of the inductance must be chosen to suit the frequency of the current—high inductance is required where the frequency is low and vice versa. To obtain a high reactance at low frequencies the coil is wound with many turns on a closed iron core and is referred to as a "low-frequency choke" when used in a wireless circuit.

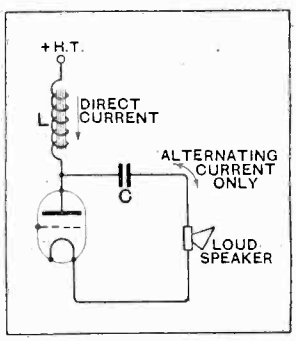



**Fig. 6.—Normal output circuit for the last stage of an amplifier. By the action of the choke L the alternating currents in the plate circuit are forced to pass through the loud speaker.**

In a receiving circuit choking coils are used in various places where it is required to pass a direct current freely and to prevent as far as possible the passage of alternating current, the object being to filter out the alternating current from the direct. A case in point is the output filter circuit between the last valve of an amplifier and the loud speaker. It will be shown later that a condenser has the reverse effect—allowing alternating currents to pass whilst totally preventing the passage of any direct current.

*(To be continued.)*

# Broadcast Brevities

*By Our Special Correspondent.*

***The Twin Regional Station.—What of the Prague Plan?—Missing Bass.***

### Listeners and Brookman's Park.

Optimistic though the Technical Correspondence people at Savoy Hill undoubtedly are, they fully expected a storm to break over their heads on the morning after the change-over from Oxford Street to Brookman's Park. At the time of writing there has been no storm, but only sunshine and shower as represented by a nearly equal proportion of favourable to unfavourable reports.

As might be expected, crystal users are loudest in their disapproval of the new order. Valve set owners, even if they suffer some inconvenience in areas near the new transmitter, have a technical grasp of the situation which the average crystal user seems unable to obtain.

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### The Real Test to Come.

The mass of reports from all districts within the service area of Brookman's Park confirm predictions in a remarkable manner. Listeners far afield who obtained only an indifferent service from Oxford Street are unanimous in praising the new station, while those who have enjoyed the London transmissions without disturbance are inclined to criticise the quality of signals and the comparative coarseness of tuning.

But the real test has yet to come. Tweedledum and Tweedledee must perform simultaneously before we can justly assess the value of either.

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### Is Tweedledee Performing?

A rumour has reached me that the second transmitter has already been in action.

When I recall the vision of that noble transmitter standing idle, merely awaiting the manipulation of a few switches to set it in operation, I find myself wondering whether B.B.C. engineers have superhuman powers of restraint. It might be worth while to test this theory by listening after midnight in the region of 252 metres.

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### Another Mouth to Feed.

I can discover no anxiety among the members of the Programme Department regarding the additional work lying in wait for them when the second station begins regular transmissions.

"There's plenty of time yet," was the airy reply to my query. "Tweedledee must undergo its tests first; the question of a programme won't crop up until January."

During the testing period, timed to begin in mid-December, the second station will relay the programme of 5GB.

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### The Passing of the Prague Plan.

"The Prague Plan is already dead," says a friend of mine who, with a hyper-selective super-sensitive receiver, has spent the last fortnight in "touring" Europe. "Heterodyning on the British stations is bad enough," he asserts, "but on the Continent it is infinitely worse, and the U.I.D.R. at Brussels seems unable to control the pandemonium."

He considers that the present separation of 9 kilocycles between stations is useless in view of the universal tendency towards higher power, and he pleads for a separation of 15 kilocycles as the irreducible minimum.

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### Mañana.

An instance of the way in which the instructions of the Brussels frequency measuring centre are ignored occurred last week when, at the request of the B.B.C., a message was sent from Brussels to the San Sebastian broadcasting authorities asking them to keep off Glasgow's frequency of 752 k.c. "Mañana," said the Spaniards, and nothing was done. The British Post Office is now approaching the Spanish Government on the question so possibly Glasgow will soon be relieved of San Sebastian's whistle, but at whose expense? No doubt San Sebastian had splendid reasons for quitting its allotted frequency. Every station has.

### The Missing Bass.

There was a state of ferment at Savoy Hill a few days ago when a listener whose opinion carries weight telephoned to say that the bass notes were not coming through. A rushing hither and thither, with hurried consultations in the control room, revealed nothing amiss on the technical side. Then somebody smitten with a brain-wave dashed to the studio in which a well-known "Auntie" was providing a pianoforte interlude.

"Bass notes not coming through?" said the pianist. "No, of course not. That last piece was for the right hand only!"

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### For Scots in Exile.

St. Andrew's Night is an even greater occasion for the exiled Scot than for the Scot who still lives on the right side of the border. With this thought definitely in mind, a St. Andrew's Night programme will be relayed on November 30th from Glasgow to 2LO, 5XX and other stations.

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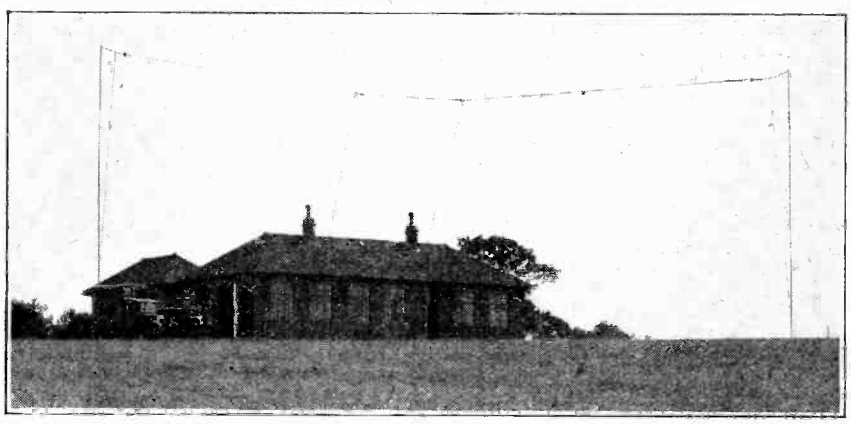
### The Week in Parliament.

Women M.P.s are to describe "The Week in Parliament," in a series of weekly broadcasts, starting on November 6th. Mrs. M. A. Hamilton, the member for Blackburn, launches the new feature, and will be followed a week later by the Duchess of Atholl. These broadcasts will run throughout the session.

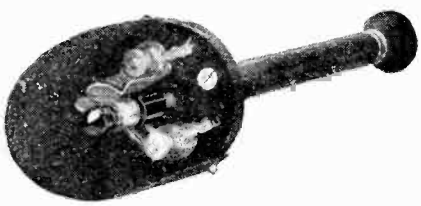


**THE B.B.C.'S RECEIVING STATION. The newly completed listening post at Tatsfield, Surrey, where British and European wavelengths are checked. The masts are 60 feet high and the site is 900 feet above sea level. During the winter the station may be used for relays from America.**


## A Review of Manufacturers' Recent Products.

### "MELBOURNE" SAFETY LEAD-IN.

Many ingenious devices have appeared to ensure complete isolation of the wireless set from the outside aerial, thus safeguarding the apparatus against damage during electrical storms. To these must be added the "Melbourne" combined lightning arrester, earthing switch and lead-in tube.



**"Melbourne" lead-in tube with outside earthing switch controlled from inside the building.**

It consists of a polished ebonite tube terminating, at the outdoor end, in a circular disc which supports aerial and earth terminals, earthing switch and a safety gap. At the other end is a large diameter knob for controlling the switch and a contact for the lead to the set. When the knob is pulled out, the aerial is disconnected from the receiver and switched to earth. Pushing in the knob disconnects the aerial from earth and connects it to a metal band, in electrical connection with the tag on the indoor side of the tube, to which the lead from the aerial terminal on the set is attached. As an additional safety measure, the outside aerial and earth connections are attached to two strips of copper mounted so that a gap of $\frac{1}{32}$in. is left between them. A semi-circular cowl is fitted as a protection against rain.

This useful device is offered at 3s. 6d., and the makers are Melbourne Radio Supply, Norwood Buildings, Hatherley Road, Walthamstow, London, E.17.

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### "PILOT" RESISTANCES.

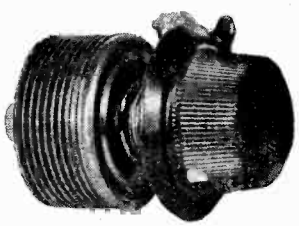
"Pilot" components, which are manufactured in America by the Pilot Radio and Tube Corporation, are now available in this country, the sole concession for their distribution having been acquired by Messrs. T. A. Rowley, Ltd., 59, Skinner Lane, Dean Street, Birmingham. The samples sent in for test comprise a "Pilot" Resistograd and a Volumgrad.

The first mentioned is a variable high resistance of the compression type, rated to be adjustable to any resistance value between 40 ohms and 10 megohms. This range is covered by four complete revolutions of the knob.

A curve is supplied with each component, showing the change in resistance with rotation of the knob. Measurements gave the minimum and maximum values as 20 ohms and 20 megohms respectively.

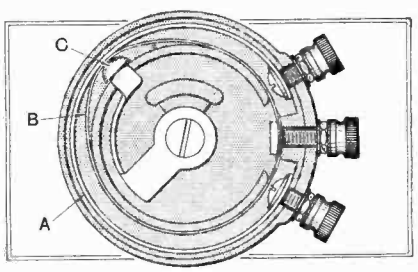
The resistance element is enclosed in a strong metal case 1½in. in diameter and 1½in. deep over the back terminal. The outside of the container is provided with fins, presumably to radiate rapidly any heat that may be generated. It can be used, therefore, in circuits passing current, such as voltage control in battery eliminators, or as a volume control across the primary of the L.F. transformer. The price is 4s. 3d.

The Volumgrad is a high-resistance potentiometer, and is made in four values —0-50,000 ohms, 0-100,000 ohms, 0-200,000 ohms, and 0-500,000 ohms. The sample supplied was the last-mentioned type—viz., 0-500,000 ohms. The measured value of this was found to be 0-550,000 ohms.



**"Pilot" Resistograd. A variable high resistance for power use.**

The device consists of a moulded bakelite case 2in. in diameter. The resistance element, which is a strip of non-hygroscopic material coated with a special preparation, is attached to the side of the hollow case, and a connection is made at both ends by means of small terminals. The variable contact is made through the medium of a flexible phosphor-bronze spring, of slightly smaller diameter than the resistance element. An insulated button, attached to the rotating arm, presses a section of this spring onto the




**Track wear is obviated in the "Pilot" Volumgrad by rolling a spring onto the resistance element. "A" is the resistance, "B" the spring and "C" the insulated button attached to the operating arm.**

surface of the resistance. Since the action is more in the nature of a rolling movement than a rubbing contact, wear on the element itself is reduced to a minimum. A single-hole fixing bush, completely insulated, is fitted.

This component should not be used in circuits passing any appreciable current. It will find favour as a potentiometer volume control in grid circuits, or across the terminals of a gramophone pick-up. The price of all models is 6s. 6d. each.

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### HAW'S MAINS EQUIPMENT.

A wide range of A.C. mains transformers, smoothing chokes, and all parts necessary for the construction of H.T. battery eliminators and L.T. trickle chargers, have been introduced recently by Messrs. Haw & Co., Ltd., 20, Cheapside, London, E.C.2. In addition, factory-made models embodying similar components are available for those not

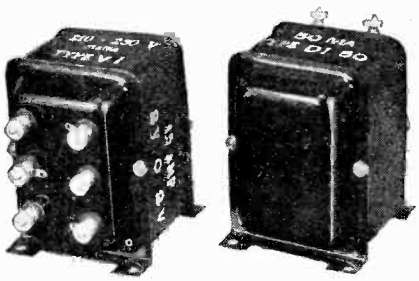
possessing the facilities for building these at home.

The complete units and parts, which are of foreign make, are being marketed at attractive prices. The A.C. eliminator,


**Haw's half-wave rectifier H.T. battery eliminator, Model N.G. A Philips 373 valve is recommended.**

Model N.G., designed for use on 200-230 volts, 50 cycle mains, is fitted with a half-wave rectifier rated to give 20 mA., and should be suitable for most 3- and 4-valve sets fitted with a small power valve. One variable tapping, 0-100 volts, and one fixed 150-volt output are provided. Complete with valve this costs 68s.

The Model VI power transformer, for use on 210-230 volts, 50 cycle mains, is designed to deliver 50 mA. at 180 volts after rectification. This carries two secondary



**Haw's mains transformer, Type VI, and large smoothing choke, D.150, rated to carry 50 mA.**

windings, 200+200 volts for H.T., and 2+2 volts, at 1.5 amps. for the filament of the valve rectifier. All terminals are clearly marked, and the price is 14s.

Smoothing chokes, ranging from 10 henrys to 40 henrys are now listed. The D.150, which is the model illustrated, has a rated inductance of 40 henrys, and is stated to carry 50 mA. The price is 13s. 9d. The small model, D.30, of 10 henrys, costs 5s. 6d.

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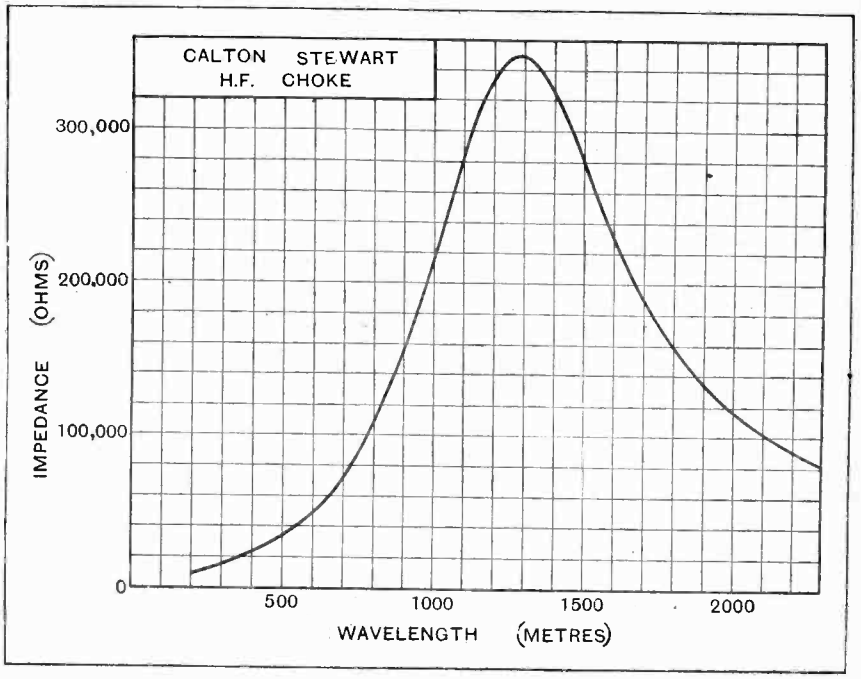
## CALTON STEWART H.F. CHOKE.

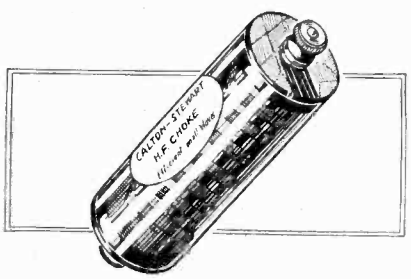
The construction of this choke enables it to be mounted in spring clips on the baseboard or suspended in the wiring of the receiver. The choke is light in weight, and is eminently suitable for the latter method of wiring, which has many points in its favour.

The windings are supported on skeleton paxolin former, and are enclosed in a celluloid tube 2¼in. long and 1in. in diameter. Terminals are carried in the moulded ebonite end plates as shown in the illustration.

Having regard to the low price of 2s., the performance is remarkably good. The curve is free from subsidiary resonances, and under working conditions the choke should be safe as regards self-oscillation up to the wavelength of 5XX. Under the conditions of the test with a small external capacity of 8 micro-mfds., the resonance is at 1,300 metres, at which point the impedance reaches 348,000 ohms. Over the 200-500-metre band the impedance rises from 9,640 to 30,600




**Impedance curve of Calton Stewart H.F. choke; external capacity 8 micro-mfd.**



**Calton Stewart H.F. choke; D.C. resistance 700 ohms.**

metres, while on ultra short wavelengths the choking effect is still adequate.

Supplies are available from Messrs. J. McMillan and Co., 1, Hunter Square, Edinburgh.

## CATALOGUES RECEIVED.

The Benjamin Electric, Ltd., Brantwood Works, Tottenham, London, N.17. —Illustrated broadsheet dealing with seven components introduced recently.

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Radio Intruments, Ltd., 12, Hyde Street, New Oxford Street, London, W.C.1.—Descriptive folder of the R.I. Screened-Grid All-Electric 3-valve receiver.

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Messrs. A. F. Bulgin and Co., 9-11, Cursitor Street, Chancery Lane, London, E.C.4.—A 55-page catalogue of Bulgin products. Profusely illustrated and devoting 20 pages to a technical description of the method of using some of the principal components now listed.

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Messrs. Garnet, Whiteley and Co., Ltd., Lotus Works, Mill Lane, Liverpool. —A 20-page catalogue illustrating their new season's components. Also a 12-page descriptive booklet of "Lotus" receivers.

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Messrs. J. J. Eastick and Sons, Eelex House, 118, Bunhill Row, London, E.C.1. —Illustrated catalogue of proprietary radio equipment handled by this firm.

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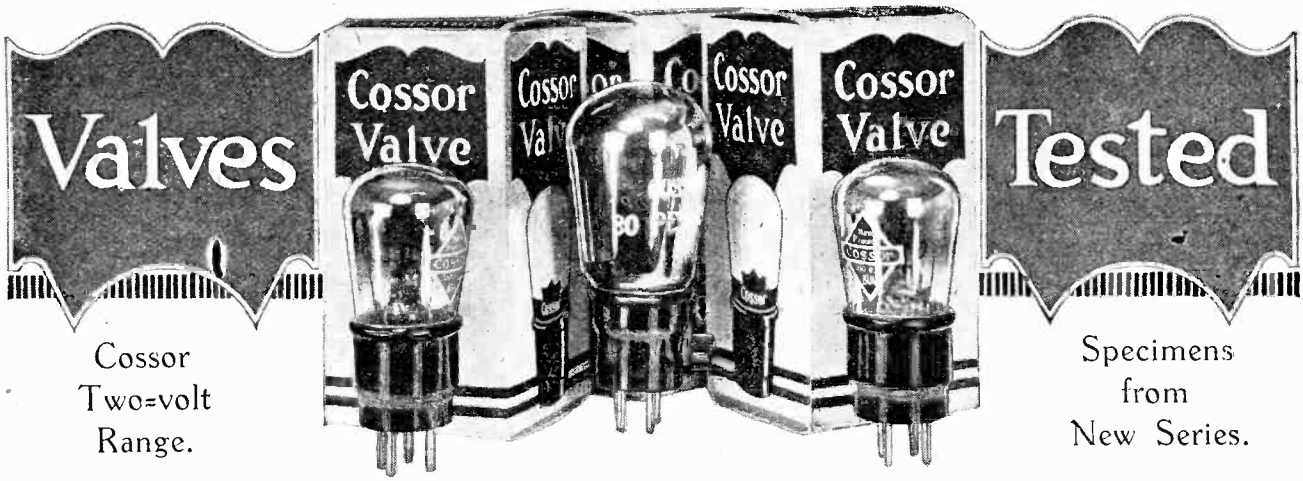
The Portable Electric Light Co., Ltd., 120, Shaftesbury Avenue, London, W.1.—Illustrated price list of Ever-Ready batteries for wireless and portable hand lamp uses.



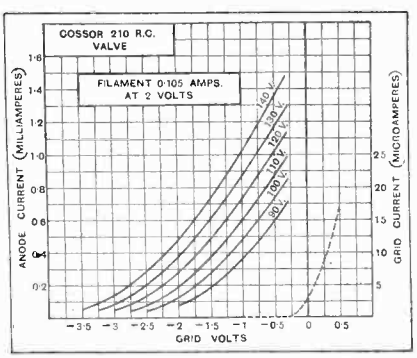

Cossor Two-volt Range.

Specimens from New Series.

THE complete range of two-volt valves in the Cossor series comprise seven types in all, but owing to certain specimens not being available we are restricted in this review to a consideration of the merits of five. Those to be dealt with are the 210 R.C., 210 H.F., 210 L.F., 220 P., and the 230 P.T. The first four are triodes, and the last-mentioned a pentode. The complete range includes, in addition, a super-power three-electrode output valve, the 230 X.P., and a screen-grid type, the 220 S.G. It is hoped that an opportunity may arise to deal with these two valves later.

### 210 R.C.

This is a high-impedance valve with a nominal A.C. resistance of 60,000 ohms and an amplification




**Average values under working conditions: A.C. resistance, 67,000 ohms; amplification factor, 40; mutual conductance, 0.6 mA/v.**

factor of 40. The particular function allotted to a valve in this class hitherto was that of an amplifier followed by resistance-capacity coupling. Today this practice is not usually adopted, as it has the disadvantage that the higher musical frequencies are not amplified in the same proportion as the very low notes, so that its usefulness is generally restricted to that of an anode bend detector. However, as this must be used in conjunction with a high value of anode resistance, some loss in the amplification of the higher musical notes will be inevitable. Where superlative quality of reproduction is not of paramount importance, but high sensitivity and selectivity is the first consideration, this valve will find a useful application.

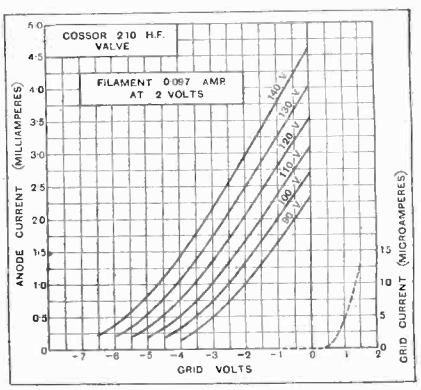
As will be seen from the table below, the measured characteristics agreed sensibly with the makers' figures.

It was noticed that grid current commenced to flow when the grid was given a negative bias of 0.3 of a volt, so that it would be advisable to apply the maximum permissible voltage to the anode, thereby enabling a negative bias of such order to be used that the operating signal does not override the permissible peak voltage that can be applied to the grid.

For dealing with relatively large inputs the suggested working conditions are 120 anode volts, and −3 volts grid bias. Small inputs can be dealt with satisfactorily by biasing the grid to −1.5 volts only. Of course the anode voltage should be reduced accordingly.

### 210 H.F.

As its description implies, this valve is intended for use as an H.F. amplifier, but as it is a three-electrode type a neutralised circuit must




**Average values under working conditions: A.C. resistance, 26,500 ohms; amplification factor, 20; mutual conductance, 0.75 mA/v.**

be employed to obtain worth-while results. Since this type of H.F. circuit is a relic of the past, the present-day function of the 210 H.F. valve is either that of a leaky grid detector or of an L.F. amplifier between the detector and output stages. When a

**Characteristics at 100 Volts H.T. and Zero Grid Bias.**

| 210 R.C. | A.C. Resistance. | Amplification factor. | Mutual conductance. |
|---|---|---|---|
| Makers' Rating .. .. .. | 60,000 ohms | 40 | 0.66 mA/v. |
| Specimen I .. .. .. | 66,500 „ | 37 | 0.56 „ |
| Specimen II .. .. .. | 67,000 „ | 39 | 0.58 „ |

**Valves Tested.—**

low-frequency transformer follows this valve, preference should be given to one which possesses a high inductive primary winding, as the A.C. resistance of the valve is of the order of 20,000 ohms.

**Characteristics at 100 Volts H.T. and Zero Grid Bias.**

| 210 H.F. | A.C. Resistance. | Amplification factor. | Mutual conductance. |
|---|---|---|---|
| Makers' Rating .. .. .. | 20,000 ohms | 20 | 1.0 mA/v. |
| Specimen I .. .. .. | 25,000 ,, | 20 | 0.8 ,, |

Owing to the improved efficiency of modern valves, it is usually permissible to employ choke-capacity coupling between the penultimate L.F. amplifier and the output stage. This possesses certain advantages, particularly as regards initial cost. A choke of not less than 100 henrys is recommended.

One specimen only of this type was suitable for test. The other showed a trace of reversed grid current which was attributed to a slight softening of the vacuum. Grid current started at zero grid volts in the specimen tested, so that with a working anode voltage of 120 a maximum grid swing of 6 volts, peak value, can be handled. The normal anode current with the above stated H.T. and −3 volts grid bias will be about 1.4 mA.

### 210 L.F.

This is essentially a low-frequency amplifying valve, and its characteristics suggest that its most useful function will be in the penultimate position in a two or more stage amplifier. Its rated characteristics are: A.C. resistance, 12,000 ohms; amplification factor, 10; and mutual conductance 0.83 mA. per volt. Transformer coupling can be used, therefore, provided the component chosen is capable of carrying the anode current without leading to saturation of the iron circuit. Average values of anode current with various anode voltages are given below.

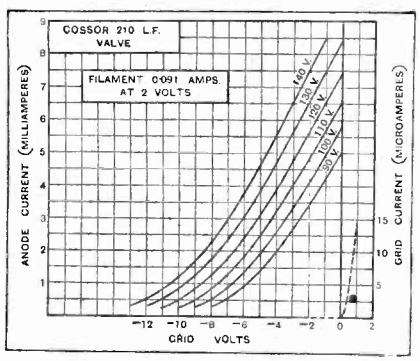
| H.T. | G.B. | Anode current. |
|---|---|---|
| 110 | −4.5 | 2.8 mA. |
| 120 | −4.5 | 3.5 ,, |
| 130 | −6 | 3.05 ,, |
| 140 | −6 | 3.75 ,, |

Grid bias values are given to the nearest 1.5 volts, since without the use of a potentiometer the grid bias cannot be varied in smaller steps than this.

Should it be desired to use one of the many types of L.F. transformers wound on special high-permeability iron, which limits the primary current to one or two milliamps, the parallel feed arrangement using an anode resistance and large feed condenser may be used. An anode resistance of about 30,000 ohms would be suitable, and a 1 mfd. condenser is recommended. This circuit deflects the steady D.C. current through the resistance and allows the A.C. component only to pass to the transformer.

Two samples of this type were tested and the measured characteristics were found to agree fairly closely with the makers' figures. Grid current commenced at zero grid bias. There was no trace of reversed grid current, showing that the vacuum in these samples is dead hard.

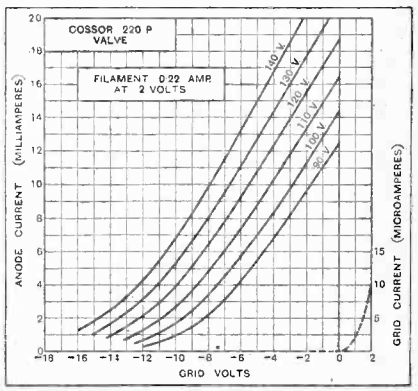
The three types dealt with so far all require 0.1 of an ampere at 2 volts for the filament.




**Average values under working conditions: A.C. resistance, 16,000 ohms; amplification factor, 11.0; mutual conductance, 0.7 mA/v.**

### 220P.

This is a power-amplifying valve, and will be used as a terminal valve in a receiver, or amplifier, designed for loud speaker reproduction. It cannot be included in the "super" class, but will be suitable for operating reasonably sensitive loud




**Average values under working conditions: A.C. resistance, 5,400 ohms; amplification factor, 8.5; mutual conductance, 1.6 mA/v.**

speakers at sufficient volume for rooms of average size. It should appeal to those listeners restricted to the use of dry batteries for the H.T. supply, as the anode current is comparatively low for a power output valve. The demand made on the battery at various anode potentials is given in the following table:—

| H.T. | G.B. | Anode current. |
|---|---|---|
| 110 | −7.5 | 5.5 mA. |
| 120 | −7.5 | 7.1 ,, |
| 130 | −9 | 6.7 ,, |
| 140 | −9 | 8.4 ,, |

Suggested grid bias values are shown to the nearest 1.5 volt for the reason mentioned earlier.

The makers give the mutual con-

**Characteristics at 100 Volts H.T. and Zero Grid Bias.**

| 210 L.F. | A.C. Resistance. | Amplification factor. | Mutual conductance. |
|---|---|---|---|
| Makers' Rating .. .. .. | 12,000 ohms | 10 | 0.83 mA/v. |
| Specimen I .. .. .. | 12,500 ,, | 10.5 | 0.84 ,, |
| Specimen II .. .. .. | 16,000 ,, | 11.0 | 0.7 ,, |

**Valves Tested.—**

ductance of the 220 P. as being 2mA. per volt, but this figure was not quite attained with the two specimens tested. With one, a mutual conductance of 1.6 was attained, and with the other 1.87 mA. per volt. How the measured characteristics compare with the makers' rating can be seen best from the following table:—

**Characteristics at 100 Volts H.T. and Zero Grid Bias.**

| 220 P. | A.C. Resistance. | Amplification factor. | Mutual conductance. |
|---|---|---|---|
| Makers' Rating .. .. .. | 4,000 ohms | 8 | 2.0 mA/v. |
| Specimen I .. .. .. | 4,880 ,, | 7.7 | 1.6 ,, |
| Specimen II .. .. .. | 4,650 ,, | 8.7 | 1.87 ,, |

Grid current started to flow at zero grid volts, and both specimens were found to be satisfactorily evacuated, as there was not the slightest trace of reversed grid current.

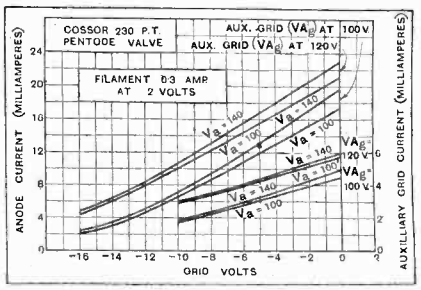
### 230 P.T.

The 230 P.T. is a five-electrode, or pentode, valve, and is, of course, a power amplifier. Pentodes will not accept, in general, a large grid input, so for this reason their usefulness is restricted to sets having but one low-frequency amplifying stage. As has been shown in a recent article, the characteristics of these particular valves vary between wide limits with change in auxiliary-grid and working-grid voltages, so that unless the conditions under which the makers measured the characteristics of the valve are known, comparison between figures obtained under different conditions would be misleading. This information is not available.

Our measurements were made under two conditions: first, average values between 100 and 140 volts on the anode with a fixed auxiliary grid potential of 120 volts and zero working grid bias. The second set of measurements were made with between 120 and 140 anode volts and with the auxiliary grid at the same potential. The working grid was biased to −7.5 volts.

The average characteristics from the first set of readings were: A.C. resistance, 20,000 ohms; amplification factor, 30.8; and mutual conductance, 1.54 mA. per volt. In the second case the average A.C. resistance was found to be 40,000 ohms; amplification factor, 50; and mutual conductance 1.25 mA. per volt. The makers' rating is 20,000 ohms, 40 and 2 respectively.

When choosing an H.T. battery, or supply unit, for these valves, consideration has to be given to the current flowing in the auxiliary grid circuit. To facilitate this, the curves shown are the anode-current-grid-volt curves, together with auxiliary-grid-current-grid-volt curves. The total current can be found readily at any grid bias values.




**Average values under working conditions: A.C. resistance, 40,000 ohms; amplification factor, 50: mutual conductance, 1.25 mA/v.**

The total current demands are rather heavy for most dry-cell type batteries, and where mains are available an H.T. supply unit would be preferable. Otherwise an accumulator H.T. battery would be, perhaps, the most economical source of H.T. supply.

| Anode volts. | Auxiliary grid volts. | G.B. | Anode current. | Auxiliary grid current. | Total (mA). |
|---|---|---|---|---|---|
| 100 | 100 | −6 | 10.8 mA. | 2.8 mA. | 13.6 |
| 140 | 100 | −6 | 11.8 ,, | 3 ,, | 14.8 |
| 100 | 120 | −7.5 | 12.7 ,, | 3.5 ,, | 16.2 |
| 140 | 120 | −7.5 | 13.7 ,, | 3.7 ,, | 17.4 |

## BOOK REVIEW.

**Speech and Hearing.**

By H Fletcher. (Macmillan and Co., Ltd. 1929. 20s.)

The recent work on speech and hearing from the point of view of telephonic communication is ably summarised in this book.

It is surprising to learn that, while most of the energy of speech sounds is carried by frequencies below 500 c.p.s., the intelligibility is only reduced three per cent. when these frequencies are removed by a filter. The speech power emitted during average conversation is about ten microwatts, so that it would require a million people talking simultaneously to light a ten-watt lamp. Very loud speech corresponds to 1,000 microwatts, and 0.001 microwatts is the power for a soft whisper.

In the analysis of musical sounds we find that a piano emits bass notes almost entirely on harmonics, and that with the 'cello organ pipe the 3rd harmonic has about five times the amplitude of the fundamental.

The work on noise is of great interest. In perfectly silent surroundings conversation is possible over a range of 1,000ft., in a busy office over 30ft., in a boiler factory over ½in.

The masking of one tone by another shows that intense sound of low pitch can, by generating harmonics in the ear, obliterate the power of hearing all other sounds of higher pitch, but a high-pitched sound does not obliterate sound of lower pitch.

The book is packed with quantitative results about all phases of sound production and reception, and shows clearly what defects are permissible in telephone or wireless systems without undue depreciation of quality. R. T. B.

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## BOOKS RECEIVED.

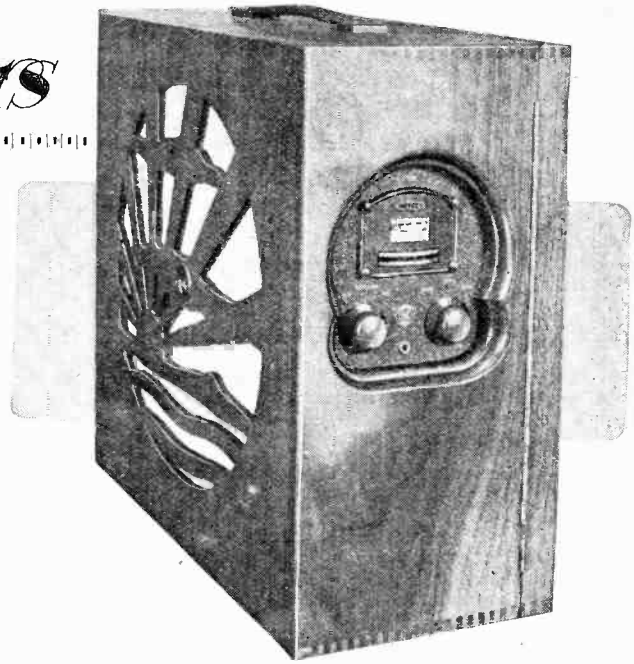
*A.B.C. of Television or Seeing by Radio.* By R. F. Yates. The theory, construction, and operation of telephotographic and television transmitters and receivers, explained in simple language. Pp. 210, with 78 diagrams and 20 illustrations. Published by Chapman and Hall, Ltd., London. Price 10s. 6d. net.

*A Course-shift Indicator for the Double-modulation Type Radiobeacon.* By H. Diamond and F. W. Dunmore. (Bureau of Standards, Research Paper No. 77.) A short description of the indicator used at beacon stations in U.S.A. Pp. 10, with six diagrams and illustrations. Published by the Department of Commerce, Washington, D.C. Price 5 cents.

# Broadcast Receivers

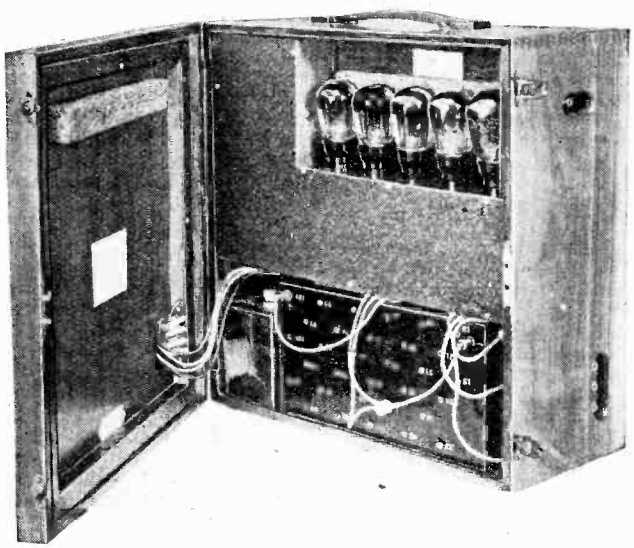
# The 1930 PYE PORTABLE

## Aperiodic H.F. Coupling Retained: Many Detail Refinements.



THE two aperiodic H.F. stages in the Pye Portable, using three-electrode valves, have given such satisfactory results in the past that it has been decided to retain this form of coupling in the 1930 model. Although the circuit principle and the general interior appearance of the set remains unchanged, the removal of the inside cover plate reveals that the circuit has been completely redesigned in detail. Instead of the rotating reaction coil and damping ring of last year there is a differential reaction condenser and regeneration is now confined to the detector stage. This has resulted in an improvement in selectivity on long waves.

Another important modification is the provision of sockets at the back of the set for the attachment of an external battery eliminator for H.T. supply. There are three sockets coloured to correspond with the H.T. wander plugs, which are plugged into the sockets inside the set after removing the battery. Decoupling resistances are incorporated in both positive leads and in other branches of the H.T. circuit, so there should be no trouble due to back coupling.



**Interior of the new Pye Portable, showing sponge rubber damping for the valves. Note sockets on extreme right for the connection of a battery eliminator.**

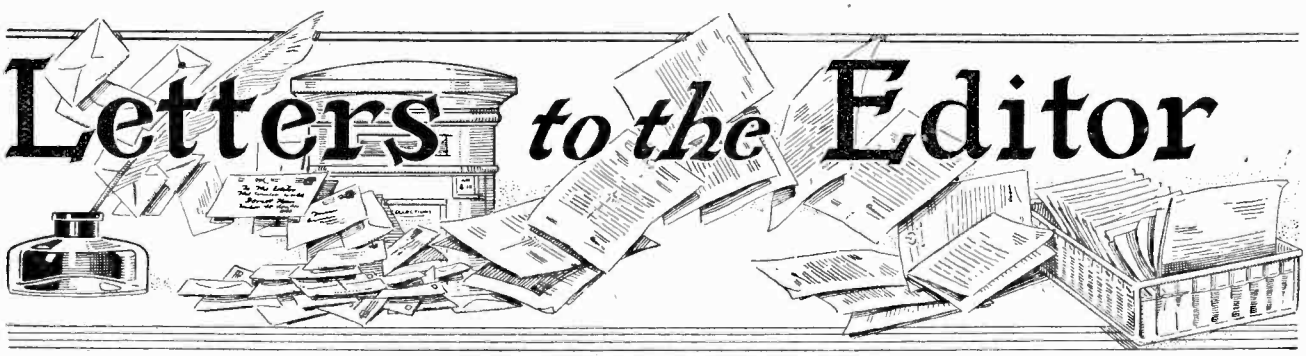
The control panel has been completely redesigned and is extremely pleasing to the eye. The tuning condenser is now mounted with the spindle vertical and the original bevelled dial has been replaced by a slow-motion edgewise drum dial. The scale is calibrated in metres on both wave bands and is framed in a handsome moulded escutcheon plate provided with a celluloid window and hair line. The reaction control is now placed in an accessible position below the main tuning dial in line with the wave range switch.

One of the first questions to be asked about a receiver to-day is the degree of selectivity to be expected and the manner in which it will react to the new Regional stations. Tests were made with the new Pye in central London during transmissions from Brookman's Park, and the tuning control was set first to the wavelength of 5GB and then at 261 metres—the approximate wavelength of the alternative programme transmitter at Brookman's Park. At both these settings the 356 metre transmission was still just audible even with reaction critically adjusted. The volume, however, would be insufficient to cause interference during periods of modulation and would only be heard during intervals in the programme being received.

The long wave selectivity has been much improved and there is little difficulty now in separating Radio Paris, Königswusterhausen, and Daventry 5XX.

The range and quality of reproduction are quite up to the standard of the earlier model. There is evidence that the set is sufficiently sensitive to overload the P.215 valve in the last stage, and it might be a good plan to invest in a P.240 for use with an H.T. eliminator. The P.215 would then be kept in reserve for outdoor use with the dry cell H.T.

An A.C. battery eliminator, specially designed for the Pye Portable, is available, and costs £5, while the price of the set itself is £23 10s.




The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

## *THE REGIONAL SCHEME.*

Sir,—I cannot understand your attitude towards the Regional Scheme, involving, as it does, dual-wave, high-power transmissions.

You have recently described a series of excellent receivers, which you state will function satisfactorily with the advent of the new conditions. Surely it is up to listeners to bring their sets up to date rather than retard the progress of efficient transmission.

The power used in the tests from Brookman's Park, while adequate during daylight, is only just sufficient, at 100 miles from the transmitter (the limit of its range) to overcome interference from foreign stations after dark.

Lowestoft. A. E. MANNING.

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Sir,—The views which you expressed in your editorial in the issue of October 16th will, I think, be endorsed by very many of your readers. There has, in my opinion, been too much confidence shown by the B.B.C. in the success of the regional stations.

Brookman's Park is, of course, a remarkably fine achievement as an engineering job, and the technical staff of the B.B.C. are entitled to be proud of it, but whether the regional scheme is the best solution to providing satisfactory broadcasting in this country has yet to be proved. The B.B.C. has always contended that they have to cater for the crystal set user and that they are not entitled to force him to buy a valve set, but now that they have rendered so many valve sets obsolete because of the power of the new transmitter, how are they going to reconcile this action with their attitude of the past? Nobody wants to stop progress, and no doubt the designs for receivers which *The Wireless World* produces will be a complete answer to the requirements of selectivity, but is it fair that the B.B.C. should have the power to compel listeners to spend money on buying new sets, or on bringing their old sets up to date? It seems scarcely right. "FAIR PLAY."

Golders Green.

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Sir,—Your views in the Editorial of *The Wireless World* issue of October 16th are so remarkable that I feel a little explanation is due, and so I am setting out one or two points that you may care to reply to.

With regard to the new Regional station, may I ask why all the concern for listeners around this station, including London and suburbs?

When the Daventry station, 5GB, was started up I do not recollect any great sounding of trumpets from you, and I, incidentally, lived about 12 miles from this station at that time and had to get over the difficulty as best I could, and many other people did the same. We did not even bother you or the B.B.C. about it, but adapted our sets to suit.

Are we to assume that your outburst is due to the trouble being a little nearer you, in the Brookman's Park transmitter? As for the Press outcry, well, that should go the way of most of their articles, and I sincerely hope will cause no fear at Savoy Hill.

But now we come to a serious side of the question. What of the new receivers designed especially for the Regional Scheme? Are the manufacturers' claims all wrong? Is it impossible to design a sufficiently selective set?

What of your own articles *re* means for obtaining selectivity? Are these no good, too? Or do you suggest that listeners should retain their old sets and that the B.B.C. should make their strides of progress to suit.

And last, but not least, would not this latter way hit the radio trade badly?

Come! We who are old readers do not like to see you indulging in what appears to be a fit of temper because Savoy Hill have not told you why the new station did not take over on October 14th as scheduled, and this is the first thing that will occur to some of your readers when reading your Editorial.

You are surely not averse to progress, and your technical experts should be able to deliver we poor amateurs from the paths of unselectivity unto the future of selectivity.

We look to you to lead the way technically. Let the newspapers do the grumbling; no one takes any notice of them, anyway. W. H. CHIPPERFIELD.

London, W.12.

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Sir,—You ask, "Must the Regional Scheme be scrapped?" Certainly not. The B.B.C. exists to give the best possible service to the greatest number of listeners. Therefore the fact that those within a few miles of the transmitter have in the past been unduly favoured is no reason why this monopoly of easy and good quality reception should continue. It will be necessary now for them to use selective sets, but they will still be much better off than those 100 miles away and near the coast.

It will mean a little trouble for the minority, but the majority will immensely benefit. As for the Continental stations, I often hear them and can say that their programmes, on the whole, are distinctly inferior to those given by the B.B.C., and as all announcements, talks, etc., are naturally given in the native language, comparatively few English people can understand them. Of course, there are specially good items at times, but these do not occur sufficiently often to make their reception a vital question. ARTHUR HOBDAY.

Margate.

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## *SPARE APPARATUS.*

Sir,—May I appeal through the columns of your magazine for the gift of any spare wireless gear that may be at the disposal of your readers.

This mission for social work among East End boys is unfortunately very cramped for funds. We have started a wireless class, and despite the enthusiasm of the boys we are painfully short of gear; in fact, we have practically nothing at all.

If any of your readers will send to me at this address, anything they are willing to give, I shall be most grateful.

Those who respond to this appeal will have the satisfaction of knowing that their gifts are being used to the utmost advantage, and also that they have been the means of bringing a good deal of happiness to those whose opportunities for enjoyment are at the best somewhat limited. W. A. CROWE.

London, E.2.


# READERS' PROBLEMS.

"The Wireless World" Supplies a Free Service of Technical Information.

*The Service is subject to the rules of the Department which are printed below; these must be strictly enforced, in the interest of readers themselves. A selection of queries of general interest is dealt with below, in some cases at greater length than would be possible in a letter.*

### Multiple Battery Cables.

*Is there any reason why a commercial five-way battery cable should not be used for connecting up the "New Kilo-Mag Four"? I believe that the use of these cables in highly sensitive receivers is sometimes responsible for instability.* T. C. A.

As all the circuits of this set are isolated by means of decoupling resistances and condensers, it is impossible that any interaction should take place between the various battery leads, and consequently there is no risk in using this form of connecting cable.

o o o o

### "Record III." Transformers.

*Will you please tell me if it would be permissible to wind the primary and neutralising sections of the "Record III" medium-wave H.F. transformer over the secondary winding, instead of underneath it? Of course, these coils would be carried on ebonite spacing strips placed over each rib of the former.* J. R. S.

From the point of view of electrical efficiency, it is quite immaterial which form of construction is adopted; that illustrated in the descriptive article offers the advantage that the fragile primary windings are protected from harm by the secondary. Needless to say, the spacing between the coils should be exactly as described, and the single-turn neutralising coil should be carried on extensions of the spacing strips.

o o o o

### Larger Condensers Permissible.

*Would it be permissible to use variable condensers of 0.0005 mfd. for tuning the secondary and H.F. transformer circuits of the "Wireless World" Kit Set"? I already have spare condensers of this capacity, and should like to use them if there is no serious objection.* N. H. C.

Tuning condensers of 0.0005 mfd. capacity can most certainly be used throughout in this receiver, provided that they have not exceptionally high minimum value. It should be pointed out, however, that tuning will be slightly more difficult, as the angular displacement of the vanes corresponding to a given wavelength change will be less than when the specified capacity is used. Of course, this slight disadvantage could be overcome by redesigning the coils, but this course would entail some reduction in sensitivity, and is not recommended.

With condenser values as specified, it will be found that the three dials run in step reasonably closely over the tuning scale; this will not hold good if alterations are made.

o o o o

### L.F. Potentiometers.

*I am using an anode potentiometer for controlling the volume of my four-valve set (H.F. amplifier and anode bend detector, followed by resistance-and transformer-coupled L.F. stages). I am told that the same effect can be obtained by using a "grid potentiometer." Will you explain how this device is connected, and also say if it is superior to the method at present in use.* V. D. S.

These two methods of volume control are shown diagrammatically in Fig. 1. The anode potentiometer which you are already using appears in sketch (*a*).

As you will see from diagram (*b*), grid potentiometer control is effected by replacing the usual fixed grid leak by a high resistance (of the value normally chosen for working in association with the coupling condenser). A sliding contact on this resistance is connected to the grid of the first L.F. amplifier in such a way that any desired proportion of the total signal voltage existing across the leak may be applied. This method has no advantage over the other scheme, except in the matter of cost, and often in convenience of wiring. A high-resistance potentiometer of the grid leak type is readily obtainable, and is quite inexpensive, while one's choice in the matter of suitable resistances for the anode circuit is somewhat restricted, and the majority of components having sufficient current-carrying capacity are considerably more expensive.

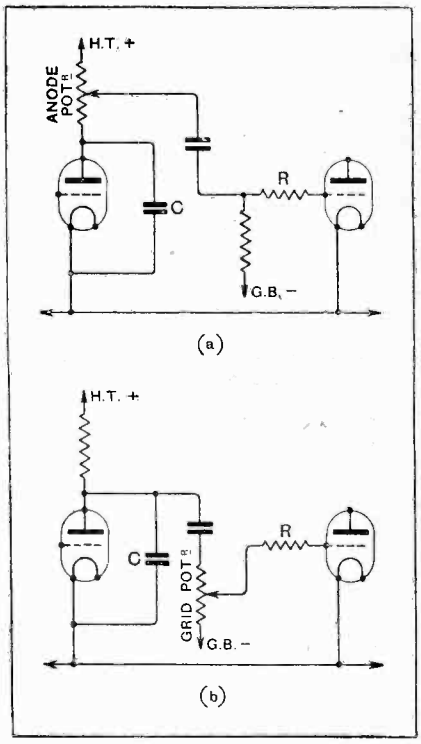


**Fig. 1.—Two methods of post-detection volume control, whereby input from the detector to the L.F. amplifier may be regulated. In each diagram (c) represents the detector anode by-pass condenser, and R the conventional H.F. stopping resistance.**

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*RULES.*

(1.) *Only one question (which must deal with a single specific point) can be answered. Letters must be concisely worded and headed "Information Department."*

(2.) *Queries must be written on one side of the paper, and diagrams drawn on a separate sheet. A self-addressed stamped envelope must be enclosed for postal reply.*

(3.) *Designs or circuit diagrams for complete receivers cannot be given; under present-day conditions justice cannot be done to questions of this kind in the course of a letter.*

(4.) *Practical wiring plans cannot be supplied or considered.*

(5.) *Designs for components such as L.F. chokes, power transformers, etc., cannot be supplied.*

(6.) *Queries arising from the construction or operation of receivers must be confined to constructional sets described in "The Wireless World" or to standard manufacturers' receivers.*

*Readers desiring information on matters beyond the scope of the Information Department are invited to submit suggestions regarding subjects to be treated in future articles or paragraphs.*

### Adjusting Detector Bias.

*My set is on the lines of the original "Everyman Four," but with a screen-grid H.F. amplifier. Is there a simple method of setting detector-grid bias other than the usual procedure of making this adjustment when listening to actual signals? I am aware of the fact that this can be done by inserting a meter in the anode circuit and balancing out the steady D.C. current, but should imagine that this is rather difficult.* E. H. W.

We agree that the balancing method is not too easy to apply, but very much doubt if it is possible to improve—from the strictly practical point of view—upon the usual procedure. If adjustments of bias are carefully made when listening to really weak incoming signals, it is generally possible to find the best setting without much trouble.

### 250,000 Times Amplification!

*Do you consider that it would be practicable to set up two H.F. stages similar to those included in the "Record III." receiver? If you think that it would be possible to construct such a set satisfactorily, I should build it in a standard "Wireless World" four-compartment cabinet, mounting the aerial tuning coils and their condenser in the base of the compartment.* C. L.

By observing extreme care at every point—particularly with regard to screening and decoupling—it would be possible to build a "2-H.F." set with something approaching the stage amplification of the receiver in question; but unless you have had considerable experience we should be doing you a disservice by recommending that you should proceed with your plan.

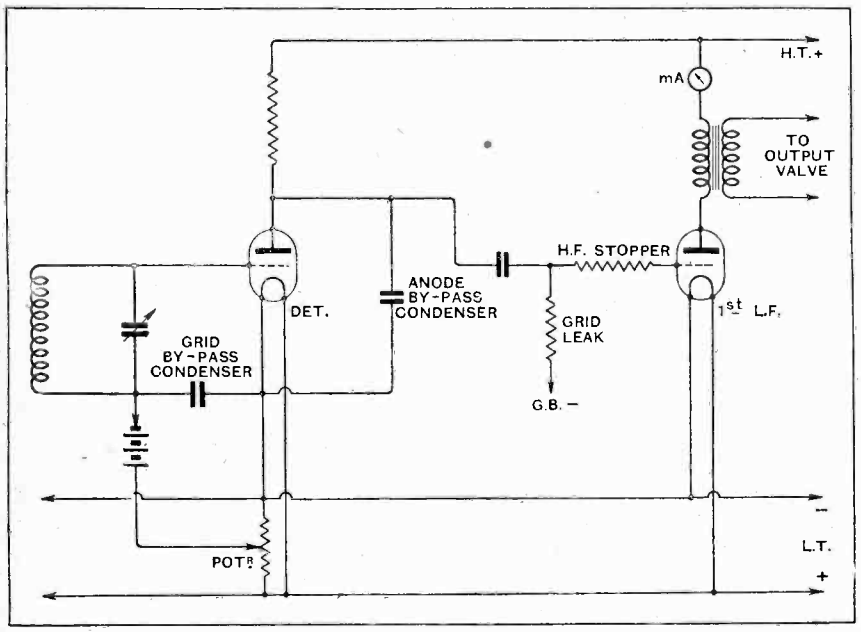


**Fig. 2.—Converting a first-stage L.F. amplifying valve into a valve voltmeter: a simple method of making an accurate adjustment of detector grid bias.**

A satisfactory way of making a comparative measurement of the rectified output from the detector is shown in Fig. 2; this is readily applicable to your own set, and requires no other apparatus beyond a fairly sensitive milliammeter, which is inserted in series with the anode circuit of the first L.F. amplifier. The procedure is to convert this valve into an L.F. signal rectifier by approximately doubling its negative grid bias, and, while listening to a signal of constant amplitude (such as a tuning note) to adjust grid bias until the milliammeter reading is at maximum.

Although a detector potentiometer is not usually considered as necessary when a valve of comparatively low impedance is used, we certainly think it should be included when one is attempting to make a really accurate adjustment, and accordingly this feature is shown in our diagram.

### A Faulty Transformer Primary.

*My set (detector followed by two transformer-coupled L.F. stages) works reasonably well, provided that the H.T. pressure is not increased beyond 60 volts. As soon as an attempt is made to apply sufficient voltage for good quality and adequate volume, violent crackling noises are heard in the loud speaker, and signals sometimes fade away altogether. Can you suggest what is wrong? From replies to other correspondents, I suspect that one of the transformer primaries has developed a fault, but the usual "phone and battery" test seems to suggest that everything is in order.* N. P. R.

We think that you are correct in assuming that one of the transformer primaries is responsible for the trouble; it seems that a rather unusual (but by no means unknown) type of open circuit in the windings has developed, and that this manifests itself when the current passing reaches a certain fairly critical value. A fault of this kind would not be revealed by the usual tests, and we suggest that you should attempt to locate the defective component by temporarily inserting phones or loud speaker in the anode circuit of the first L.F. valve in place of the transformer primary. If, with this connection, the trouble persists, it can be assumed that the first stage transformer is at fault; if, on the other hand, the set works well, it is probable that the other is to blame.

Of course, you must not lose sight of the fact that the loud speaker or the output choke (or transformer, if one is used) may also cause a similar trouble.

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### "Designing an Eliminator."

*With reference to the article under the above heading, which appeared in your issue for October 2nd, will you please tell me if the centre-tapped double 0.1 mfd. condenser mentioned need be of any special form, or will it be satisfactory to use two ordinary condensers connected in series, taking the negative supply lead from the junction between them? I refer, of course, to the arrangement shown in Fig. 1 (c) of the article.* W. H.

Any good condensers, with the usual commercial tolerance as to their precise values, will do for this purpose; they are connected in the manner you state.

## FOREIGN BROADCAST GUIDE.

## KOVNO

**(Lithuania).**

Geographical position: 54° 55′ 00″ N. 23° 56′ 00″ E.

Approximate air line from London: 1,015 miles.

**Wavelength: 1935 m. Frequency: 155 kc. Power: 7 kw.**

Time: Central European (60 minutes in advance of G.M.T.).

**Standard Daily Transmissions.**

G.M.T. 11.00 and 17.00 weather and news; 18.30 and 20.00 concerts. Usually closes down at 21.00

Dance music 20.00—21.15 (Sats. only).

Male announcer. Call: *Allo! Allo! Lietuvoss Kaunas*, with, at times, French translation: *Ici Poste de Radiotéléphonie de Kovno.*

Opens transmission by playing a gramophone record.

**Interval Signals:** a stroke on a gong.

Closes down with a few bars of the Lithuanian National Anthem.

Under the heading "Foreign Broadcast Guide," we are arranging to publish a series of panels in this form, giving details regarding foreign broadcast transmissions.