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Editor: HUGH S. POCOCK. Assistant Editor: F. H. HAYNES.

Editorial Offices: 116-117, FLEET STREET, LONDON, E.C.4. - - Editorial Telephone: City 9472 (5 lines).

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# *"Home Talkies."*

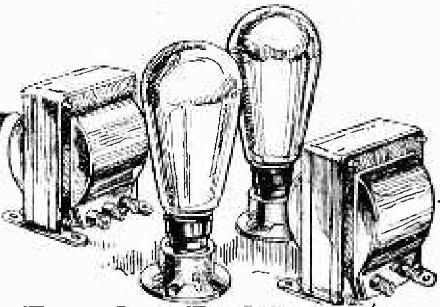
AMATEUR cinematography is rapidly gaining ground, and it would seem that radio enthusiasts are foremost among those to whom the intricacies of the home cinema are making an appeal. In keeping with the radio amateur spirit to make and modify, the question is continually arising as to how best to convert the silent film for sound accompaniment, thus applying valuable radio experience to some further accomplishment embodying electrical, chemical and mechanical interests which are the source of so many hobbies.

Let us consider the prospects of home talkies, giving the facts with frankness. To regard the home equipment as a rival to the cinema theatre is folly, for to hire and project a film with sound accompaniment is too troublesome and costly. Essentially, home cinematography is not the projecting of hired subjects, but rather the taking of one's own films and thus completely eclipsing ordinary photography, the normal function of which is that of providing a still and dumb record of holidays, outings, children's activities, sport, etc. No one will disagree as to the merits of the results obtained with cinematography, particularly in the case of 16 mm. film.

Turning attention to the problems of sound recording and synchronising, our experience may be readily summarised. It is a simple matter to synchronise a gramophone disc with the film, avoiding the elaborate equipment used with the early talking pictures, and, through suitable gearing and flexible drive, actually locking the gramophone disc and film sprocket wheel. Thus, with home recording available the home talkie is at once within the reach of anyone with model-making facilities. The quality of the picture and the contrast with the talking film of the theatre expose the present failings of this method of recording. Light recording is the field to exploit, and it is full of radio interest. The velocity of 16 mm. film through the projector is never more than half that of standard film, so that a record on the film would give but poor reproduction, while there is, of course, no adequate space available on so narrow a strip. For home purposes an auxiliary 9 mm. film must be used for the sound record and driven at a sufficiently high speed, using all the available width of the film in order that as much light as possible may pass through it on to the photo-cell during projection. Recording and projection with film calls for a generous amplifier feeding a small recording lamp and the use of a photo-cell followed by several stable resistance-coupled stages, but no difficulty is involved which is out of the ken of the radio enthusiast.

Whether or not home talkies are required is a matter for the public taste to decide, but the home cinema is full of interest, and the making up of reasonably simple and not too costly recording and reproducing equipment for home use is an open field for the radio enthusiast and the enterprising manufacturer.

## In This Issue



# PUSH PULL PROBLEMS

## Increased Power Output and Simplified Smoothing Equipment.

By W. T. COCKING.

THE push-pull circuit was originally designed as a means of obtaining increased power output in the days when power valves were unknown, and there have been many misconceptions as to the amount of the increased power which it makes available. It is the purpose of this article, therefore, to clear up some of these misconceptions, and to indicate some of the peculiarities of the circuit and where it may be used with advantage.

The circuit of the usual push-pull output stage is shown in Fig. 1, and it will be seen that the voltages developed between the two ends of the secondary winding of the input transformer are split into two halves. One-half of the total voltage, therefore, is applied to the grid of each output valve. Now, it should be carefully noted that the voltages applied to these valves are out of phase by 180 degrees; that is, when a signal causes the grid of one valve to swing in a positive direction the grid of the other valve swings by an equal amount in a negative direction.

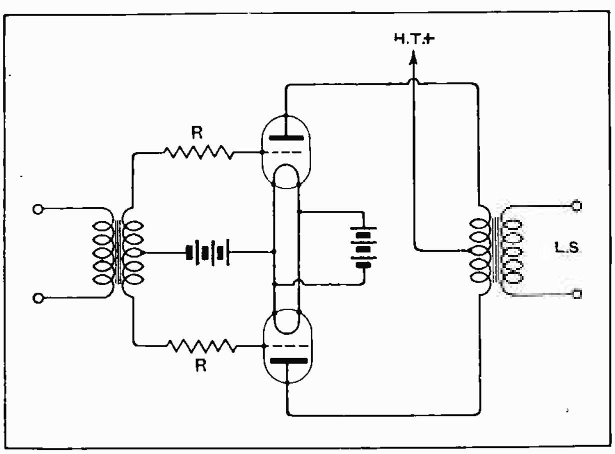



**Fig. 1.—The fundamental push-pull circuit for battery operation. The resistances R should have a value of about 100,000 ohms for ordinary valves and are for the prevention of parasitic oscillation.**

Since identical valves are assumed, their anode currents are also of equal strength, but of opposite phase; and so a centre-tapped output transformer, or choke, is required in order to recombine the signals. If the two anodes of the valves were joined together and connected to the usual choke filter output circuit, nothing would be heard, for the currents would balance out.

### Power Output.

The question of the amount of power available in the output circuit is one of considerable importance in view of the doubt which prevails upon the subject. It has been stated that this output is anything up to four or five times that of a single similar valve, but there appears to be no justification for the truth of this statement. It has been further stated that the output is only double that of a single valve, or the same as that of two valves in parallel. This is perfectly true, provided that the same limit is placed to the output in each case; namely, that the amplitude of the second harmonic introduced by each valve is not greater than 5 per cent. of the amplitude of the fundamental frequency output of each valve.

The limit of 5 per cent. second harmonic distortion, however, is inapplicable to the push-pull stage, for the reason that these harmonics are very largely balanced out. With push-pull the true limit to the power output is placed, not so much by the percentage of second harmonic distortion as by the percentage of third harmonic. Figures for power output based upon third harmonic distortion are rarely available, however, and so it is impossible to state with any degree of accuracy the actual output available from a push-pull circuit. Experience indicates, however, that the output is about 2.2 to 2.4 times that of a single similar valve; this is a gain of from 10 per cent. to 20 per cent. over two paralleled valves, and is a pure gain due to the adoption of push-pull. There are, of course, other gains.

That the action of a push-pull stage is quite different from that of a paralleled or single-valve output stage is readily seen by connecting a milliammeter in the H.T. supply to the valves. As usual, the needle remains steady with a small input, and as the input is increased a point is reached at which the needle begins to kick upwards. As the input is still further increased, however, instead of large upward kicks taking place the

**Push-pull Problems.—**
needle starts to kick downwards with push-pull. It is possible, therefore, to use an input with which the needle neither kicks upwards nor downwards to any great extent, but oscillates about its mean position. Under this condition the distortion is usually undetectable by ear, which would certainly not be the case with paralleled valves.

*THE push-pull stage is usually considered to be somewhat of a luxury, and to be practicable only where a very large output is required. This is not necessarily so, however, for its use is sometimes a true economy. Owing to cancellation of even harmonics, the power output is greater than that from two valves in parallel and both hum and feed-back are considerably reduced. This has the advantage that quite modest smoothing equipment is required, leading to a simplified layout.*

**Feed-back.**

Now it will be seen that the slight extra output of 20 per cent. or so is hardly sufficient to justify the use of push-pull in preference to paralleled valves, and we should not use the circuit were it not for several other very important advantages which it confers. It was stated earlier in this article that the alternating anode currents of the two valves are exactly out of phase with each other, and the practical meaning of this is that the currents flowing in the H.T. leads balance out; that is, no effective A.C. flows through the H.T. supply. As a result, no potential can be developed across an impedance in the H.T. supply, and no feed-back to earlier stages of amplification can occur.

In practice, of course, a perfect balance can rarely be obtained, and so feed-back is not entirely absent, but it is usually so small that it can be ignored. It has proved perfectly practical to use a push-pull stage following a power grid detector with no decoupling at all; but in general it is advisable to include some measure of decoupling, if only for safety's sake. This absence of feed-back applies also to the grid circuit of the push-pull stage, and we find that it is unnecessary to include decoupling in the grid bias arrangements for these two valves.

**Hum.**

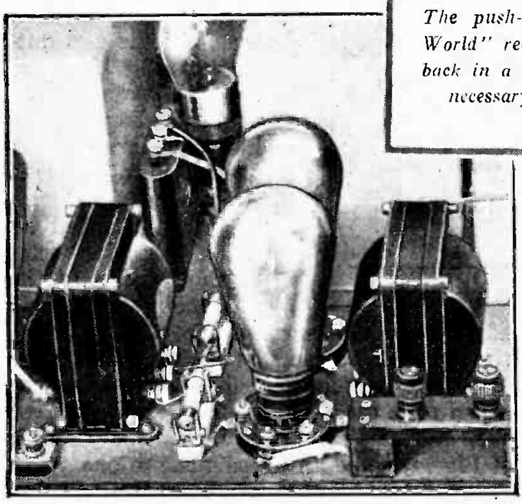
For exactly the same reasons that feed-back is almost eliminated, hum is reduced to a small fraction of what it would be with a plain output stage. When the push-pull stage is balanced any disturbance in the H.T. supply affects both valves to the same degree and in the same manner, and is, therefore, balanced out in the output transformer.

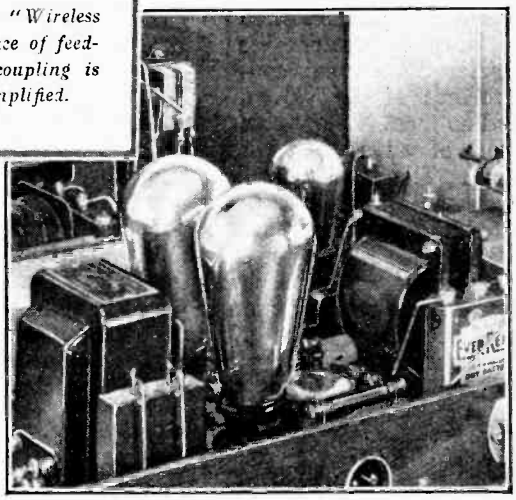
With a perfectly balanced push-pull stage the H.T. would require no smoothing at all, but, needless to say, we cannot in practice approach this degree of perfection, and some smoothing is always necessary.

A much smaller choke can be used, however, than would be required with only a single valve in the output stage, and a considerable economy can thus be effected. This hum-balancing action applies also to the grid and filament circuits, and so there is no risk of introducing hum by the use of automatic grid bias, while even thin filament type valves can be heated from raw A.C. without excessive hum.

It should, of course, be understood that this reduction of hum does not in the least affect the degree of smoothing necessary for the earlier stages of a receiver, but applies only to the push-pull stage. In general, hum will be reduced by the use of push-pull only when the hum voltages affect both valves to the same degree and in the same phase. As a result, hum due to electromagnetic pick-up in the intervalve transformer is not eliminated, nor is hum from the earlier stages, for this is passed along through the transformer with the signal.

*The push-pull output stages of two "Wireless World" receivers. Owing to the absence of feed-back in a well-balanced stage, little decoupling is necessary and the layout becomes simplified.*






**(Left) The output stage of *The Wireless World* Band-Pass Four receiver.**

**(Right) The D.C. Band-Pass Five receiver showing valves in push-pull.**

**Parasitic Oscillation.**

It has been found in practice that one of the drawbacks of the push-pull method of amplification is that there is sometimes a tendency for the valves to oscillate at a very high frequency. This frequency is usually very high indeed, and is far above audibility, since it often corresponds to a wavelength of 3 metres. The

**Push-pull Problems.—**

usual symptoms of parasitic oscillation are distortion and a reduced output, together with an increase in the steady anode current of the valves. When it is found that such oscillation is taking place, steps must be taken to cure it at once, for it often results in a large reduction in the life of the valves.

The trouble from parasitic oscillation has been rather overstressed in the past with regard to push-pull, for this method of amplification is not the only one to suffer from it. Paralleled output valves are also prone to it, and it is by no means unknown with only a single valve; there is no doubt, however, that it occurs most easily with push-pull. In the writer's experience, its prevention is simple, and consists of the inclusion of a stabilising resistance in the grid lead of each valve. These resistances, which can have values between 10,000 ohms and 100,000 ohms, according to the type of valve used, are shown at R in Fig. 1. The writer has consistently used push-pull output stages for over two years, and has yet to experience parasitic oscillation in a receiver which included the grid series resistances.

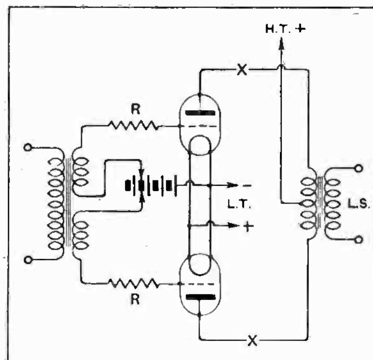



Fig. 2.—(Above) A method of balancing applicable when batteries are used; it is not recommended for A.C. mains operation. A special input transformer is required and the valves are biased independently.

It will be realised, of course, that the tendency towards oscillation is always greater the greater the mutual conductance of the valves, and so there is more risk of trouble with the latest types of valves than with some of the older patterns. The trouble is most frequently met with, however, when large power valves of the type rated to dissipate 25 watts or more at the anode are used, and it is rare for it to be at all serious with the smaller valves, such as the P.625. In cases where parasitic oscillation is found in spite of the presence of the series grid resistances, it is well to try the effect of connecting a resistance of a few hundred ohms in series with the anode lead to each valve.

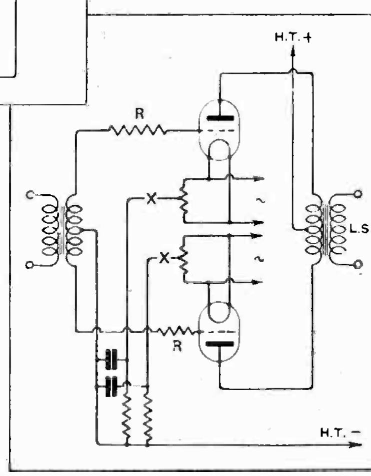
### The Balanced Output Stage.

It has often been stated in the past that it is necessary to use matched valves with push-pull, and undoubtedly the best results are obtained when this is done. Unfortunately, however, it is found that a pair of matched valves are no longer matched after a few weeks' use; valve characteristics always change somewhat in use, and two specimens do not usually change by the same amount after being used for the same time. It is desirable, therefore, to include some method of balancing the circuit, for then matched valves are by no means so essential.

It has been the writer's experience that the results can be noticeably improved by arranging the circuit so that the anode currents of the two valves are equal. This is most readily achieved by the use of separate grid bias for each valve, and the circuit of Fig. 2 shows how this may be done when a battery is used to provide the bias voltage. It will be seen that a special input transformer with the secondary wound in two separate sections is necessary, but this need present no difficulty, as such instruments are now available. A milliameter is inserted in the anode lead to one valve at X, and the bias voltage on that valve adjusted so that the anode current is in accordance with the valve maker's rating. The milliameter is then inserted in the anode circuit of the other valve, and the bias of that valve adjusted to give the same anode current.

In a mains receiver, where automatic bias is used, the same scheme may be adopted by substituting two potentiometers in parallel for the usual biasing resistance. It has been found, however, that the adjustment is rather difficult, since an alteration in the bias of one valve alters the anode current and bias of the other valve by a considerable amount. Where A.C. mains are used, therefore, it is recommended that the arrangement shown in Fig. 3 be adopted. A special input transformer is now no longer necessary, and a standard push-pull model can be employed; the filaments of the two output valves, however, must be heated from separate windings on the mains transformer. A separate bias resistance is used for each valve, and the stage is balanced by inserting a milliammeter at X in the lead to the filament centre tap of one valve and adjusting the bias resistance of that valve. The meter should then be inserted in the other valve circuit, and the bias resistance of that valve adjusted. The point to aim at is the same value of anode current for each valve, and this can readily be achieved with the circuit of Fig. 3, since an adjustment to one valve has only a very small effect upon the adjustment of the other.

Fig. 3.—(Below) The simplest method of balancing the push-pull stage when working from A.C. mains. The valves are run from separate windings on the mains transformer, and the values of the two bias resistances are varied to obtain a balance.




It has been found that a carefully balanced stage gives a slightly greater output, less distortion, and greater freedom from hum and feed-back than one in which no care in balancing is obtained. This is probably due to the better balancing out of second harmonics, and to the complete freedom from a D.C. polarising action on the output transformer. It will be realised, of course, that the simple balancing method described here does not allow a perfect balance to be obtained, and so the valves should have characteristics which are

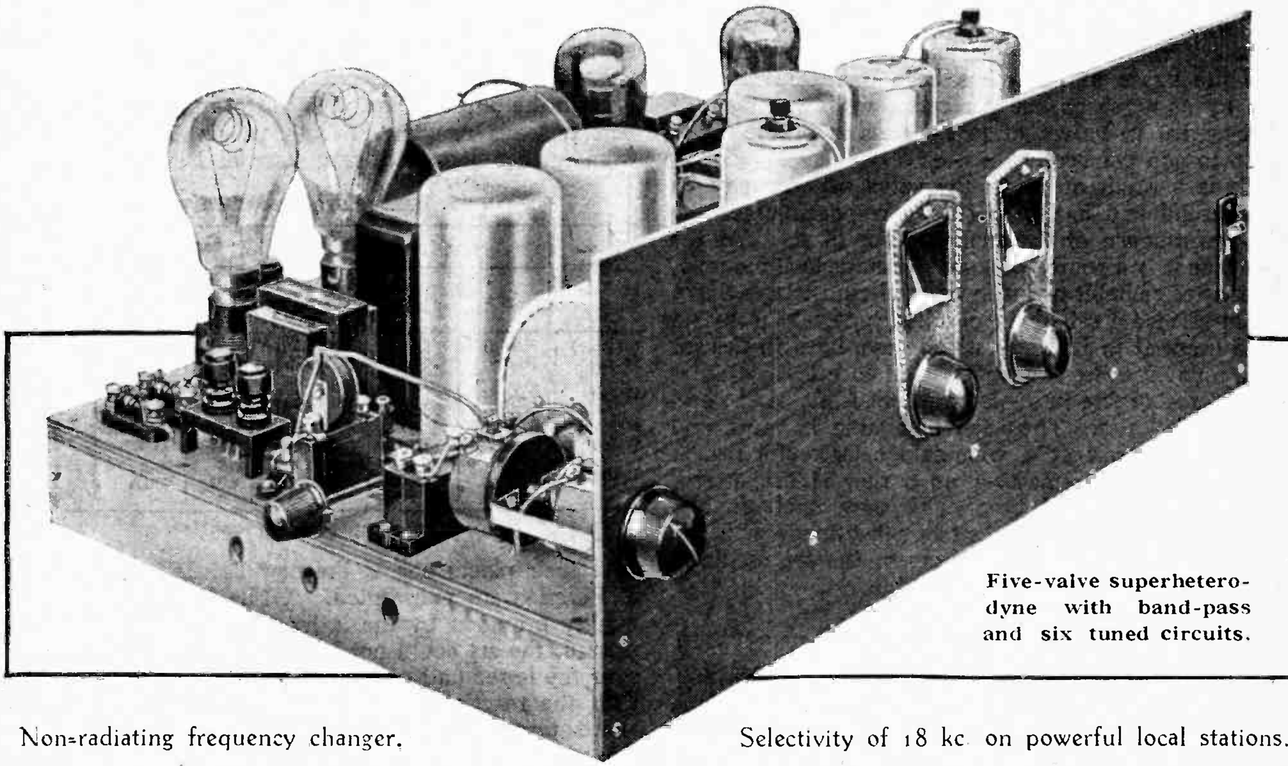
**Push-pull Problems.**—

reasonably alike. The circuit, however, will usually give as good results with a pair of average valves as the ordinary method with a pair of matched valves.

It will be seen, therefore, that a push-pull output stage will give over double the output of a single similar valve, but it requires about double the input signal voltage for its operation. The quality is better, for second harmonics are largely balanced out, and the fact that there is no effective D.C. through the output transformer means an improved frequency characteristic and little risk of the iron introducing amplitude distortion. Probably the most important advantages, however, are the greatly reduced feed-back and the small amount of smoothing which is needed, for these allow such a simplification of the receiver design that it is sometimes found to be cheaper to use two valves in push-pull than a single output valve. The sole disadvantage of the circuit, its tendency towards parasitic oscillation, is not great at the present time, for it occurs nearly as frequently with ordinary circuits, and its cure is usually quite easy.

# Next Week's Issue: D.C. SUPER SELECTIVE FIVE

To meet the requirements of readers having D.C. mains, a specially designed version of the popular new superheterodyne receiver will be fully described and accompanied by detailed constructional diagrams.



Five-valve superheterodyne with band-pass and six tuned circuits.

Non-radiating frequency changer.

Selectivity of 18 kc on powerful local stations.

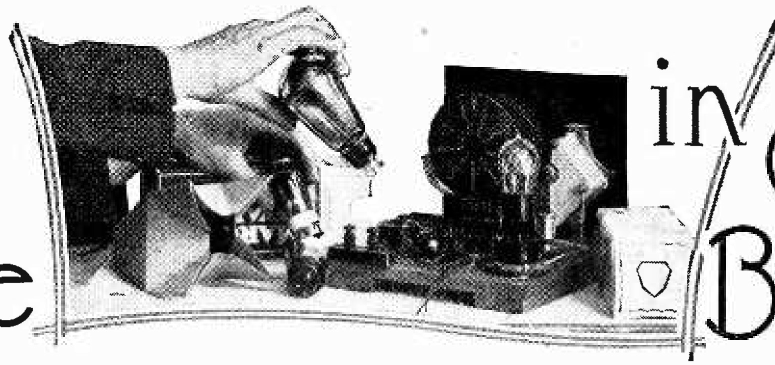
## LIST OF PARTS REQUIRED

1 L.F. transformer ............ (Varley Nicore. 1)
1 Dual L.F. choke ............ (Varley, D.P. 11)
1 Two-gang condenser, 0.0005 mfd. and drum dial ............ (Polar Tub)
1 Variable condenser, 0.0005 mfd. and drum dial ............ (Polar Universal)
2 Grid leaks, 0.25 megohm ............ (Ediswan)
1 Porcelain grid leak holder ............ (Bulgin)
3 Fixed condensers, 0.0001 mfd. ..(Dubilier, No. 620)
2 Fixed condensers, 0.001 mfd. ....(Dubilier, No. 620)
1 Fixed condenser, 0.002 mfd. .... (Dubilier, No. 620)
1 Fixed condenser, 0.05 mfd. .. (Dubilier, Type B775)
5 Fixed condensers, 1 mfd. 500 volt, A.C. test ............ (Ferranti, Type C7)
10 Fixed condensers, 2 mfds., 500 volt A.C. test ............ (Ferranti, Type C8)
4 Fixed condensers, 4 mfds., 500 volt A.C. test ............ (Ferranti, Type C9)
1 D.C. mains switch, with Escutcheon plate (Bulgin, S56)
5 5-pin A.C. valve holders ............ (W.B.)
3 Valve screens ............ (Colvern)
2 I.F. transformers, 110 k.c. ............ (Colvern)
1 Twin volume control potentiometer, 25,000 ohms. ............ (Colvern)

1 H.F. choke ............ (Wearite, HFO)
1 Aerial band pass coil and screen ...... (Watmel)
1 Secondary band pass coil and screen .... (Watmel)
1 Oscillator coil and screen ............ (Watmel)
1 Slab coil ............ (Watmel)
2 Insulated ganging couplers ............ (Cyldon)
1 Pentode choke ............ (Atlas, Type C.P.S.)
1 Pre-set condenser, 0.0005 mfd. max. .... (Polar)
1 Resistance, 280 ohms, to carry 35 mA. and holder ............ (Varley Bi-Duplex)
1 Resistance, 400 ohms, to carry 20 mA. and holder ............ (Varley Bi-Duplex)
1 Resistance, 7,000 ohms, to carry 10 mA. and holder ............ (Varley Bi-Duplex)
1 Resistance, 40,000 ohms, to carry 5 mA. and holder ............ (Varley Popular)
1 Resistance, 500 ohms, to carry 10 mA. and holder ............ (Varley Tagtype)

2 Resistances, 600 ohms, to carry 10 mA. and holder ............ (Varley Tagtype)
1 Resistance, 1,000 ohms, to carry 2 mA. and holder ............ (Varley Tagtype)
1 Resistance, 3,000 ohms, to carry 10 mA. and holder ............ (Varley Tagtype)
1 Resistance, 10,000 ohms, to carry 2 mA. and holder ............ (Varley Tagtype)
1 Resistance, 20,000 ohms, to carry 5 mA. and holder ............ (Varley Tagtype)
2 Resistances, 30,000 ohms, to carry 5 mA. and holder ............ (Varley Tagtype)
1 Resistance net, 6in. × 6in., 104 ohms (Cressall, Type S.R.30)
2 Baseboard fuse holders, with 1 amp. fuses (Belling & Lee)
4 Ebonite shrouded terminals .... (Belling & Lee)
2 Terminal mounts ............ (Belling & Lee)
2 Smoothing chokes ............ (R.I. Hypercore)
2 Robertson lamps, 130 volts, 32 c.p. ...... (C.E.C.)
2 Lamp holders, Batten type.
1 Bakelised panel, 21in. × 8in. × $\frac{3}{16}$ in.
1 Baseboard, 14½in. × 21in.
Sleeving, copper foil, wire, screws, wood, mains, socket and flex, etc.

# New Wine in Old Bottles



## Adapting Old-type Circuits for Use with Modern Valves.

DURING the past three or four years the efficiency of all types of thermionic valves has shown an astonishing improvement. A glance at the table opposite is sufficient to show that during the past four years the figure of merit has been increased in some cases by as much as 600 per cent., while the average improvement in valves of every class is of the order of 200 to 300 per cent.

This is a result of which the valve makers may be justly proud and has been chiefly responsible for the high performance of the modern type of set. At the same time it is a source of some difficulty to those who, as a matter of habit or by force of circumstances, have kept in service a set of an obsolete type. It is by no means unusual to find sets which have been in use for three, four, or even five years with no attention other than the recharging or replacement of L.T., H.T., and grid-bias batteries. Then the inevitable happens and a valve burns out or a wholesale catastrophe results from an error in connecting up a new H.T. battery. Valves of the original type being now unobtainable, the nearest modern equivalent is substituted, with the result that, in the majority of cases, the set oscillates and becomes generally unmanageable.

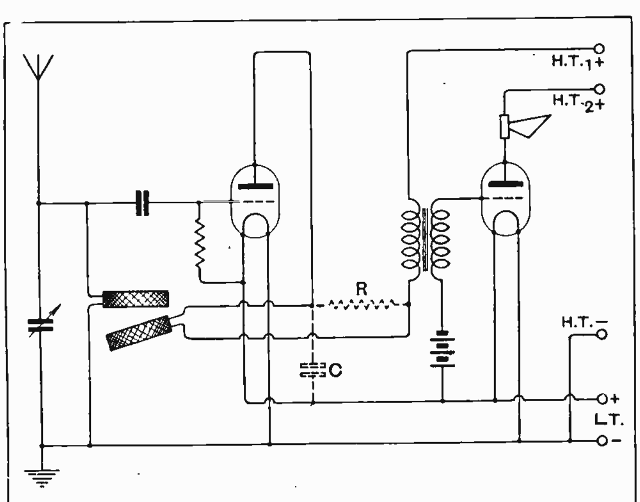



**Fig. 1.—Reaction feed-back may be reduced by connecting a by-pass condenser C or a shunt-resistance R across the reaction coil.**

Take the case of the simple reacting detector-L.F. circuit in Fig. 1. The writer is personally acquainted with an instance where a set of this type has been in continuous use for four years with a 1927 PM L.F. valve in the detector stage and a PM2 of the same year in the output stage. A misfortune with the H.T. battery leads resulted in both valves being acquitted from further service after a long and useful life. To

**1927-1931 FOUR YEARS' PROGRESS IN VALVE DESIGN.**

| Make. | H.F. | | Detector. | | Output. | |
|---|---|---|---|---|---|---|
| | Type. | Figure of Merit. | Type. | Mutual Conductance. | Type. | Mutual Conductance. |
| (Cosmos) | SP18 G | 11.5 | SP18 G | 0.9 | SP18 RR | 1.3 |
| Mazda | **HL210** | **18.0** | **HL210** | **1.3** | **P220A** | **3.5** |
| Cossor | 210 H.F. | 10.5 | 210 Det. | 0.4 | 215 P | 0.8 |
| | **210 H.F.** | **15.5** | **210 Det.** | **1.15** | **230 XP** | **3.0** |
| Marconi | DE2 H.F. | 5.7 | DE2 L.F. | 0.3 | D.E.P.215 | 1.0 |
| Osram | **HL210** | **13.2** | **HL210** | **0.87** | **P2** | **2.8** |
| Mullard | PM1 H.F. | 8.1 | PM1 L.F. | 0.5 | PM2 | 0.6 |
| | **PM1 H.F.** | **12.0** | **PM2DX** | **1.25** | **PM2A** | **3.5** |

1931 valves are indicated by black type.

take their places one of the new PM2DX valves and a PM2*A* were substituted. While the volume and quality provided by the latter were in every way improved, the set could not be prevented from oscillating over the lower half of the tuning-condenser scale, even with the reaction coupling at minimum. The table shows that the mutual conductance of the PM2DX is 250 per cent. greater than that of the original PM1LF. The mutual conductance alone is not, strictly speaking, a complete criterion of the performance of a detector valve, but it plays an important part, and for the present purpose may be taken as an indication of the substantial difference in the efficiencies of the two valves.

### Modifying the Reaction Circuit.

The receiver employed a well-known make of tuner which would have been difficult to modify, and the course adopted to bring the reaction under control was to connect a shunt resistance R across the reaction-coil terminals. In general, this resistance will be less than 1,000 ohms, the exact value being found by trial, preferably with a variable resistance. The required value having been ascertained, a fixed resistance can

**New Wine in Old Bottles.**—be subsequently connected permanently across the terminals.

An even better scheme is to connect a by-pass condenser of about 0.0003 or 0.0005 mfd. capacity between anode and filament of the detector valve. This method has the advantage that the detector efficiency is improved by the additional capacity in the anode circuit.

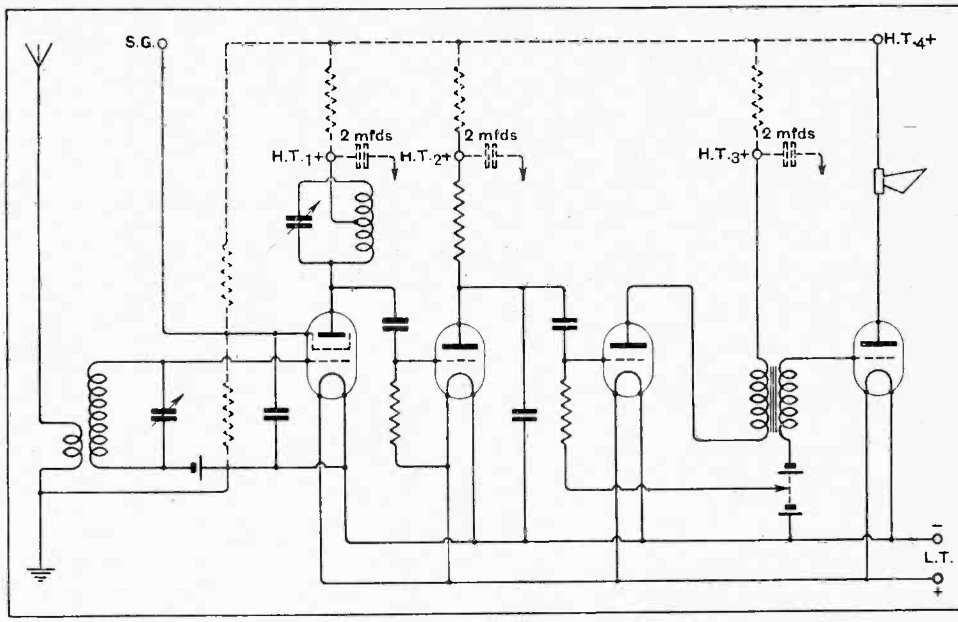



Fig. 3.—The addition of decoupling resistances may be necessary to combat "motor-boating."

In receivers employing one or more H.F. stages, the substitution of up-to-date H.F. valves is almost certain to result in self-oscillation. Some idea of the improvement achieved in modern three-electrode valves suitable for high-frequency amplification is given in the table, the figure of merit having been calculated from the formula $\mu\sqrt{R_o}\times 100$ where $\mu$ is the amplification factor and $R_o$ the A.C. resistance of the valve. In receivers of the "Everyman Four" type, instability can generally be traced to the inability of the screening to deal with the increased stage gain. A cure can usually be effected by extending the screening partition as shown at S in Fig 2. In particularly stubborn cases it may be necessary to enclose the H.F. valve anode circuit and the detector valve in one of the standardised aluminium screening boxes marketed by the component manufacturers. It should also be remembered that the average A.C. resistance of modern H.F. valves is lower than that of their predecessors. Consequently, it may be necessary to take a few turns off the H.F. transformer primary windings to retain the requisite degree of selectivity.

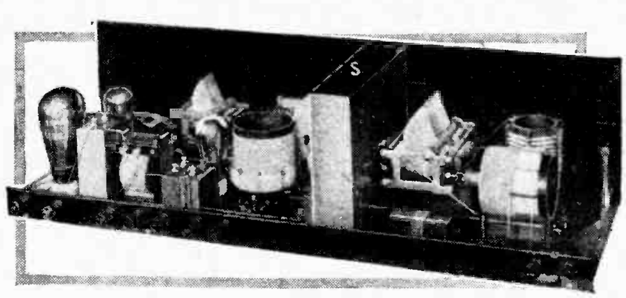



Fig. 2.—In receivers of the "Everyman Four" type the increased H.F. amplification with modern valves calls for an extension of the metal screening partition.

The old-fashioned tuned-anode H.F. coupling with three-electrode valves may prove a stumbling block. If tapping down the anode coil, as in Fig. 3, fails to produce stability it may be advisable to change over to screen-grid valves and to introduce the necessary screening between the grid and anode-tuned circuits.

As in the case of valves of other types, the modern screen-grid valve shows a greatly increased figure of merit as an H.F. amplifier. This does not necessarily mean that the extra H.F. amplification will result in oscillation when these valves are inserted in receivers designed for earlier types of screen-grid valve. The increase in amplification has gone hand-in-hand with a reduction of the residual grid-anode capacity, so that feed-back has been correspondingly reduced.

### Minimising Feed-back.

Where the reduction in capacity has not kept pace with the improvement in performance, however, self-oscillation is possible. Without making any alterations in the constants of the tuned circuits, it is often possible to stabilise the circuit by using an input volume-control potentiometer of, say, 0.5 megohms. This should be connected as in Fig. 4 (*a*). Its action in reducing feed-back is made clear by the schematic circuit in Fig. 4 (*b*). The top half ($r_1$) of the potentiometer resistance is virtually in series with the grid-anode capacity $C_1$, and the tuned-grid circuit and the potentiometer can be adjusted until a considerable proportion of the feed-back voltage is dropped in $r_1$. This method was successfully employed in *The Wireless World* "Megavox" receiver. It should be clearly understood that it deals only with feed-back through the valve. Stray couplings between the grid and anode coils must be treated separately by adequate screening.

Apart from slight alterations in grid bias, the new valves call for very little alteration in the L.F. stages of an obsolete receiver. Improved reproduction of the lower frequencies generally results from the reduced A.C. resistance, while the overall amplification will be

**New Wine in Old Bottles.—** very noticeably increased. In some instances this may result in "motor-boating," which is easily cured by

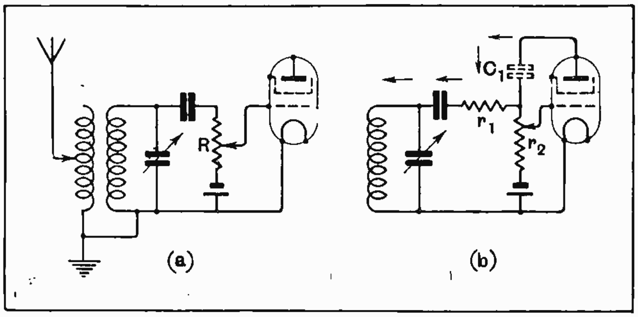



Fig. 4.—Instability due to feed-back through a screen-grid valve can be cured by connecting an input volume control potentiometer R in the grid circuit.

suitable decoupling. The majority of old sets were provided with separate +H.T. tappings for each valve, and the addition of decoupling resistances and by-pass condensers is a simple matter, as will be evident from the circuit of a typical four-valve receiver shown in Fig. 3. There is then only a single +H.T. connection to be made (H.T.4+). The values of the decoupling resistances are easily worked out by dividing the voltage to be dropped by the H.T. current taken by each valve. It may happen that the resistance values so obtained are less than those usually advocated, but in most cases the decoupling, however small, will be sufficient to reduce the feed-back to the point where "motor-boating" ceases.

### A Final Hint.

In conclusion, having experienced the improvement brought about by modern valves, it may be worth while to consider the possibility of pensioning off the receiver itself and building, in the near future, a more modern set which will ensure that the best qualities of the new valves are appreciated to the full!

# CURRENT TOPICS

## Events of the Week in Brief Review.

### NEW PARISIAN GIANT.

During the last month powerful and well-modulated telephony transmissions have been heard late at night in France. These emanate from the new 85 kW. transmitter at Essarts-le-Roi, which is now undergoing tests, and will shortly replace the existing transmitter of "Radio Paris."

We understand that regular programmes may be expected during the next week or two. The official inauguration will probably coincide with the opening of the Paris Radio Show on September 3rd.

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### CZECHO-SLOVAKIA'S 120-KILOWATT STATION.

The new station at Cesky Brod, Czecho-Slovakia, is now testing on 487 metres with a power of 120 kilowatts.

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### TELLING THE WORLD.

Russia's new 200 kW. broadcasting station now under construction at Noginsk, near Moscow, will give programmes in Russian, French, English, Spanish, German and Italian.

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### MUSIC FROM MONACO.

Monaco, the smallest European "State," is to erect a powerful broadcasting station.

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### STATIC STOPPERS ON CARS.

Resistance units which are said to offer "a practical, simple and inexpensive solution" of the radio interference problem are now offered by the International Resistance Company of Philadelphia, Pa. The units are made for attachment between the spark plug leads and the distributor, and it is claimed that they eliminate all ignition noise in the car radio set.

### MEMORIES OF THE SUN.

On Saturday last the Brussels broadcasting station dedicated its evening programme to the sun. It is believed that some of the more elderly listeners had actually seen this celestial object.

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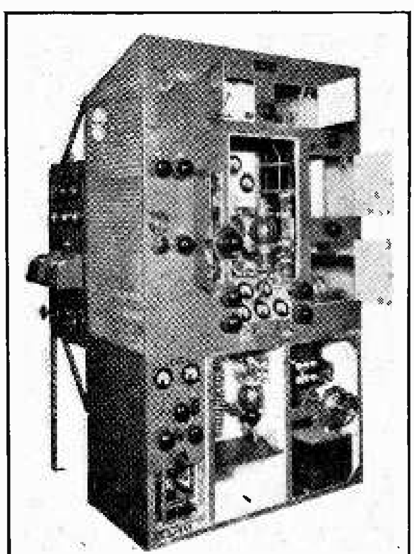
### FAKING A BROADCAST.

A "speech" by the "Reverend So-and-So," seated on a camp stool somewhere in Central Africa, recently produced a deep impression on a gathering of students and Bible teachers at a North London Wesleyan Church. The "broadcast" was staged by members of the Tottenham Wireless Society.

"At a certain point in the proceedings," writes Mr. W. B. Bodemeaid, hon. secretary of the society, "juvenile members of the guild, dressed in native costumes representing Africa, Burma, Jamaica, etc., made speeches and informed the audience that they would hear a talk broadcast by the reverend gentleman himself."

The "speech" was actually given by a senior member of the guild in a small room adjoining the hall. The apparatus used consisted of a moving coil Magnavox speaker, kindly lent by the Rothermel Corporation, coupled to a push-pull amplifier.



A SUBMARINE TRANSMITTER. The new Marconi T.N.10 telegraph and telephone set specially constructed for long- and short-wave transmission on submarines and other vessels in which space is strictly limited. The maximum power on the long-waveband is 1 kW.

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### ANTI-STATIC CLUB.

When the last blurb of static wings its way into the local ether the new radio club at La Baule, France, will close its doors. The sole function of the new body is to suppress "industrial parasites."

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### DUTCH RADIO STORM.

What is described as a formidable demonstration for the maintenance of adequate broadcasting facilities was witnessed in the Spanderswoud Forest, near Hilversum, on July 12th. A correspondent reports that members of the Socialist radio group to the number of 130,000 came to the appointed rendezvous in thirty-eight trains, or cycled from Amsterdam, a distance of over 20 miles.

Angry speeches and other demonstrations of popular opinion all indicated that the Dutch Government has to cope with a highly "radio-conscious" body of citizens who are determined that their rights as listeners shall not be encroached upon.

There are actually some 270,000 registered listeners in Holland, representing 6 per cent. of the population, but well-informed observers state that nearly half the population listen to the programmes.

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### HURRY UP, TELEVISION!

Mademoiselle Juliette Vuillet, described as "a delicious blonde of 22 springs," is one of the leading "speakers" at Radio Lyons. She has just been appointed "Queen of the City."

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### "MORAL DANGERS OF RADIO."

A French accountant has been sentenced for embezzling £800 of his employer's money for the purpose of wireless experiments. *L'Auxiliaire Financier* has risen to the occasion by publishing a leading article on "The Moral Dangers of Radio," in which it is urged that prospective cashiers should be examined not only in regard to their attitude to beauty, betting and strong drink, but from the standpoint of their devotion to wireless.

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### DID YOU HEAR IT?

A correspondent writes: "Colonial listeners heard a priceless test transmission from Chelmsford (5SW) on Monday, July 27th. For an hour or more the engineers were apparently trying to make the transmitter stand on its head by gross over-modulation.

"There were wild shouts and deafening hand claps, 'hello's' in many keys, and finally a gramophone record which might possibly have been recognised as 'Melody in F,' punctuated by polite regrets for the distortion. Finally, an announcement was made explaining that G5SW was 'testing and, we fear, blasting!'"

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### A COURTEOUS REQUEST.

The Geneva police evidently believe that the broadcast listener should be treated like a gentleman. For courtesy and sweet understanding of human frailty it would be difficult to find a match for the following official notice addressed to local wireless users:—

"Sans-filistes! You who love music, from whatever country it comes, enjoy it plenteously, with intoxication (ivresse), but do not oblige your neighbours to hear, when they wish to rest, the concerts which charm you. Do not expose the loud speakers on balconies or in gardens. After 10 p.m. have the courtesy to close your windows, and then indulge luxuriously in all sorts of music, gay or sad, classic, popular, or of the dance variety; but do not impose it on neighbours who do not desire it!"

If such a notice is disregarded the police may be excused if they resort to machine-guns.

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### TUNE-IN EUROPE—AND LEARN AMERICAN.

Signs are not wanting that American radio interests will make fresh bids during the coming winter to establish world-wide broadcasting services on the short waves. We learn that foreign listeners themselves are partly responsible for this new wave of enthusiasm, having been so lavish in their reports of various experimental short-wave transmissions. Several months ago the Federal Radio Commission denied the request of the Westinghouse Electric Company, which operates KDKA, for authority to broadcast commercially on a short wavelength with the comparatively low power of 25 kilowatts. When the Commission again meets in the autumn the Westinghouse claim will have to be reheard, together with several others.

The Short Wave Broadcasting Corporation of Boston is the latest to enter the international broadcasting field. A correspondent informs us that this company proposes to build a 15 kilowatt short-wave station for re-broadcasting from more than 100 American stations to Europe, South America, and even the Orient.

News of this kind has a special interest when we remember that Europe already possesses a number of stations which are eager to sell their "time on the air" to the highest bidder. It would not be in the least surprising if the European ether, already so sadly congested, were soon to resound with the American accent.

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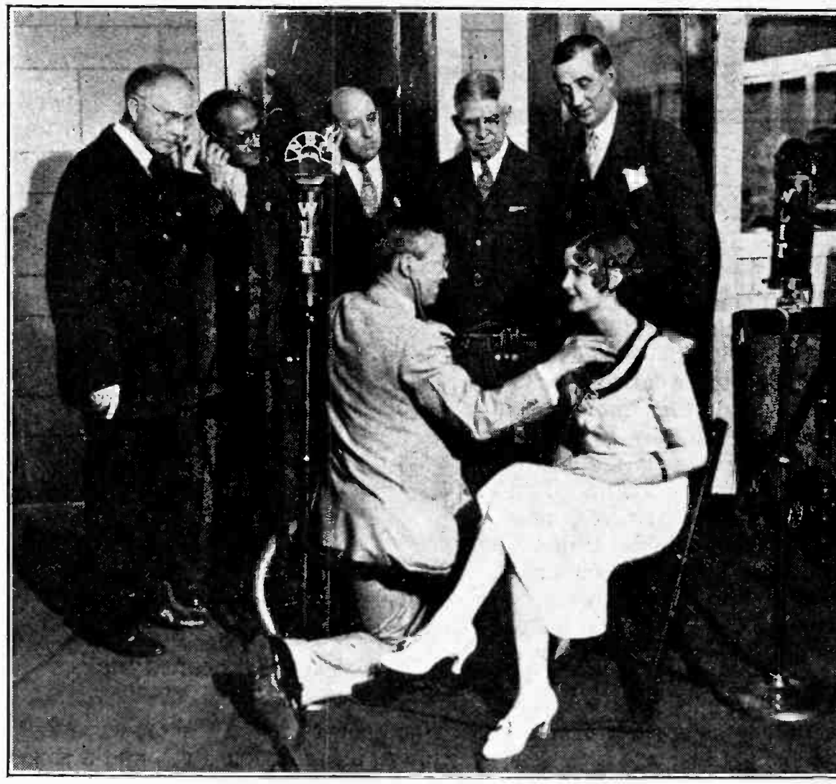

**HEART THROBS BROADCAST.** The American National Broadcasting Company recently visited the University of Pennsylvania to broadcast the sound of heart beats as heard on the new electrical stethoscope. Miss Elizabeth Gallen, whose heart was listened to all over America, is here seen with a group of doctors at the microphone.

### A MEDAL FOR AN IDEA.

The growing use of trolley 'buses, which cause considerable interference with radio reception, has prompted the Radio Association to offer a gold medal for the most practical and constructive paper dealing with methods of obviating the nuisance. In judging the papers submitted, major attention will be paid to their technical content, but competitors are invited to deal also with the administrative side of the question, particularly with a view to determining the division of responsibility between the Post Office and the B.B.C. research staff in the tracing and elimination of interference. Papers should be sent to the head office of the Association at 22 and 23, Laurence Pountney Lane, E.C.4.

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### TRADE NOTE.

A wiring diagram for an A.C. eliminator, printed on "Konductite" metallised paper, which acts as a screen when pasted to a wooden baseboard, has been prepared by Gramo-Radio Amplifiers, Ltd., of 1a, New London Street, London, E.C.3.

The eliminator, which employs a valve rectifier and "G.R.A." components, provides an ample output for almost any purpose; it is intended that feed resistances shall be included, where necessary, in the receiver itself.

We are asked to state that copies of this diagram will gladly be sent to readers who send a 2d. stamp.

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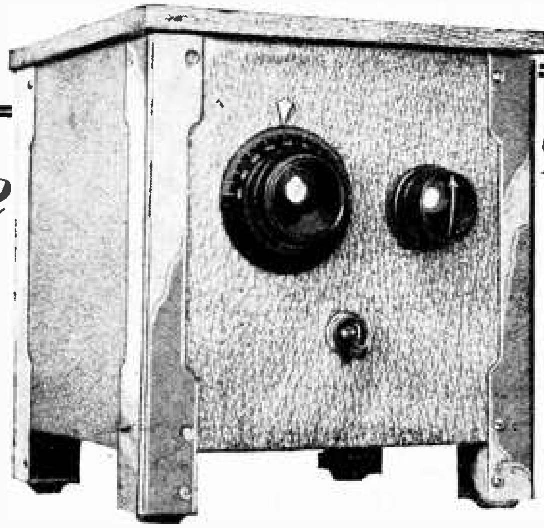
### INTOLERABLE.

A proposal made in the Californian legislature to tax radio sets 2s. a year to defray the expenses of a board of State inspectors of radio provoked the following comment in the *Ventura Free Press*: "The Wagy bill has all the earmarks of a czaristic measure and is not to be tolerated here in America, where every man's house is presumed to be his castle. Such a scheme would work well in Italy under Mussolini, but America is not yet ready to submit to such tactics."

# EELEX Short-Wave Adaptor TYPE "A"



A Simple Unit for Converting a Broadcast Set to a Short-wave Superheterodyne.

NOT many listeners take an interest in short-wave reception. Results are considered to be far too inconsistent, and the number of broadcasts too few to justify the use of a separate short-wave receiving outfit. This point of view, however, now requires revising, because the number of broadcasts on short wavelengths has considerably increased of late, and in many cases the power now used is greater than formerly. In addition, results from a superheterodyne completely modifies one's judgment on the behaviour of short-wave sets, reception being much more reliable than with the simple oscillating detector.

A broadcast receiver is capable of easy conversion to a short-wave superheterodyne, and experience has shown that a simple reacting detector tuned to the short wavelengths produces beat frequencies which can be amplified by the broadcast set when switched over to the long waves, the H.F. stages of the broadcast set corresponding to the intermediate amplifier of a superheterodyne. Such an arrangement is made use of in the "Eelex" Short-Wave Adaptor, a product of J. J. Eastick & Sons, 118, Bunhill Row, London, E.C.1. The attachment for use in front of the broadcast receiver comprises a short-wave tuner with reaction connected to a triode detector. The circuit arrangement is quite orthodox, and makes use of separating H.F. chokes in its anode circuit. It will be noticed from the circuit that a short-wave H.F. choke assists in maintaining regeneration, but this is of low reactance to the resultant long-wave beat frequency that is fed on to the broadcast receiver, a normal H.F. choke being used as a means of feeding the H.T. supply into the circuit. Circuits of this type are usually associated with a short-wave H.F. stage, not for the purpose of producing amplification, but in order to give constant regeneration and to remove the "dead spots" on the tuning dial brought about by the constants of the aerial. By carefully arranging the turns of the tuning and its associated reaction coil almost uniform regeneration results with the "Eelex" unit.

The makers recommend that the broadcast receiver shall be left tuned to a wavelength of about 1,100 metres, pointing out that this wavelength is free from interference. It was found, however, that results were improved when the broadcast receiver was tuned to the top end of its wavelength scale, and in spite of the fact that amplification at this setting was probably not so great. This circumstance was probably brought about by some other properties of one or other of the components, but the cause was not obvious. Very little amplification is required between the short-wave unit and the detector valve of the broadcast set, and a single H.F. stage will suffice.

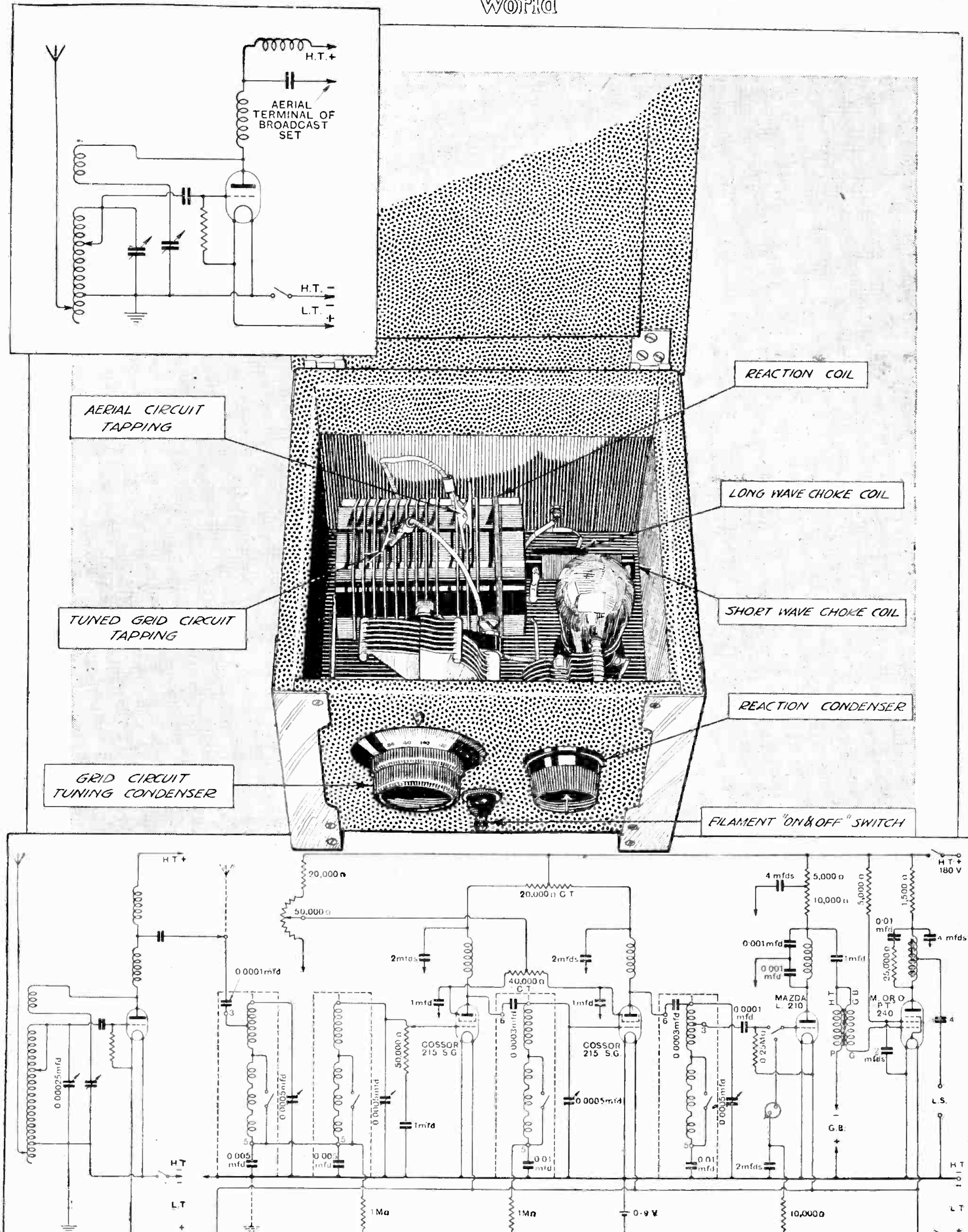
Tested in front of the "*Wireless World* Four," the band pass filter used in the set is no doubt responsible for the almost complete elimination of interference. The aerial input volume control was turned down to just off zero and good reception resulted when one of the H.F. valves was taken out of circuit by transferring the anode lead of the second valve across to the first. Any standard three- or four-valve set embodying an H.F. stage can be used with the unit.

### Good Reception of American Stations.

In less than a minute the unit is brought into action by transferring across the aerial lead in the broadcast set. It provides the best method for listening to American programmes, 2XAD and 2XAF, the Schenectady stations, coming in, as is customary with apparatus of this class, with the strength on occasions of a local station. By adjusting the tapping point on the tuning coil, a wavelength range of 16/60 metres is covered.

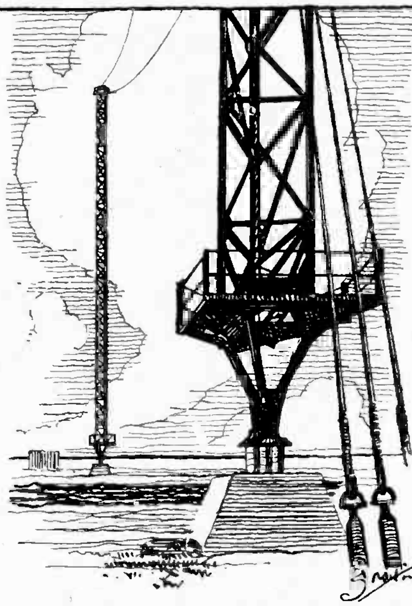
As the link between the unit and the broadcast receiver is through a condenser, complete separation between the battery circuits results, and no complication will be encountered when the battery supply for the unit is picked up from a common source. Owing to fact that the unit makes use of leaky grid detection and, therefore, requires no biasing potential, it becomes quite a simple matter to adapt it for use with an indirectly heated valve. A simple form of construction is adopted for the unit, and the components are in every way reliable.

*Single-valve autodyne with triode detector.*
*Leaky grid detection.*
*Choke-fed anode circuit to connect with tuned grid circuit of broadcast receiver.*
*Wave range 16/60 metres.*
*Tapped aerial and tuned grid coils.* *Price £3.*




The Eelex short wave adaptor, for converting a broadcast receiver to a short wave superheterodyne.

# BROADCAST BREVITIES



By Our Special Correspondent.

### Short Waves from Daventry?

Daventry has already won European fame; now there are indications that the name of this somewhat obscure English borough may be trumpeted to the ends of the earth. I understand that Mr. Whitley, chairman of the B.B.C., is showing great interest in an Imperial broadcasting venture which would make Daventry the starting-off point, as it were, of a mobile short-wave transmitter.

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### Locality Tests.

The plans, which are wrapt in a thick wadding of mystery, have yet to be discussed at the Colonial Office; it can be said, however, that opinion is hardening in favour of locality transmission experiments as opposed to the more familiar method (often so troublesome to other people's transmitters) of juggling with the wavelength. It is believed to be quite possible that, while a transmission from Chelmsford may not reach India satisfactorily, signals on exactly the same wavelength may get there if transmitted from, say, Derbyshire or the Lake District.

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### World-wide "Field Days."

A mobile transmitter of the kind suggested would first be tried out at Daventry, and would then start on a systematic tour of the country, trusty observers sending in their reports from different parts of the Empire in accordance with a prearranged time-table. Such a campaign would, I imagine, provide intensely interesting results; it would be like a Saturday afternoon field day on a grand scale with the whole world as the "field."

oooo

### Not Forgetting 5XX.

These rather romantic plans are not blinding the B.B.C. engineers to the necessity of improving 5XX, which is now earning the rather dubious title of "The Grand Old Man of the Ether." Mr. Ashbridge realises only too well that, unlike France and Germany, we have only one long wave, and that in the European battle for power we must make the most of the available artillery. With *Toulouse* and *Radio Paris* about to increase their power out of all proportion to their previous normal output, it behoves Great Britain to show quickly whether other countries are to be allowed to rule the ether waves without a challenge.

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### 100 Kilowatts?

Until the European nations reach the sensible conclusion that power, as well as wavelengths, must be controlled, each country must perforce fight for its place in the sun—an undertaking in which Britain has never yet been altogether a failure.

I learn that the new 5XX will have a power of at least 100 kilowatts.

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### That "Missing Link."

That most barbaric relic of the dark ages of radio—the "wireless link"—disappeared within the last fortnight so far as listeners in the Northern Region are concerned. The establishment of a new cable network ensuring the B.B.C. three exclusive landlines throughout the twenty-four hours is more important to provincial listeners than half a dozen "Broadcasting Houses."

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### Repeater Stations.

After nearly ten years of broadcasting the B.B.C. at last possess what are virtually private lines—two for transmission from London to the North, and one for use in the opposite direction. Valve repeater stations of the latest approved pattern have been installed at Fenny Stratford, Leicester, Derby, and Leeds.

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### A Post Office Promise.

At present these repeaters are admittedly not all they might be for dealing with the full gamut of musical frequencies, but I understand that within the next two or three months the Post Office engineers will endeavour so to adapt the amplifying gear that it will satisfy the most exacting of musical critics. This seems almost too good to be true, but the proof of the pudding will be in the eating. The transmission of the Hallé concerts from Manchester has never impressed me, a Londoner, from the technical point of view; that Northern listeners and those beyond the Tweed never get anything better when taking a programme from London is one of those bitter facts that Southerners are perhaps too ready to forget.

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### A Postponed Talk.

It was disappointing to be told almost at the eleventh hour that Marchese Marconi would be unable to give his promised talk on the pioneer days in radio. I am glad to know, however, that the pleasure is merely postponed, probably until the autumn. Perhaps the inventor of wireless will be persuaded to talk to us on the eve of the Olympia Radio Show, which could hardly have a better "send-off."

Incidentally, it is good to hear that there is no foundation for the reports that the Marchese is seriously unwell.

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### A Belgian Tribute to the B.B.C.

The success of the B.B.C. National Orchestra seems to have fired the ambition of the Belgian broadcasting authorities. A friend on the Continent tells me that a special orchestra of fifty-five picked musicians is being formed to give distinction to next winter's concerts from Brussels and other Belgian stations.

They will also play at the Ostend Kursaal, but, unfortunately, there is, at the moment, "a lack of harmony" between the Ostend Municipality and the local Musicians' Federation, and until the discords are resolved, the microphone is barred from the Kursaal. In the meantime the B.B.C. are arranging to "tap" the Casino at Knocke during a concert on August 30th.

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### A Burlesqued Play.

Through no fault of Edward Hope-Jones, the schoolboy author, his play, "The Smugglers," was given an unnecessary note of burlesque. The aerial pursuit provided a good yarn, which would have gone down well in the "Children's Hour," but the B.B.C. thought fit to put on the play in the main evening programme, and were neither to its virtues very kind nor to its faults a little blind.

### FUTURE FEATURES.

**National (261 and 1,551 metres).**

AUGUST 10TH.—De Bear Revue.

AUGUST 11TH.—Promenade concert from the Queen's Hall.

AUGUST 13TH.—"Fireside," an impossibly possible conversation imagined without prejudice by L. du Garde Peach and released by Peter Creswell.

AUGUST 14TH.—A running commentary on the dirt-track racing, relayed from Wembley.

**London Regional.**

AUGUST 11TH.—De Bear Revue.

AUGUST 15TH.—"Fireside."

**North Regional.**

AUGUST 12TH.—"Major Butterfield's Adventure," a comedy in one act by H. Hering.

**West Regional (Cardiff).**

AUGUST 12TH.—Band concert at the Ciné-Radio Carnival in aid of the Queen Alexandra Memorial Hospital, relayed from Weston-super-Mare.

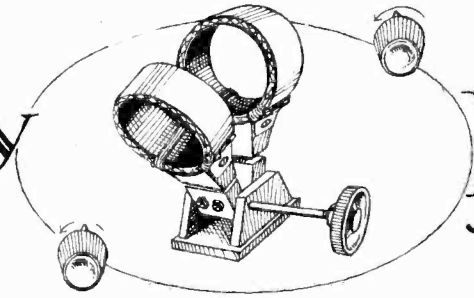
**Glasgow.**

AUGUST 14TH.—The Ballymulcaghey Broadcasting Station feature programme.

**Belfast.**

AUGUST 10TH.—"Let the Credit Go," a mystery play by Major Bryan Cooper.

# SIMPLE THEORY of REACTION



## The Effect of Transferring H.F. Energy from Anode to Grid.

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

*WHETHER the immediate object be the deliberate introduction of reaction or the prevention of self-oscillation, it is essential to have a knowledge of the main principles on which the transfer of energy from the output to the input of a valve depends. The phase relationships of currents and voltages in an ordinary reaction circuit are here explained in simple terms and a number of numerical examples are given showing the change in apparent resistance of a tuned circuit. In a subsequent article the case of the oscillating valve will be taken whereby, tightening the coupling between anode and grid inductances, reaction is purposely applied beyond the critical value.*

A FEW years ago, before high-frequency amplification was so extensively used in valve receiving sets, and when the detector valve was directly connected to the aerial tuning circuit, it was a matter of great importance to reduce to a minimum the damping effects of resistance in and associated with the tuned circuit, because, for weak signal voltages applied to the detector, the sensitivity of the latter is roughly proportional to the square of the signal strength. It was then the usual practice, when designing a receiver, to make special provision for feeding back to the grid circuit a certain fraction of the oscillating energy in the anode circuit of the valve, the object being in this way to compensate for the inevitable losses occurring in the grid circuit and so to enhance both the sensitivity and selectivity of the receiver.

But in modern receivers embodying one or more stages of high-frequency amplification before the detector, the problem is completely reversed. We no longer have to seek for means to enable energy to be fed back from the output circuits to the input circuits, but we have to take very special precautions to prevent this from happening. Owing to the high degree of amplification obtained, a very small fraction of the high-frequency energy of the anode circuit fed back to the input side will be sufficient to produce complete instability and uncontrollable self-oscillation. Unless special precautions are taken there are quite a number of channels, in the form of stray couplings between the output and input circuits, through which energy can be transferred from the former to the latter. The comprehensive decoupling required in a modern receiver bears evidence of the number of these channels.

The term "reaction" is applied more particularly where special provision is made for purposely transferring some of the high-frequency energy in the anode circuit of a valve to the grid circuit. On the other hand, the term "feed-back" is, strictly speaking, a misnomer, because the energy is not really fed *back*; the oscillating energy in the anode circuit of a valve comes from the source of high-tension current and no portion of it was ever in the preceding grid circuit.

### Phase Relationships of Currents and Voltages.

Oscillating energy can only be transferred from one circuit to another if they are electrically coupled, and there are three possible kinds of coupling, namely, (*a*) inductive, (*b*) capacitative, and (*c*) conductive. These may exist separately or, on the other hand, two of them or all three may be present simultaneously between the two circuits under consideration. In the first place, that type of reaction will be considered in which the anode circuit of a valve is coupled to the tuned grid circuit through the medium of mutual induction.

For the purpose of explanation let us consider initially a triode arranged as in Fig. 1 (a) with the grid and cathode connected across a tuned circuit $L_1C_1$. Suppose that a high-frequency voltage $E_o$ is generated in the tuning coil $L_1$ by a high-frequency current in an adjacent coil $L_o$, connected, in this case, in the aerial circuit. Then, when the closed circuit is tuned to resonance, the current set up in it will be $L_1 = E_o/R_1$ amps., providing there is no other voltage injected into

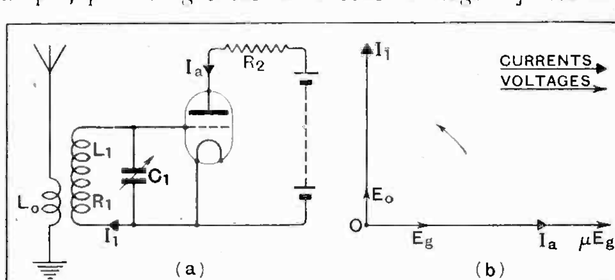



**Fig. 1.—(a) Simple valve circuit where a resistance load is connected in the anode circuit. (b) Vectors showing the phase relationships of the various currents and voltages. The currents in the grid circuit and the anode circuit are a quarter of a cycle out of phase.**

the coil $L_1$ or applied to it in any other way. To simplify matters it will be assumed that no capacity exists between the grid and anode of the valve so that any voltage set up across the external anode circuit will not influence the grid circuit. And further, for the present, the anode load will itself be considered

**Simple Theory of Reaction.—**

as a pure resistance of $R_2$ ohms, which will therefore have no magnetic influence on the grid circuit.

The current $I_1$ is exactly in step with the voltage $E_o$ producing it, so that these two quantities can be represented by two vectors[1] $OE_o$ and $OI_1$ in line with each other, as shown in Fig. 1 (b), because at the resonant frequency the inductive and condensive reactances cancel each other out round the closed circuit. But the voltage $E_g$ developed across the tuned circuit, and therefore applied between the grid and filament of the valve, is equal to the product of the current $I_1$ and the reactance of the coil, namely, $E_g = \omega L_1 I_1$ volts, where $\omega = 2\pi \times$ frequency, and this voltage lags behind the current $I_1$ by a quarter of a cycle (the induced back E.M.F. of a coil always lags by 90° behind the current producing it). Its vector position in Fig. 1 (b) is therefore horizontally to the right, as shown by $OE_g$.

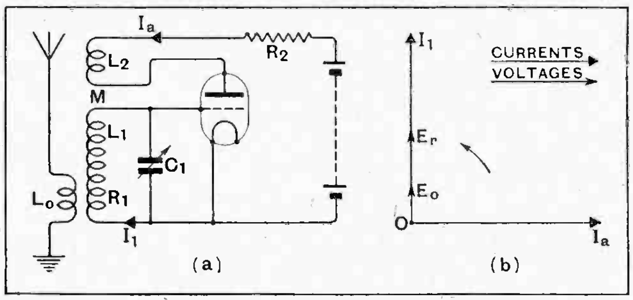



**Fig. 2.—(a) Simple reaction circuit formed by connecting a coil $L_2$ in the anode lead of Fig. 1 and coupling to the grid circuit. (b) Vector diagram showing that the E.M.F.s due to coils $L_0$ and $L_2$ are in phase with each other. The current in the tuned circuit is $I_2 = (E_0 + E_r)/R_1$.**

This is the voltage applied to the grid of the valve, and if $\mu$ is the amplification factor of the latter, an alternating voltage $\mu E_g$ will in effect be set up in the anode circuit due to the action of the valve, this voltage being exactly in step with $E_g$. Hence the vector or line representing $E_g$ will also be drawn horizontally to the right.

Now when the anode load consists of a pure resistance of $R_2$ ohms, as shown in Fig. 1 (a), the alternating component of current produced in it will be $I_a = \mu E_g / (R_a + R_2)$ amperes, where $R_a$ is the A.C. resistance of the valve, and *this current will be in phase with* $\mu E_g$. The corresponding current vector will accordingly be parallel to that representing $\mu E_g$, and therefore at right angles to the vector $OI_1$ giving the current in the tuned circuit.

From the foregoing we have elicited the important information that when the anode circuit of a valve contains no reactance (as in the case of resistance coupling) *the alternating component of the anode current lags by a quarter of a cycle behind the current in the tuned grid circuit.*

### Simple Reaction Circuit.

With the circuit arrangement of Fig. 1 (a) where there is no interelectrode capacity in the valve, no energy could possibly be transferred from the anode circuit to the grid circuit, and no reaction occurs. The H.F. voltage applied to the grid of the valve merely causes a high-frequency current to be set up in the anode circuit, and no portion of the power represented by this current is transferred to the grid circuit.

Now suppose an inductive coil $L_2$ to be connected in series with the anode resistance $R_2$ of Fig. 1 (a), as shown in Fig. 2 (a), and that this coil is inductively coupled to the main tuning coil $L_1$. It will be assumed that $L_2$ has a few turns only, so that its reactance at the working frequency is small compared with the total resistance $R_a + R_2$ of the anode circuit. Then the conditions which apply to the previous circuit as regards the relationships between current and voltage in the anode circuit are not appreciably upset; that is to say, the current $I_a$ in the coil $L_2$ is practically a quarter of a cycle out of phase with respect to the current $I_1$ in the tuned circuit. This phase relationship is shown by the angle between $OI_1$ and $OI_a$ in Fig. 2 (b).

When the coil $L_2$ is so placed that lines of magnetic force produced by the current $I_a$ in it are linked with the turns of $L_1$ an E.M.F., additional to that already referred to, is induced in the latter. If M is the mutual inductance in henrys between $L_1$ and $L_2$, the E.M.F. induced in $L_1$ by the current in $L_2$ is given by $E_r = \omega M I_a$ volts, in exactly the same way as for a high-frequency transformer, where the same principles apply.

### Importance of Phase Relationship.

But in order to determine the precise effect of this new electromotive force injected into the grid circuit, the phase relationship of $E_r$ to the current $I_1$ in the tuning coil must be known. The induced E.M.F. is at all times proportional to the rate at which the current producing it is changing, and consequently, $E_r$ must be a quarter of a cycle out of step with respect to $I_a$. Now, since $I_a$ is itself 90° out of phase relative to $I_1$, it follows that the voltage $E_r$ produced by $I_a$ must be either in phase with $I_1$ or 180° out of phase (antiphase), according to which way round the coil is connected.

When the reaction coil $L_2$ is so connected that the voltage produced by it in the tuned circuit is just in phase with the oscillating current $I_1$, it is clear from Fig. 2 (b) that $E_r$ is in phase with $E_o$, the original voltage responsible for all of the alternating quantities in both parts of the circuit. This means that the voltage $E_r$, coming from the reaction coil, directly assists in maintaining the oscillating current $I_1$ in the tuned circuit, and that, therefore, the current in this circuit will be greater when the reaction coil is coupled to $L_1$ than when it is not. To express it another way, a smaller energising voltage $E_o$ will be required to produce a given current in the tuned circuit when the reaction coil is used than without it.

### Numerical Calculation.

An example worked out numerically should prove helpful in endorsing this conclusion in a practical way, Suppose the main tuning coil $L_1$ in the grid circuit to have an effective H.F. resistance of 20 ohms and that its reactance at 1,000 kilocycles per second is 1257 ohms,

[1] See "The Vector Explained," *The Wireless World*, May 20th, 1931.

**Simple Theory of Reaction.—**

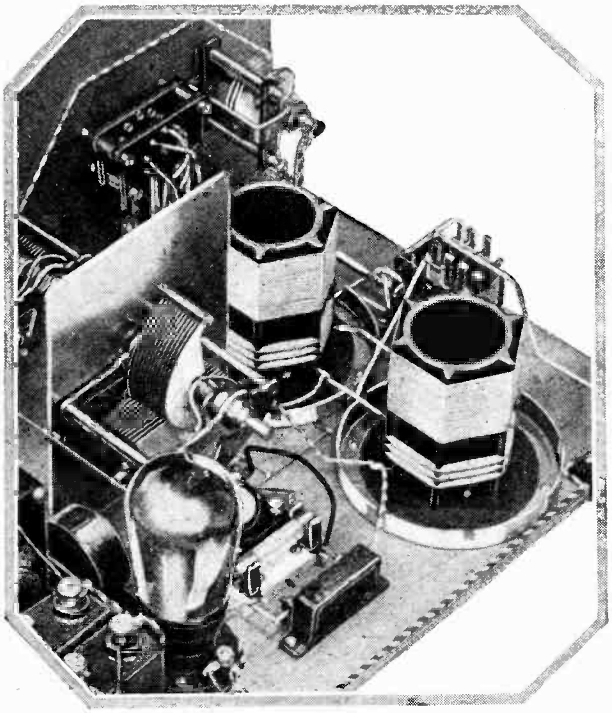
being the reactance of a 200 $\mu$H coil at this frequency. Without any reaction a signal E.M.F. of 2 millivolts induced into the tuned circuit by the aerial current would produce a current of $\frac{2}{20} = 0.1$ milliamp. at the resonant frequency. The voltage set up across the tuned circuit would then be $E_g = 1257 \times 0.0001 = 0.1257$ volt.

Now, supposing the amplification factor of the valve to be $\mu = 30$, and the total resistance in the anode circuit to be R = 40,000 ohms (including the A.C. resistance of the valve), the alternating component of current in the anode circuit will be

$$I_a = \frac{E_g}{R} = \frac{30 \times 0.1257}{40{,}000}$$

= 0.0942 milliamp. These figures apply when there is no reaction.

When the reaction coil is included and arranged to have a mutual inductance of M = 2 microhenrys with respect to the tuning coil $L_1$, the E.M.F. induced into the tuned circuit in consequence is $E_r = 2\pi f M . I_a = 6.283 \times 10^6 \times 2 \times 10^{-6} \times 0.0924 = 1.18$ millivolts. This is the voltage introduced into the tuned circuit through the medium of the reaction coil; it is in phase with the original electromotive force $E_o$ coming from the outside source, and so assists the latter in driving the current round the circuit.



*The Wireless World* "Flexible-Two" receiver in which a highly specialised control of reaction was used. The method is known as "throttle-control" whereby the H.F. energy in the anode of the detector is fed through two condensers to maintain a balanced feed.

### How Reaction Affects Circuit Resistance.

The current in the tuned circuit was assumed to be 0.1 milliamp., and it was shown that an E.M.F. of 2 millivolts was required to maintain this current. But the reaction is now providing 1.18 millivolts towards the total required, so that, with the reaction coil in operation, the controlling E.M.F. from the external source needs to be only 2 − 1.18 = 0.82 millivolts to give the same current. Or if the original voltage $E_o$ were to be maintained at 2 millivolts the current in the tuned circuit would rise from 0.1 milliamp. to $0.1 \times \frac{2}{0.82} = 0.244$ milliamp. as a result of the introduction of the reaction coil, the voltage applied to the grid of the valve being thereby increased 2.44 times.

Under all conditions the grid circuit is assumed to be tuned to resonance, and therefore the current in it is obtained by dividing the total E.M.F. injected into it by the H.F. resistance. Now we have seen that, for a given applied voltage $E_o$ derived from the aerial coupling coil, the resulting current is greater when reaction is applied than without it, and it would therefore appear that the effective resistance of the tuned circuit is actually reduced by the use of reaction. The true resistance was given as 20 ohms, but when reaction is introduced to the extent considered the ratio of applied voltage to current, that is, the apparent resistance, is only $\frac{2}{0.244} = 8.2$ ohms, less than half of the actual value. Of course, what is really happening is that the power expended in the tuned circuit is not all being drawn from the original source, but partly from the anode circuit of the valve, and it is this effect which is being expressed as an apparent reduction of resistance.

It is convenient to consider the application of reaction as the introduction into the tuned circuit of a "negative resistance" which partly nullifies the actual resistance. The value of this equivalent negative resistance is equal to the ratio of the voltage induced by the reaction coil into the tuning coil, to the current in the latter. Its numerical value in this case is therefore $\frac{1.18}{0.1} = 11.8$ ohms, or in terms of the symbols already used, it can be expressed as $R'_1 = \frac{E_r}{I_1}$ ohms.

Now, the voltage $E_r$ generated by the reaction coil in the tuning coil was seen to be proportional to the mutual inductance M between the coils $L_1$ and $L_2$. Consequently, if the reaction coil is coupled more tightly to the tuning coil by bringing it closer, the apparent resistance of the tuned circuit will be still further reduced. The apparent resistance is $R_1 - R'_1$ ohms, where $R_1$ is the actual high-frequency resistance and $R'_1$ is the negative resistance effect, so obviously there will be one critical value of the coupling between the reaction coil and the main tuning coil for which $R'_1$ will become equal to $R_1$, and under these conditions the effective resistance of the tuned circuit becomes equal to zero. When this happens there is nothing to limit the growth of current in the tuned circuit, a stage having been reached where the current is maintained entirely by the electromotive force arising from the reaction effect, the whole of the energy represented by this current coming from the anode circuit. And so, with this critical value of reaction, the oscillating current will, once it is started by the incoming impulses from the aerial circuit, continue to flow even after the energising

**Simple Theory of Reaction.—**

signal has been cut off. Theoretically, if the degree of reaction were adjusted to the critical value for which the effective resistance of the circuit is just reduced to zero, the current would persist with an amplitude equal to that existing at the instant the outside source is cut off, But this would not happen in practice because it corresponds to a state of unstable equilibrium—a poker will not stand on end even though it is in equilibrium when vertical.

Although there is theoretically a critical value of reaction it cannot be exactly attained in practice; the actual value will always be either less than or in excess of the critical value, and, therefore, the current oscillations will either die out when the outside source of energising E.M.F. is cut off, or will continue to increase even after that, respectively. In the latter case self-oscillation sets in and the amplitude of the current increases until a limit is imposed by the characteristics of the valve.

# Letters to the Editor.

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.**

## *TIME FROM THE MAINS.*

Sir,—We are pleased to note that Mr. H. S. Selves, in his letter published in your issue of July 8th, draws attention to the fact that the North Metropolitan Company were several years in advance of any other supply undertaking in this country in accurately controlling their system frequency. All credit is due to their Chief Engineer, Captain Donaldson, for having recognised so long ago the absolute necessity for frequency control on an extensive system—a necessity upon which all supply engineers are to-day agreed. As a result, the consumer receives the inestimable benefit of a "time-regulated" frequency.

Correct time from the mains is but one more of the benefits which the consumer receives, and the hand-wound or hand-regulated domestic clock will soon be as much of an anachronism as the domestic rain-water butt.

Incidentally, we may mention that Mr. Selves is wrong in thinking that synchronous clocks are expensive. The Warren (Synclock) retails at all prices from £3 7s. 6d. upwards.

London, N.W.9. K. EDGCUMBE,
Everett, Edgcumbe and Co., Ltd.

## *AVOIDABLE INTERFERENCE.*

Sir,—The letters *re* "Avoidable Interference" recently published in your journal I have read with great interest, especially that of J. W. Haughton in your issue of July 8th. Being in the same boat as himself as regards noise from D.C. generators, I appreciate his difficulty. The Post Office engineers took the matter up here and incidentally put the local lighting company to the expense of a large bank of smoothing condensers with no result whatever. Here it is a case of getting signal strength above noise, in which respect the new North Regional is a godsend. The lighting company are to be sympathised with, as they have done all they know to minimise the trouble, and faced with complaints from listeners and the Post Office, they are in a curious position. Like Mr. Haughton, I should like to see readers putting forward methods of dealing with this form of interference. R. McELNEA.

Newcastle, Co. Down.

## *THE AMATEUR SPIRIT.*

Sir,—I read your Editorial entitled "Rekindle the Amateur Spirit" with more than usual interest, and I feel that you have hardly been fair to, at any rate, the average British amateur.

You are much better informed than is the average member of the public on the score of the work done by amateurs, and, therefore, realise that while up to a few years ago records were regularly being broken, in that new countries were being worked almost daily, and on very short wavelengths, beyond this not a great deal was done, and since that year, 1926, a very great deal of extremely useful and interesting work has been carried out.

You must realise that once a country has been worked on, say, 14 m.c., no matter how much more reliable the subsequent working becomes, no mention of this is made, *as it is not a record*. The public, and evidently yourselves, obviously imagine that if no records are broken no progress is made; but it is plain that if this argument held all amateur stations might as well close down immediately all countries had been worked. Is "dx" necessarily the be-all and end-all of amateur radio work? Surely not. It is my firm opinion that much more useful experimenting has been done in the last five years than in the period of valve use which preceded it. I purposely say "valve use," as obviously the change-over to valves was a big step.

The average British station to-day is a model to the world, both as regards the type of signal and the method of operation. The average British station using up to 100 watts runs schedules weekly with every part of the world.

The amateur spirit, far from needing rekindling, is now in a much more satisfactory state than at any previous period, and, furthermore, the flame of the spirit is burning more brightly now as a result of co-operation, both in experiment and in schedule working. "RADIO-GRAMOPHONE."

Galashiels.

[Our correspondent confines his comments to amateur work in long-distance communication. In the Editorial notes referred to attention was drawn to the amateur's apparent neglect of other fields of enterprise and invention.—ED.]

## *"OF THE EARTH ——"*

Sir,—On page 66 of your issue of July 15th it is suggested that the word "Earthy" be used to denote the low-potential part of a radio circuit, because the usual word "Earthed" often loses its literal meaning as regards the D.C. potentials in such a circuit.

It is evidently assumed that at the moment it is correct to use "Earthed" for the "black-line" part of a circuit, whether this is connected directly to earth or not. Since we have to deal with all manner of different voltages in a radio set, it is difficult to see why the writer of the paragraph in question assumes that the "signal-frequency potentials" are the only ones to which this word can refer.

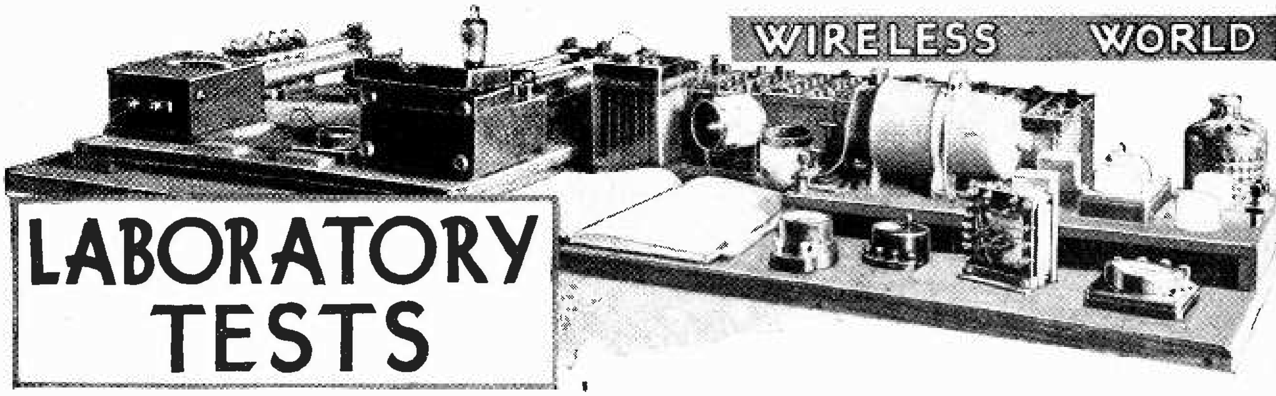
It is not usual to say of a D.C. mains-fed set that the filament negatives are earthed. It conveys a wrong impression. It is a bit long-winded to say "earthed through the usual condenser," but its meaning is not open to doubt.

We have quite enough to put up with in the sins of our fathers when they made a positive "negative" and a negative "positive." And there is also that muddle about "impedance" and "A.C. resistance," and some try to make it clearer by writing "A.C. plate resistance," which is concise, but nobody could call it short."

If we are to sustain our reason, surely "Earthed" must mean "Earthed," not only in the future, but now as well. If a word for the low-potential end of a signal-frequency circuit is required, "Earthy" is as good as any.

But, for the life of me, I cannot see what is wrong with "at low-potential." It means what it is, and cannot refer to D.C. if one is talking about A.C. It is certainly no longer than "A.C. plate resistance." H. A. R.

Shortlands, Kent.




# LABORATORY TESTS

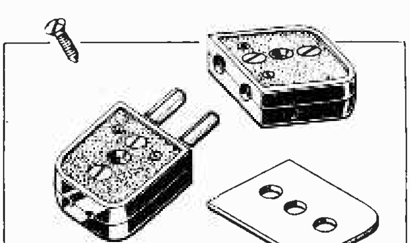
## A Review of Manufacturers' Recent Products.

### NON-REVERSIBLE CONNECTOR.

This connector is intended for use when it is required to extend certain external leads associated with the broadcast set and its accessories. It consists of a two-pin plug and a companion socket unit, and the pins being of different diameter precludes any reversal of the connection. When the two parts are joined, all metal contacts are completely insulated, an essential feature if it is employed in the H.T. circuits or mains leads.

As a safety measure, the "live" leads should be attached to the socket part, since otherwise the exposed pins on the other unit might accidentally come in contact with some metal-work and cause a short circuit.

These connectors are available in black, mahogany, walnut and oak finished bakelite, the price being 1s. 9d. in each case. Connectors finished in colours such as ivory, cream, etc., are in



**Quaker non-reversible double-pole extension connector.**

course of production and will be available shortly; the price, however, will be 2s. each in these cases.

The makers are Silas Quaker, Ltd., 110, Park Street, Camden Town, London, N.W.1.

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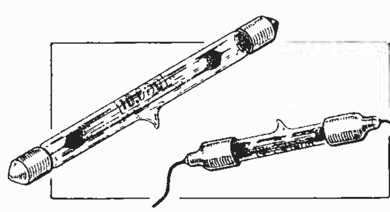
### LOEWE POWER RESISTANCES.

The Loewe Radio Co. have for long past made a speciality of the high vacuum type resistances, and recently some new models have been introduced. These take the form of two types the one rated to dissipate 0.5 watt and the other 1.0 watt. They have been developed especially for use in battery eliminators, all-mains receivers, etc., and can be obtained fitted with either the familiar end caps, or with wire end connectors, or with combined cap and wire ends.

They are made in various values ranging from 1,000 ohms to 1 megohm, the prices being 2s. each for the 0.5 watt type and 2s. 3d. for the 1-watt style. A test



**Loewe power resistances rated to dissipate 1 watt for use in eliminator and all-mains sets.**

was made on a 10,000-ohm. 1-watt resistance, which, when passing its rated maximum current of 10 mAs., could be handled without discomfort, since the heat generated is rapidly dissipated owing to its generous proportions. The size of this model is 3¼in. long by 5/16in. in diameter. The change in resistance, when passing the maximum permissible current, was found to be of the order of 1 per cent., as compared with its value when passing a few micro-amps. only.

Supplies are obtainable from the Loewe Radio Co., Ltd., 4, Fountayne Road, Tottenham, London, N.15.

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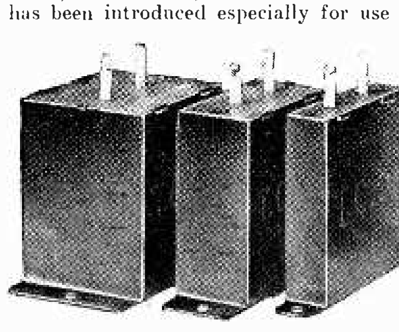
### NEW T.C.C. CONDENSERS.

A new range of T.C.C. condensers, styled the type 65 and consisting of three sizes., viz., 1 mfd., 2 mfds. and 4 mfds., has been introduced especially for use in



**New style T.C.C. condensers for use in mains receivers.**

mains sets. These are rated at 250 volts D.C. working potential, and they are housed in metal cases and fitted with soldering lugs. The prices are 2s. 3d. for the 1 mfd. size, 3s. for the 2 mfd. size and 5s. for a 4 mfd.; and the makers are Telegraph Condenser Co., Ltd., Wales Farm Road, North Acton, London, W.3.

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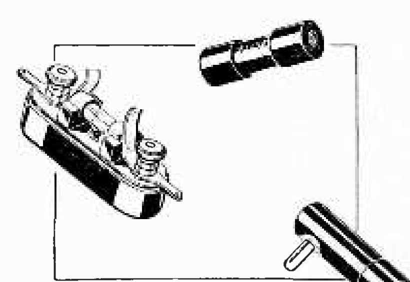
### BELLING-LEE FUSES.

In all electric supply circuits fuses, or a current-limiting device, are included to safeguard the various electrical appliances, and it is now becoming general to fit a device of this nature to wireless receivers. In the case of all-mains-operated sets, it is virtually essential and for battery-operated sets highly desirable.

Those made by Belling and Lee, Ltd., Queensbury Works, Ponders End, Middlesex, are available in three different styles; a baseboard type, an insulated



**Range of Belling-Lee safety fuses.**

fuse container for inserting in loose leads and designated the "Flexible Lead Fuse-holder," and a "Wanderfuse," which combines a fuse holder and a wander plug.

For these, fuses are obtainable in sealed glass tubes fitted with metal end-caps and suitable for use in either H.T. or L.T. circuits. The H.T. fuses are rated to "blow" at 150 mAs., while the L.T. pattern fuse at 0.5 amp.

The baseboard type costs 1s. 9d. complete with ½-amp. fuse, while the "Wanderfuse" and the flexible lead type cost 1s. 6d. each. Spare fuses cost 9d. each for 150 mA. type and 6d. each for ½ amp., 1 amp. and 2 amp. sizes.

## CHALLIS MAINS TRANSFORMERS.

The two transformers dealt with in this review are new models, the one designed for use with a Marconi or Osram U8 rectifying valve, and the other for a new style of rectifier which will be officially designated the U12. In both cases the maximum output current, after rectification, is 120 mAs. The Universal U12 transformer, as the second-mentioned model is described, is tapped for use on mains of from 200 volts to 250 volts, 40 to 100 cycles A.C., and carries one H.T. secondary winding, giving a maximum of 345+345 volts, and is provided with tappings disposed symmetrically about the centre point, and giving 250+250 volts and 300+300 volts. In addition, there are four 4-volt windings and one 6-volt winding, all with centre tappings.

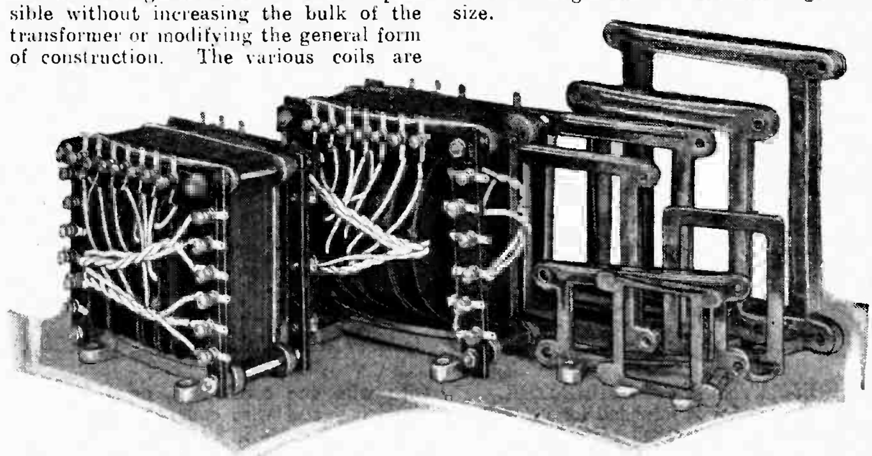
For the purposes of the present test, all windings were arranged to deliver current, and the voltages in every case measured with the rectifier giving its maximum of 120 mAs. In the first case, one ampere was taken from each of the L.T. windings, and the measured voltages were approximately 5 per cent. high in every case. When fully loaded, the actual voltage was, in each case, only a shade higher than the marked values.

The regulation curve reproduced here shows the D.C. output under the conditions mentioned above, using an average specimen U12 rectifier, the filament of this valve taking 2.5 amps. at 4 volts.

When fully loaded, the voltage across each half of the H.T. secondary was 9 per cent. lower than under open circuit conditions, and on half load the difference was approximately 6 per cent.

A better regulation would seem impossible without increasing the bulk of the transformer or modifying the general form of construction. The various coils are wound on paxolin bobbins, thus ensuring a high standard of insulation throughout. This is an important feature and of far more value than indifferent insulation but an exceptionally good H.T. secondary regulation.

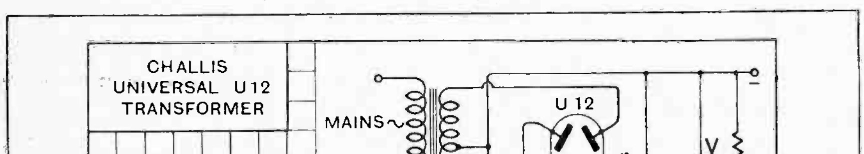
On full load the available H.T. is ample for most purposes, but where a higher voltage is required the Universal U8 transformer can be employed. The H.T. secondary on this model gives 500+500 volts A.C. with tappings at 400 and 450 volts. It carries the same number of L.T. windings and is somewhat larger in size.



Challis Universal U12 and Universal U8 transformers. Also some samples of aluminium end-clamps.

These transformers are exceptionally well made and run perfectly cool. The makers are: O. M. Challis, 22, Park Road, Rugby, and the price is 37s. 6d. for the Universal U12 model and 47s. 6d. for the Universal U8 model.

Special cast aluminium end-clamps for practically every size of stamping available to the home constructor can be obtained from the same firm; the prices range from 1s. to 5s. per pair.




Output regulation curves of the Universal U12 mains transformer.

## A NEW METAL RECTIFIER.

A reduction in price of all the more popular types of Westinghouse metal rectifiers became effective on July 1st. Units Nos. H.T.5 and H.T.6 cost 2s. 6d. less than formerly, while the H.T.7 rectifier, originally 21s., is now priced at 17s. 6d.

On the same date, a new high-tension rectifier, styled H.T.8, was introduced. Judging by the information at present available, it should prove highly popular, as the smoothed output—250 volts at 60 milliamperes—should be entirely adequate for almost all modern sets, not excluding those of the more ambitious type. The new unit, which costs 21s., is primarily intended for use in a voltage-doubling circuit, and is of compact size.

In the issue of January 28th, 1931, certain loud speaker units obtainable from Messrs. Henry Joseph, of 11, Red Lion Square, W.C., were referred to in a review under the name "Goliath."

It has been brought to our notice that the word "Goliath" is the registered trade-mark of the British Blue Spot Co., Ltd., of Blue Spot House, 94-96, Rosoman Street, Rosebery Avenue, E.C.1, and that Mr. Joseph has issued an apology for his inadvertent infringement of this trademark, with an undertaking not to infringe in the future.

*Next Week's Set Review:*

***PHILIPS ALL-ELECTRIC D.C. RECEIVER, MODEL 2653.***

# READERS' PROBLEMS

## Replies to Readers' Questions of General Interest.

*Technical enquiries addressed to our Information Department are used as the basis of the replies which we publish in these pages, a selection being made from amongst those questions which are of general interest.*

### Current-carrying Capacity.

*When winding a power transformer, how should one estimate the safe current-carrying capacity of any particular gauge of wire?*

It is usual to work on a basis of about 1,000 amperes per square inch of cross-sectional area; some designers prefer to allow as much as 1,200 amperes per square inch.

The cross-sectional area of any particular gauge can be ascertained from wire tables.

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### Faulty Variable Condensers.

*Recently I have noticed a scraping and scratching noise in the loud speaker when the H.F. tuning condenser of my 1-v-2 set is manipulated. Although this is not a very serious trouble, it is annoying, and I should like, if possible, to overcome it. All connections have been examined and cleaned, but the scraping persists. Can you give me any advice?*

Noises of this kind are almost always caused by dust between the vanes, or by an imperfect electrical connection between the rotor and the external circuit. In the first case the remedy is fairly obvious; if a faulty connection is responsible, we advise you to make sure that the "pigtail" connection, if fitted, is not frayed through, and is properly anchored. It may be necessary to adjust the bearings of the spindle, or, if they are worn, to add a flexible connection to the rotor vanes.

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### More Eliminator Output Needed.

*Since fitting power grid detection and a pentode in my receiver, I find that the output of the eliminator is inadequate. Would it be satisfactory to connect another rectifying valve in parallel with the existing one? If so, would it be correct to join the terminals of the extra valve holder to the corresponding ones of that at present included in the eliminator?*

Eliminator output can theoretically be increased in the manner you suggest, and the method of connecting the extra valve as described is correct.

We should point out, however, that unless your power transformer happens to be designed on very generous lines, there may be an appreciable falling-off in its voltage output—both for H.T. and filament heating—when an extra load is imposed. This will tend to defeat the object of the addition.

We advise you to consult the makers of the transformer before obtaining an extra valve.

### A Free Grid.

*In order to improve the ganged tuning of my H.F.-det.-L.F. A.C. receiver, I have followed advice given in your pages, and have inserted a condenser of the same value as that used in the filter coupling in series with the detector grid circuit. Unfortunately this alteration has not had the desired effect; signals are weak and distorted, and the receiver seems to be choked when I attempt to tune in a strong transmission.*

*Is there any other way whereby the distributing effect of the filter coupling condenser may be balanced out?*

If we may say so, we do not think you are correct in saying that you have followed advice given in *The Wireless World*. From your description of your trouble, it seems quite certain that the condenser has been added in such a way that there is no leakage path between grid and filament of the detector valve: we expect that your grid leak is connected in parallel with the grid condenser, and that the equalising condenser (C) has been connected in the position shown in Fig. 1 (a). This will account for a choked grid circuit, which is obviously the trouble.

We imagine that your ganged condenser is of the type in which the rotors are connected together and earthed, and on this assumption would suggest that the simplest way out of the trouble is to connect the grid leak in series, as shown in Fig. 1 (b). If you do not care for this plan, the equalising condenser might be joined between the stator of the tuning condenser and the high potential end of the coil, as shown in dotted lines in Fig. 1 (c). On the other hand, if the condenser rotor is not permanently earthed, it might be joined in the alternative position shown—between the rotor and earth.

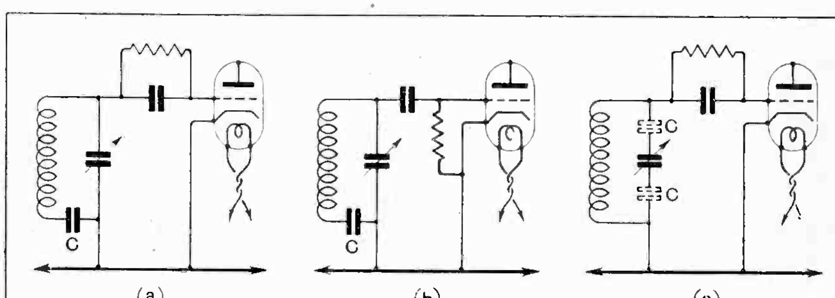


**Fig. 1.—Diagram (a) shows an incorrect method of inserting an equalising condenser (C) in the detector grid circuit of a receiver with ganged tuning. When connected in this way, the grid leak is isolated from the cathode. Methods of avoiding this trouble are indicated in diagrams (b) and (c).**

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### A Grid Circuit Fault.

*With the following symptoms as a guide, can you offer a suggestion as to the likely cause of a fault that has just developed in my set? Quality of reproduction has become poor; the application of various values of grid bias to the output valve makes no noticeable difference whatever, and this valve becomes very hot after a few minutes' use.*

*The set is a straightforward three-valve combination, with a grid detector followed by resistance- and transformer-coupled L.F. stages.*

Everything points to the existence of an open circuit in the grid circuit of the output valve. The connections should be carefully checked, and, if nothing obvious seems to be wrong, you should suspect that the secondary winding of the L.F. transformer has developed a defect.

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### Anti-lightning Devices.

*Is it likely that a lightning arrester of the type in which a safety gap is fitted will introduce any noticeable loss?*

Provided that apparatus of this sort is reasonably well designed, the losses introduced by it should be quite negligible. But, due to the fact that these devices, to be fully effective, are usually mounted out of doors, it should be realised that, being exposed to the weather, their insulating properties are likely to deteriorate, and they should receive periodical attention.

### Inserting a Loading Coil.

*If it is possible to do so, I should like to modify the circuit of the "Light-weight Portable" receiver by fitting a plug-in loading coil for long-wave reception. Will you please show me how this may be done in the simplest way?*

The wave range of this receiver may be extended quite simply to cover the long broadcasting waveband by fitting a centre-tapped loading coil (of about 200 turns) in the manner shown in Fig. 2. A three-pin mounting must be fitted to the coil, and a corresponding three-pin short circuiting plug with all contacts joined together must, of course, be provided for use when the set is used for medium-wave reception.

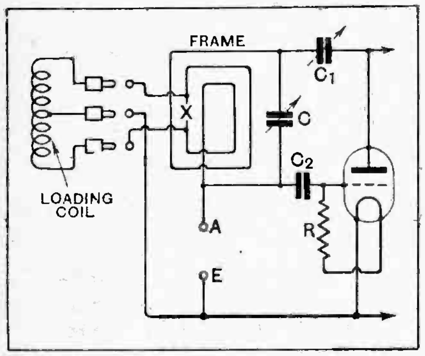


Fig. 2.—Modifying the "Lightweight Portable" for long-wave reception.

In order to make these alterations, it will be necessary to break the frame aerial circuit at the centre point (marked X in our diagram), and to transfer the original centre-tap external connection to a plug socket as shown.

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### Matching a Pentode.

*When a loud speaker is to be used with a pentode valve, is it advisable to obtain an instrument with a specially designed winding? I refer to loud speakers of a moving iron type.*

Nowadays it is usual to employ what is known as a compensated output circuit for pentode valves, and if this is done, there is no necessity for the loud speaker to have a special winding.

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### Coils at Right Angles.

*My present receiver includes anode bend detection, and the medium- and long-wave detector grid coils are mounted close together, but at right angles to each other. It is now proposed to change over to power grid rectification, and to add reaction; would it be possible to mount a single reaction coil in such a way that it would be effective over both wavebands? I should perhaps make it clear that it is not desired to use a swinging coil; reaction is actually to be controlled by a differential condenser.*

Without seeing the coils, it is not easy to give definite advice in this matter, but it would appear possible to mount the reaction coil in such a way that its field interacts with both sets of windings. This, we are afraid, is a matter that can only be determined by experiment, and in any case it is more than doubtful if really good control of reaction will be obtained. It would seem better to use two reaction coils.

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### Bias and Decoupling Resistance Confused?

*Is there any simple way of ascertaining whether the automatic bias voltage applied to an H.F. valve is correct? I gather that it is impossible to measure it directly with an ordinary voltmeter.*

*The 100,000-ohm bias resistance included in my set seems to be of unusually high value, and I am inclined to think that it is too high.*

The simplest way is to measure the anode current of the valve concerned; if it is approximately in accordance with the maker's figures, it may generally be assumed that bias is about right. Alternatively, the plan of measuring anode current when a bias battery of known voltage is substituted for the "automatic" device may be employed.

As you say, a bias resistance of 100,000 ohms certainly seems to be infinitely too high. We think, however, that this resistance will be for the purpose of decoupling, and will not be directly connected with the bias system.

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### To React or Not?

*There seems to be a tendency to regard the use of reaction as out of place in a set designed primarily for high-quality reproduction; as I am engaged in planning a 1-v-1 receiver, from which great things are expected in this direction, I should be glad of your advice.*

The fact that provision is made for reaction should not affect the quality obtainable from the receiver; the harm is done when it is used to excess. But when a modern input filter is used in a set such as you propose to build, it is often found that the use of a fair amount of reaction between plate and grid circuits of the detector has actually a beneficial effect with regard to quality. We think, on the whole, you would be well advised to include it in the set.

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### Resistance-Fed Transformer Coupling.

*On changing over to power grid detection I altered the L.F. coupling of my receiver by fitting a parallel resistance feed for the transformer. I am surprised to find that this modification has brought about a very considerable loss of magnification: it has been proved that this is not due to incorrect functioning of the detector, as I have experimentally reverted to the original values of components associated with that valve.*

*Is this loss of signal strength a normal occurrence? If not, can you suggest where it has gone wrong?*

There should be no loss; indeed, by adopting certain methods of connection, there should be a slight gain in L.F. amplification.

We think it likely that you have inadvertently connected up your transformer in such a way that the maximum possible step-up ratio is not produced; the various ways of joining up this component were discussed at length in the "Readers' Problems" section of our issue for May 27th.

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### Smoothing Out a Resonance.

*After careful observation, and partly as a result of testing my loud speaker with another receiver, I have come to the conclusion that the quality of reproduction is impaired by a tendency of the loud speaker to over-emphasise a narrow band of the higher musical frequencies—in the neighbourhood of 2,000 cycles.*

*At present a resistance of 100,000 ohms is inserted in series with the L.F. valve grid to act as an H.F. stopper. Do you think it would be worth while to replace this by a 250,000-ohm resistance?*

In any case, your proposed method of tone correction is somewhat crude, and it is most unlikely to be effective in coping with an objectionable resonance. For this purpose some form of tuned circuit, of which the sharpness of tuning may be controlled to a certain extent, is distinctly preferable.

## FOREIGN BROADCAST GUIDE.

## HEILSBERG

**(Germany).**

Geographical position: 54° 42′ N., 20° 30′ E.

Approximate air line from London: 878 miles.

**Wavelength: 276.5 m. Frequency: 1,085 kc. Power: 75 kW.**

Time*: Central European.
(*Coincides with B.S.T.)

**Standard Daily Transmissions.**

06.00 B.S.T., physical exercises; concert (Sun.); 08.00, sacred service (Sun.); 11.40, gramophone records; 12.55, time signal, news; 16.30, concert; 20.00, main evening programme; 22.30, concert or dance music. Also relays Berlin.

Male announcers only. Call: *Achtung! Hier Ostmarken Rundfunk Heilsberg, Koenigsberg und Danzig* (or *Ostmarken Rundfunk und Danzig*).

Interval signal: two notes (D flat, A flat) repeated three times in 4½ seconds with a similar interval.

Closes down with: *Die Sendergruppe Heilsberg, Koenigsberg und Danzig hat ihr Tagesprogramm beendet. Gute Nacht, meine Damen und Herren. Vergessen Sie nicht die Antenne Zu erden,* followed by the German National Anthem. (The Heilsberg Koenigsberg and Danzig group of transmitters has concluded its programme. Good Night, Ladies and Gentlemen. Do not forget to earth your aerial.)

Relays: Koenigsberg, 217 m. (1,382 kc.), 1.7 kW.; Danzig, 453.2 m. (662 kc.), 0.6 kW.

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# *Decentralisation of Broadcasting.*

AN interesting article under the above title is contributed to the July number of the *Nineteenth Century* magazine by R. Raven-Hart, whose name will be known to our readers as an occasional contributor to *The Wireless World*.

The article draws a comparison between different systems of programme organisation in Europe and, in particular, comments on the relative merits of the British and German organisations. The article is of special interest to us, since the author touches upon a number of points which have been raised in *The Wireless World*—in particular, in a leading article under the title "Competitive Programmes" which appeared in our issue of March 4th last. In that contribution we urged the desirability of a division of programme organisation, made possible as a result of the introduction of the alternative programme scheme, and we contended that arrangements could quite conveniently be made for the alternative programmes to be placed under two distinct Programme Boards competing with one another.

Raven-Hart points out that under a decentralised system it is impossible for the personal preferences of any one musical director to cover the whole broadcasting system, as could so easily be the case in Britain under the present organisation. It is stated that in Germany there are actually ten separate programme compilers, although the broadcasting system, as in England, is State owned and administered by an officially privileged company.

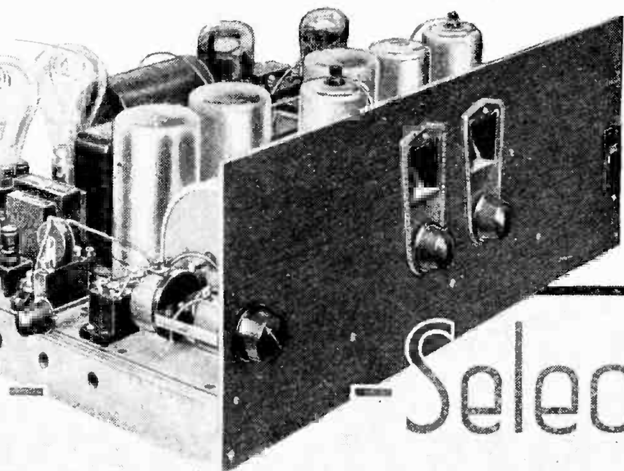
Readers will, no doubt, recollect that in the early days of broadcasting here the various stations did actually transmit independent programmes, locally compiled, but that, with the extension of land-line intercommunication enabling exchange of programmes and simultaneous broadcasting, the independent Programme Boards were abandoned in favour of the present system of centralisation. It must be remembered, however, that in those days the need for economy was much greater than at present, and the change was also encouraged as the result of complaints made that the best programme material was generally available in the London area with the consequent result that London listeners had better fare than the listeners to provincial stations.

If, however, a proper arrangement were made for encouraging local orchestras, and supporting the provincial station programmes, from time to time, with good items from other centres, transferred by land line, these former objections could, we consider, be overcome.

Raven-Hart concludes his article by suggesting that an experiment of decentralisation would be of greater interest if the listener were able to give a tangible proof of his preferences, and he suggests that some system might be introduced whereby the listener, when taking out his licence, could stipulate to what station of the group he wished the licence revenue to go. In our issue of March 4th, we also emphasised that it would be important that the public should know which was which of the transmissions, in order that comments and criticisms on any particular programme would go to those responsible for its compilation.

## In This Issue

# D.C. Super-Selective Five



## A Sensitive Superheterodyne for High Quality Reception.

By W. T. COCKING.

THE single fact that the superheterodyne is unquestionably the most selective type of receiver known is alone sufficient justification for its use under modern broadcasting conditions. When the high amplification and the high quality of which it is capable, to say nothing of its simple operation and easy construction, are taken into consideration, it will be seen that it offers the most satisfactory approach to the ideal which has yet been attained.

In recent issues of this journal, superheterodynes for A.C. mains operation[1] and for battery supply[2] have been described, but, in view of the large number of D.C. supplies which still exist, and will exist for years to come, it is felt that the range would be incomplete without a receiver taking its whole power supply from direct current mains. Although it is probable that all D.C. supplies will eventually be converted to A.C., the process of conversion is likely to take a long time; and in the meantime there is no reason why those who are so unfortunate as to have this kind of supply should be deprived of the undoubted advantages of mains operation.

The problem of D.C. mains receiver design is considerably more difficult than in the case of sets taking their power supply from A.C. mains, largely because comparatively little attention has been devoted to it. Many of the difficulties have disappeared recently, however, owing to the introduction of a range of special indirectly heated D.C. mains valves whose characteristics are almost identical with those of the familiar A.C. types. Indeed, the chief difference between the two types of valve lies in the heater voltage and current; the D.C. mains valves consume a current of 0.5 ampere at 6 volts for the screen grid and detector types, and at 8 volts for the pentode.

The Super-Selective Six, for A.C. mains operation, has proved so eminently satisfactory that, when considering the design of the D.C. model, it was decided to adhere as far as possible to the same circuit and values for the components. This has been rendered possible, of course, only by the great similarity between the characteristics of the D.C. and A.C. valves. The modifications introduced, therefore, are principally in the smoothing and voltage-dropping devices, and only very minor alterations have been made to the receiver proper.

An inspection of the complete circuit of Fig. 1 shows that five valves are employed; a single stage of intermediate frequency amplification with a grid detector and a pentode output stage is preceded by a two-valve frequency changer, and provides sufficient sensitivity, selectivity, and power output for all ordinary purposes.

### SPECIFICATION.

*Five-valve superheterodyne for operation from D.C. lighting mains of 200/250 volts.*
*Band-pass tuning with six tuned circuits.*
*Two tuning controls. Ganged waveband switching.*
*Dual ganged volume control. New non-radiating frequency changer.*
*Special circuit for cutting out long wave interference.*
*Grid detection. Pentode power output of 1,500 milliwatts.*
*18 kc. selectivity on powerful local stations.*
*Simplified grid bias circuits.*
*Hum-free operation.*
*Low running costs: power consumption on 200 volts mains, 108 watts; on 250 volts mains, 135 watts.*

### The Frequency Changer.

A two-stage band-pass filter, the sections of which are inductively coupled, precedes the first detector, and provides the high selectivity needed to keep second channel interference at a minimum. Completely screened coils, with built-in waveband switching, and a completely screened two-gang condenser, are used, and it should be emphasised that this screening is essential, otherwise direct pick-up on the secondary circuit may

[1] "The Super-Selective Six," June 3rd and 10th, 1931.
[2] "The Super-Selective Five," July 15th and 22nd, 1931.

**D.C. Super-Selective Five.—**

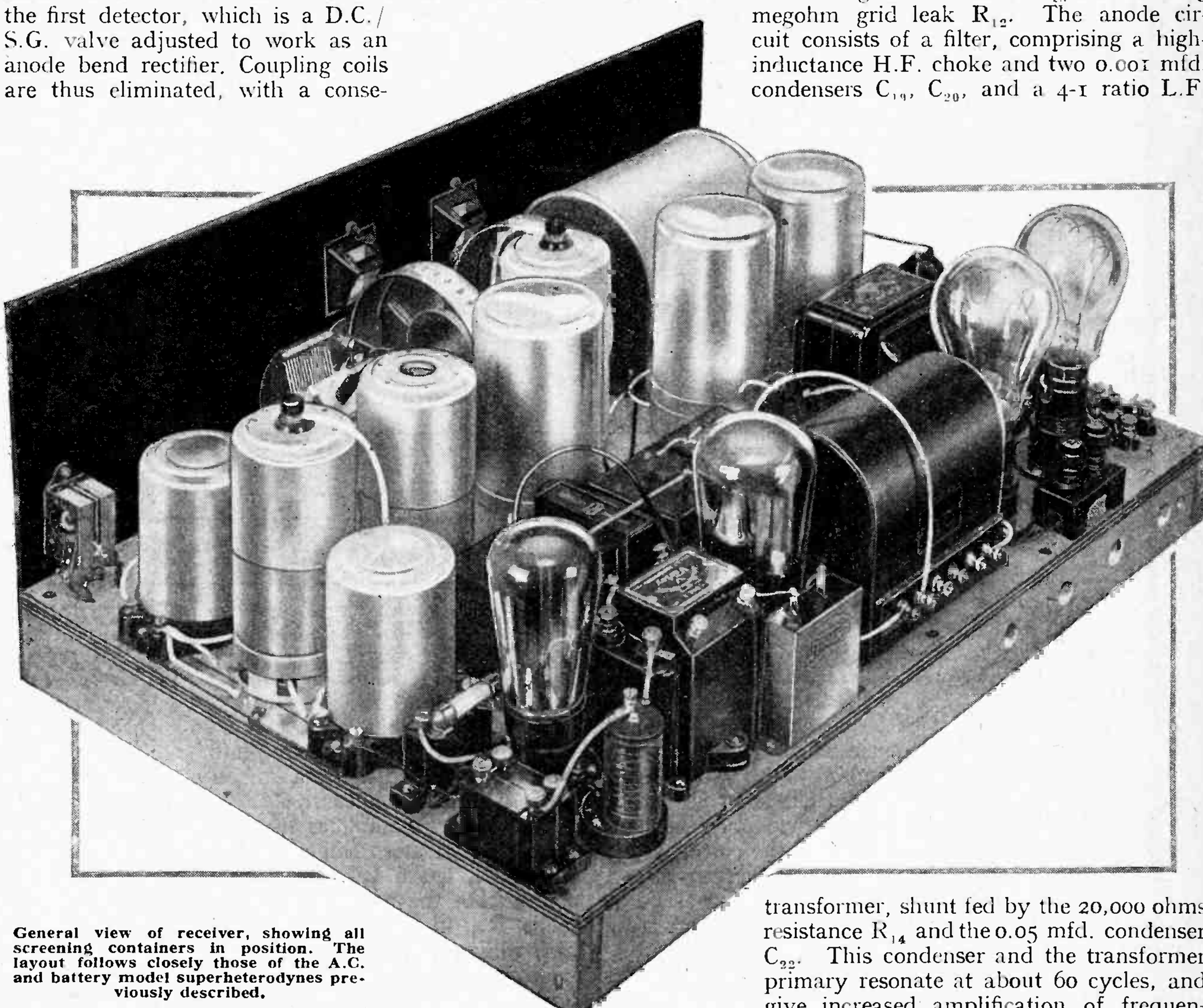
nullify the advantages of the filter. A 50-mmfd. condenser, comprising the two series-connected 0.0001-mfd. condensers, $C_4$, $C_5$, is inserted between the primary of the filter circuit and the aerial, while a 25,000 ohms potentiometer $R_1$ acts as an aerial input volume control. This control is ganged to another potentiometer $R_{13}$, controlling the screen-grid voltage of the I.F. valve, and the double control affords a complete and distortionless control of volume. An acceptor circuit, $L_1$, $C_3$, is tuned to the intermediate frequency of 110 kc., and serves to eliminate I.F. interference when receiving on the long waveband.

The D.C./H.L. oscillator has its anode circuit tuned to keep the harmonic generation at a minimum, and the whole tuned circuit is included in the anode circuit of the first detector, which is a D.C./S.G. valve adjusted to work as an anode bend rectifier. Coupling coils are thus eliminated, with a consequent simplification of the switching, and the circuit is rendered non-radiating. An outdoor aerial is thus permissible, and the use of a preliminary stage of H.F. amplification, with its attendant cross-modulation difficulties, is avoided.

**The I.F. Amplifier.**

The primary of the first intermediate frequency transformer is included in the anode circuit of the first detector, and passes the signal on to the single screen-grid valve, a D.C./S.G., which acts as the I.F. amplifier. Two identical transformers are used for the couplings between this valve and the two detectors. Each transformer is a band-pass filter, and contains two coupled coils tuned to 110 kc. by small adjustable condensers within the base. The coupling between the coils in each transformer is readily adjustable, and so a complete control over the selectivity and quality can be obtained, and the best compromise for any particular conditions can be reached.

The D.C./H.L. second detector acts as a grid rectifier with a 0.0001 mfd. grid condenser $C_{18}$ and a 0.25 megohm grid leak $R_{12}$. The anode circuit consists of a filter, comprising a high-inductance H.F. choke and two 0.001 mfd. condensers $C_{19}$, $C_{20}$, and a 4-1 ratio L.F. transformer, shunt fed by the 20,000 ohms resistance $R_{14}$ and the 0.05 mfd. condenser $C_{22}$. This condenser and the transformer primary resonate at about 60 cycles, and give increased amplification of frequencies in this neighbourhood, thus tending to compensate for the deficiencies of the vast majority of loud speakers, and to reduce any risk of motor-boating. The D.C./Pen. output valve has a 30H. choke in its anode circuit, and this choke is provided with four tappings so that it can be used as a variable



**General view of receiver, showing all screening containers in position. The layout follows closely those of the A.C. and battery model superheterodynes previously described.**

**D.C. Super-Selective Five.—**
ratio auto-transformer, and the speaker accurately matched to the valve.

### The Heater Supply.

So far, the receiver follows normal superheterodyne practice, and is little different from the A.C. model previously described. It is when we come to consider the heater and smoothing circuits that we find radical changes. The heaters are all connected in series, and consume 0.5 ampere; four of the valves require 6 volts each, and one 8 volts, the total voltage required, therefore, is 32 volts. The mains voltage is assumed to be 200 volts, so that 168 volts at 0.5 ampere must be dropped in some form of resistance. Probably the simplest, cheapest, and most compact resistance is a carbon type is fitted, so that the whole set is isolated from the mains when switched off.

The H.T. smoothing circuit follows normal practice; two choke are used—$Ch_1$ to smooth the whole current for the set, and $Ch_2$ to smooth the current for all stages except the pentode. It is particularly important to note that the two smoothing condensers $C_{29}$ of 4 mfd., and $C_{30}$ of 2 mfd., are not returned to the negative H.T. lead, as is usual; instead, they are taken to the earth lead, and only if they are connected in this manner is their presence beneficial.

### Decoupling.

Owing to the limited H.T. voltage available, full decoupling is by no means easy to obtain. A resistance feed for the pentode screen grid is not permissible on

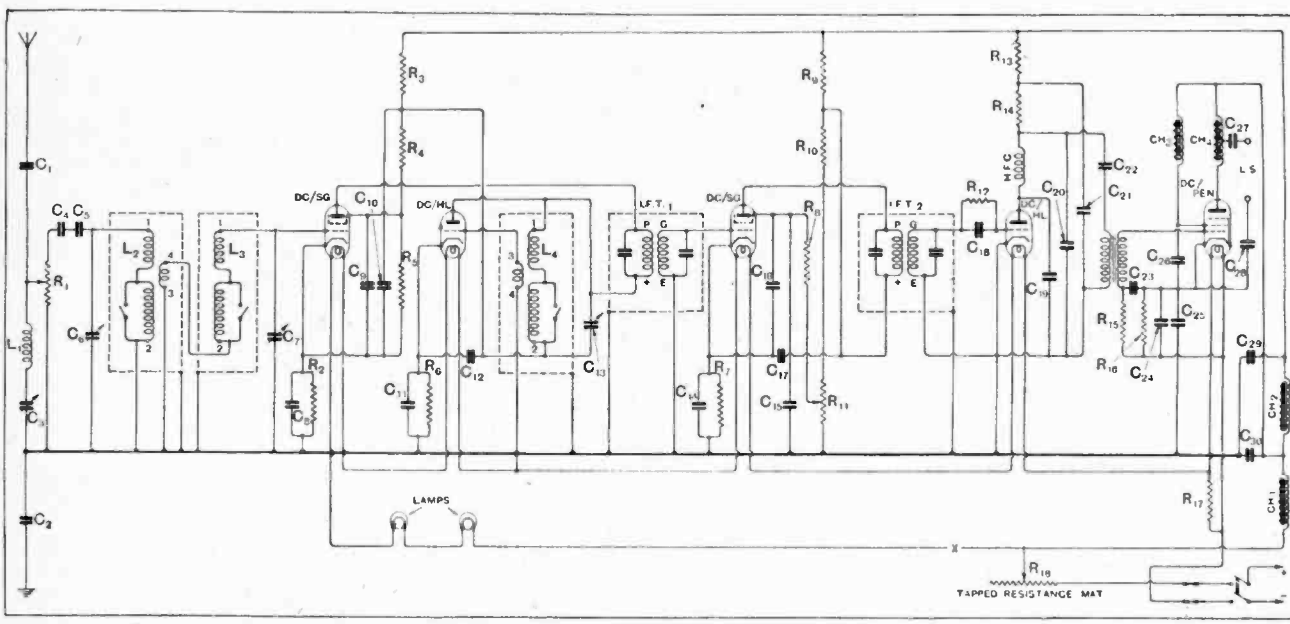



**Fig. 1.—The values of the principal components are as follows:—$C_1$, 0.002 mfd.; $C_2$, $C_4$, $C_9$, $C_{10}$, $C_{11}$, $C_{15}$, $C_{16}$, $C_{17}$, $C_{21}$, $C_{30}$, 2 mfd.; $C_3$, 0.0005 mfd. pre-set; $C_1$, $C_5$, $C_{18}$, 0.0001 mfd.; $C_6$, $C_7$, 0.0005 mfd. two-gang; $C_{11}$, $C_{12}$, $C_{23}$, $C_{24}$, $C_{25}$, 1 mfd.; $C_{13}$, 0.0005 mfd. variable; $C_{19}$, $C_{20}$, 0.001 mfd.; $C_{22}$, 0.05 mfd.; $C_{26}$, $C_{27}$, $C_{28}$, $C_{29}$, 4 mfd.; $R_1$, $R_{11}$, double 25,000 ohms volume control; $R_2$, 1,000 ohms; $R_3$, 7,000 ohms; $R_4$, 40,000 ohms; $R_5$, $R_{10}$, 30,000 ohms; $R_6$, $R_8$, 600 ohms; $R_7$, 500 ohms; $R_9$, 3,000 ohms; $R_{12}$, $R_{15}$, 0.25 meg.; $R_{13}$, 10,000 ohms; $R_{14}$, 20,000 ohms; $R_{16}$, 280 ohms; $R_{17}$, 400 ohms; $R_{18}$, tapped resistance mat; $Ch_1$, $Ch_3$, 30H. chokes; $Ch_2$, 70H. choke; $Ch_4$, 30H. pentode choke; $L_1$, slab type coil; $L_2$, primary band-pass coil; $L_3$, secondary band-pass coil; $L_4$, oscillator coil.**

filament lamp; these lamps have the further property of possessing a higher resistance when cold than when hot, and this acts as a protection to the valves when the current is switched on. Two lamps in series are used in order to provide the necessary resistance, and it is important that they should be of the correct type; two 130 volts, 115 watts (32 c.p.) Robertson carbon lamps are required, and no attempt should be made to use ordinary metal filament lamps, as this will probably result in the destruction of the valves.

The set is intended to work normally from 200 volts mains, and, in order to accommodate higher voltages, a tapped resistance mat, $R_{18}$, is included. As the lamp resistance is not exactly correct to give 0.5 ampere through the heaters, a small proportion of this resistance must be included even on 200 volts. Fuses are fitted in both mains leads to guard against a short circuit, while a double pole switch of the quick make-and-break account of the voltage drop, and so a 30H. choke $Ch_3$ is used in conjunction with a 4-mfd. condenser $C_{26}$. The detector is decoupled by a 10,000 ohms resistance $R_{13}$ and the 2-mfd. condenser $C_{21}$.

For the I.F. amplifier the decoupling resistance $R_9$ cannot be greater than 3,000 ohms, and so the condenser $C_{17}$ has a value of 2 mfd. The screen supply comes from the 25,000 ohms volume control potentiometer $R_{11}$ in series with the 30,000 ohms resistance $R_{10}$, while a 600 ohms resistance $R_8$ is inserted in series with the screen lead to avoid feed-back on the long lead to the volume control. The screen grid is shunted to the cathode by the 2-mfd. condenser $C_{16}$, and to earth by an additional 2 $\mu$F. condenser $C_{15}$, and these connections were found necessary in order to avoid instability and motor-boating.

The anode supply for both the first detector and the oscillator is taken from the 7,000 ohms resistance $R_3$,

**D.C. Super-Selective Five.—**

with a 2-mfd. condenser $C_{10}$ shunted to the detector cathode and a 1-mfd. condenser $C_{12}$ to the oscillator cathode. The two series-connected resistances $R_4$ and $R_5$ of 40,000 ohms and 30,000 ohms respectively form a potentiometer for supplying the screen-grid voltage to the first valve, while the screen is by-passed to the cathode through the 2-mfd. condenser $C_9$.

### Grid Bias.

In a D.C. mains set it is the usual practice to take the grid bias from the voltage drop along the valve filaments. In a set employing indirectly heated valves, difficulties may arise in a multi-valve set owing to the fact that the heater current is unsmoothed; furthermore, grid circuit decoupling must be used, and this is undesirable in H.F. stages on account of valve noise. Bias in this receiver, therefore, is obtained in exactly the same manner as in an A.C. set; that is, by the use of a resistance in each cathode lead; and practical tests have shown this scheme to be eminently satisfactory.

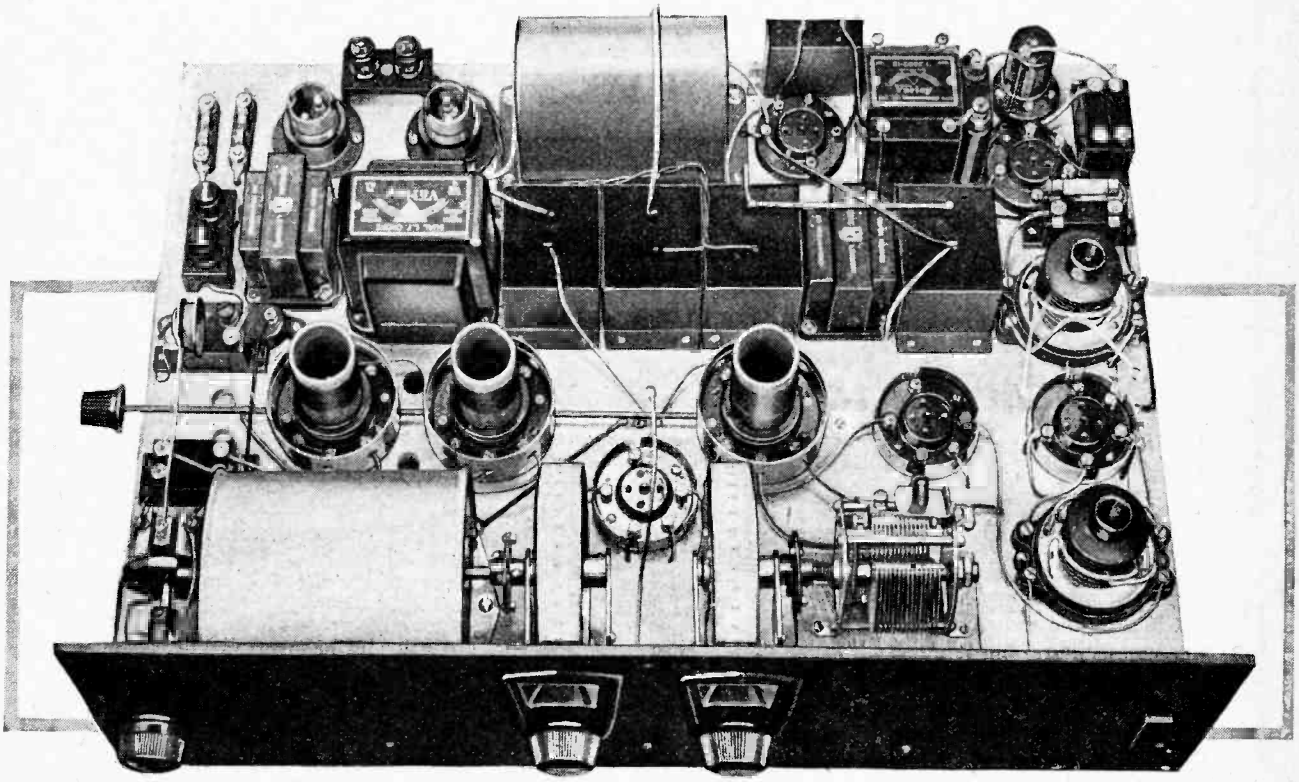
The cathode of the first detector is returned to the common earth lead through a 1,000 ohms resistance $R_2$ shunted by a 2-mfd. condenser $C_8$; the second detector cathode, on the other hand, is returned directly to the earth lead, since no negative bias is required. The oscillator is biased in the same manner, by means of the 600 ohms resistance $R_6$ shunted by the 1-mfd. condenser $C_{11}$, while the I.F. valve has values of 500 ohms for the resistance $R_7$ and 2 mfd. for the condenser $C_{14}$.

The pentode is biased by the 280 ohms resistance $R_{16}$ shunted by the 1-mfd. condenser $C_{24}$, and the grid circuit is decoupled by the 0.25 megohm resistance $R_{15}$ and the 1-mfd. condenser $C_{23}$. Another 1-mfd. condenser $C_{25}$ is connected between the pentode cathode and the common earth lead, and serves to remove the last trace of hum.

### Heater Connections.

Now, when all the heaters are connected in series, the order in which they are wired becomes of considerable importance, as the H.T. voltage is reduced on the valves at the positive end of the chain. The pentode, therefore, which requires the greatest H.T. voltage, is connected at the negative end—that is, one end of the heater is taken directly to the negative of the supply mains, and the bias resistance is also returned to this point.

Viewed from the negative mains lead, therefore, the heaters are connected in the following order: Pentode, second detector, I.F. stage, oscillator, and first detector. The positive end of the heater of this last valve is taken to the carbon lamp resistances. The question now arises as to the position for the connection between the earth lead and the heaters, for such a connection is necessary to complete the H.T. circuit. We should like to take this to negative H.T., as this would give the minimum loss of voltage, but, unfortunately, this would create too great a potential difference between the heaters and the cathodes of the valves at the positive end of the chain. The earth, therefore, is connected to



View of receiver from above, showing disposition of components on baseboard. Valve and coil screens have been removed.

## LIST OF PARTS REQUIRED

1 L.F. transformer ............ (Varley Nicore, 1)
1 Dual L.F. choke ................ (Varley, D.P. 11)
1 Two-gang condenser, 0.0005 mfd. and drum dial ...................... (Polar Tub)
1 Variable condenser, 0.0005 mfd. and drum dial ...................... (Polar Universal)
2 Grid leaks, 0.25 megohm ............ .. (Ediswan)
1 Porcelain grid leak holder ............ (Bulgin)
3 Fixed condensers, 0.0001 mfd. ..(Dubilier, No. 620)
2 Fixed condensers, 0.001 mfd. ....(Dubilier, No. 620)
1 Fixed condenser, 0.002 mfd. .. . (Dubilier, No. 620)
1 Fixed condenser, 0.05 mfd. .. (Dubilier, Type B775)
5 Fixed condensers, 1 mfd. 500 volt, A.C. test .................... (Ferranti, Type C7)
10 Fixed condensers, 2 mfds., 500 volt A.C. test .................... (Ferranti, Type C8)
4 Fixed condensers, 4 mfds., 500 volt A.C. test .................... (Ferranti, Type C9)
1 D.C. mains switch, with Escutcheon plate (Bulgin, S56)
5 5-pin A.C. valve holders ................ (W.B.)
3 Valve screens ...................... (Colvern)
2 I.F. transformers, 110 k.c. ............ (Colvern)
1 Twin volume control potentiometer, 25,000 ohms. ..................... (Colvern)
1 H.F. choke .................... (Wearite, HFO)
1 Aerial band pass coil and screen ...... (Watmel)
1 Secondary band pass coil and screen .... (Watmel)
1 Oscillator coil and screen ............ (Watmel)
1 Slab coil .......................... (Watmel)
2 Insulated ganging couplers ............ (Cyldon)
1 Pentode choke .............. (Atlas, Type C.P.S.)
1 Pre-set condenser, 0.0005 mfd. max. .... (Polar)
1 Resistance, 280 ohms, to carry 35 mA. and holder .................. (Varley Bi-Duplex)
1 Resistance, 400 ohms, to carry 20 mA. and holder .................. (Varley Bi-Duplex)
1 Resistance, 7,000 ohms, to carry 10 mA. and holder .................. (Varley Bi-Duplex)
1 Resistance, 40,000 ohms, to carry 5 mA. and holder .................. (Varley Popular)
1 Resistance, 500 ohms, to carry 10 mA. (Varley Tagtype)
2 Resistances, 600 ohms, to carry 10 mA. (Varley Tagtype)
1 Resistance, 1,000 ohms, to carry 2 mA. (Varley Tagtype)
1 Resistance, 3,000 ohms, to carry 10 mA. (Varley Tagtype)
1 Resistance, 10,000 ohms, to carry 2 mA. (Varley Tagtype)
1 Resistance, 20,000 ohms, to carry 5 mA. (Varley Tagtype)
2 Resistances, 30,000 ohms, to carry 5 mA. (Varley Tagtype)
1 Resistance net, 6in. × 6in., 104 ohms (Cressall, Type S.R.30)
2 Baseboard fuse holders, with 1 amp. fuses (Belling & Lee)
4 Ebonite shrouded terminals .... (Belling & Lee)
2 Terminal mounts ... .......... (Belling & Lee)
2 Smoothing chokes .......... (R.I. Hypercore)
2 Robertson lamps, 130 volts, 32 c.p. ...... (G.E.C.)
2 Lamp holders, Batten type.
1 Bakelised panel, 21in. × 8in. × $\frac{3}{16}$in.
1 Baseboard, 14½in. × 21in.
Sleeving, copper foil, wire, screws, wood, mains, socket and flex, etc.

the lead joining the oscillator and I.F. valve heaters, for this gives the minimum potential difference between heaters and cathodes.

It will be seen that with this method of connection the anode current of the four earlier valves will pass through the pentode heater. The pentode is not constructed to withstand this current, and so it has been necessary to shunt its heater by the 400 ohms resistance $R_{17}$, and no reduction in valve life need then be anticipated.

In a D.C. mains set it will be realised that there is no isolation between the receiver circuits and the mains, and that all metal parts are connected directly to the lighting supply. It is necessary, therefore, to take certain precautions if complete safety is to be ensured and the I.E.E. regulations complied with. A 2-mfd. condenser $C_2$ is connected in the earth lead, therefore, and a 0.002-mfd. condenser $C_1$ in the aerial lead; there is thus no danger of a short-circuit if the aerial blows down, and the aerial and earth leads can be handled with impunity. Two 4-mfd. condensers, $C_{27}$ and $C_{28}$, are connected in series with the loud speaker for the same reason. Care should be taken, however, not to touch the metal parts within the receiver while it is in operation, as it is impracticable to isolate these; the screening, for instance, is connected to the negative of the mains, and it will be at full mains potential if the positive be earthed, as is often the case, and so it is wise to operate a D.C. set only in its cabinet.

Full constructional details will be given in next week's issue.

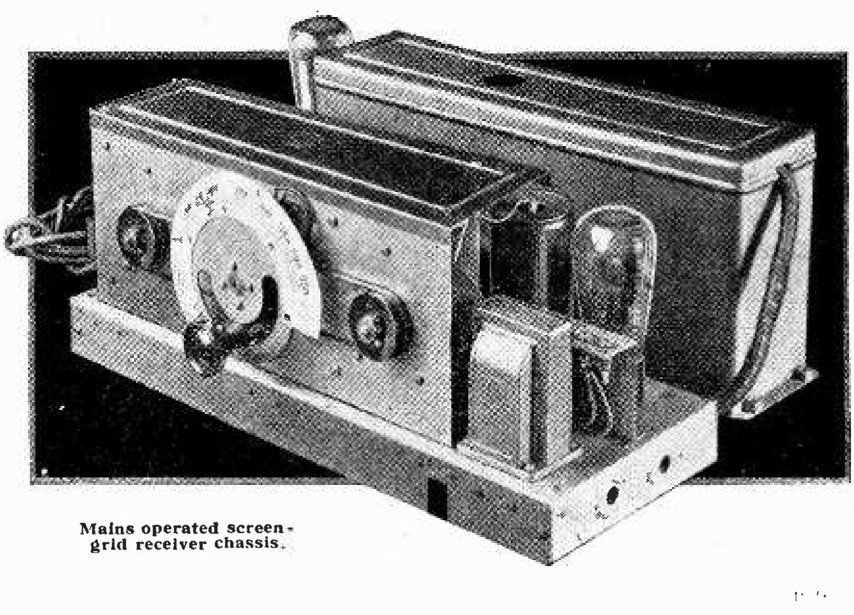
*(To be concluded.)*

# RECEIVER DESIGN IN AUSTRALIA.

## An Example of Present-day Workmanship.

AUSTRALIA does not at present export wireless receivers to this country, but, nevertheless, it is of interest to see an example of an Empire product of the industry.

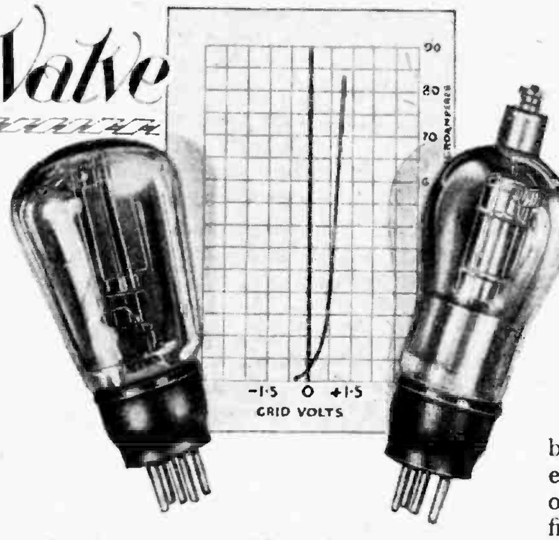
The accompanying photograph shows a four-valve, screen-grid chassis which is produced by the Amalgamated Wireless Company of Australia. Although there are three screen-grid stages, all tuned, ganging has been satisfactorily achieved so that tuning is effected by a single control. The set is entirely mains-operated, and is extremely robust in construction. The strong construction of these receivers is, in fact, a distinctive feature and very essential in a country where sets may have to travel many hundreds of miles to their ultimate destinations.



Mains operated screen-grid receiver chassis.

# Is the S.G. Valve a good Detector?

## The Triode *versus* The Tetrode.




By

M. G. SCROGGIE,

B.Sc., A.M.I.E.E.

ALTHOUGH the screen-grid valve has not come into very general use as a detector, an article dealing with its characteristics in this respect appeared in *The Wireless World* as long ago as October, 1928.[1] The information therein was confined exclusively to the anode-bend method, and although that is still the only satisfactory system in the case of superheterodyne first detectors—for which a screen valve is now commonly used—it is the "straight" detector that is being considered here. For that purpose the power grid method is the one on which interest is now concentrated, so it is not out of place to reconsider the S.G. valve in the light of recent practice.

At a very early date grid rectification was mixed up in the same valve with amplification, so that the essential principles of it have tended to become obscured by matters pertaining to the amplifying process. Mr. Colebrook has recently separated them again, and even those who do not care to devote an extra valve to rectification in order to put his recommendation into practical effect can hardly fail to gain a clearer picture of the action of a grid detector by a study of his article.[2]

Let us examine the requirements for a good detector valve, assuming that it is combined with the amplifier in the customary manner. In the first place, the grid current/grid voltage characteristic must be good, that is to say, steep in slope, and straight, with little curved foot portion. The steepness of the slope, or, in other words, the smallness of the grid path impedance, depends largely on closeness of spacing of the electrodes, and therefore modern valves are better in this respect than those of former days. There are other more complicated matters affecting it, however, such as the nature of the emitter. The straightness is also controlled by a number of factors, but one of the most important effects is that due to the potential of different parts of the cathode or filament, and, for reasons which have often been explained in detail, results are vastly superior when the potential is the same all over, so that the whole of the cathode comes into action at once, so to speak, when the grid potential reaches the point at which it attracts electrons and thus sets up a grid current. Separately heated cathode valves are therefore much to be preferred to battery valves.

*THAT the screen-grid valve, when used as a detector, imposes no load on the input is an attractive feature. Offsetting this advantage, however, are the difficulties resulting from high internal valve impedance. This article shows how to take these conflicting points into consideration when designing the detector stage, and explains the effect of different component values on performance.*

### Grid Detection Explained.

The separate functions of a valve as detector and amplifier may be seen more clearly by considering them separately, as in Fig. 1, which shows the equivalent circuit. $V_1$ is a diode rectifier, corresponding to the grid/filament path; $LC_2$ is the tuned circuit which gives rise to the H.F. voltage, which is conveyed to the rectifier by the grid condenser $C_1$. $R_1$ is the grid leak, which serves to establish a suitable initial potential at the grid, here represented by the anode of $V_1$. $R_1$ acts also as an anode resistor for coupling the rectifier to the amplifier in the same way as in any resistance-coupled amplifier. $V_2$ can be connected to amplify in any of the recognised ways, such as that shown, using another coupling resistor $R_2$. The grid-bias for $V_2$ is provided by the rectified voltage across $R_1$ caused by the carrier wave. It will be seen that $V_1$ may be abolished without altering the principle, for its path is merely in parallel with the grid/filament of $V_2$. The circuit is then identical with the old favourite.

By making $R_1$ large the variations in the impedance of $V_1$, which cause the curvature of the characteristic, become of little account. Even with the comparatively small values of $R_1$ now used, say 0.25 megohm, the resulting characteristic is practically straight except right at the foot, and by arranging for a large input voltage the curved foot is a small part of the total working portion. $R_1$ must not be too large, however, or $C_1$ will shunt the higher

[1] "The Screened Grid Valve as Detector," A. P. Castellain, *The Wireless World*, October 10th, 1928.

[2] "A New Development in Power Grid Detection," F. M. Colebrook, *The Wireless World*, June 10th, 1931.

**Is the S.G. Valve a Good Detector?—**

audible frequencies, causing high-note loss, and $C_1$ must not be too small or the inter-electrode capacity of $V_1$ in series will cause a drop in H.F. potential and hence loss of efficiency. Thus, by compromise, we arrive at the values recommended for normal use—0.25 megohm and 0.0001 mfd.

### The Miller Effect.

The second requirement for a good detector-amplifier valve is a satisfactory amplification characteristic at the working point which has been chosen for good rectification. This is where we come across the disadvantage of making one valve do two things. The best rectification conditions may not be at all the best for amplification. Hence the shortcomings of the grid detector with inadequate anode voltage, for the working portion of a high-amplification valve with low anode power is right down on the curved portion of the anode-voltage/anode-current characteristic, and the distortion debited against the grid detector is really due to faulty amplification. So our valve must have a good straight characteristic at the working point, i.e., at the bias imposed by the rectified carrier wave and well on each side of it to take care of deep modulation. The first heading has provided one reason for the carrier voltage being large, and, in addition, it is very desirable, with the object of reducing the necessary L.F. amplification to a minimum, in order to avoid feed-back, hum, and microphony. Also the correspondingly greater H.F. amplification necessary generally carries along with it a greater degree of selectivity.

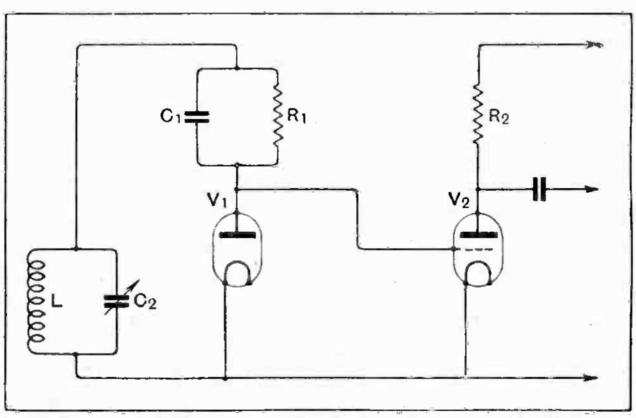


Fig. 1.—The two functions of the detector are easily understood if they are considered separately as a diode followed by a triode amplifier.

The third requirement is that the anode-grid capacity should be very small. This is generally appreciated in connection with H.F. amplification, but it is not always realised how much loss of efficiency and selectivity is due to feed-back through the inter-electrode capacity of the detector valve. Unless the anode by-pass condenser is so large as to ruin quality, the anode-grid capacity of an ordinary triode valve feeds back positive resistance which exceeds all other sources of grid-circuit damping, and also feeds back capacity, which is particularly undesirable in gang-tuned receivers. This capacity may be many times greater than the actual inter-electrode capacity. For reasons previously mentioned it is desirable to have high amplification, close spacing of electrodes, and high external anode resistance, but all these things aggravate the feed-back trouble.

Let us see how the screen-grid valve fits in with these requirements. The grid-rectifying properties are determined by features which are mainly confined to the cathode and grid, and hence a S.G. valve does not greatly differ in this respect from a triode of corresponding type. So far, then, it scores level points. Coming to the amplifying characteristics, the theoretical amplification of the S.G. valve is, in general, very much greater. But the amplification that can actually be used, without spoiling the quality, is not necessarily ahead of the triode. The S.G. valve tends to maintain constant audio current in the anode circuit irrespective of the coupling impedance therein, so if the coupling impedance varies greatly with frequency, as in the case of an inter-valve transformer, the output voltage follows suit, which is not allowable in the best circles. On the other hand, if this difficulty is avoided by resistance coupling, the greatest resistance one can use with reasonable H.T.—and reasonable preservation of high notes—is insufficient to utilise a very large fraction of the amplification of the valve. Nevertheless, it is possible with cheap components to turn out considerably more amplification of good quality than that given by a triode in similar circumstances, perhaps more than with a triode and an expensive step-up transformer. There is, however, the extra expense of the valve, and an extra voltage tapping. Points in the second round are still fairly level.

But the third round is a walk-over for the S.G. valve, for the damping and mistuning reflected from the anode circuit may be neglected, assuming that the screen electrode is well anchored to earth. If no reaction is used in either case the increased efficiency due to screening puts the S.G. valve ahead of even the transformer-coupled triode, and there is the better selectivity to be taken into consideration. If reaction is used this advantage is lost, except that the absence of "Miller effect" in the S.G. valve may be sufficient to enable provision for reaction to be dispensed with, and that is quite a substantial point in its favour. It should be noted that this third requirement is of special importance in the superhet.

### Screened Pentodes.

The pentode may be regarded as a modified form of S.G. valve, so it is legitimate to consider it here. Its claim for recognition as a detector may be assessed by noting that it is superior as an amplifier where more power than usual is to be handled, and so has a possible field of application, but as at present constructed in Europe its impedance reflection through the inter-electrode capacity is, if anything, worse than in the triode. There is no reason why this should be so except convenience of mounting, and in America pentodes are used for H.F. amplification, by bringing the anode and control grid out at opposite ends and making a true screened valve. Such a valve is perhaps the nearest

**Is the S.G. Valve a Good Detector?—**

approach to an ideal detector, as it scores maximum points under all headings. The Cossor M.S.-PEN-A has recently been produced as a British representative of this class.

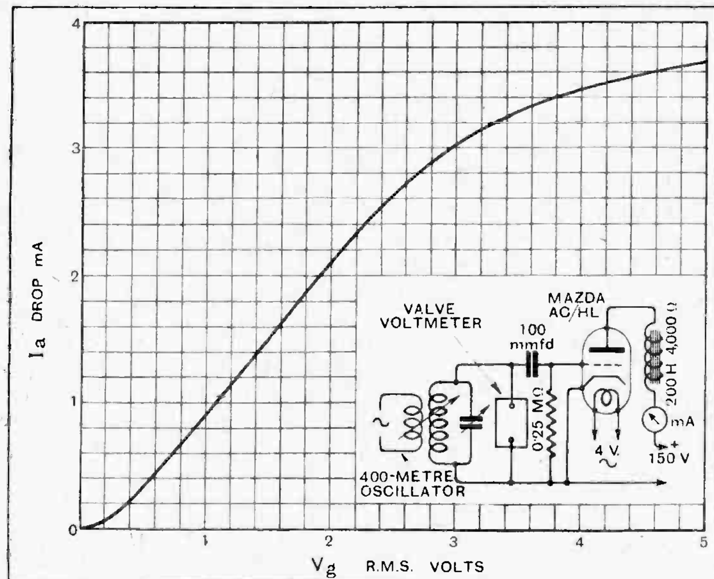



**Fig. 2.—Detector efficiency curves of a typical indirectly heated triode—the AC/HL valve.**

But to return to the normal type of valve, Figs. 2 and 3 show detector characteristic curves of representative triode and S.G. valves respectively. The circuit details are also illustrated, and it will be seen that the curves were taken by applying a 400-metre oscillation of varying voltage $V_g$ to the input and noting the drop in anode current $I_a$. The triode valve AC/HL was working under good power grid conditions and would handle a carrier of about 1.5 volts, heavily modulated, without appreciable distortion. It should be understood that the curve shown is a static characteristic, that is to say, obtained by plotting points for steady input voltages, and therefore the external anode-circuit impedance was limited to the resistance of the choke intended for coupling purposes, i.e., 4,000 ohms. Under working conditions the impedance would be very much higher, which would tend to reduce the curvature still further.

The AC/SG valve, under comparable working conditions and taking about the same normal current, does not handle much over half the input voltage, but the slope is steeper, and as the current swing is maintained much better under working conditions it does not require such a large input as the triode in order to provide the required output. Also the curved foot is only half as large as that of the triode.

In considering this type of curve one is struck by its resemblance to that of an iron-cored inductance.

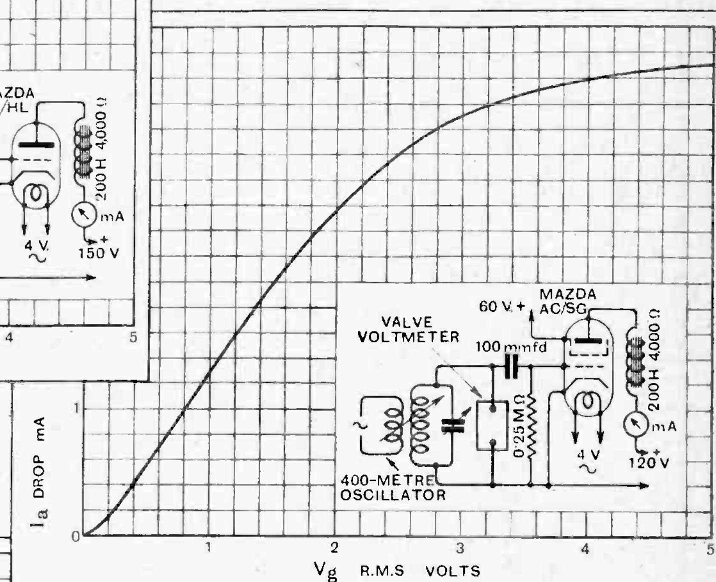



**Fig. 3.—Detection characteristic of a screen-grid valve. Only about half the input, as compared with the triode, can be handled, but the slope is steeper and the current swing better maintained.**

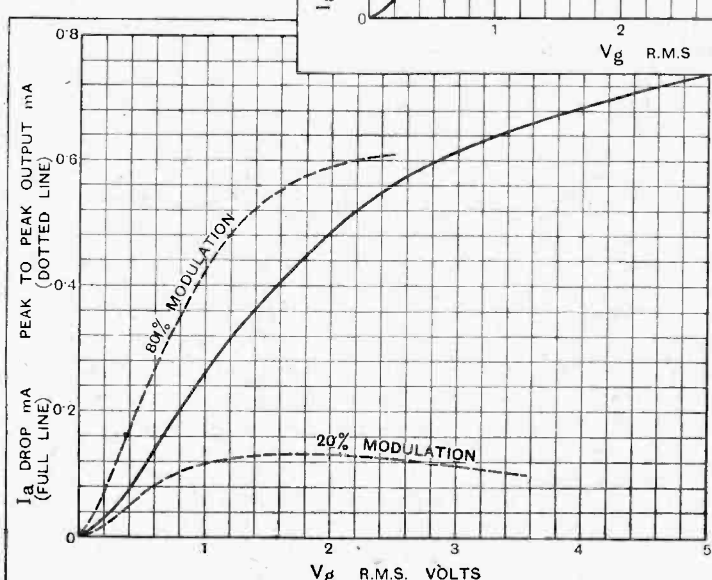



**Fig. 4.—The dotted curves show the distortion due to using a triode as detector with inadequate H.T.**

If the variation in anode current corresponding to the minimum and maximum grid voltage under modulation is plotted, giving the dotted curves in Fig. 4, which illustrate a triode detector with inadequate H.T., it will be seen to fall off on account of the flattening of the anode characteristic, in the same way as the inductance of an iron-core coil falls off due to saturation. The saturation can be minimised by a suitable air gap, and, correspondingly, the characteristics of a detector

**Is the S.G. Valve a Good Detector?—**

are improved by a suitable anode resistor. The output falls off much more seriously when the modulation percentage is low, and, similarly, the inductance of a choke falls off to a greater extent when the superimposed ripple is a small proportion of the steady polarising current.

The difficulties ineffectively utilising the amplification of the S.G. valve have already been touched on. What is wanted is a coupling impedance which is practically constant at all desired audio frequencies. An intervalve transformer does not qualify, for at low frequencies it is inductive, at high frequencies it is capacitative, and somewhere in between it resonates and acts as an immense impedance. It is possible so to design a transformer and associated circuit that the impedance is always large compared with that of a triode valve, and the amplification is thus nearly uniform, but a S.G. valve has too high an impedance for that, even though the situation is eased somewhat at the high-note end by the possibility of omitting the anode by-pass condenser. Granting the existence of a fairly ample H.T. voltage, it is practicable to use an anode resistor of 0.25 megohm, or even more, without noticeable high-note loss, giving an amplification with a modern low impedance high amplification valve of about 200 or even greater, which is more than enough to drive a good power valve or pentode. It is essential, however, to select a working point on the anode curve which permits of the necessary output swing without serious distortion, for, unfortunately, even a 0.25 megohm anode resistor is *not* sufficient to swamp the valve-impedance curvature, as it would do in the case of a triode.

In order to get over the loss of H.T. voltage caused by a large anode-circuit resistance the possibility of using a choke can be considered; 300 henrys is about as much as is practicable when carrying several milliamps., and at 50 cycles that is about 0.1 megohm; so to prevent the impedance rising greatly above this value it is desirable to shunt it with a resistor of about the same value. There will still be a slight loss of low notes, which will probably be made up by the low H.F. damping. The proportion of valve amplification utilised is now lower, but this is compensated for by the fact that the valve amplification itself is higher as a greater H.T. voltage reaches the anode.

**Summary.**

These theoretical results are confirmed by trial, and particular reference may be made to a comparison between the two valves concerned in the curves of Figs. 2 and 3, the AC/HL being coupled by a $1:3\frac{1}{2}$ transformer to a pentode, and the AC/SG by a 0.25 megohm anode resistor (0.5 leak following), with approximately 180 volts overall and 30 volts to the screen. The triode and transformer give an amplification of nearly 100, and the S.G. valve rather more, no reaction being used. With full reaction the balance sways in favour of the triode. It is rather interesting to note that with a 200-henry choke in the anode circuit of the AC/SG, unshunted by resistance other than a 0.25 megohm leak at the pentode grid, 100 volts to the anode and 50 to the screen, the sensitivity is several times greater than with the triode combination, and the quality not as dreadful as would be supposed, but, on the contrary, practically indistinguishable from more theoretically desirable arrangements. This cannot be regarded as a precision test, of course, as many unspecified factors entered into it, but it is interesting.

Summing up, the law of relativity must govern the choice of detector valve. It is not an absolute thing that can be determined without reference to the other circumstances of the case; each must be decided on its merits, and the principles herein discussed will perhaps be of assistance in doing so.

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# *MILLIAMMETER OR KICKMETER?*

## Detecting Output Valve Distortion.

RECENTLY the writer of this note met a man who had just fitted a milliammeter into the plate circuit of his output valve, and who was extremely dissatisfied with its performance. He was a man who believed that if you want a good article you should pay a good price for it; consequently, he had bought a milliammeter that could be classed as a laboratory instrument. Now, such an instrument has a coil of comparatively few turns on a metal former in a business-like magnetic field, and is perfectly dead-beat. Consequently, unless the output valve was so overloaded that the blasting was obvious to any but a deaf mute, the "kick" of the pointer was scarcely noticeable. The function of a "kickmeter" is to give warning of overload *before* the distortion is detectable by ear, and a good dead-beat moving-coil instrument is the most unsatisfactory meter to use. The writer uses a very cheap and nasty moving-iron meter with no sort of pretence at damping; the slightest fluctuation in the plate current sets the pointer quivering. As the pointer is a wide strip of blackened aluminium foil with an alarming spear-head at the end, it can be seen from the opposite side of the room. It may be worthless for any other job, but it is ideal as a kickmeter.

The point is that the kickmeter is not being used as a milliammeter at all; it is being used as an oscilloscope, and there should be a good market for a cheap and effective instrument designed for the purpose. If it does give an approximate reading of the plate current, that is no disadvantage, but it should have a good broad black pointer on a white ground, have negligible damping, and, as an additional refinement, a tapped coil, so that it can be adjusted to bring the pointer somewhere towards the middle of the scale.

D. F. V.

# Unbiased . . . .

By FREE GRID.

### *A Sartorial Experience.*

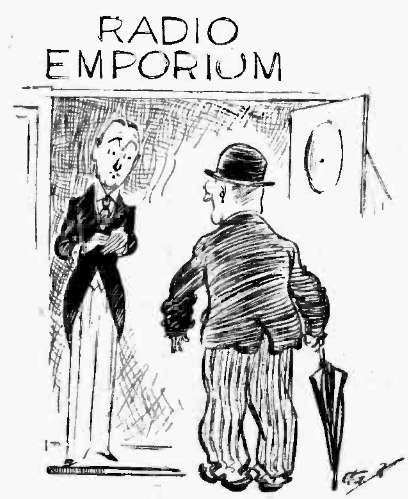
From time to time I have felt it necessary to administer a gentle rebuke in these columns to radio manufacturers for their numerous shortcomings, and it is with all the more pleasure, therefore, that I take up my pen to record an act of what I regard as great generosity on the part of one of them.

It so happened that a relative of mine who possesses a well-known four-valve set had, in the course of house-moving, mislaid the aerial plug. Needless to say, the manufacturer of the set had chosen to make the aerial socket on the set of such dimensions that no other plug would possibly do, so that one would always be compelled to turn to him when a replacement was desired. As the local dealer did not stock the article I promised my relative that I would drop into the West End showrooms of the firm in question and obtain the necessary article the following morning. I noticed as I went in that the commissionaire gave me a rather chilling look, but this was nothing to the frigidity with which I was received in the showroom, which made me think of public mortuaries and similar places of good cheer. I at once perceived to my horror that I was the only customer not attired in faultless morning dress. Furthermore, I was conscious of the fact that the trousers—sorry, "pants" is the correct sartorial expression, I believe—of my lounge suit were distinctly baggy, and were reminiscent of the Old Kent Road rather than Savile Row.

### *For This Relief, Much Thanks.*

I stated my wants brazenly, however, but the vacuous-looking youth who attended to me quickly let me know that they dealt in nothing less than a complete set. To give him his due, however, he was at great pains to direct me to the place where I *could* be served. At his behest I took the first turning on the right and then the first on the right again, and found myself at the back of the building, at what I presumed was the servants' entrance. Picking my way carefully through a lot of old packing cases I approached a greasy-looking youth who was leaning up against a still more greasy-looking counter; rather a contrast, I thought, to the immaculate ones at the front.

"Whatdyerwant?" said the greasy one, with a delightful old-world accent. I repeated my wants, and taking his pencil from behind his ear he proceeded to make out what I, in my commercial ignorance, always vulgarly refer to as "the bill." "One plug, Type so-and-so, 1/-," he murmured, as he wrote, "less 30 per cent., 9d." he droned on, scornfully ignoring halfpennies like a bank clerk. His act of generosity was not finished yet, however, and he proceeded to get into higher mathematics as he endeavoured to find out what was 3 per cent. of 9d., which was evidently an extra discount for cash which he proposed to allow me. He decided in the end, however, that I must be content with what I got, and so it was ninepence that I eventually had to pay; I thought that, to say the least of it, it would be unmannerly of me to point out that I was only getting 25 per cent. and not 30 per cent., as it said on the bill, more especially as I was neither entitled to, nor expecting, any discount at all, and was, moreover, a total stranger. I presumed that I had strayed round to the wholesale counter by mistake, but subsequent investigation has not enabled me to find the whereabouts of the retail counter for replacements, and it would seem, therefore, that it would be infinitely cheaper to buy sets in bits and pieces round at the back rather than to buy them ready assembled round at the front. Apparently I am not the only one who thinks this, as, when I related this instance at a Radio Society meeting, I am sorry to say that many of the low fellows there, instead of going round to the front door in morning dress for their requirements have been deliberately nosing round the old clothes shops and then presenting themselves at the back entrance.



**Received with frigidity.**

### *A.C.* versus *D.C.*

For some little time now I have been an interested spectator of a very intensive fight for life at present being waged between the D.C. mains receivers fitted with the new indirectly heated D.C. valves which have lately appeared upon the market, and the various rotary converters to enable A.C. sets to be used on D.C. mains, which have also made their appearance quite recently.

For years past the A.C. man has been getting all the good things of radio, and manufacturers have, in spite of heated protests, ignored the claims of the D.C. user. In the past year or so, they have woken up and produced the necessary valves and receivers, and, by a not uncommon coincidence, the manufacturers of converters woke up about the same time. One or other must die the death sooner or later, and I am interested in watching to see which.

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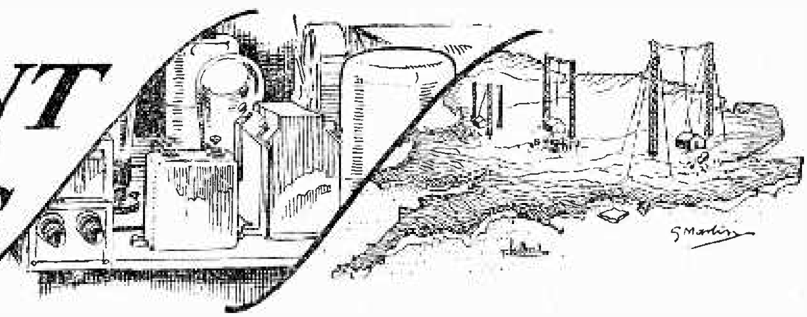
### *In a Plain Van.*

By the way, I have just heard from my dear old Aunt Agatha in the country, who writes to me at great length on the subject of B.B.C. announcers; she is of the opinion that they must have acquired their charming delivery from those speakeasies which the newspapers are so full of nowadays.

# Current Topics



## Events of the Week in Brief Review.

**MORE STATIONS: LESS POWER.**

Finland has decided to reverse the popular slogan, "Fewer Stations: More Power," by declining to increase the power of the Helsingfors station, concentrating instead on the establishment of a chain of twelve low-powered relay stations.

What Finland thinks to-day, Europe may act upon to-morrow.

**TRY THIS ON YOUR CAMEL.**

At a radio rally recently held at Casablanca, the "originality prize" was won by a competitor who came on a camel. His portable (says a correspondent) was hitched on one of the humps, while round his head was a frame aerial "resembling a saintly halo."

**UNVEILING A STATUE BY RADIO.**

On October 12th Senatore Marconi will repeat his famous relay experiment of two years ago when, by means of a short-wave signal from his yacht "Elettra," he lighted the electric lamps at an Australian exhibition. This time the same method will be employed to unveil the great statute of Christ at Rio de Janeiro. The statue is 150 feet tall and stands at the top of the Corcovado Mountain, overlooking the city.

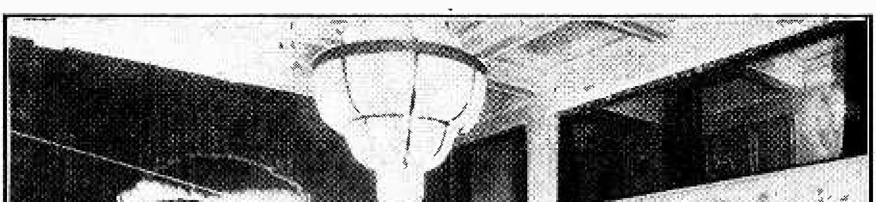
**DON'T FORGET OLYMPIA.**

Already it is certain that the coming National Radio Exhibition at Olympia, opening on September 18th, will be the largest of its kind ever held in any country. There will be more than 450 stands.

It is worth noting, too, that there are more "secrets" and "surprises" waiting than ever before.

**AN ANTI-STATIC COMMISSION.**

Congratulations are due to the French Minister of Public Works for deciding to establish a Commission to enquire into means of preventing disturbance to broadcast listeners by high-power lines and electrical apparatus. We learn that the Commission is to be thoroughly representative, and that with this aim in view the authorities are inviting delegates from the radio clubs and other interested bodies.



**EUROPE'S MOST POWERFUL BROADCASTER. A view in the imposing main studio at Warsaw, the 158 kW. station which was constructed by the British Marconi Company. Warsaw is heard at excellent strength in most parts of Britain.**

**THE RELAY QUEUE.**

Five wireless relay companies have applied for permission to supply a service to the City of Hereford. They must wait patiently till October, when the Council meets.

**THE "MODEL ENGINEER" EXHIBITION.**

Radio and other electrical hobbies will be well represented at the "Model Engineer" Exhibition, to be held at the Royal Horticultural Hall, Westminster, from September 3rd to 12th.

**WHY LADY ANNOUNCERS MUST GO.**

Recently we were much distressed to learn that lady announcers would soon disappear from the Italian ether. A correspondent who has been enquiring into the matter informs us that the reason for the forthcoming dismissals is not, as was supposed, that the ladies are unpunctual and perfunctory in the performance of their duties. The real reason is "that threequarters of the correspondence received by the Italian stations has consisted of burning love missives addressed to the 'speakerines.' The station directors think that there can be too much of a good thing, and are arranging to bring about a 'fading' of these amorous waves."

**MOSCOW TO CALL AFRICA?**

Russian radio plans for the coming winter may include a special "barrage" in the direction of South Africa. According to the *African World*, the Soviet authorities will endeavour to reach the masses in Johannesburg and Cape Town by means of the new and powerful station now in course of erection near Moscow. The reference is obviously to the 200 kW. transmitter at Noginsk.

Up to the present no Russian station has been heard regularly in the Union.

**WHERE WIRELESS IS ESSENTIAL.**

Every room in the new wing of the Royal Northern Hospital at Holloway, London, is equipped with a telephone and a wireless set.

The St. David's wing, as it is called, is designed to provide accommodation at a small inclusive fee for people of the professional classes who cannot afford nursing-home fees.

**"RADIO WEEKS" IN THE WEST.**

Bristol will hold its second radio week from September 19th to September 27th. Cardiff will make the experiment for the first time at the end of October.

**THE LATE MR. R. C. CLINKER.**

Mr. Richard Charles Clinker, who met his death in tragic circumstances while mountaineering in Wales last week, was chief research engineer of the British Thomson-Houston Company, Rugby. Although in recent years he had specialised less in radio problems, Mr. Clinker was at one time well known among wireless workers as a writer on radio topics and research.

**WHAT NOT TO EXPECT.**

Hopes that the Vatican broadcasting station would send out regular programmes for the benefit of the world at large were dispelled on August 3rd, when the authorities issued the following unequivocal statement :—

"We do not and will not have regular broadcast programmes. Hours have been fixed for transmissions at 11 a.m. (British summer time) on a wavelength of 19.84 metres, and at 8 p.m. on a wavelength of 50.26 metres. At these times the station will send out news, notices, and letters addressed to the missions.

"On Sundays and other feast days at 11 a.m. liturgical and spiritual letters are read for the sick."

**POSTMEN TO COLLECT FRENCH LICENCE FEES.**

General Ferrié and a technical committee are carving up a map of France into a number of broadcasting circles indicating service areas which could be covered by stations of 60 kilowatts, writes our Paris correspondent. When completed, the plans will be passed over to M. Guernier, the most radio-minded Premier that France has ever had, and it is believed that, thus armed, this energetic politician will soon press forward the new Broadcasting Bill, which has been languishing "on the shelf" for many months."

It appears that when the scheme is in operation, not all the wavelengths allotted by the Prague Plan will be required by the Government, and the hope is held out that a few superfluous channels will be available to private users.

Revenue for the new scheme will be obtained through a valve tax and "a tax on apparatus collected monthly by postmen."

**NEWSPAPERS' "COUPS" BY BROADCAST.**

When the ordinary Russian listener has retired for the night the Moscow stations now transmit a special service for the benefit of country newspapers. Reporters take down the news from rapid dictation, and next morning the local "rags" glisten with the same stories of crime, politics, passion and market activity as the journals of the metropolis.

In Russia the problem of broadcast competition with the Press does not exist.

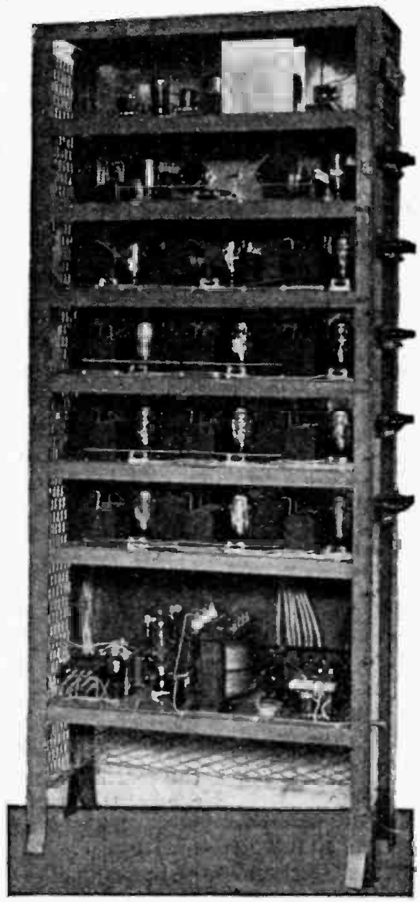
**GIANT TRANSMITTER FOR MUNICH.**

Another entry in the European race for broadcast power will be made in January next, when Bavaria will open a new transmitter at Goldachof, near Munich, with a power from 75 to 150 kilowatts.

**ANOTHER ROYAL LISTENER.**

"One cannot live now without radio," said The Dowager Queen Marie of Roumania, in a recent interview. "When you have a good apparatus," added Her Majesty, "you need not take any of the great express trains to find out what is going on in the world."

The Queen spends many hours listening to programmes, not only from Bucharest, but from Britain and France. She is especially fond of the transmissions from London.



**AUTOMATIC HOSPITAL SET.** Designed and constructed by Mr. F. W. Murthwaite, A.M.I.R.E., this receiver has been installed at Tooting Bec Hospital. The circuit consists of band-pass aerial tuner, power grid detector, intermediate L.F. valve and ten LS6a and four LS5a power valves. The set is automatically switched on and off three times daily.

**GRAMOPHONES ARE POPULAR.**

Broadcast reception is the rich man's pastime in Bulgaria, where the annual receiving licence costs about £4. A receiver intended for operating a public loud speaker is taxed at £20, which perhaps explains why anti-loud speaker bylaws are unnecessary.

**"NEW WINE IN OLD BOTTLES."**

We regret that, owing to a printer's error, a mistake occurred in the article bearing the above title in our last issue. The formula given on p. 133, col. 1, line 27, should read :— $\frac{\mu}{\sqrt{R_a}} \times 100$.

**RADIO INVITATIONS TO THE WORLD.**

The Olympiad Committee (which, by the way, has no connection with the organisers of the National Radio Exhibition) has fixed up an arrangement with the American Radio Relay League whereby its members will co-operate with 30,000 brother amateurs in all parts of the globe in issuing radio invitations to the Olympic Games, which are to be held at Los Angeles next year. Nearly fifty countries will be swept by these expressions of hospitality.

It is wisely pointed out that in many countries special governmental permission must be secured by amateurs desiring to handle these messages. Count de Baillet-Latour, president of the Olympic Committee, is personally endeavouring to bring his influence to bear upon the authorities concerned, and we wish him success, particularly when he asks the indulgence of the British Post Office.

**CHINESE FIVE YEAR RADIO PLAN.**

Chinese railway stations—the favourite rendezvous of the population in their leisure hours—are to be the venue of a great loud speaker campaign to urge the benefits of broadcasting. The province of Chekiang has gone so far as to organise a Five Year Radio Plan, with the object of establishing a broadcasting system on a sound basis.

**ALL ABOUT RADIO LAW.**

The legal side of wireless has developed so much in recent years, particularly since the advent of broadcasting, that several universities in America devote special courses to the subject. And now Mr. Frank Stollenwerck, A.B., LL.B., lecturer on Radio Law at the University of Baltimore, has produced the first "Key to Radio Laws, Regulations and Procedure," dealing with the multitudinous rules and regulations of the Federal Radio Commission. The book gathers up the tangled skeins of court decisions, collisions with authority, and rulings on hard-fought questions affecting wavelengths, modulation, power and hours of service.

A unique feature is that the book has no end; many tough knots have still to be unravelled, and in order that lawyers, engineers, technicians and laymen may follow the gyrations of the legal position from hour to hour a loose-leaf section is included which will be constantly fed by a service of supplements.

We wish that some such vade-mecum could be prepared for European wireless users, but when we tune in to the Continent we begin to wonder whether there are at present any laws worth cataloguing.

# PHILIPS

## All-Electric D.C. Receiver Model 2653

### Technical Details and Performance of a New Season's Model.

THIS D.C. console model forms part of the Philips programme for the coming season. It is an imposing instrument and is built into a cabinet of unusually massive construction. For instance, the quartering of the front panel is not a veneer finish, but is carried through the full thickness of the wood, the crossing of the grain thus forming a loud-speaker baffle which is acoustically dead and free from resonances.

To preserve as far as possible the lines of the cabinet, the controls, instead of being assembled on a tuning panel, are spaced apart at intervals round the front and sides. The illuminated bevel tuning scale is viewed through a window in the centre near the top of the front panel. On the right of this is the wave-range switch and on the left a dual volume and tone control. The mains on-off switch is mounted on the right-hand side panel and the local distance switch on the left. The receiver is of Dutch origin, and the mains switch operates in the opposite direction to that usually adopted in this country.

#### Metal-coated H.F. Valves.

The circuit and chassis layout, while showing numerous advances in design, give ample indications of their relationship to the well-known Philips type 2511 receiver. There are two H.F. stages with tuned anode coupling and ganged tuning, grid detection, and a transformer-coupled L.F. stage.

In the H.F. stages the new metal-coated P.M.13 screen-grid valves are used, the first valve having a variable shunt resistance across the filament for the purpose of volume control.

The input circuit is adapted for either frame or outdoor aerials, and a local distance switch is provided for reducing the input from the local station. The switch brings into circuit an additional condenser $C_2$, which forms, in conjunction with $C_1$, a capacity potential divider in parallel with the input circuit.

The grid circuit of the detector is provided with two grid condensers and leaks. One pair is adjusted for H.F. coupling and the other for rectification. Connections for an external pick-up are introduced at this point and the grid lead is screened to prevent undesirable pick-up when using the radio side. It will be noticed that blocking condensers are inserted in both leads to protect the circuit from accidentally earthing of the pick-up.

The connections of the parallel output valves appear at first sight to be complicated. The decoupling of the input grid circuits is necessitated by the fact that the filaments are in series and that a higher value of bias must be found for the first than for the second valve to compensate for the volt drop in the filaments. The valves are transformer coupled to the moving-coil loud speaker, and terminal sockets $L_1$ and $L_2$, connected to tappings on the secondary, are provided for external loud speakers of either low or high impedance.

In D.C. mains receivers the maintenance of a steady filament current is important. This is ensured by the inclusion of a hydrogen-filled regulator lamp which automatically adjusts its resistance to compensate for fluctuations in the mains voltage. The pilot lamp illuminating the tuning scale serves as a fuse to protect the circuit. Safety contacts are also fitted to the back panel to isolate the receiver when the back is opened for inspection.

Before testing the set the total current consumption was tested and found to be just over 0.3 amp. This includes the current for the loud speaker field winding.

**SPECIFICATION.**

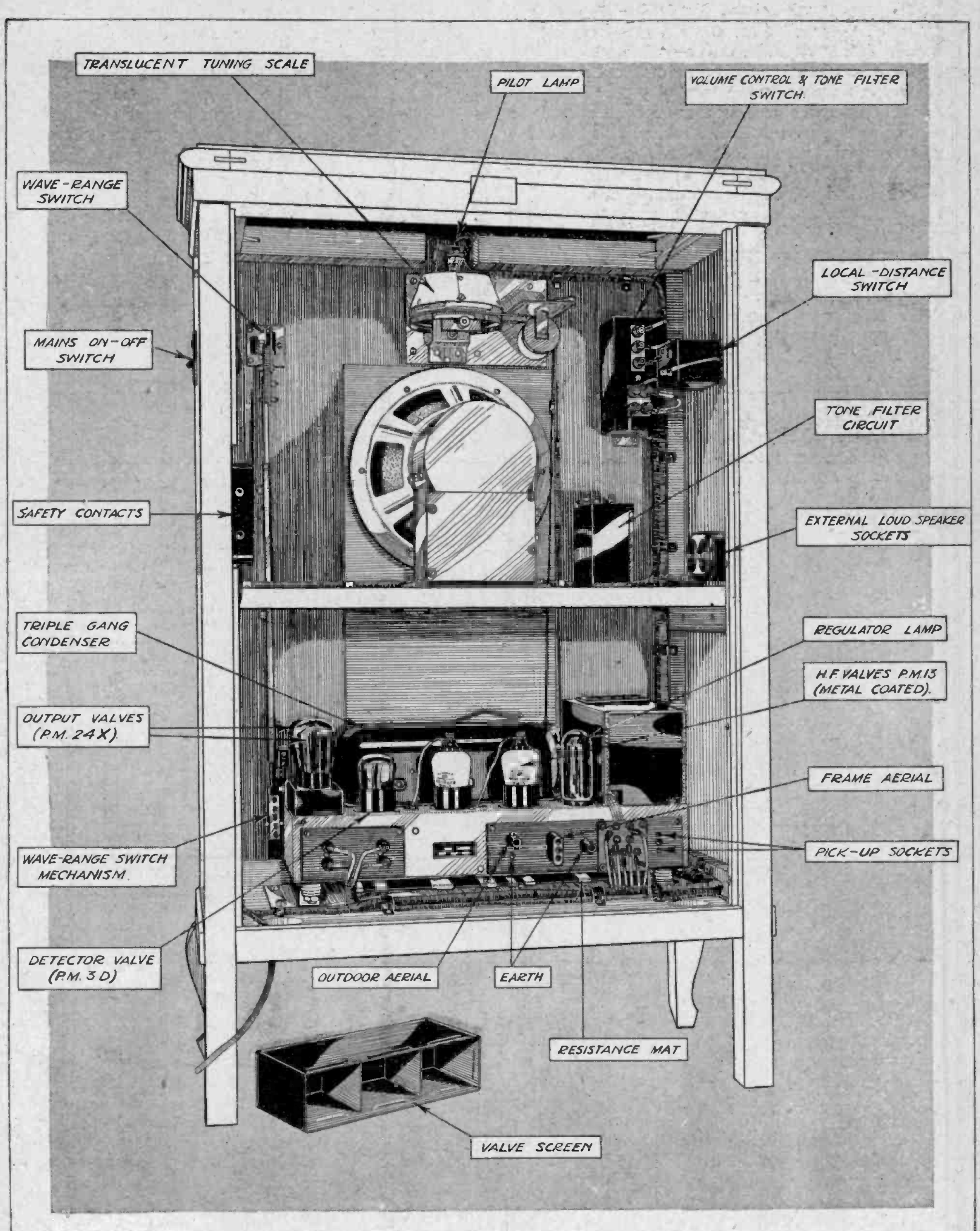
*CIRCUIT: Two screen grid H.F., grid detector, two pentode output valves in parallel. Ganged tuning.*

*CONTROLS: (1) tuning, (2) volume, (3) tone, (4) local distance switch, (5) mains on-off switch.*

*GENERAL: Moving coil loud speaker. Automatic current regulation. Provision for pick-up and external loud speakers. Alternative frame or outside aerial.*

*PRICE: £39 10s.*

*MAKERS: Philips Lamps Ltd., 145, Charing Cross Road, London, W.C.2.*

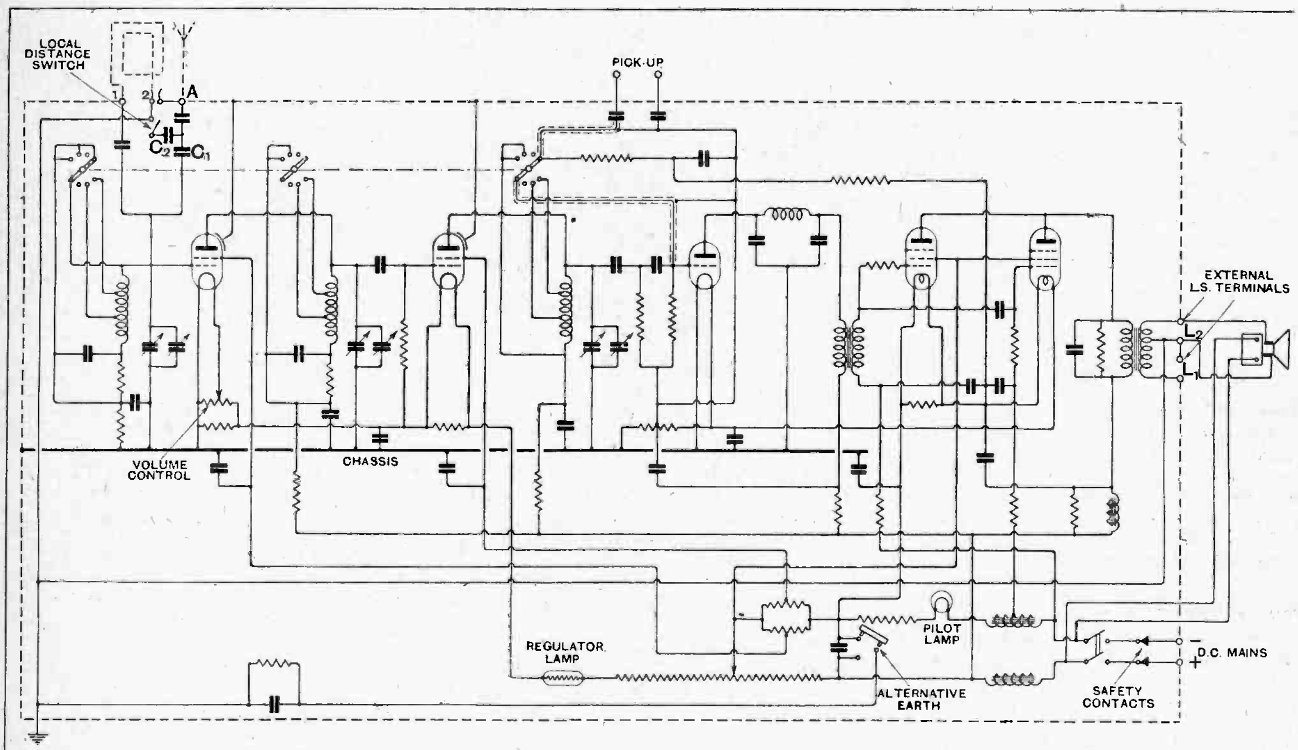



**Philips type 2653 D.C. mains receiver with back panel removed.**

**Philips All-Electric D.C. Receiver Model 2653.**—

The sensitivity on all three wave ranges is of a high order and should be capable, with a good outdoor aerial, of bringing in all Continental programmes that are worth listening to from a programme point of view. The local distance switch may be brought into use with advantage when receiving the new B.B.C. National and Regional transmitters within a radius of 15 miles, as adequate volume is obtained under these conditions with a reduction in background noises. The sensitivity is noticeably higher at the lower end of each wave range, but as the two medium wavebands overlap considerably the choice of two alternative settings is available for most stations below 500 metres. In general, the highest sensitivity will be found on the higher of the two wavebands where the ratio of inductance to capacity, for a given station, is greatest.

The volume control is smooth in action and is commendably free from the time lag often associated with filament current volume controls. It gives a satisfactory low minimum and does not provoke oscillation in the H.F. stages when at maximum.




**Complete circuit diagram of Philips type 2653 receiver.**

### Selectivity.

The selectivity is adequate for modern conditions in the ether, and at a distance of 15 miles from Brookmans Park interference was not experienced from either station outside a zone of two degrees on either side of the true settings on the tuning scale. When a station can be tuned in on both the middle (300-800 metres) and lower (200-500 metres) wavebands it will be found that the greater degree of selectivity will be obtained on the lower waveband, since the ratio of capacity to inductance will be higher.

The quality of reproduction provided by the type 2064 is notably rich in the bass. The higher frequencies are present up to at least 6,000 cycles, but are not sufficiently obtrusive to cause harshness. The tone filter, however, clearly shows their importance, for the quality becomes soft and round when it is brought into operation. At the same time, the reproduction is definitely more pleasing with the filter in action during periods of interference from heterodyne whistles or atmospherics. Actually the filter cuts off sharply above 3,500 cycles without affecting the reproduction below that frequency.

### Ample Volume.

The undistorted volume provided by the two parallel pentode valves is sufficient for the largest rooms likely to be found in any private house. It is possible to overload the valves, however, but when this happens visual warning is given by the flickering of the pilot light due to fluctuations in the mean anode current taken by the valves.

Constructionally, the receiver is exceptionally well turned out. The mechanical parts, such as the switch gear and condenser drive, are both ingenious and reliable, and the wiring between units is neat and substantial.

In conclusion, no trace of mains hum could be detected, even with the receiver detuned and the volume control at maximum.

# Broadcast Brevities

*The masts at "Broadcasting House" are useful as well as ornamental.*

*Our photographer climbs as near as he can to the Heaviside Layer.*

*By Our Special Correspondent.*

**That Synchronisation Test.**

The B.B.C. engineers will have a tough fight if they are to make a success of the Newcastle-Moorside Edge synchronisation test. The experiment was always regarded as a rather daring one, and now the public are endorsing this view with a vehemence which must be very disturbing to Mr. Ashbridge.

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**Heterodyning.**

In Newcastle itself no trouble seems to be experienced from running the local transmitter on the same wavelength as Northern Regional, but on the outskirts of the Newcastle service area the heterodyne whistle, particularly on the first two days of the test, seems to have been most marked. Better synchronisation is now being achieved, but it would not be surprising if the idea were ultimately abandoned.

It is one thing to synchronise widely spaced relay stations of low power, and quite another when one of the transmitters is putting out 70 kilowatts.

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**To Be or Not to Be.**

I understand that Mr. Ashbridge will definitely decide before the end of August whether the present arrangement is to continue.

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**B.B.C. and the Economy Committee.**

If and when the report of the Economy Committee is acted upon, it is very unlikely that the B.B.C. will oppose the revenue reductions which have been proposed in the interests of national economy.

The sacrifice entailed would amount to some £475,000 for 1932.

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**The Regional Scheme.**

It is most important to note, however, that projects like the Regional Scheme and the reconstruction of Daventry 5XX would not be affected. A noteworthy recommendation of the Committee is that the Corporation's liabilities should be taken over by the Government when the Corporation ceases to exist.

This provision would enable the B.B.C. to borrow the required money while being free from the necessity of clearing up all debts by 1936.

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**Dance Lessons by Wireless.**

During the coming winter it is hoped to broadcast from Scottish stations a series of lessons in Scottish national dances. This is a development of the experiment carried out at the London station two or three years ago, when M. Santos Casani gave a series of dancing lessons. Recently a test has been conducted by a Scottish teacher of dancing who, unseen by his pupils, instructed them successfully in the exact motions.

**Filling the Niche.**

The exterior of "Broadcasting House" still awaits the finishing touch which will be given to it when the gaping niche over the main entrance is filled with Mr. Eric Gill's group of statuary. I hear that the sculptor has completed his model and is now working in the stone.

Although "Ariel and Prospero" are not yet on public view, I can say that they infringe no copyright of Mr. Epstein.

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**A Gloomy Interior.**

The electricians have now completed their colossal task of wiring the control room, which is situated at the top of the building, with wiry tentacles reaching out in all directions.

Apart from this step forward, the interior still wears a very primitive aspect. The plaster walls have a mud and wattle appearance, and the place is as dark as a crypt. No doubt things will brighten up when the walls are distempered.

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**Buying the House Next Door.**

As I ventured to forecast many months ago, "Broadcasting House" will be too small for its purpose. Hence the negotiations which are already going forward for the purchase of those fine old Regency houses adjoining the new building. These, I suppose, will be pulled down, one by one, until "B.H." eventually extends from Regent Street to Regent's Park, with a studio annexe in the Zoo.

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**The Bach Cantatas Again.**

The Bach Cantatas will be reinstated in the Sunday programmes on September 6th after a ten weeks' rest. The first Cantata to be given will be No. 17, with Percy Pitt as conductor; it will be relayed from All Saints' Church, Margaret Street.

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**An Exclusive Club.**

One day, perhaps, a club will be formed which will be the most exclusive in the world. This sacred little colony will consist of those few celebrities who have never at any time been considered as prospective Governors of the B.B.C.

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**Non-runners?**

Another crop of nominations for the B.B.C.'s governing board has recently been exposed to the public gaze, but if my information is correct, it is extremely unlikely that any of the persons mentioned will be asked to serve.

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**Sir Robert Donald.**

If I might put forward a "probable runner," I would mention the name of Sir Robert Donald, G.B.E., who has always taken a keen interest in wireless administration. An untiring writer in the cause of radio development, Sir Robert was chosen as chairman of the Wireless Telegraphy Committee which, in 1924, recommended the extension of our Empire wireless service. Since then he has watched the growth of broadcasting with a fatherly eye which would add confidence to the deliberations at the Governors' round table.

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**Relaying the St. Leger.**

A running commentary on the St. Leger will be relayed from the Doncaster course on the National Wavelengths on September 9th. This will be the fifth year in succession that the B.B.C. has broadcast a description of the last great classic of the season.

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**"L.G.'s" Wireless Set.**

There was more romance than truth in the story that B.B.C. engineers had installed a broadcast receiver at Mr. Lloyd George's bedside in London to enable the sick statesman to hear the Eisteddfod relay from his native country.

The true story is the much less satisfactory one that the engineers installed a set at Mr. Lloyd George's home at Churt, Surrey, a few days before his illness. The set has not yet been used.

# "The Upper Register"

by
N. W. McLACHLAN, D.Sc., M.I.E.E., F.Inst.P.

## How the Size of the Cone and Coil Mass Influence Resonances.

(Continued from page 109 of previous issue.)

THE reader must realise that the data given apply to the diaphragm and coils specified. Since a large number of commercial speakers use diaphragms of somewhat similar size, the conclusions are not wide of the mark in general. It should be noted that the coils cited in connection with the experiments are wound on paper tubes and not on paxolin. To appreciate the influence of the latter, curve 3, Fig. 4 (in last week's instalment) should be examined. We still have the 2,000 cycle resonance—with a slight valley on the peak—and the upper register does not fall away so rapidly, in fact, on broadcast reception the reproduction was quite good. But the overall output is much reduced, due to the paxolin (effect of large mass probably). This is seen by the resistance values as compared with those of curve 2, Fig. 4.

The next step in the argument is to show a way in which the coil itself *might* be associated in aiding the upper register. If we consider the process of energising the diaphragm, it is clear that to get electrical energy transformed into sound energy the coil must move axially (i.e., in and out of the pot). When the coil moves sideways, i.e., at right-angles to the axis, it does not cut the magnetic field to any appreciable extent. In fact, any output obtained from sideways motion is due to non-uniformity of the radial magnetic field, i.e., throughout the *radial length* of the gap—not the axial length, as shown in Fig. 5, *The Wireless World*, November 26, 1930. Now when a coil flexes after the manner illustrated in Fig. 7, it may be difficult to see why it moves axially to and fro. Instead of attempting to explain the geometry of this problem by a lengthy description, I ask the reader to study Fig. 7 and to take a diaphragm—more particularly one with a flexible coil and a free edge—and squeeze the coil at each side between the thumb and forefinger. He will then see that the coil not only moves inwards and downwards, but that the periphery of a free-edge cone becomes oval. When it is stated that a few millionths of an inch axial motion of a diaphragm at 4,000 cycles constitutes a reasonably audible sound, there ought now to be no difficulty in understanding the action of the coil when it flexes. When a coil is driven axially as in the M.C. speaker, difficulty may be experienced in conceiving why it should flex at all. But the same difficulty arises in connection with the radial (flexural) modes of a disc or a free edge cone. The bending of the edge of a cone is easy to demonstrate by the Neon lamp method. In some cases the bending can be seen with the naked eye due to peculiarity in the motion.

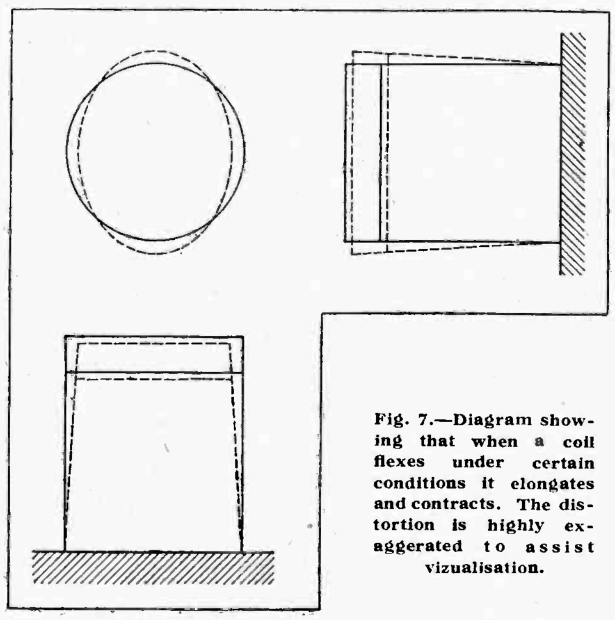


Fig. 7.—Diagram showing that when a coil flexes under certain conditions it elongates and contracts. The distortion is highly exaggerated to assist vizualisation.

To obtain experimental data concerning the preceding argument, the following test was performed. The lower end of the neck of the coil—this being the cylindrical former—was serrated, folded over and glued securely to a lead block weighing about 10 to 12 lb. The magnet pot was placed in a vertical position, and the coil arranged in the air gap, as illustrated diagrammatically in Fig. 8. Resistance measurements were then made as in the preceding experiments. On first thoughts one might imagine that the apparent radiation or output resistance of an arrangement like this would be zero.

The block is so heavy that it cannot be moved perceptibly by the coil, and this is undoubtedly true. But if we consider the block to be immovable, the coil can either flex or stretch the paper former. Actually it does both, as we shall see presently. If a sine-wave oscillator is applied to the coil and the frequency varied, the sound is very weak indeed, but can be heard by applying one's ear to the lead block—preferably through a piece of cloth, as "neat" lead feels extremely cold! The sound reaches its maximum value when the coil oscillates on the neck as though it were a simple coil spring—see Fig. 9. This is called the longitudinal mode of oscillation, since the neck acts as a spring, which elongates and contracts with variation in current (i.e., the current alternates thereby altering the direction of the force on the neck). The results of a bridge test on a high-resistance coil of 1,000 turns of 47 enamelled wire bakelised, are given in Fig. 10. Resonances due presumably to flexure of the coil occur at 1,670, 2,250, 2,650, etc., cycles, whilst at about 5,000 cycles the coil

**"The Upper Register."—**
oscillates longitudinally on the paper neck and the resistance shoots up to over twenty times its value at 3,000 cycles.

As regards the flexural oscillations, we see that they occur in the region 1,600 to 4,000 cycles, just where the upper register is enhanced when the coil drives a diaphragm. It will be evident that if the coil can flex adequately when securely fixed to a huge block of lead, it can surely flex more when mounted on a paper cone. Also, in the latter case one would expect the flexural frequencies to be somewhat different from those on the lead block, due to the lesser restraining influence of the cone.

In the article on the lower register (May 6th and 13th, 1931), I pointed out that the resistance due to the iron losses differed when the coil was fixed and free. Moreover, the values of radiation resistance below 3,000 cycles being quite small, an appreciable proportion may be due to variation in iron loss. Since no peaks were obtained in the radiation resistance curve of a 28 s.w.g. coil, it seems reasonable to suppose that those at 1,670, 2,250, 2,650, etc., cycles, were due to resonance of the 47 s.w.g. coil.

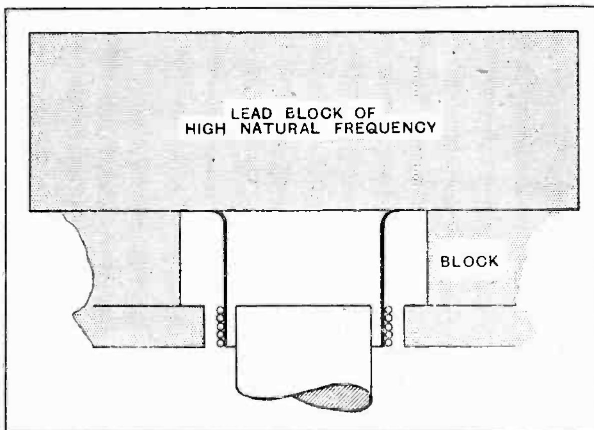
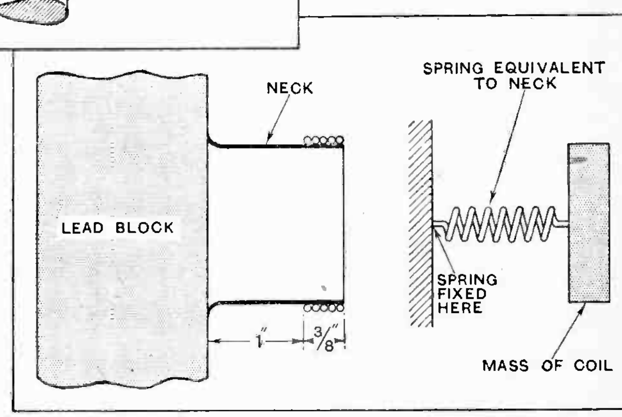



**Fig. 8.—(Left) Diagram showing disposition of coil, magnet and lead block for tests on flexural and longitudinal resonances of coil wound on long former (about 1 inch free length).**

**Fig. 9.—(Below) Simple diagrammatic arrangement of coil and spiral spring—equivalent to coil on paper former—illustrating the longitudinal mode of oscillation of the coil on the former.**




Due to the variation in iron loss, the difference between the fixed and free resistances of a permanent magnet M.C. speaker tested early in 1928 was negative at frequencies above about 4,000 cycles. At first, the possibility of a negative sound output was rather startling! Variation in iron loss seemed the only explanation, and this was subsequently confirmed. The fickle behaviour of the iron introduces considerable difficulties when accurate measurements of the sound output from a diaphragm are required at the higher frequencies.

The lead block experiment illustrates the impossibility of preventing motion of the coil by merely loading up the diaphragm alone with sand or a heavy block. In fact, I have found that the only way to fix a coil in the magnet at high frequencies is to run it in solid with paraffin wax or glue of some kind.

Let us consider the very powerful resonance at 5,250 cycles per second. The neck of the coil is about four times as long as that used in practical reproducers. The frequency of the coil oscillating on a short neck (say ¼in. long) would be in the neighbourhood of 10,000 cycles per second. This is actually much lower than the frequency obtained with the coil secured to a paper diaphragm whose effective mass at high frequencies is insignificant compared with that of the lead block (see Fig. 11). Thus in a loud speaker whose diaphragm conforms to the dimensions of Fig. 2, but with a coil neck of the usual length (¼in. or less), the longitudinal resonance lies beyond 10,000 cycles and can, therefore, be disregarded. If the mechanical properties of the paper are known the longitudinal resonance frequency for the lead block experiment can be calculated. In the present series of tests the calculated and experimental values were in quite good agreement.

### Effective Mass of Diaphragm.

Reverting to the effective mass of the diaphragm, the curves of Fig. 11 may be of interest. The full line curve 1 refers to a diaphragm with a reinforced edge but no surround. The effective mass rises with frequency partly due to accession to inertia (*The Wireless World*, March 30th, 1927, also *Philosophical Magazine*, Vol. VII, Suppl., p. 1024, 1929; Vol. 9, p. 35, p. 1137, 1931), and partly to the mechanical properties of the diaphragm up to 600 cycles. Thereafter it falls until in the region of 900 cycles (first symmetrical resonance) it is a minimum. Above 1625 cycles it is actually negative. Bearing in mind that inductance is equivalent to mass, negative values of these two quantities are comparable. Negative inductance means capacity which is equivalent mechanically to a compliance or spring effect. In other words, a negative mass is equivalent to an elastic effect, i.e., the diaphragm behaves as a spring.[1] Above 2,000 the mass becomes positive again, but its value is relatively small.

The dotted curve 2 is for a similar diaphragm with a rubber surround. The latter causes the mass to become negative in the neighbourhood of the resonance

[1] Those interested in this problem should refer to Warren's analysis of flat discs (*Philosophical Magazine*, May, 1930), and to the experimental confirmation by Mr. Sowter and the author (*Philosophical Magazine* January, 1931). It should be noted, however, that cones and discs behave quite differently.

**"The Upper Register."—**
frequency (of the surround *per se*). The usual minimum occurs about 750 cycles, whilst at 2,000 cycles or thereabouts the effective mass is small, i.e., near the second symmetrical mode.

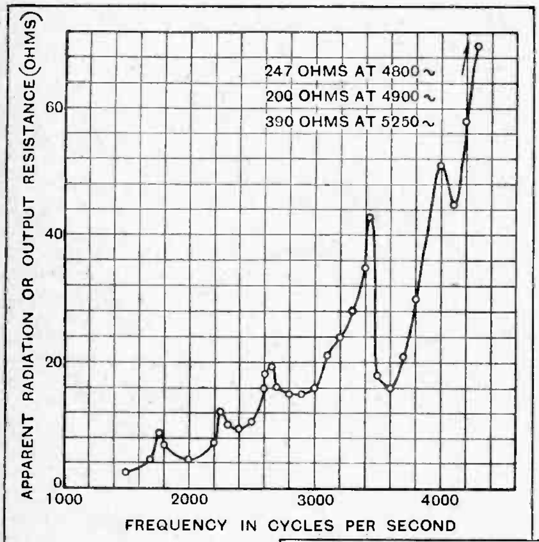
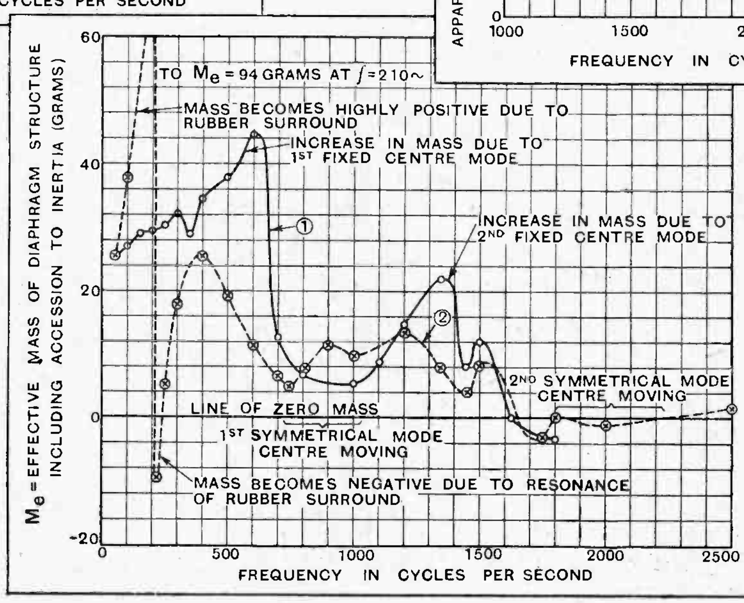



**Fig. 10.—(Above) Curve showing resonance of coil on a paper former.**

**Fig. 11.—(Right) Curves showing effective mass (including moving coil and accession to inertia) of diaphragms (1) reinforced edge (2) rubber surround.**




Measurements on an aluminium disc and on a 160° cone revealed negative effective masses—just after the first centre stationary mode of vibration—many times the natural masses of the vibrating diaphragms. Actually, as shown in the first instalment of this article, this is a position of minimum amplitude and not of complete rest owing to transmission and radiation losses.

### Influence of Coil Mass and Size of Cone.

As a special example of a coil of reduced mass we can quote a case where the outer layer of 20 turns was removed from one of the 40-turn 28 s.w.g. coils. This left only one layer, so that the mass of the coil was about one-half of its previous value. The output resistance for this case is shown in curve 1, Fig. 12, whilst curve 2—reduced to a 20-turn basis for quantitative comparison—is that for the coil before half its turns had been removed. There is no doubt that the upper register has been extended appreciably by removal of the outer layer of the coil. In fact, from 2,400 cycles upwards this register is *actually* more powerful with the 20-turn than with the 40-turn coil. The resonance with the 40-turn coil extending from 1,700 to 2,000 cycles is, of course, associated with the second or major centre-moving symmetrical mode of the conical diaphragm discussed earlier.

### The Dimensions of the Cone.

We now come to the influence of the dimensions of

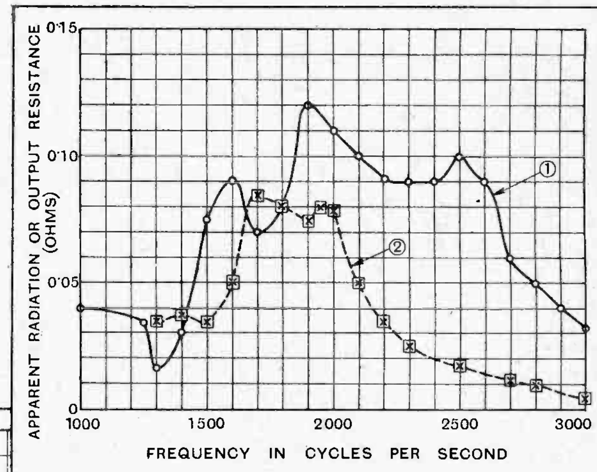
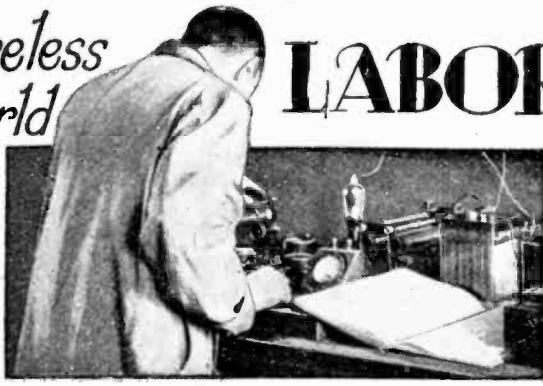



**Fig. 12.—Curves showing effect on output resistance of halving the number of turns on a coil driving a standard diaphragm. Curve 1 = 20 turns of 28 d.s.c. Curve 2 = 40 turns of 28 d.s.c. with output reduced to 20 turns level for comparison.**

the cone upon the resonance frequency. Apart from the thickness of the paper and the diameter of the coil, there are two dimensions which can be varied, namely, the angle at the apex and the diameter at the mouth or open end. Assuming the angle at the apex (apical angle) remains unaltered, what happens if we take a standard diaphragm, as shown in Fig. 2, and cut a portion off the base, thereby reducing its diameter? The answer is obviously that the resonance frequency—i.e., the major symmetrical resonance—will increase. With a free-edge cone whose radius is 12 cm., and apical angle 90°, the main resonance occurs about 2,000 cycles. When the radius is 7.6 cm. (6in. diameter) the main resonance (second symmetrical mode) occurs about 2,700 cycles.

Taking the same kind of paper and making the apical angle 130°, what do we find? Clearly, the stiffness of the cone is now reduced because it approaches the paper disc stage. (*To be concluded.*)



# Wireless World LABORATORY TESTS

Review of New Radio Products.

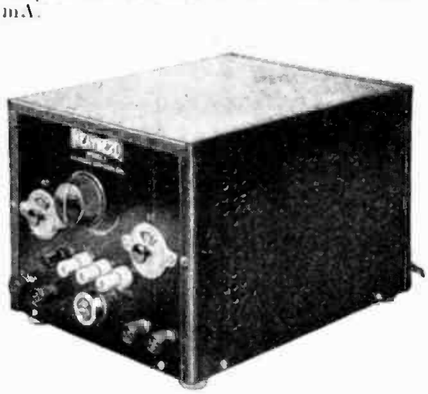
## HEAYBERD ALL-ELECTRIC UNIT. Model E150.

This unit has been designed to serve a dual purpose; it provides H.T. for those possessing battery-operated sets, and, in addition, trickle charges the 2-volt accumulator, or, if a change has been made to A.C. valves, provides 4 volts A.C. up to 4 amps. The H.T. output is limited to 25 mAs. at 150 volts from the power tapping and, in addition, there are two intermediate tappings, one rated at 120 volts and the other a variable output derived from a potentiometer arrangement, and intended as a screen potential for S.G. valves. All intermediate tappings have separate voltage dropping resistances and by-pass condensers, and the smoothing is adequate for all normal requirements

The output from the 4-volt L.T. winding was measured with current loads up to 4 amps., and with the H.T. side delivering 25 mA. at 150 volts using a fixed loading resistance. The measured L.T. voltages are as follows :—

1 amp. 4.6 volts (R.M.S.).
2 amps. 4.4 ,, ,,
3 ,, 4.15 ,, ,,
4 ,, 4.05 ,, ,,

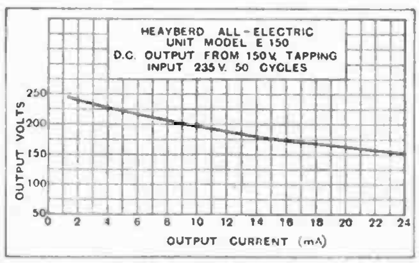
When current is drawn from the L.T. winding a small reduction occurs in the output from the H.T. portion. For example, with 4 amps. flowing the H.T. output was reduced to 139 volts at 23.5 mA.



Heayberd model E150 All-Electric Unit for A.C. Mains.

The trickle charger, which is controlled by a separate switch, charges a 2-volt cell at 0.7 amps. approximately. When using the trickle charger the H.T. should be switched off, for which purpose the switch, appropriately marked, must be used. A red pilot lamp indicates when the unit is operative.

The price of the model E150 is £6 15s., and in the same series is included a companion unit designated the model E200, the maximum output of which is 30 mA. at 200 volts, and the price is £7 10s. All units incorporate Westinghouse rectifiers. The makers are F. C. Heayberd and Co., 10, Finsbury Street, London, E.C.2.




Regulation curve of the D.C. output from the 150-volt tapping on the Heayberd model E150 A.C. Unit.

## TRIX MAINS COMPONENTS.

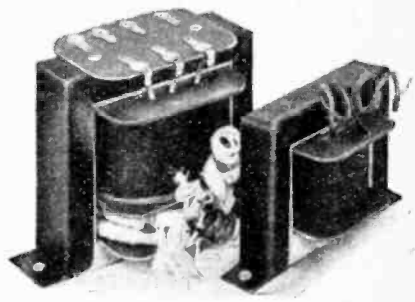
A new range of mains transformers and L.F. chokes has been introduced recently by Eric J. Lever (Trix), Ltd., 8-9, Clerkenwell Green, London, E.C.1, for the coming season. In all there are five models of transformers and three types of chokes. The transformers are officially described as models V220/30B, V250/40A, V250/60E, V300/60A and V300/60B. The first set of figures indicate the secondary H.T. voltage while the last set give the maximum H.T. current output in mAs.

With the exception of the last-mentioned model, provision is made for a 4-volt 1-amp. rectifying valve, and each carries a second L.T. winding, also giving 4 volts at from 2 to 4 amps. according to the model. The V300/60B is designed for use with a 5-volt rectifier taking 1.6 amps., and in addition this model carries two 4-volt windings giving 3 amps. and 0.3 amp. respectively. Prices range from 18s. 6d. to 35s.

The L.F. chokes are described as C30, C50 and C60, the respective inductances being 30 henrys, 20 henrys and 30 henrys, the type number indicates the maximum D.C. the choke will carry. These cost 11s. 6d., 15s. and 18s. each respectively.

A test was made on a C30 choke and its inductance measured with various quantities of D.C. flowing. The values found are tabulated below :—

The inductance is well maintained throughout the range of D.C. specified, the marked value being attained when



Trix model V220/30B mains transformer and type C30 L.F. choke.

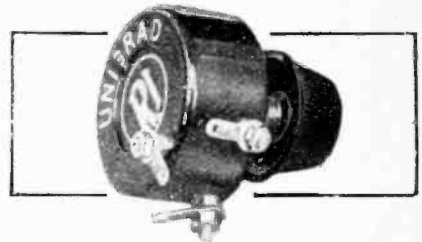
the choke is passing its maximum D.C. The D.C. resistance of this choke is 750 ohms.

| D.C. in mA. | Inductance in Henrys. |
|---|---|
| 0 | 43.5 |
| 5 | 36.5 |
| 10 | 34.3 |
| 15 | 33.2 |
| 20 | 32.6 |
| 25 | 31.5 |
| 30 | 30.3 |

Some voltage measurements were made with a V220/30B transformer, and with all windings correctly loaded the L.T. output was 4.1 volts at 1 amp. for the rectifier, the voltage from the other winding being 4 volts when 2 amps. were flowing. This model would be used in a set fitted with two indirectly heated A.C. valves.

## R.I. "UNIGRAD."

The "Unigrad" is a volume control of the potentiometer type, suitable for use in radio gramophones and wireless receivers. It is available in a wide



New "Unigrad" volume control for radio and gramophone uses—an R.I. product.

range of values, the smallest being 1,000 ohms and the largest 5 megohms. The resistance element is formed by a special process which renders it impervious to climatic changes, and the design is such that no metal parts whatsoever move over the resistance element. This is, therefore, relieved of all mechanical wear, and, as a consequence, the resistance should remain intact and undamaged.

The sample tested was delightfully smooth in action, and quite silent electrically. It takes up very little space behind the panel, and has a one-hole fixing attachment. An insulated washer is supplied for use with metal panels. The makers are Radio Instruments, Ltd., Purley Way, Croydon, and the price is 5s. 6d.

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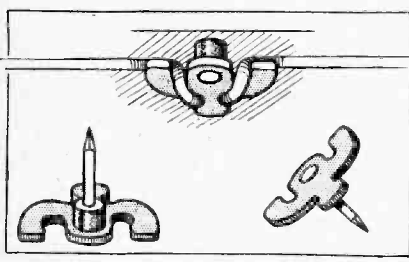
### GRIPSO INDOOR AERIAL INSULATOR.

This device combines the function of an anchorage and an aerial insulator and is intended for use in conjunction with indoor aerials only. It consists of a specially shaped piece of thin insulating material, through the centre of which is passed a $\frac{3}{4}$in. nail, and a washer is provided which serves to space the insulated hook about $\frac{1}{8}$in. from the woodwork to which it will be fixed.

The manner in which the wire is attached to the hook can be seen from the diagram, which gives, also, a very good idea of the general form of construction.



**Gripso indoor aerial hook, showing method of attaching the wire.**

These small insulating hooks are made by the Gripso Co., 32, Victoria Street, London, S.W.1, and they cost 6d. a dozen.

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### SAXON "CONNEXIT" WIRE.

The Saxon Radio Co., Henry Street, Blackpool, Lancashire, have just produced a useful range of connecting wires made up in 10ft. coils, and with special high-grade insulating coverings in a number of distinguishing colours. Those who take a pride in the appearance of their sets, or desire something out of the ordinary for exhibition purposes, will find these wires exceedingly useful.

They are available with varnished coverings in bright green, red, gold and white at 7d. per coil, or with superior cotton covering, unvarnished, at 8d. per coil.

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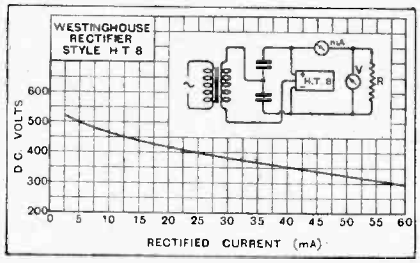
### WESTINGHOUSE STYLE H.T.8 RECTIFIER.

This is the latest addition to the range of metal rectifiers made by the Westinghouse Brake and Saxby Signal Co., Ltd., 82, York Road, King's Cross, London, N.1. The improvements made in the design of A.C. valves tending towards heavier current consumption at a working voltage of the order of 250 has led to the demand for a unit capable of delivering some 50 to 60 mAs as a maximum.



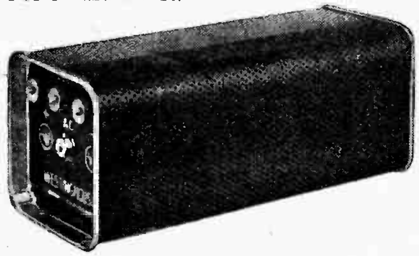

**Regulation curve of the output from Westinghouse Style H.T.8 rectifier. The input is maintained at 200 volts throughout.**

With the rectifier under discussion a voltage doubling circuit must be used and the mains transformer should give between 200 and 210 volts A.C. output. Each of the condensers in the voltage doubling circuit should be 4 mfds. each. For the purposes of our test the transformer output voltage was maintained at 200 volts; thus the regulation as shown by the curve is that of the rectifier alone. The degree to which this will be modified in a practical case will depend on the "goodness" of the transformer and in some measure on the qualities of smoothing equipment if the regulation of the smoothed output is required to be known.

In designing this unit the makers have allowed for voltage loss in smoothing choke, or chokes, since they rate the unit as giving 250 volts at 60 mAs, whereas measurements show that, without smoothing, the output at 60 mAs is just a shade under 300 volts.

The overall size of the style H.T.8 rectifier is, length $7\frac{3}{8}$in., width $3\frac{1}{8}$in., and height $3\frac{1}{8}$in. It weighs 1 lb. 10 ozs. approximately, and is enclosed in a perforated metal case with the three terminals arranged conveniently at one end.

The new unit will fill the gap which has long existed between the H.T.7 model and the large H.T.1, and as a consequence should prove exceedingly popular, especially as the price is but 21s. There is little to go wrong with the unit, and if correctly handled and never overrun or the output short-circuited should have an exceedingly long life of usefulness.



**New Westinghouse rectifier, style H.T.8, giving 250 volts (nominal) at 60 mA.**

### CELESTION R.P.M.12 LOUD SPEAKER.

This is an entirely new model, and makes use of a cross-type cobalt steel permanent magnet instead of the pot-type magnet in the earlier D.100 model. To prevent the ingress of dirt into the back of the air gap, the whole of the permanent magnet is enclosed in a pressed aluminium case, while the front is protected by a disc of special gauze material stretched across the apex of the diaphragm, and centred by a single screw to the inner pole-piece.

The diaphragm is of the well-known Celestion reinforced type, and has a shallow angle cone which considerably reduces focusing in the upper register. It is suspended at the edge on doe-skin built up in six sections.

The moving coil has an average impedance of 6.5 ohms and an output transformer is supplied with primary tappings suitable for output valves having A.C. resistances from 750 to 6,000 ohms. The transformer is very well designed and made, and has an air-gapped core.

Our tests showed that the sensitivity is good, but slightly less than that of the average mains-energised moving coil. Between 50 and 3,500 cycles the output was sensibly uniform, apart from slight dips at about 800 cycles and 3,000 cycles. There is still some response at 6,000 cycles, but between 4,500 and 6,000 cycles the output falls rapidly. As a result, there is no lack of brilliance in the general effect, yet this is not accompanied by undue harshness.

**Celestion type R.P.M.12 permanent magnet moving coil loud speaker and output transformer.**

The R.P.M.12 chassis costs £6, and the output transformer £1. A small edition—the R.P.M.8—is available at £3 10s., and its output transformer costs 15s.

The makers are Messrs. Celestion, Ltd., London Road, Kingston-on-Thames.

*Next Week's Set Review:—*
*GRAVES S.G.3.*

# 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.**

### *STRAIGHT SET OR SUPERHET?*

Sir,—We were particularly interested in the leading article entitled "Straight Set or Superhet?" which appeared in your issue of July 29th.

We fully endorse your remarks that single-dial control, as exemplified by the Marconiphone model 560 introduced last year, has come to be recognised as an essential feature of a well-designed and up-to-date set. We also agree that under present broadcasting conditions the particular features of the superheterodyne are bringing this type of receiver back into well-deserved prominence.

We feel sure that both you and your readers will be interested to learn that the disadvantage of two-dial tuning hitherto associated with superhets has now been overcome by the Marconiphone designers.

Olympia will see the introduction of the new Marconiphone model 535 superheterodyne radio gramophone, which embodies a highly efficient circuit, and possesses, in addition to the well-known advantages of its type, the unique feature of a single tuning control calibrated directly in wavelengths and covering both medium and long wavebands.

H. J. DYER, Press Representative,
The Marconiphone Co., Ltd.

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Sir,—Your Editorial "Straight Set or Superhet" is timely.

Either the present chaotic state of the ether will be cleared up or it won't.

If it is, then the straight set will be ideal for the man who wants good music and who doesn't care where it comes from.

If it is not, he must either build a superheterodyne or give up listening.

If you can extract from the powers that be information as to whether anything is going to be done to secure improvement, such information will enable many of your readers to shape their courses. E. SHIRLEY JONES.

Bentley, Hants.

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### *LONG-WAVE BROADCASTING?*

Sir,—Your correspondent who signs himself "Simplicity" suggests, in *The Wireless World* of July 29th, that long-wave broadcasting should be abolished.

It would seem that he must be entirely unaware of the very great service that the long-wave transmitter, 5XX, is to many thousands of listeners who live in parts of the country less favourably placed in relation to broadcast transmitter than is the town in which he appears to live. If 5XX were to be discontinued a vast number of listeners would be cut off entirely from *reliable* broadcasting.

I would suggest that "Simplicity" packs up his receiver and brings it to Devonshire or Cornwall for a few weeks, or to North Wales or the northern part of England.

I think he will immediately cease to make such a suggestion as he has done in your valuable paper, and come to the conclusion that the matter is not nearly so simple as he suggests.

Moreover, as has been frequently pointed out, 5XX is the transmitter which, on the Continent, is looked upon as representative of British broadcasting.

It would be a blow to the prestige of British broadcasting if 5XX were discontinued.

One is only too pleased to learn that there is a movement on foot for the reconstruction of 5XX, so bringing it up to date, and thus making it all the more worthy of the B.B.C. and of the British Isles.

In the present state of the science of broadcasting no medium-wave station can possibly replace the long-wave 5XX, and may that station soon be reconstructed and long may it continue.

Torquay. "NO AXE TO GRIND."

### *RECEPTION IN THE NORTH.*

Sir,—In your issue of July 22nd your Special Correspondent, under the heading of "Broadcast Brevities," refers to the "sensible manner in which northern listeners have accepted the new arrangements."

I would like to remind him that there is a disgust "too deep for words," and to put in a plea for a little quality in the transmissions.

In Brookmans Park, Londoners (and most of the wireless experts) have two programmes of supreme quality due to two things: one, the fact that nearly all the items originate in the studio, and the other, the shortness of the landline between the studio and the transmitter.

This is not so in the case of the unfortunate northerner. The National programme has to travel 180-200 miles by landline, and suffers in consequence. The material for the alternative or Regional programme is drawn from a wide area, stretching from Scarborough to the Isle of Man, and even from the London Regional programme. All extremely long landlines, and again a loss in quality.

A few weeks ago an organ recital was given from York *via* Leeds. It sounded like a thin gramophone record with a large excess of surface noise, coupled with the constant note of a microphonic detector valve.

Items originating in the studio are few and of short duration. Now that the excellent Northern Wireless Orchestra has been disbanded we get no orchestral concerts comparable with those transmitted from Brookmans Park.

The Londoner can revel in his diode, power grid, and push-pull rectifiers, but they are very largely wasted up here.

NORTHERN QUALITY LOVER.

Chorlton-cum-Hardy.

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### *TRAMWAY INTERFERENCE*

Sir,—Apropos a paragraph headed "Bravo, Glasgow," on "Current Topics" page in your issue of July 22nd, in which you state that the Glasgow Municipal Transport Committee, by scrapping trolley wheels and replacing them by the Fischer Bow collectors should cut out all tramway interference with broadcast reception. As a member of the Blackpool Corporation Tramways Electrical Department I was decidedly interested in your remarks. I suggest that this is rather a sweeping statement on your part; in other words, static from tramway systems is due to trolley wheels, and not, as thought by many, to one or all of the following three things:—(a) Rise and fall in current of the overhead line; (b) motor trouble, i.e., bad commutation, etc.; (c) bad earth return of rail. In my personal opinion, the only static from trolley or pulleys is that which is caused by the wheel striking an ear or frog, making it jump slightly and leave the wire, forming a small arc, thus making a "plop" in the listener's set. In support of this statement I say that set owners living near a cross-over or bend where there are many frogs, ears, spans, etc., grumble much more than others living on a straight track where ears come only at about every 60 to 80 yards. Granted that Bow collectors eliminate this trouble, as they do not require frogs, etc., at bends, I do not see that they will completely cut out all interference. Even in tramway systems where grooved or figure eight wire is used exclusively of all others in their overhead line, which to all intents and purposes is the same as Bow collectors so far as pulley jumping is concerned, and have no lips at the frogs, etc., set owners are not free from interference in the reception. In my opinion only about 20 per cent. interference is caused by trolleys, the other 80 per cent. by one or all of the three factors mentioned earlier in this letter. H. BALL.

Marton, Blackpool.

### "STEREOPHONIC" OUTPUT.

Sir,—I notice that your correspondent, Mr. C. L. Yelland, makes the common mistake of using the word "stereoscopic" to describe the effect of using two loud speakers placed some distance apart. Would it not be more correct to employ the word "stereophonic" in this connection, as "stereoscopic" relates expressly to vision? S. C. KIRK.

Hillingdon, Middlesex.

### PICK-UP AMPLITUDE RESPONSE.

Sir,—In the report of the I.R.E. Standardisation Committee of 1931 the gramophone pick-up is defined as "an electro-mechanical transducer actuated by a phonograph record and delivering power to an electrical circuit, the waveform in the electrical system corresponding to the waveform in the phonograph record."

I wonder how many pick-ups on the market comply with this definition? Obviously we assume this to be so, otherwise we would not consider (as we most enthusiastically do) curves showing either the relation volts/frequency or decibels/frequency. Until the question of amplitude response is studied these curves are, in themselves, no criteria of performance—they require to be corrected for output form-factor.

In the ideal pick-up we look out for a rise in the v/f characteristic below 300 cycles, but how much of this increase (when obtained) is due to a higher form-factor than that of the record? In testing a pick-up, use is made of standard frequency records wherein the amplitude is approximately inversely proportional to the frequency; consequently, below 300 cycles we are experiencing amplitudes far in excess of those ever encountered in practice with certain distortion of waveform.

The question of output waveform is calculable but tedious, and it is rather difficult to investigate experimentally without the use of elaborate apparatus; however, some idea could be obtained if an amplitude response curve were plotted. The record in this case would be of one frequency with constant form-factor and amplitude increasing uniformly with time. Instantaneous values of output voltage plotted against their corresponding amplitudes would then comprise the amplitude response curve, which incidentally would require some correction for the "spiral effect" of the record. Then, provided the curve be a straight line, the pick-up could be said to comply with the introductory definition.

WM. D. OLIPHANT, B.Sc., A.M.I.R.E.

Edgware, Middlesex.

### EMPIRE BROADCASTING: COLONIAL "SLACKNESS".

Sir,—In "Broadcast Brevities" in your issue of June 10th, 1931, I am glad to see that you have brought to the notice of our Colonial readers their respective Governments' slackness in the matter of this much-hoped-for Empire broadcast.

I can only surmise that the "shirking" of the Southern Rhodesian Government is that they are quite content to let matters rest as they are, i.e., raking in the 10s. licences and doing nothing in return.

In this colony we have no broadcasting station, and yet have to pay a 10s. yearly licence.

The nearest station, in an adjoining territory, is approximately 800 miles away and operating on 450 metres. You can imagine the joy, during the six months of the rainy season, picking out the programme from amongst "X's"!

We receive Chelmsford very clearly for the first half-hour of its programme, after which time 25 metres seems to fade away.

Thanking you for bringing up this matter of an Empire broadcast. G. R. SYFRET.

Salisbury, S. Rhodesia.

### "GOOD REPRODUCTION".

Sir,—Mr. Cosky, in his letter on the above subject in your issue of July 22nd, has followed the example of most of your previous correspondents in missing the whole point of my argument.

Reproduction (the "good" is really redundant) means the provision of an exact duplicate of an original. If a person chooses to modify the reproduction of original broadcast matter to suit his own taste, he is at perfect liberty to do so, and, while providing himself with, from his point of view, an excellent evening's entertainment, he has not proved himself to be an unbiased critic of quality of transmission or reception.

When Mr. Cosky says "I don't suppose Mr. Hartley would like the reproduction I like" he is entirely confusing "kind of output quality" with "reproduction," and this brings his whole argument to nothing.

Mr. Yelland appears to have the same confusion of ideas, although he says that he is getting results, for a moderate outlay, which are not greatly inferior to mine. I presume that he means he is getting reproduction, so, if he really possesses that musical ear which he says he has, I invite him to listen to my set. I can promise him, since he has divulged the nature of his receiver, that all his preconceived ideas will go by the board, but I wonder if he will write and tell you so?

Isleworth, Middlesex. H. A. HARTLEY.

### RESONANCE IN ORGAN REPRODUCTION.

Sir,—Now that the reproduction of sound has assumed so much general interest, possibly some of your scientific readers may be able to advise how to give the effect of resonance to the tone of a pipe organ where the acoustics of the hall or organ chamber do not possess the necessary properties.

It has been suggested that the effect of resonance or echo can be obtained artificially by reproducing the tone by means of microphone, amplifier and loud speaker, the reproduced tone being electrically delayed during a time interval necessary to give the echo effect when the main tone and the reproduced tone are heard together.

Perhaps some of your readers may have tried some similar device, and could say if it promises any chance of success.

Saxmundham. F. U. W.

### THE NIGHTINGALE.

Sir,—If "Free Grid's" suppositions concerning the B.B.C. "Nightingale" broadcasts are substantiated by actual facts, it would seem at first thought deplorable that the B.B.C. should descend to such a subterfuge in order to illusion the listening public.

But, after careful consideration, you will agree that the amount of pleasure created by the illusion more than justifies the means.

Candidly, I believe that 50 per cent. of the pleasure of the nightingale song is derived from its association with nature.

It is appreciated most by people confined to the towns.

You have already suggested that the actual song and the artificial recording are precisely the same to all intents and purposes.

Why, then, is it necessary to go further into the question of right or wrong in this respect?

I would contend that "reproduced" broadcasts are always justifiable, inasmuch as the radio receiver is an artificial reproducing instrument itself.

You cannot expect to combine realism with idealism in that way and *really* get away with it. R. M. LAMBERT.

London, W.2.

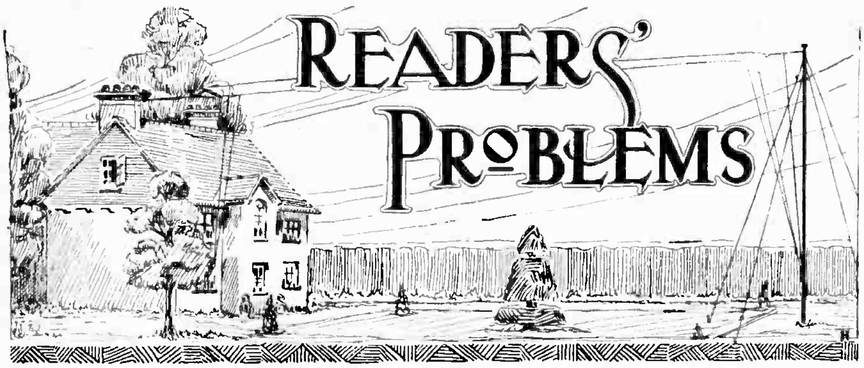
### THE AMATEUR.

Sir,—I agree with Mr. Kay that there are a certain number of amateurs whose sole idea is to collect a quantity of highly decorative QSL cards, to the annoyance of members of the public who are only interested in broadcast reception. I think, however, he does not give full justice to the serious experimenter who studies other people's pleasure and religiously carries out his experiments outside broadcast hours. In any case an amateur transmitter who causes interference with a neighbouring receiver is apparently using an illegal circuit, which is contrary to the G.P.O. regulations.

I carried out some experiments four or five years ago with a transmitter using 1 kW. input power, with the results checked on a short-wave receiver 50 yards away. No response from the transmitter could be heard on any wavelength beyond two degrees on the tuning dial either side of the fundamental.

If all amateurs were to use transmitters capable of being adjusted in the correct manner, arguments such as Mr. Kay has aroused would be entirely unnecessary.

London, S.W.17. L. H. FITZ-GIBBON.




Replies to Readers' Questions of General Interest.

*Technical enquiries addressed to our Information Department are used as the basis of the replies which we publish in these pages, a selection being made from amongst those questions which are of general interest.*

### Calibrating a Superheterodyne.

*Is it likely that any difficulty will arise when using a heterodyne wavemeter for calibrating a superheterodyne receiver?*

Provided the wavemeter is used in the ordinary way, there will be no complications. Difficulties might conceivably arise if the instrument were tightly coupled to the oscillator circuits of the receiver, but as these are always screened nowadays there should be no risk of this trouble.

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### By-pass Condenser Defects.

*My battery-fed H.F.-det.-2 L.F. receiver, after working well for a considerable time, has developed motor-boating. The fitting of a new set of H.T. batteries has done nothing to improve matters; indeed, it has had rather the opposite effect. As the set is thoroughly decoupled, I am quite unable to account for this trouble, and should welcome any suggestions which you may be able to make.*

The most probable cause of this trouble is the failure of one of the by-pass condensers associated with your decoupling arrangements; this fault will take the form of a more or less complete disconnection (internal or external), and not the more usual insulation breakdown.

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### Failing Resistances.

*Several of the anode-feed resistances included in my 2-v-1 mains-driven receiver have broken down on two or three occasions. These components are made by a reputable manufacturer, and I am quite at a loss to see why this trouble should arise. Can you suggest how its recurrence may be avoided?*

We assume that your resistances are of the wire-wound type, and, if so, their failure must be ascribed either to the fact that the current passed through them is greatly in excess of that for which they are designed, or, alternatively, that they are poorly constructed. With regard to the first possibility, there is usually quite a large margin of safety, and, if your components are well made, we think it very likely that the trouble is due to an intermittent short-circuit.

### Double-wound and Auto-transformer Combined.

*I have a dual-range aerial-grid transformer, of which the windings are connected as shown by the attached diagram. By rewinding the medium-wave primary and altering the long-wave aerial tapping point, it would appear possible to use this component as a coupling between an S.G. valve and a grid detector. If you agree, I propose to do this, but, as there is metallic conductivity between primary and secondary, it will, as far as I can see, be necessary to adopt a choke-fed parallel circuit.*

*Is there any way of avoiding the use of a choke?*

A choke is by no means essential, and the coil assembly shown in your diagram, reproduced in Fig. 1 (a), will probably function quite well if connected in the manner indicated in Fig. 1 (b).

It will be observed that the tuned oscillatory circuit is completed through a fixed condenser C, which should be of large capacity. This acts, in effect, as a by-pass across the source of H.T. supply, which would otherwise be included in the H.F. circuit.

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### Short-circuits through Valve Filaments

*After reading a paragraph in your journal concerning the correct arrangement of filament circuits, I examined the connections of my own set, and found that apparently the result of a short-circuit between the positive side of the H.T. battery and the metal chassis would be to burn out the valve filaments.*

*This is due to the fact that one side of the on-off switch is in permanent contact with the metal-work, and both H.T. negative and L.T. negative are joined to the other switch terminal.*

*What is the simplest way of changing connections so that the valves will be safe in the event of a short-circuit?*

You are correct in assuming that the arrangement described introduces an unnecessary risk of burning out the valve filaments. Probably the easiest way of avoiding this risk is to join the H.T. negative terminal directly to the metal chassis, leaving the L.T. negative connection as it is at present.

With this alteration no harm will be done to the valves should an accidental short-circuit take place between the positive side of the H.T. battery and the chassis when the switch is in the "off" position.

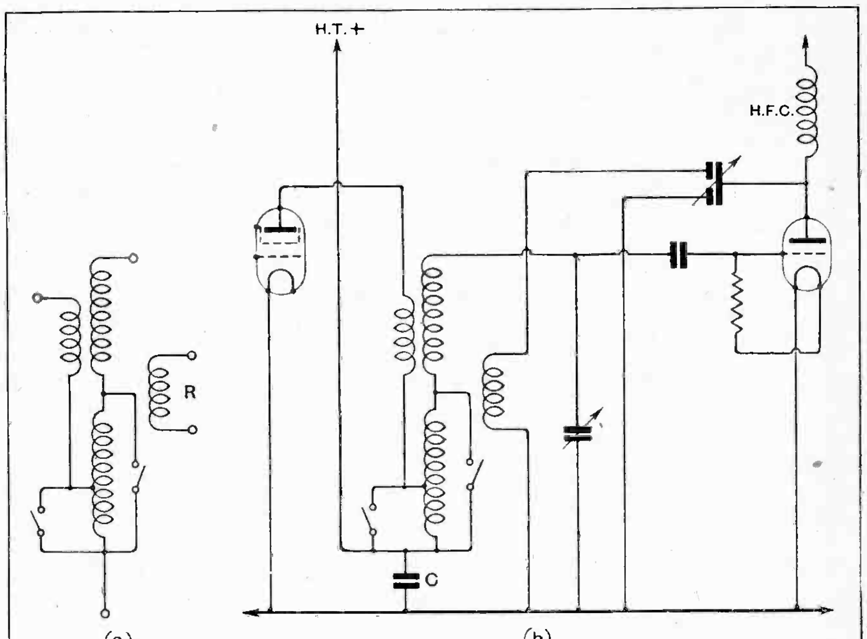


**Fig. 1.—Adapting a dual-range tuning coil for use as an intervalve coupling.**

### Dual-range Lightweight Portable.

*Will you please tell me how to modify the "Lightweight Portable," described in your issue of July 8th, so that long-wave broadcasting may be received? I should like to effect the change-over by means of a switch, rather than by inserting a plug-in loading coil.*

The conventional method of loading the frame aerial of a receiver of this type is shown in Fig. 2. A centre-tapped long-wave coil, of some 200 turns, is inserted at the mid-point of the frame; the operation of short-circuiting this loading coil is most conveniently effected by means of a three-point switch, S.

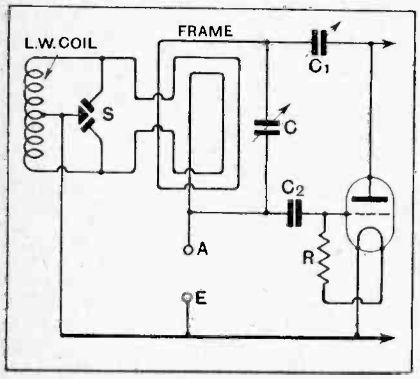


**Fig. 2.—A long-wave loading coil and wave-changing switch added to a receiver with throttle-controlled reaction.**

○○○○

### Valve Mounting.

*At one time it was recommended that valves should be mounted in such a way that their filaments might be in a vertical position, but, as methods of construction have changed considerably, I presume that now it is permissible to mount the valves in any way that may be convenient.*

*I ask this question because I am building an A.C. set in which it would be convenient to fit the valves in a horizontal position.*

Modern valves are so robust that, with hardly an exception, they may be mounted in any way that is convenient.

○○○○

### Grid Acceptor Detection.

*I have just modified my receiver by fitting a detector acceptor circuit as described in your issue of May 20th. On the whole, results are extremely good, but I find it impossible to tune the series circuit to wavelengths below about 300 metres; consequently, the set is more or less inoperative on all wavelengths below that figure.*

*The effect of removing a few turns from the extra tuned coil has been tried, but this does not make any appreciable difference. Will you please advise me what should be done?*

As the number of turns in the extra coil runs into hundreds, it may be pointed out that, to make a really noticeable change in its inductance value, it will be necessary to take off quite a large number (about fifty) of turns before a noticeable increase in the lower limit of tuning is noticeable. But we should imagine that it will be unnecessary to do this; in all probability there is an excessive stray capacity across the tuned circuit. We advise you to use a tuning condenser with a low minimum, and also to arrange the wiring as carefully as possible.

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### Bias for A.C.-heated Valves.

*In an article recently published in* The Wireless World, *it was stated that a certain directly-heated valve, when fed with raw A.C. for its filament circuit, should be biased more negatively by 2 volts than normally.*

*Does the same apply to any "battery" valve when it is fed from A.C. mains through a step-down transformer?*

As a general rule, in these circumstances it is necessary to apply a greater negative bias voltage than that recommended when an L.T. battery is employed. This extra negative voltage should be equal to a little more than half the filament voltage rating of the valve.

In the case of battery-heated valves, the negative side of the filament is taken as the zero point, but with A.C. heating we are, in effect, working from the electrical centre of the filament.

○○○○

### Compensated Pentode Output.

*As my receiver seems to give undue emphasis to the higher frequencies, I have just fitted a compensating output circuit for the pentode valve, adopting the scheme included in several "Wireless World" receivers. A centre-tapped output choke is used, and this is shunted by a fixed condenser of 0.01 mfd. in series with a fixed resistance of 25,000 ohms.*

*Unfortunately, it seems that by doing this tone correction has been carried to excess, and reproduction is now lacking in brilliancy. Would you advise me to use a smaller shunt condenser of, say, 0.05 mfd.?*

The alteration which you propose would probably have the desired effect, but we think it better to replace the fixed resistance of 25,000 ohms by variable resistance of some 50,000 ohms.

By increasing the value of this resistance the tone-lowering effect of the shunt condenser may be reduced within wide limits.

○○○○

### Output Circuit Decoupling.

*I have a high-resistance moving-coil loud speaker with a winding specially designed for direct insertion in the anode circuit of a pentode valve. Would it be permissible, when modernising my receiver, to bring it into line with your later designs, to omit the choke filter output circuit that is generally included, and to join the loud speaker moving coil directly in series with the anode circuit?*

Apart from the question of tone compensation and other considerations, you run a risk, by modifying a published design in the way you describe, of provoking uncontrollable L.F. oscillation. It must not be forgotten that an output filter choke acts to some extent as a decoupling device, and tends to restrict the passage of signal-frequency currents in the output anode circuit through the common impedances and resistances of the eliminator or other source of H.T. supply.

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### Bottom Bend Biasing.

*It seems to me that a considerable economy in H.T. current could be effected by biasing push-pull output valves to the lower end of their characteristic curves, rather than in the usual way, where the valves are biased to work on the straight part of the curve.*

*Are there any objections to this plan?*

The practice of operating push-pull valves at the lower end of their characteristic curve is theoretically sound, but it is so full of difficulties in practice that it cannot be recommended for general use.

## FOREIGN BROADCAST GUIDE.

## BRATISLAVA

**(Czechoslovakia).**

Geographical position: 48° 10′ N., 17° 8′ E.

Approximate air line from London: 800 miles.

**Wavelength: 279 m. Frequency: 1,076 kc.**
**Power: 14 kW.**

Time*: Central European.
(**Coincides with B.S.T.*)

**Standard Daily Transmissions.**

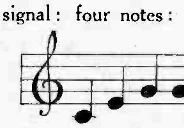
07.00 B.S.T., Carillon from St. Veits Cathedral, Prague, relay of concert from Carlsbad (Sun.); 11.00, relay of concert from Podiebrad (Sun.); 14.30, concert; 20.00, main evening programme; 22.15, organ recital (Thurs.); 22.30, dance music and variety (Sun., Mon., Sat.).

Relays Prague and exchanges programmes with Brno, Moravska-Ostrava and Kosice.

Woman announcer. Call: *Allo! Radio Journal Bratislava* (for call, when relaying capital programme, see *Prague*). Announcements are often made in Slovene, Czech, Magyar, French, German and English (occasionally).

Opening signal: Tuning note (A).

Interval signal: four notes:



Closes down with the words: *Hallo Bratislava damy a panovia dnesny programsme. Dobrou noc* (This concludes our to-day's programme. Good Night).

Associated stations: Prague, 487 m. (617 kc.), 5.5 kW. (temp.); Brno, 342 m. (878 kc.), 22 kW.; Kosice, 293 m. (1,022 kc.), 2.5 kW.; and Moravska-Ostrava, 263 m. (11,139 kc.), 11 kW.

# The Wireless World

AND RADIO REVIEW
(19th Year of Publication)

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

## *Are Prices Right?*

It is still some weeks before the annual Olympia Radio Show opens its doors and reveals to the public all those new products upon which the British radio manufacturers have been concentrating their attention during months past. As a privileged party, we have recently had the opportunity of inspecting quite a number of the newest sets by various manufacturers and new components which will then be on view.

We may, we think, be excused for having been inclined to doubt whether the British manufacturer intended this year to make that real effort to produce receivers of first-class performance at prices which would be tempting enough, in view of the highly competitive conditions existing to-day. We must at once say that the impressions we have so far gained in regard to the new products are distinctly encouraging. There is every indication that set manufacturers are fully alive to the necessity of bringing prices to a lower level, yet, at the same time, the standard of British workmanship has not been in the least impaired, and performance will, we believe, be a pleasing revelation to the public visiting Olympia and serve to renew confidence in our ability to cater adequately for the home market.

So much, then, by way of advance comment on the new sets and components, but can we speak as confidently of the valve position? In point of performance British valves are second to none, and on that score the manufacturers are to be congratulated. But the cost of valves, even taking into account a recent small reduction, is, in our view, still too high and compares most unfavourably with the prices of equivalent types abroad. The cost of valve replacements to the user is so high as to make him hesitate to invest in a valve set at all; moreover, much of the bad quality emanating from receivers in the hands of the public to-day is traceable not to faults in the receiver but to the worn-out condition into which the valves have been allowed to degenerate because of the excessive cost of replacements. Manufacturers of sets, by virtue of the quantities which they order from the valve manufacturers, are able to obtain their supplies of valves at prices which bear no comparison whatever to the cost to members of the public who purchase individual valves. The difference is, in our view, unreasonably great, and the private purchaser ought, we contend, to benefit to a much greater extent in the cheapening influence on production of the ever-increasing demand.

We have, on one or two occasions in the past, found it necessary to urge manufacturers to reduce valve prices before such a reduction has taken place. For some months past we have felt that a substantial reduction in prices, particularly of mains valves, was overdue, but we had hoped that, in common with set and component manufacturers, valve manufacturers would, on their own initiative, have modified their prices substantially. It is because we have cherished this hope that we have not made comment on this subject earlier.

### In This Issue

# The Adjustment of Modern Receivers

Putting a New Set into Operation.

Getting the best from one-dial control.

*HOW often is the behaviour of a set marred by lack of attention to detail? So many new principles have been recently introduced in receiver design that difficulties are often encountered as the result of the novelty of the arrangement. Modern sets embodying such features as ganged tuning, trimming, complicated voltage adjustment and screening, are discussed at length in this article; there is also much helpful information on superheterodyne practice.*

THE days when the home construction of a receiver necessitated a considerable amount of mechanical skill have gone, and it is now possible to build a first-class set merely by the assembly of factory-built components. In spite of the modern simplicity of construction, however, there are certain electrical adjustments to be made when the set is put into operation; and nowadays it is these which are the greatest source of trouble in the home-made set.

The operations involved in making the necessary adjustments are by no means difficult, provided that they are properly carried out; and it is the purpose of this article, therefore, to indicate the adjustments necessary and some of the more common troubles encountered, together with means for overcoming them. The adjustment which is probably the most troublesome to the inexperienced is the ganging of the variable condensers, for upon the accuracy with which this is carried out depends the success of the receiver. The skeleton circuit of a typical set is shown in Fig. 1, and for the purposes of illustration reference will be made to this; it should be clearly understood, however, that the remarks apply directly to any ordinary tuned H.F. set.

### Ganging.

In ganged receivers it is assumed that all the variable condensers have the same capacity when their vanes are enmeshed to the same degree. This, of course, is never exactly the case, but good-quality condensers are very nearly identical. Accurately matched condensers are quite essential for good ganging, and so care should be taken when building the receiver to see that they are all in good condition and undamaged.

The tuning coils also must be matched, although they are not quite so important as the variable condensers, and care should be taken to see that they are all disposed in similar relation to the screening.

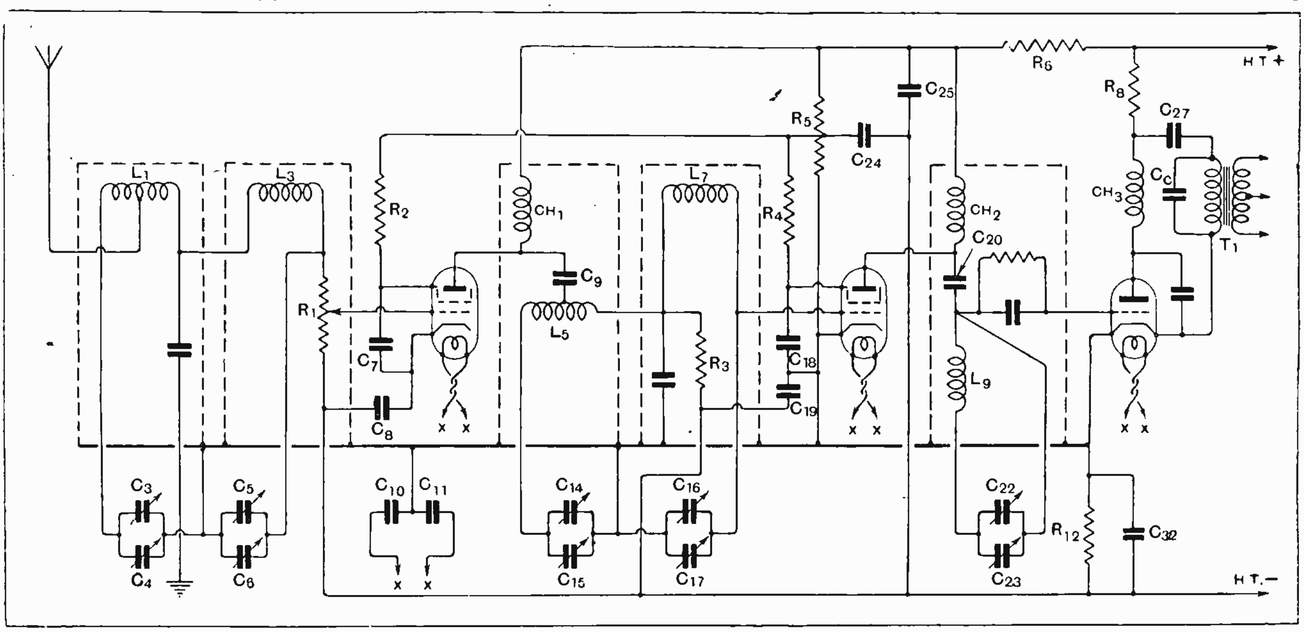
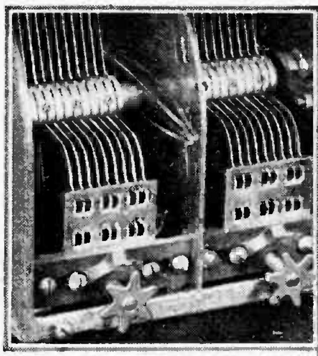



Fig. 1.—The circuit of a typical modern receiver illustrating the trimming condensers for the adjustment of the ganging. Comprehensive decoupling is used, and the danger points are indicated in the body of the article.

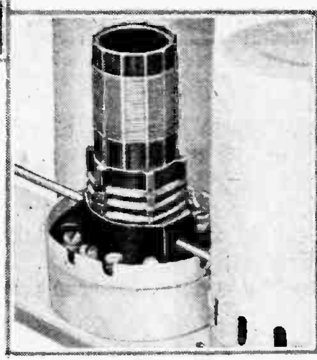
**The Adjustment of Modern Receivers.**—In this connection it is worthy of remark that less trouble is likely to be encountered when the coils are screened separately from the other components.

Assuming for the moment that the set has all the variable condensers and coils accurately matched, we are left only with the stray capacities and circuit variations due to the aerial and the input impedance of the valves. From the point of view of ganging, these are generally treated as purely capacitative, although this is not quite accurate theoretically. The stray capacities across the various tuned circuits are usually different; and in order to balance them it is necessary to connect very small additional variable condensers, called trimmers, across the main tuning condensers, so that the minimum capacities of all the circuits may be equalised, though, under certain conditions, the stray capacity associated with each tuned circuit may be such that the use of trimmers may be avoided.



With ganged condensers minimum capacities are equalised by trimmers.

Trimmers are shown in Fig. 1 as $C_4$, $C_6$, $C_{15}$, $C_{17}$, and $C_{23}$, connected across the main tuning condensers $C_3$, $C_5$, $C_{14}$, $C_{16}$, and $C_{22}$. Their adjustment is easily carried out by tuning-in a station using each trimmer as a tuning condenser, and it will be obvious that this operation is best done with the ganged condensers set as near their minimum as possible. With the ganged condensers set in this position, the stray capacities form the greater portion of the total capacity in each circuit, and their effect is greatly accentuated. When the trimmers have been correctly set at the bottom of the scale, the ganging should hold over the entire wavelength range, and an alteration in their setting at any other wavelength should result in a decrease of signal strength. This result can usually be achieved by careful construction of the receiver, but in some cases it may be found that the circuits go out of tune as the capacities of the ganged condensers are increased.



Unwanted couplings are avoided by separate screening of coils.

### Unmatched Coils.

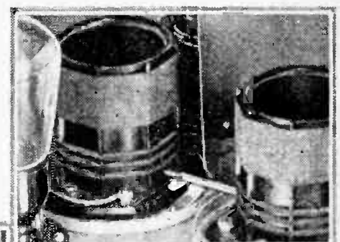
The most probable cause of the trouble is unmatched coils, and it is fortunate that we have at our disposal a ready means of eliminating the effects of this, provided, of course, that it is not too great. Most modern condensers are of the log. law type, and these were originally designed for the purpose of ganging by staggering the rotors, and, when used in this manner, small differences in inductance can be balanced out.

The procedure to be adopted, therefore, when it is found that ganging by means of the trimmers alone is unsatisfactory, is to make use of this property of log. law condensers. The circuits should be ganged at a short wavelength, say 250 metres, by means of the trimmers. A station on a higher wavelength, say 500 metres, should then be tuned-in by means of the ganged control, and each circuit brought into exact resonance by altering the relative positions of the various condenser rotors. *At this high wavelength the trimmers must not be touched.*

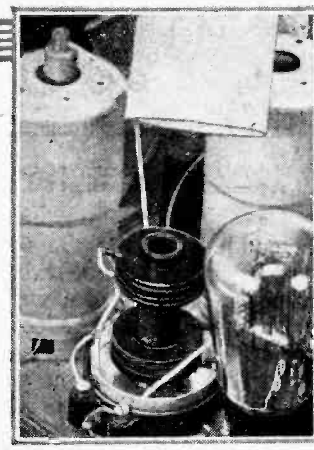
It is next necessary to return to the shorter wavelength, and re-gang by means of the trimmers; then to go back to the higher wavelength and re-gang by staggering the condenser rotors. This procedure should be repeated until no further adjustment at either wavelength is necessary. The ganging will then be found to hold sufficiently well for all ordinary purposes over the entire wavelength range. It should be emphasised: use the *trimmers* only at a *short* wavelength, and never at a high; and *stagger the rotors* only at a *high* wavelength, and never at a short.

### Instability.

Although ganging is, strictly speaking, the only adjustment usually required, among the troubles frequently encountered in a new receiver is instability. This is usually due to some constructional fault or to faulty components. Faulty ganging, of course, will not lead to instability, but it will result in poor sensitivity and selectivity. The greatest source of trouble is feed-back; and according to the phase of the fed-back currents the receiver is rendered either unstable or insensitive. Where the feed-back is due to insufficient decoupling, the set usually oscillates continuously, and the remedy is to fit larger by-pass condensers. This must not be taken literally, however, when dealing with radio-frequencies, for a large-capacity paper type condenser may have a higher internal impedance than one of small capacity, and so give less effective de-coupling.



The metal control rod for ganged waveband switching should be earthed.



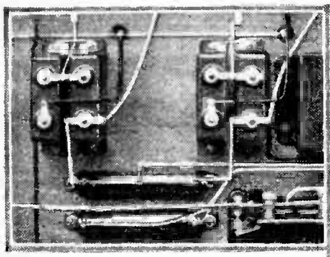
Screened band-pass I.F. transformer for the superhet.

It is important, therefore, to see that the condensers are of the type having a low internal impedance at the

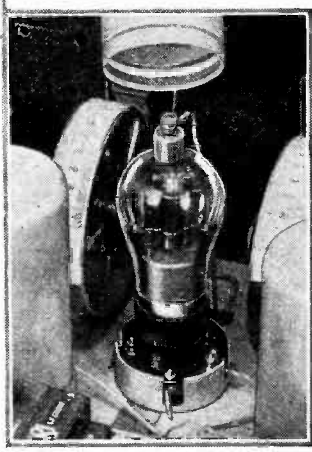
**The Adjustment of Modern Receivers.**—

frequencies at which they are to be used. In a circuit of the type shown in Fig. 1, probably the most important condenser is $C_{32}$ shunting the H.F. bias resistance $R_{12}$. For the condenser to be effective, its impedance must be low compared with the bias resistance, and, as this may be only 100 ohms or so, a large capacity is indicated, and, furthermore, this large capacity should be obtained by the use of several normal-capacity condensers in parallel, in preference to a single condenser.

There is little fear of trouble from insufficient screening, provided that the original design is adhered to; but care should be taken to see that the screens are all properly earthed, and that there are no long open joints. The wiring, too, must receive attention; although all the connections may be correct, the wires may have been run in a manner different from that in the original receiver, and this is sometimes sufficient to cause instability. A further point is to see that all wires which in any way wander about the set are at earth potential to high-frequency currents. This means that the heater wiring may have to be connected to earth through fixed condensers $C_{10}$, $C_{11}$, while metal rods used for switch ganging should be earthed at several points.



Decoupling is essential in a modern receiver with high magnification.

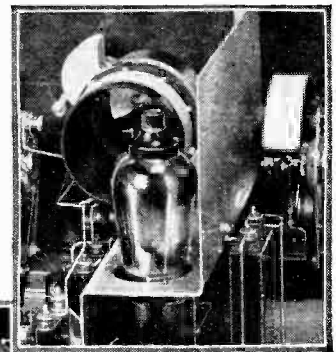


The S.G. first detector of the superhet. should be screened.

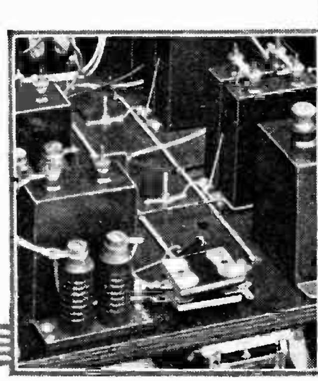
The aerial and earth system itself is of considerable importance, and in particular the earth. A good earth is essential, not only to avoid hand-capacity effects and to obtain the full signal strength, but to prevent instability. With a poor earth it is impossible to obtain the full measure of screening. A poor aerial, on the other hand, will not necessarily affect the stability of a well-designed set, although it will, of course, lead to reduced signal strength. It is important, however, that the aerial lead should not wander round the set at all, otherwise instability may be produced by the capacity between the aerial wire and the valves or other components which are unscreened.

### Valves and Voltages.

In spite of the possibilities of trouble due to the factors just mentioned, the H.T. supply is a more likely source of trouble in a mains-operated set. No difficulty whatever should be encountered if the valves, resistances, and condensers have all their correct values and are in good condition. A faulty by-pass condenser, however, which is either short-circuited or which leaks, will lead to incorrect voltages on the valves, and correct working will be impossible. Resistances of incorrect values or which are open-circuited or short-circuited will also prevent good results from being obtained. A faulty valve, too, will lead to trouble, not only because it will not have the correct characteristics, but because its abnormal value of anode current will upset the working conditions of the other valves, unless the eliminator regulation is exceptionally good.



A popular method of mounting a screen-grid valve.



Efficient detection is ensured by a well-designed anode by-pass circuit.

Of all the voltages, that of the screen-grid is the most important. If this be too high instability may occur; while if it be much too high there will be a big loss of signal strength. On the other hand, if it be too low, signals will be weak; but if it be very low, instability may again set in. The possibility of a poor contact of the valve in its holder should never be overlooked; and, in the case of an indirectly heated valve, instability may be caused by a bad contact between the cathode pin and its socket.

### The Detector.

When searching for the cause of instability, the anode circuit of the detector should not be forgotten. If the anode by-pass condenser is in any way imperfect, the damping on the tuned-grid circuit will not have its correct value. A condenser which is too small usually means that the input circuit is too heavily damped; on the other hand, with some H.F. chokes, too small a capacity might lead to an inductive anode-circuit load, with consequent instability. Too large a capacity will rarely have a detrimental effect, except upon the quality. This by-pass condenser and the H.F. choke affect the presence of H.F. in the L.F. circuits; and in this connection it must be remembered that by themselves they do not form an efficient filter. They depend for their action largely upon the presence of the by-pass capacity $C_c$ (Fig. 1), after the choke, and in parallel with the transformer primary. In some cases this condenser is included in the L.F. transformer, and so its presence may not be obvious; with an R.C. amplifier, however, it is represented by the grid-filament capacity of the following valve.

**The Adjustment of Modern Receivers.—**
**The Superheterodyne.**

The recent revival of the superheterodyne makes this article incomplete without some mention of the faults which may be experienced with it. In general, there are few faults which are not encountered with ordinary sets, but more trouble may be found in tracing them owing to the comparative unfamiliarity of the apparatus. Instability in the I.F. amplifier is very unlikely to occur, but when it is found it is treated in exactly the same manner as in a tuned-H.F. set. It is worthy of note that such instability is always accompanied by a multitude of heterodyne whistles as the tuning dials are rotated.

Any trouble is more likely to lie with the frequency changer, however, for if the oscillator ceases to function nothing will be receivable; although a small amount of valve hiss should be audible with the volume-control fully turned up. If the valves are in good condition and have their correct applied voltages, the most likely cause of no oscillation is an incorrectly connected reaction coil or a faulty by-pass condenser $C_4$, Fig. 2.

A further cause of trouble lies in the self-oscillation of the first detector; the symptom of this is a large number of heterodyne whistles during tuning. A good test for it is to remove the oscillator valve, and then tune the set normally. It should prove impossible to receive stations; but if it be found that this is not the case and that stations can definitely be tuned-in on the oscillator dial, it is a sure sign that the detector valve is oscillating, and that the grid and anode circuit require more careful screening. This trouble should not occur if sufficient screening is used in the original design, but when departures from the layout are made it is a very probable source of any trouble.

Just as in the case of a tuned-H.F. set, a faulty filter in the anode circuit of the second detector will lead to trouble, and, in fact, its efficiency is even more important with the superheterodyne. Not only will a poor filter give rise to distortion and a tendency towards instability, but it may cause whistles during tuning. The higher harmonics of the intermediate frequency fall within the broadcast band of frequencies and they are inevitably present in the second detector output. Now, if these harmonics can find their way into any of the tuned input circuits they will be passed by these circuits at certain settings of the tuning dials and cause interference. It is always wise, therefore, to pay particular attention to this filter circuit to ensure that it is working at its maximum efficiency.

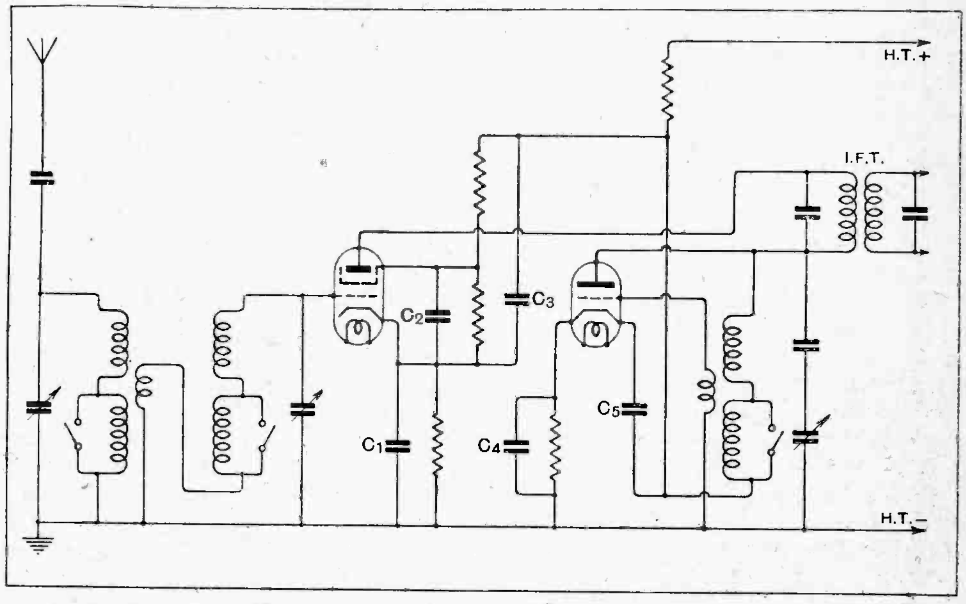



**Fig. 2.—The circuit of a modern non-radiating frequency changer is illustrated. It is only in this portion of the apparatus that the superheterodyne differs essentially from the ordinary tuned H.F. receiver.**

# BOOKS RECEIVED.

*British Standard Specifications for Mains Supply Apparatus for Radio and Acoustic Reproduction (A.C. Mains), including* points to be observed in the design and construction of mains supply apparatus, protection of live parts, isolation for supply mains, isolation of terminals, recommended apparatus for measuring hum, etc. Pp. 14. Published by the British Engineering Standards Asssociation, 28, Victoria Street, S.W.1, price 2s. net.

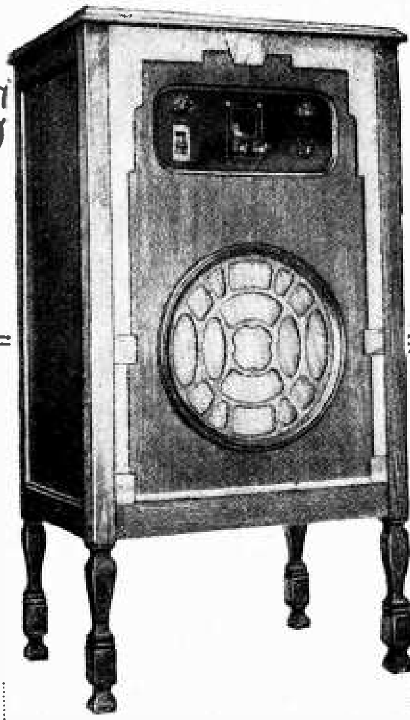
*Experimental Radio Engineering*, by John H. Morecroft, E.E., D.Sc. A text book of laboratory experiments and testing. Pp. 345, with 250 diagrams and illustrations. Published by John Wiley and Sons, Inc., New York, and by Chapman and Hall, Ltd., London, price 17s. 6d. net.

*Practical Radio, including Television*, by James A. Moyer, S.B., A.M., and John F. Worstrell. (Fourth edition.) A text book for students, including chapters on Common Troubles and their remedies, Television—General Applications of Radio, and Important Events in Wireless History. Pp. 410, with 235 illustrations and diagrams. Published by McGraw Hill Publishing Co., Ltd., London, price 12s. 6d. net.

*Admiralty List of Wireless Signals* 1931. This new edition of the well-known list is issued in two separate volumes. Vol. I (which will be revised annually) contains Particulars of Coast and D.F. Stations, Fog-signals and Beacons, Stations Transmitting Weather Bulletins, Storm Signals, Navigational Warnings, Time Signals, etc., with notes concerning individual stations. Vol. II (which will be republished at intervals of approximately five years) contains general information and regulations affecting the various sections, Details of Codes, Lists of Observation Stations, Time-signal Codes. Extracts from the Washington Convention, and other matters of a semi-permanent nature hitherto included in the Appendices. Published by H.M. Stationery Office, and sold by J. D. Potter, 145, Minories. E.C.3. Price, Vol. I, 6s. net; Vol. II, 5s. net.

# GRAVES S.G.3

## An Inexpensive General-purpose All-mains Set with Built-in Loud Speaker.



MANY battery-fed sets, long overdue for superannuation, would probably be finally discarded if their owners would but realise how great a saving in maintenance costs can be effected by changing over to a mains-operated receiver. Still more would the prospective purchaser of a new set—provided, of course, that his home is connected to an electrical supply system—refuse to consider anything else if it could be brought home to him that in some cases the extra cost of such a receiver may amount to no more than a single year's upkeep of the high-tension batteries. It is not necessary to labour the point by attempting to assess the extra cost of L.T.-accumulator recharging and replacement; with regard to performance, the mains set should score heavily, particularly as to quality of reproduction, and it is now every bit as reliable as its "battery" counterpart.

Although the new Graves A.C. pedestal cabinet model is not a luxury set, its design, construction, and performance is sound and adequate, while external finish and general appearance is good enough to compare favourably with more expensive outfits. It is sold at £14 5s. complete, a price which, during last season, would have been distinctly low even for a battery set of similar specification.

As shown in the accompanying diagram, three indirectly heated valves are used in a straightforward H.F.-det.-L.F. combination. The aerial circuit is of the single-tuned type, with separate double-wound coupling transformers for each waveband. Input to the H.F. valve is regulated by a high-resistance potentiometer, and this valve is coupled to a conventional grid detector by a choke-fed tuned-grid circuit, tapped to act more or less as a 1 : 2 ratio step-up transformer. The output valve, which feeds the loud speaker through a choke filter, is linked to the detector through a transformer.

Separate series-connected reaction windings are fitted for each waveband; the long-wave section is shunted by a short-circuiting switch, and feed-back is controlled by a variable condenser in the usual way.

**SPECIFICATION.**

*GENERAL: Three-valve receiver operated entirely from A.C. mains, 200-250 volts. Self-contained except for earth connection and, for long range work, an external aerial; a "mains aerial" connection is provided.*

*CIRCUIT: One tuned-grid H.F. stage followed by a grid detector, which is transformer-coupled to a triode output valve. Choke-filter loud speaker feed. Valve power rectifier; indirectly-heated receiver valves in each position.*

*CONTROLS: Ganged tuning with external trimmer; input volume control; reaction; wave-range switch; radio-gramophone switch; on-off switch.*

Anode current is rectified by a full-wave valve, and suitable feed voltages for the screening grid and H.F. and detector valve anodes are tapped off a potentiometer. Grid-bias voltage for the H.F. and output stages is developed across a resistance in the H.T. negative lead, and is applied through decoupling devices.

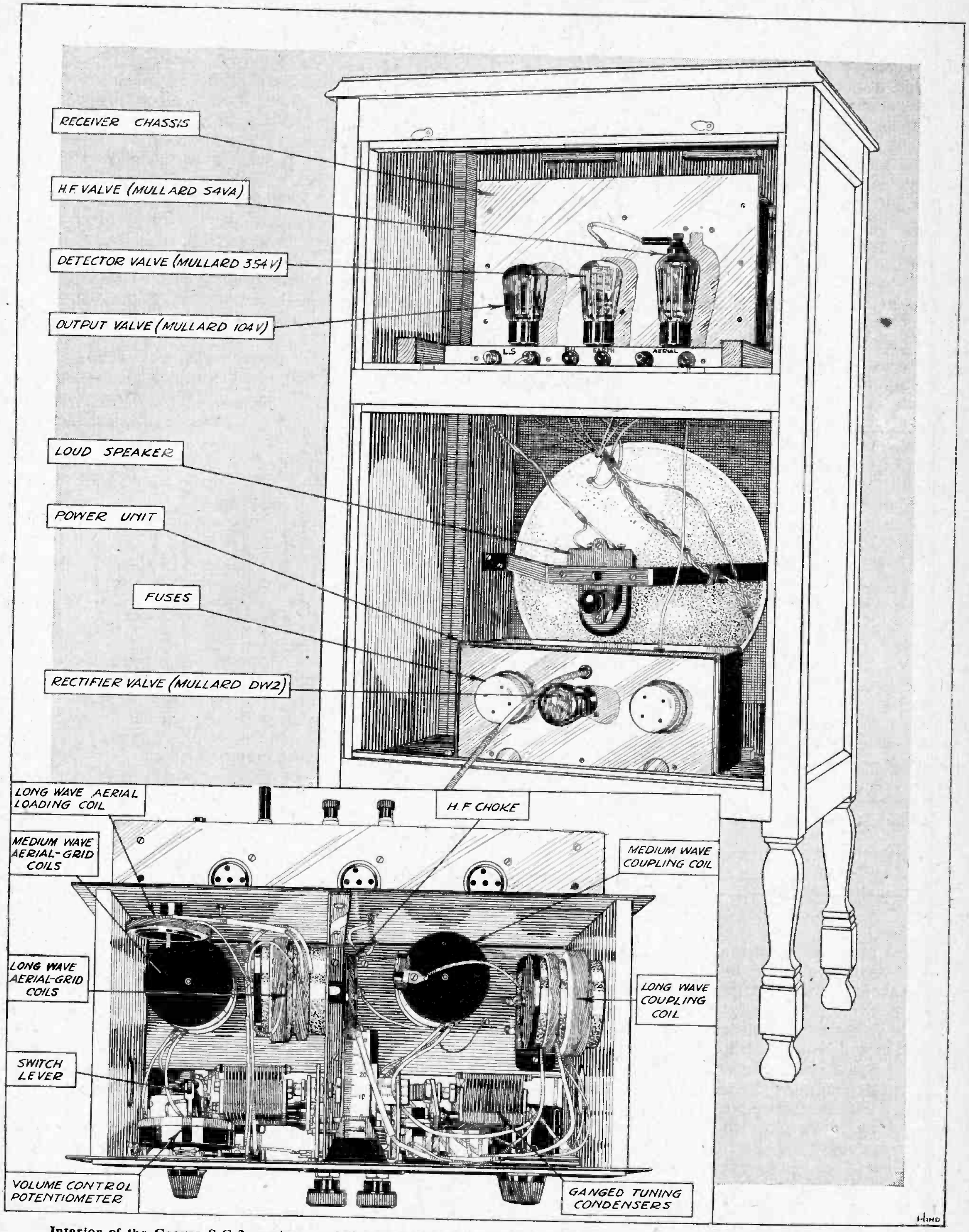
Both tuned circuits are controlled by a ganged condenser, an auxiliary external trimming condenser being provided for making critical adjustments.

A rather unusual arrangement is adopted in the intervalve H.F. circuit, where we find the medium-wave coil is divided into two equal sections, so that the long-wave winding may be inserted at its mid-point. By this means it is possible to work with centre-tapped coils on both bands without the need for a complicated switching system.

Entirely separate coil assemblies are used for each waveband in both input and intervalve circuits. The medium-wave windings are single-layer solenoids, while the long-wave sections are of the honeycomb type. It should be noted that an extra loading coil is interposed in the long-wave aerial circuit; this helps to avoid interference from nearby medium-wave stations.

Construction is on the two-unit principle. In the upper part of the cabinet is mounted the receiver chassis proper, housed in a metal container with two screening compartments, while below are the eliminator unit and loud speaker. These parts are all reasonably accessible, and can be withdrawn for examination or test after removing a few screws.

Connections between the units are made by coloured leads; a key to the colours is given in a complete circuit diagram which is supplied with each set. This is an excellent plan, as the user with some slight technical knowledge can, in the event of a breakdown, make simple tests without trouble; should it be necessary to




Interior of the Graves S.G.3 receiver, and (inset) the receiver chassis. The loud speaker unit is of the double-acting type.

**Graves S.G.3.—**

call upon the services of a professional repairer, it will be unnecessary to pay him for the time taken to trace the circuit before his real work is started! It may be recalled that the firm of Graves were among the first to endorse and adopt *The Wireless World* editorial suggestion that no set should be sent out without a circuit diagram.

It is understood that an unusually comprehensive instruction book, divided into technical and non-technical sections, is being prepared, but copies are not yet available. This sort of thing rather tends to enhance one's respect for a manufacturer, as it indicates a real desire that his products should be properly cared for when they pass into other hands. In spite of its low price, the Graves' set seems no more likely than any other to develop defects; a critical examination of such potential danger points as switch contacts, etc., fails to show any incipient weaknesses, while no undue economy is evident in the choice of components or accessories.

When putting the set into operation, a possible point of criticism was found in the position of the power-transformer primary tappings; in order to make an adjustment to suit various mains voltages it is necessary to remove the eliminator unit. But probably this objection can be overruled, as the necessary adjustment may be made before despatch.

When passing over the medium-wave tuning range, it is found that perfect resonance can only be maintained by making fairly frequent adjustment of the external trimming condenser. But the ganged tuning system is, nevertheless, of very real benefit, as, when a good average setting for this control has been found, tuning will be sufficiently accurate to enable any transmission within range at least to be heard; it can then be brought up to full strength by making a slight trimming adjustment. On the long-wave side it is seldom necessary to do this.

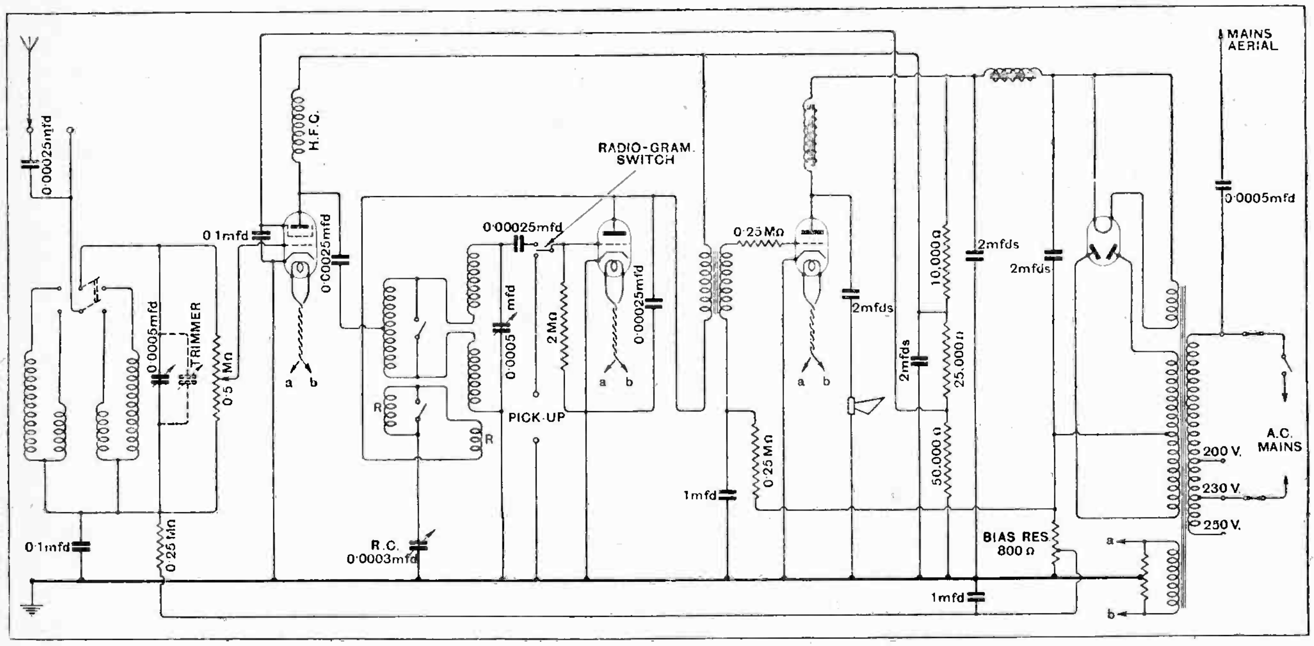
The input volume-control device is smooth and thoroughly effective, although, except when receiving an exceptionally powerful transmission, the majority of its useful range is concentrated in the first few degrees of rotation of the regulating knob.

Reaction control proves to be entirely satisfactory, and the elaboration of separate windings seems to be entirely justified by results. Both selectivity and sensitivity are well up to the average standard of a set of this type, and consequently it can provide really satisfactory long-distance reception. There is, indeed, a good reserve of sensitivity, and so it is generally possible to work with the weaker of the two optional aerial couplings provided without undue sacrifice of signal strength.

The output valve works under optimum conditions, and so gives its full rated output of some 600 milliwatts—quite enough for ordinary needs. Quality is surprisingly good for such an inexpensive set; the upper register is even and well maintained, while there is much more than a mere simulation of bass. A resonance at between 400 and 500 cycles can be picked out, but it is not so pronounced as to mar the reproduction of speech.

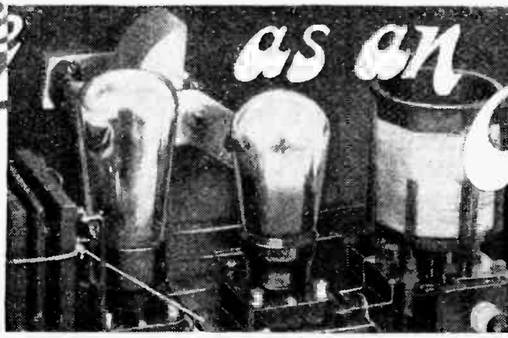
When the detector valve is operating as a gramophone amplifier, a negative voltage for its grid can be obtained by joining the low-potential pick-up lead to the "direct" aerial terminal instead of to earth, as indicated in the instructions. When playing test records, this alteration seemed to be worth while.

The receiver is made by J. G. Graves, Ltd., Sheffield, and costs £15, complete, by deferred payments. A discount of 5 per cent. is allowed for cash.




**Complete circuit diagram, with values of components. Medium- and long-wave reaction coils are marked R.**

# The Valve as an Oscillator



## How Harmonics are Produced.

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

THE elementary principles of "reaction" as applied to a simple triode circuit, with inductive coupling between the anode and grid circuits, were considered in the issue of August 5th, 1931. It was there pointed out that reaction causes an apparent reduction of resistance in the tuned-grid circuit, a greater current being produced with reaction than without it by a given applied voltage, and that the application of reaction could be considered as the introduction of a "negative resistance" into the tuned circuit.

Critical reaction was defined as that for which the "negative resistance" becomes just equal to the actual effective resistance of the tuned circuit so that the total resistance is apparently zero, meaning that the power expended in the tuned-grid circuit is just balanced by an equal amount of power being transferred from the anode circuit. In the article referred to, only those conditions relating to degrees of reaction below the critical value were considered, and the present object is to determine what happens when the reaction is increased above the critical value by tightening the coupling between the reaction coil $L_2$ and the tuning coil L of Fig. 1 (*a*).

When the coupling is increased beyond the critical value, any existing oscillation in the tuned circuit will cause energy to be transferred to the latter from the anode circuit *at a greater rate than it is being dissipated*. Consequently the excess of energy, which is not being dissipated, must be accumulated in the tuned circuit and stored there. It is being stored in the electrostatic and magnetic fields of the coil and condenser, and this increasing store of energy means that the oscillations are increasing in amplitude. In other words, the valve is itself generating oscillations in the associated circuit. The smallest initial disturbance in the circuits is sufficient to start the self-oscillation.

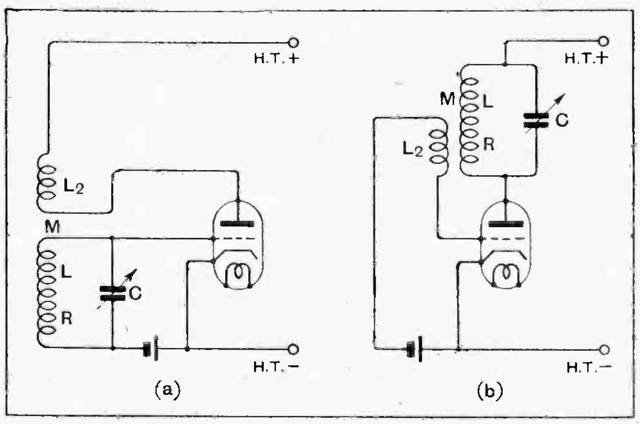



Fig. 1.—Alternative circuit arrangements whereby a valve can be made to generate continuous oscillations. With (a) harmonics are pronounced in the anode circuit, whereas with (b) the harmonics in the anode circuit are very much reduced.

It will be assumed that the oscillations have been started in the tuned-grid circuit of Fig. 1 (*a*) and that they commence to build up from a very small amplitude. Then, in the first place, we have two things to consider: (*a*) what is the frequency of the oscillations maintained by the valve, and (*b*) to what amplitude or "strength" will they rise? The frequency is determined mainly by the inductance L and the capacity C of the tuned-grid circuit, the frequency being approximately $f=\frac{1}{2\pi\sqrt{LC}}$ cycles per second, where L is in henrys and C is in farads. This is not the exact frequency, because the effective value of the inductance L is influenced by the proximity of the reaction coil $L_2$ and any other neighbouring circuits which may have currents induced in them; and, further, the main capacity C is shunted by the inter-electrode capacity of the valve itself and other small stray capacities. Obviously the coils $L_2$ and L form the primary and secondary windings respectively of a high-frequency transformer, the secondary being tuned to resonance, and the interactions between the primary and secondary windings of such a transformer were considered in detail in an earlier article on the theory of the high-frequency transformer,[1] to which the reader is referred.

The final steady amplitude to which the local oscillations build up in the

[1] "Theory of the H.F. Transformer," *The Wireless World* February 4th, 1931.

**The Valve as an Oscillator.—**

circuit of Fig. 1 (*a*) is determined by the characteristics of the valve, by the effective resistance of the tuned circuit, and by the degree of coupling between the coils L and $L_2$.

Suppose that the grid bias is set so that the valve operates at about the centre point of the straight part of the grid voltage/anode current characteristic curve. These conditions are shown on the left-hand side of Fig. 2, where OA represents the negative grid-bias and P is the centre point of the steepest part of the anode characteristic curve. With this setting the effective amplification factor of the valve has its greatest value, being proportional to the angle of slope of the curve, that is, to the mutual conductance.

Now suppose that a very small momentary disturbance of the grid voltage occurs with the reaction coil set to give a degree of feed-back above the critical value. The resulting disturbance of the steady anode current will react back on to the grid circuit, and so oscillations will commence to build up at the frequency already mentioned. While the oscillations are still small the valve will be operating over the straight part of the characteristic curve and the amplification constant will therefore remain unchanged at its maximum value. For this reason the amplitude of the oscillations will build up at a steady rate, as shown by the first part of the wave in the right of Fig. 2, where the boundaries of the anode-current wave are diverging straight lines. The initial rate of growth naturally depends on the rate at which energy is fed from the anode circuit to the tuned-grid circuit, and therefore on the degree of coupling.

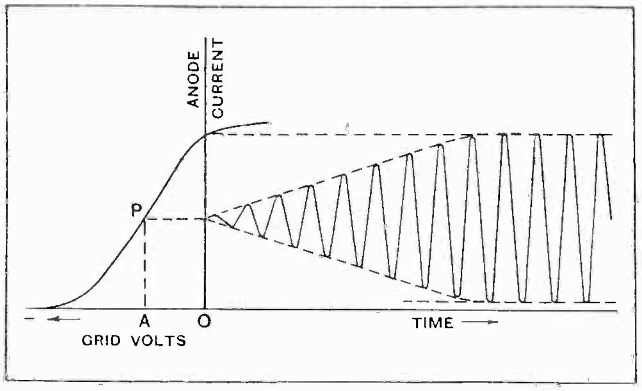



Fig. 2.—Diagram showing how self-oscillation builds up to a steady amplitude. The limit is set by the grid voltage/anode current characteristic curve shown on the left.

Obviously this steady rate of increase cannot continue for long, for the stage will soon be reached where the rising amplitude causes the valve to be operated round the bends in the characteristic curve. When this occurs the *average* slope of the curve between the upper and lower limits reached is less than the slope of the straight part. Since the effective amplification is proportional to the average slope, it follows that the degree of amplification begins to fall off as soon as the bends in the curve are reached, and so the rate of increase of the oscillations becomes less. Consequently the boundary lines of the anode-current oscillation curve, shown in Fig. 2, become less divergent or more nearly parallel as the bends of the anode characteristic curve are encroached upon. This effect continues until the boundary lines actually become parallel and the oscillation attains a steady amplitude.

The steady state is reached before the limits of operation extend right round the bends of the anode characteristic curve, for it must be remembered that the decreasing average slope of the part of the curve involved results in a lowering of the amplification and a consequent reduction in the proportion of energy transferred to the grid circuit compared with the losses in the grid-circuit resistance. When the oscillations have reached the final steady value, energy is being transferred from the anode to the grid circuit at exactly the same average rate as energy is being dissipated as heat in the grid-circuit resistance. The oscillations always build up until this balance is struck and then continue with constant amplitude.

### The Generation of Harmonics.

A point of considerable importance is the fact that under steady oscillating conditions the wave-shape of the current variations in the anode circuit is no longer a faithful copy of the wave-form of the voltage at the grid, the proportionality being lost as soon as the grid-voltage variations extend beyond the limits of linearity of the anode-current characteristic curve. For instance if a sine wave of voltage of large amplitude is applied to the grid of the valve, the resulting current wave in the anode circuit would have the peaks somewhat flattened as shown by the full-line curve of Fig. 3, where the dotted-line curve gives the true sine form which would have been obtained if the valve characteristic curve had been perfectly straight. The degree of this kind of distortion arising in the self-oscillating valve circuit increases as the reaction coupling is tightened; but, however weak the coupling may be, provided it is sufficient to start oscillations, their amplitude is bound to rise until the beginning of one or other (or both) of the bends in the anode-characteristic curve is reached. And so the current oscillations in the anode circuit will always be distorted from the true sine shape to some extent.

Now, it is well known that any periodic wave, however complex the form, is equivalent to the sum of a number of pure sine waves.[2] The principal component sine wave, called the *fundamental*, has the same frequency as the complex wave, and all the remaining sine waves, called harmonics, have frequencies which are exact multiples of the fundamental frequency. That harmonic which has three times the frequency of the fundamental is called the *third harmonic*, and so on. When both positive and negatives halves of the complex wave are of the same shape, only those harmonics whose frequencies are odd multiples of the main frequency are present, and when both even and odd harmonics are present the positive and negative halves of the actual wave will be of different shape.

An analysis of the flattened current wave of Fig. 3,

[2] "Wireless Theory Simplified," *The Wireless World*, April 16th, 1930.

**The Valve as an Oscillator.—**

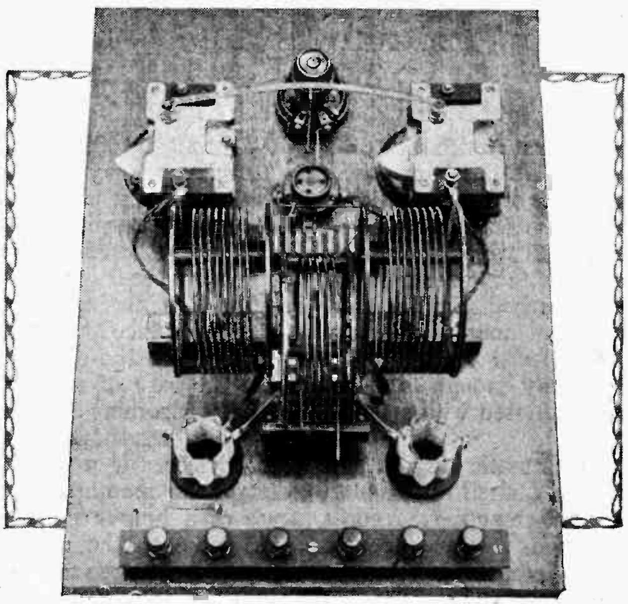
where both half-waves are assumed to be of the same shape, would show that a more or less pronounced third harmonic exists, with a less pronounced fifth harmonic. If the valve grid had been biased to a point near one of the bends in the anode characteristic curve, only one of the half-waves would have been flattened (biasing near the bottom bend would flatten off the lower half-wave, and vice versa), and in these circumstances a relatively powerful second harmonic is introduced into the anode-current oscillation. In some forms of superheterodyne receivers the second harmonic frequency of the local oscillator is employed in effecting the change from high to intermediate frequency.

### Filtering Effect of the Tuned Circuit.

The grid circuit oscillations are maintained by the alternating current in the reaction coil, through the medium of the mutual inductance M, so obviously, if the alternating component of the anode current does not obey the sine law of variation, the E.M.F. wave induced into the tuned circuit will also deviate from the true sine shape. If the anode-current wave contains, say, a third harmonic, the E.M.F. set up in the tuning coil will also contain a third harmonic.

At this point we have to exercise a little care, for it must be remembered that the E.M.F. induced into a coil by a current in a neighbouring coil is not only proportional to the mutual inductance, but also to the frequency. So if the third harmonic of the anode current in the circuit of Fig. 1 has an amplitude equal to 10 per cent. of the amplitude of the fundamental wave, the third harmonic of E.M.F. induced into the tuning coil L will have an amplitude of 30 per cent. of the fundamental. In other words, the E.M.F. wave will contain a third harmonic relatively three times as pronounced as that contained by the anode-current wave!

These proportions, however, do not apply to the resulting *current* oscillations in the tuned circuit, for the latter is tuned to resonance at the fundamental frequency only. So far as the oscillating current is concerned, the fundamental frequency is selected by the tuned circuit, whereas the harmonic frequency is, to a large extent, suppressed.



The oscillating valve is the basis of the amateur transmitting station. This illustration shows an interesting ultra-short-wave oscillator of simple construction.

This very important effect will be most easily shown by ascribing numerical values to the constants of the tuned circuit and to the frequencies involved. For instance, let $L = 200\ \mu H$ and $C = 126.7 \mu\mu F.$, so that the circuit tunes to 1,000 kilocycles or $10^6$ cycles per sec. Suppose that the effective resistance of the tuned circuit is 10 ohms at this frequency. Assuming the current in the reaction coil to contain a 10 per cent. third harmonic, the induced E.M.F. in the tuning coil will then contain a 30 per cent. third harmonic, as already explained, and thus, if the fundamental frequency E.M.F. is 10 millivolts, the third harmonic or triple frequency E.M.F. will be 3 millivolts.

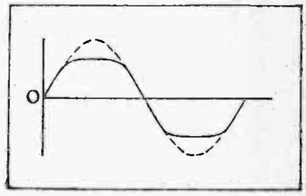



**Fig. 3.—Under steady oscillating conditions, either one or both of the half-waves of anode current wave are flattened.**

Now, at the resonant frequency of 1,000 kc. the impedance round the closed circuit is only 10 ohms, so that the fundamental sine wave of current produced in the tuned circuit will be $I_1 = \frac{10}{10} = 1.0$ milliampere.

At the third harmonic frequency (3,000 kc.) the reactance of the coil is 3,771 ohms, and of the condenser $-419$ ohms. The total reactance at this frequency is therefore $3{,}771 - 419 = 3{,}352$ ohms. Compared with this, the resistance is negligibly small, and so the impedance is also about 3,352 ohms. The third harmonic component of current is therefore $I_3 = \frac{3}{3{,}352} =$ 0.0009 milliampere.

Comparing this with the current of 1 milliampere at the main frequency, we see at once that it represents only a very small percentage, namely, $\frac{0.0009}{1} \times 100 = 0.09$ per cent. So, in spite of the reaction coil carrying a current with a 10 per cent. third harmonic, the current produced by it in the tuned circuit contains a third harmonic whose amplitude is less than one-tenth of one per cent. of that of the main wave.

It now remains to calculate the voltage developed across the tuned circuit and applied to the grid of the valve to show how completely the harmonic frequencies are filtered out by an efficient tuned circuit. The reactance of the condenser at 1,000 kc. is 1,257 ohms, and the current at this frequency is 1 milliampere. Hence the voltage developed across the circuit is $1 \times 1{,}257 = 1{,}257$ millivolts at the fundamental frequency. At the third harmonic frequency the reactance of the condenser is 419 ohms and the current is 0.0009 milliampere. Consequently the third harmonic voltage

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developed across the condenser is $0.0009 \times 419 = 0.38$ millivolt only. Expressed as a percentage, the triple frequency component of the voltage passed on to the grid of the valve is only 0.03 per cent. compared with the fundamental frequency. This means that if the alternating voltage on the grid were 1 volt the third harmonic voltage would be only 0.0003 volt. As the amplitude of the third harmonic was, in the first place, assumed to be 10 per cent. of the amplitude of the fundamental anode current wave, it follows that this particular tuned circuit has the effect of reducing the corresponding third harmonic of voltage across the condenser to 0.3 per cent. of its original relative value in the anode circuit.[3]

### Tuning the Anode Circuit.

Although the third harmonic has been chosen for purposes of explanation, it must be remembered that when a valve is generating oscillations, especially with the reaction coil tightly coupled, many harmonics are produced in the anode-current wave when the circuit of Fig. 1 (*a*) is employed. In fact, one of the most pronounced harmonics usually produced is the second, having twice the fundamental frequency.

In arriving at the foregoing conclusions, no mention has been made of grid current. In practice it is not always possible to prevent the voltage excursions of the valve grid from entering the relatively positive region where grid current flows during part of each positive half-cycle. This has the effect not only of damping the oscillations as a whole, but represents a further source accounting for the generation of harmonics.

Where it is important that a valve generator should produce harmonics to the lowest possible extent, for instance, in the case of the oscillator of a superheterodyne receiver where the fundamental frequency is utilised for effecting the necessary frequency change of the incoming modulated wave, the circuit of Fig. 1 (*b*), or some modification of this circuit, is to be preferred. Here the tuned-anode circuit has the effect of suppressing or attenuating any harmonic frequencies for similar reasons to those which apply to the tuned-grid arrangement. The tuned circuit in Fig. 1 (*b*) offers a high impedance $\frac{L}{CR}$ ohms to currents of the fundamental resonant frequency, but the tuning condenser acts as a by-pass for the harmonic frequencies. With this circuit the ill-effects of grid current are eliminated. The purity of the voltage set up across the tuned circuit depends on the efficiency of the latter, so that the lower the resistance R, and the higher the ratio L/C, the weaker will be the harmonics relative to the fundamental voltage wave.

[3] The *n*th harmonic is reduced to $\frac{n}{n^2-1} \times R\sqrt{\frac{C}{L}}$ of the original relative intensity.

# COPYING HIGH-SPEED SIGNALS.

## A Tip for the Amateur.

ONE of the greatest difficulties confronting the ambitious amateur who is determined to master the Morse code is to discover ways and means of finding signals which, at any given stage in his progress, are being transmitted at a speed within his ability to copy. Undoubtedly, the best way to master the code is to take lessons either at some recognised school or to get some experienced friend to devote an hour or so every evening to the transmission of special signals on a buzzer. But all of us are not wealthy enough to afford training fees, and not all of us are blessed with a friend who is an expert telegraphist.

Alternatives are provided by automatic mechanisms designed to reel off signals at any desired speed from specially cut metal discs, and special gramophone records can also be purchased. Both methods involve expense, and possess the disadvantage that the recorded messages become so familiar after a while that they can almost be copied from memory.

To those who possess or have access to a dictaphone or one of the increasingly popular home-recording outfits, there is another and more interesting way out. Instead of trying to copy wireless signals direct, they may be recorded by whatever method is available, and then played over at leisure at whatever speed is required to bring the speed of the signals down to the level of the student's ability. Even expert operators may profit by this method, for high-speed automatic transmissions may be slowed down and copied.

When tuning in signals for this purpose, the C.W. note should be pitched higher than usual, because the pitch will be lowered again when playing over the records at slower speed. The recording is done with the cylinder or disc running at normal speed; to play back, the speed is reduced until the signals are reproduced at a speed within the ability of the operator to copy.

In the case of a dictaphone, it is only necessary to amplify incoming signals to good strength, and then hold one telephone earpiece close to the dictaphone mouthpiece. If a loud speaker is employed, hold the dictaphone mouthpiece close to the speaker. In the case of a home-recording outfit, one earpiece may be held close to the recording microphone, or the latter may be held close to a loud speaker. Alternatively, the output of the wireless receiver may be put through an output transformer, the secondary of which should be connected to the input of the home-recording outfit in place of the microphone.

All sorts of interesting Press and other messages may be copied in this way, which, due to high transmission speed, might otherwise be lost, and at the same time the Morse code student will quickly increase his reception speed in a manner much less tedious than the more orthodox method

A. D.

# CURRENT TOPICS

News of the Week in Brief Review.

### G5BY's TRIUMPH.

"The almost unbelievable score of 11,872!" is the description applied by "Q.S.T.," official organ of the American Radio Relay League, to the triumph of Mr. H. L. O'Heffernan (G5BY), who, for the fourth successive time, has won first place in the International Relay Tests. Mr. O'Heffernan, to whom we offer warmest congratulations, sat up every night for two weeks, and by his industry captured more than double the number of points of his nearest competitor.

The basic principle for scoring was that a one-way contact gained a single point both for sender and receiver, while for two-way working both stations secured two points.

Mr. O'Heffernan keeps another speed record in British hands.

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### PROGRAMMES AT 13s. 4d. PER HOUR.

The French Colonial station at Pontoise is already "hard up." M. Julien Maigret, director of the station, reports that Colonial listeners are rather exacting. Their requirements are: less music, absolutely no gramophone records, and more live news.

We sympathise with M. Maigret. Unlike the controllers of 5SW, he must find his own programme material, and is apparently under an obligation to provide eight hours' original entertainment a day with a monthly expenditure of £160.

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### "RECEIVER" OR "SET"?

A more appropriate and dignified name for a wireless set was pleaded for by the Mayor of Southend last week when he extended a civic welcome to the delegates at the Ekco Radio Convention. The Mayor suggested that the word "set" did not nearly describe the wonders of a modern radio receiver.

Anyway, what's wrong with "radio receiver"?

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### A BRIEF RESPITE.

The super-power broadcasting stations at Breslau, Leipzig, and Frankfurt will not be ready until February, 1932.

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### RADIO AT FARADAY SHOW.

In addition to the Olympia Radio Show, London will have another autumn treat for radio enthusiasts. This will be the Faraday Centenary Exhibition at the Royal Albert Hall from September 23rd to October 3rd.

The Exhibition, which will be arranged to show how Faraday's pioneer work has influenced life to-day, will give Londoners the rare opportunity of seeing the actual transmitter panels and associated equipment to be used at the new Scottish Regional broadcasting station.

A radio museum will be another attraction. It will include the earliest wireless set, kindly lent for the occasion by Senator Marconi from his private collection in Italy.

Most fascinating of all, perhaps, will be the demonstration of "scrambled speech," the system of waveform inversion used in transatlantic telephony conversations.

### SOUND EVIDENCE.

A sound film record of noises in a dairy proved to the satisfaction of a judge in the Melbourne Supreme Court that a nuisance was being created. We can guess that the plaintiff had the volume control at "max."!

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### WORLD'S TALLEST TELEVISION STUDIOS.

For some time past the National Broadcasting Company has been transmitting television experimentally from a short-wave station on the comparatively low roof of the new Amsterdam Theatre, in Times Square, New York, but the much higher buildings which completely surround the theatre have played havoc with the outgoing signals.

As a result the N.B.C. announces that it has leased half of the 85th floor of the Empire State Building, 1,000 feet above the street, and proposes to build the world's highest television studios. The short-wave transmitting aerial will be suspended from the top of the airship mooring tower, which projects another 250 feet above the 85th floor. At present this site is well clear of any tall buildings, and better results are expected.

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### TELEVISION IN ONE YEAR.

In announcing the acquisition of this site, M. H. Aylesworth, President of the N.B.C., predicted that after about a year of intensive experimental tests under actual working conditions, television would be developed for public use.

"This does not mean that it will be 100 per cent. perfect," he said, "but television will at least have reached that stage where refinements of technique will be required rather than the development of new basic principles."

From this and other symptoms (writes our New York correspondent), it is generally agreed in New York that the R.C.A.'s closely guarded cathode-ray system will be ready in a year's time to be dumped into the N.B.C.'s lap, and into the living rooms of an anxiously waiting (?) public.

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### FIGHTING MAN-MADE STATIC.

The French National Commission organised to enquire into man-made static will be held at the Paris Colonial Exhibition on September 25th and 27th. Those present will include postal representatives, electrical manufacturers, and radio club members.

Suggestions and ideas will be welcomed from all quarters. The secretary's office is at 7, rue Vésale, Paris.

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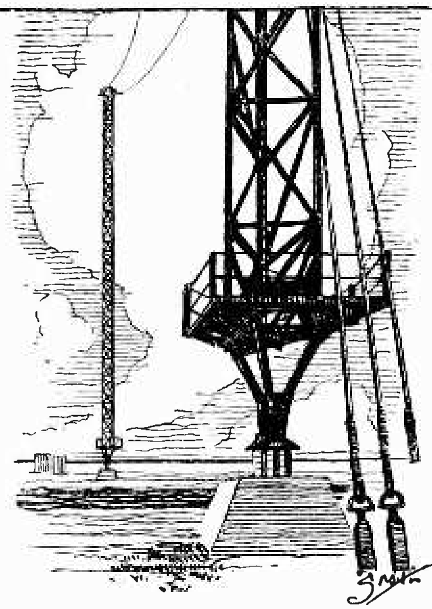
### OBITUARY.

Many wireless and cable operators will learn with regret of the unexpected death at an early age of Mr. Evan H. Wilton-Jenkins, for many years a popular instructor at the London Telegraph Training College, Penywern Road, Earl's Court, London.

**BRITISH RECORD SUCCESSFULLY DEFENDED. Mr. H. L. O'Heffernan (G5BY), winner for the fourth successive year of the A.R.R.L. Transatlantic Relay Tests, is here seen in his wireless "den" at Croydon. During the fortnight test period, Mr. O'Heffernan secured more than double the number of two-way contacts obtained by any other competitor.**

# BROADCAST BREVITIES



*By Our Special Correspondent.*

**The Portland Place Mystery.**

Why is there to be no opening ceremony when "Broadcasting House" becomes the home of the B.B.C.?

According to present plans, which are chiefly remarkable for their meagreness, the most up-to-date broadcasting building in Europe will be taken over without so much as a flutter of the interval signal.

oooo

**What's in a Name?**

From the very beginning the B.B.C. has shown an absurd modesty in regard to the new building. The very name "Broadcasting House" was, I believe, evolved by an imaginative works foreman in need of a second postal address.

oooo

**A Furtive Ceremony.**

Again, when the question of laying the foundation stone was brought up, it was left to the architect, Col. Val Myer, and the B.B.C.'s Civil Engineer, Mr. Tudsbery, to stage a dark little ceremony on their own account, with a few workmen standing by. "Not a drum was heard" as they buried beneath the foundation stone a current copy of the *Radio Times*, two or three coins of the realm, and a few pathetic gewgaws to inform posterity how we killed time in 1930.

oooo

**Safely Gathered In.**

And now, with touching consistency, comes the news that no inaugural ceremony is deemed necessary. The utmost to which the B.B.C. officials will go is to say, in effect, that "perhaps, when all the staff have been transferred, a special programme of some kind may be prepared."

Judging by the present state of "Broadcasting House," this Harvest Thanksgiving is a long way off.

oooo

**A Start on New Year's Day?**

Last week I was privileged to "tour" the building from top to bottom. (It took me nearly two hours!) An immense amount of impressive work has already been done, but one cannot pretend that the place is anywhere near being habitable, and I should be surprised if many of the staff could be safely gathered in before Christmas.

What could be more suitable than a memorable opening ceremony on New Year's Day?

oooo

**Enter Sir Henry.**

Each year, as Sir Henry Wood threads his nimble way through the orchestra and inaugurates the "Proms" with that famous bow, the microphones are put to a severer test. On Saturday, August 8th, the deafening applause lasted for a full two minutes.

oooo

**A Bassoon—and Others.**

When the B.B.C. season of Winter Symphony Concerts at the Queen's Hall opens on October 14th, the National Orchestra will have been strengthened by the addition of four more instrumentalists, bringing the total to 118.

Perhaps listeners with acutely musical ears will be able to detect what these instruments are, but, as the B.B.C. is not holding a guessing competition, it can be stated here and now that the additions are: one flute, one oboe, one bassoon, and one trombone.

**Eight Conductors—Twenty-four Concerts.**

All the concerts—there will be twenty-four—will be broadcast, and the series will extend from October 14th to May 4th.

Twelve of the performances will be conducted by Dr. Adrian Boult, five by Sir Henry Wood, and one by Sir Landon Ronald. Five of the concerts will be presided over by eminent foreign conductors, viz., Nicolai Malko, Richard Strauss, Ernest Ansermet, Felix Weingartner, and Bruno Walter.

oooo

**Mrs. Snowden and the Microphone.**

It is a queer fact that Mrs. Philip Snowden—the one lady member of the B.B.C. Board of Governors—is the only Governor who, apparently, is happy to face the microphone. Mrs. Snowden will give an introductory broadcast talk in the autumn programme of morning talks on September 7th.

oooo

**Plans for Radio Drama.**

The autumn productions open on September 7th (Regional) and September 9th (National) with Lawrence Housman's jury play, "Consider Your Verdict."

After it comes a new comedy by E. M. Delafield, entitled "To See Ourselves" (September 14th and 15th); and next a drama by Compton Mackenzie, "The Lost Cause," dealing with the Young Pretender. "The Emperor Jones," with Paul Robeson in his original part, will be broadcast on October 18th.

oooo

**The War in the North.**

At the time of writing, Mr. Ashbridge and his engineers are persisting with the experiment of synchronising Newcastle with Northern Regional on 479.2 metres. The success is by no means complete, but already there is a sufficient improvement to show that the effort is not such a hare-brained one as certain of the critics would have us believe.

oooo

**This "Wicked" B.B.C.**

To judge from some of the letters published in the Northern newspapers, the B.B.C. has been maliciously seeking to deprive widows and orphans of their sole remaining joys; "disgraceful" is the adjective in greatest favour, though many listeners are content to describe the test as "childish."

oooo

**Trying to Please Everybody.**

These epithets are unjust. No doubt it is very hard to have one's reception upset, even for a week or two, but it is scarcely fair to impute evil motives to a body of hard-working individuals whose only crime—if it be a crime—is a somewhat impulsive desire to feed as many mouths as possible with one spoon.

oooo

**What Newcastle Really Wants.**

If, by the end of August, synchronisation proves a failure, Newcastle listeners may depend upon it that Mr. Ashbridge will beat an honourable retreat. I am less hopeful that he will give them an independent wavelength of their own. This is what Novocastrians are really fighting for, and who can blame them?

### FUTURE FEATURES.

**National (261 and 1,554 metres).**

AUGUST 24TH.—Light orchestral concert.
AUGUST 25TH.—Promenade concert.
AUGUST 27TH.—"The Fun Factory," a revue by John Watt.
AUGUST 28TH.—Vaudeville programme.

**London Regional.**

AUGUST 23RD.—Programme of French music.
AUGUST 24TH.—Promenade concert.
AUGUST 26TH.—Vaudeville programme.
AUGUST 28TH.—"The Fun Factory."
AUGUST 29TH.—Songs and cries of Old London.

**Midland Regional.**

AUGUST 25TH.—"The Travels of Tiadatha," by Owen Rutter.
AUGUST 28TH.—A Coleridge Taylor programme.

**North Regional.**

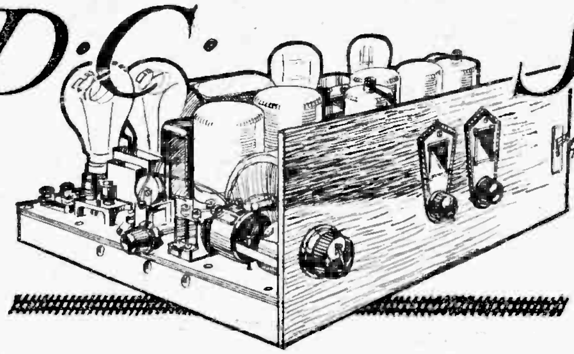
AUGUST 28TH.—Instrumental variety programme (from Leeds).

**West Regional (Cardiff).**

AUGUST 28TH.—"Hamlet in Modern—Rush," a play by H. C. G. Stevens.

**Glasgow.**

AUGUST 27TH.—Speeches at the ceremony of the gifting of a gymnasium to Kirkcudbright Academy.



# D.C. Super-Selective Five

## Constructional Data. Voltage Adjustments. Operating Hints.

By W. T. COCKING.

(*Concluded from page 152 of previous issue.*)

THERE is nothing complicated about the constructional work, and the details can be seen from the various drawings and photographs. It should be noted, however, that the two variable condensers are insulated from the drum dials by flexible couplers. This is to ensure that the metal escutcheon plates of the dials are dead, and to remove the possibility of any shock while tuning.

The screened coils, I.F. transformers, and valve screens are earthed by screwing them down on strips of copper foil which was also used as a common return lead for a number of connections. The valve screen of the first detector is fairly close to the two drum dials, and care should be taken to see that it does not actually touch them, otherwise their insulation will be rendered ineffective, and the rubbing contact may give rise to noisy reception.

The mains resistance mat is placed beneath the baseboard, and as it gets quite hot with high voltage mains, a number of holes should be drilled above it in the baseboard, and in the wooden beading supporting the baseboard, to ensure adequate ventilation. For the same reason, it is wise to drill a few holes in the back of the cabinet behind the carbon lamps, as these also run quite hot.

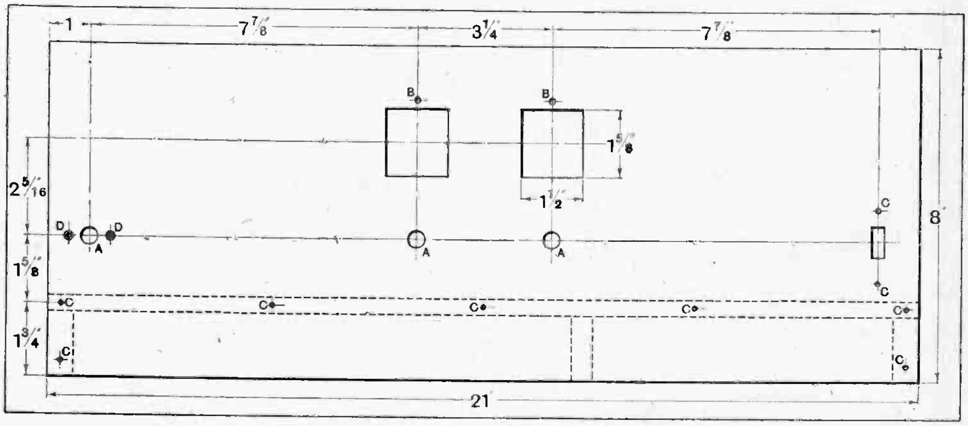
The wiring is straightforward, and little trouble should be experienced. Particular care should be given to the wiring of the heater circuits, as endless trouble can be caused by a mistake here. A connection which one is particularly liable to forget is that between the heaters and the common earth lead.

### Voltage Adjustment.

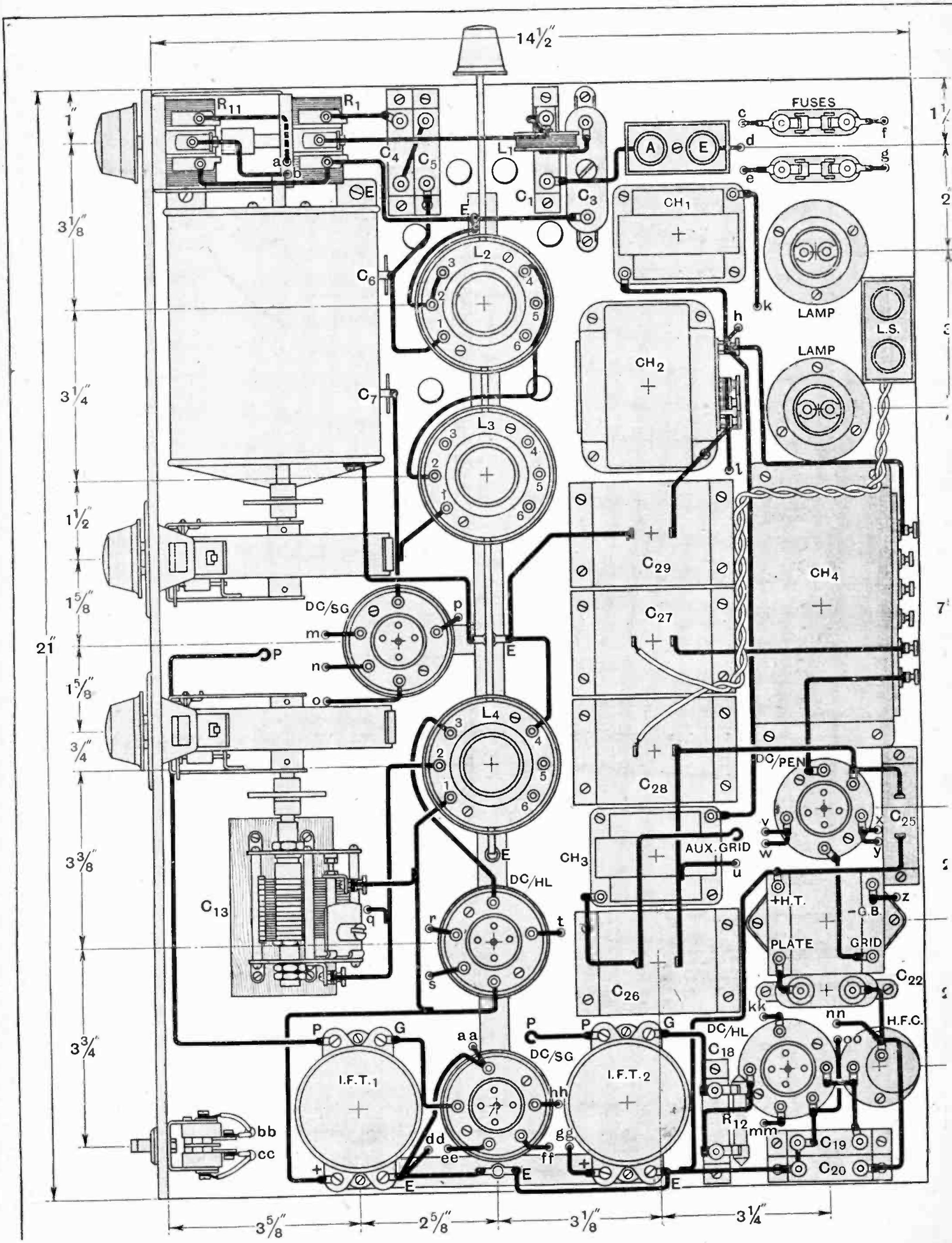
When first setting up the receiver it is very desirable to use an ammeter in the heater circuit to make sure that the current passed is correct. The meter should be inserted at the point marked "X" in Fig. 1, and the tapping point on the resistance mat adjusted until the current passed is 0.5 ampere. It will probably be found that it is impossible to obtain exactly this value of current, but it will be quite sufficient to adjust the tapping until it is within plus or minus 5 per cent. of the rated value, that is, between 0.475 ampere and 0.525 ampere. If no suitable ammeter be available, the tapping should be adjusted with the aid of a good quality high-resistance voltmeter, connected across the heater of either the first detector or the oscillator valve, until it reads 6 volts.

It must never be forgotten that the current measured must be the steady current after the valves have warmed up, and not the current obtained immediately on switching on. The current before the valves have warmed up is slightly greater than the steady current, and in a case when the steady current was 0.51 ampere it was found that the initial current was 0.54 ampere. In view of the difficulty in getting the voltages just right without a voltmeter or ammeter, it must be considered somewhat dangerous from the point of view of valve life to set up the set without such an instrument, and its use is recommended wherever possible.

As a guide to the choice of tapping, it may be stated that on a measured mains voltage of 206 volts the tapping lead is connected to the second tap down the mat, whereas with 240 volts the full mat should be included. In the case of 250 volts mains, where the voltage is known never to exceed this figure they may be connected to the tapping for 240 volts; but where there is a likelihood that they may rise to 260 volts or so, as is often the case, an additional resistance of 50 ohms or so should be included in series with the mat,




**Panel dimensions and drilling data. A is $\frac{7}{16}$ in. diameter ; B $\frac{5}{32}$ in. diameter ; C $\frac{1}{8}$ in. diameter and D $\frac{1}{8}$ in. diameter and countersunk.**


14½"
R11
R1
C4
C5
L1
C1
C3
A
E
FUSES
c
d
f
g
e
CH1
L2
C6
LAMP
L.S.
h
k
CH2
C7
L3
l
C29
CH4
DC/SG
p
m
n
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P
E
C27
L4
C28
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-G.B.
PLATE
GRID
z
C26
C22
kk
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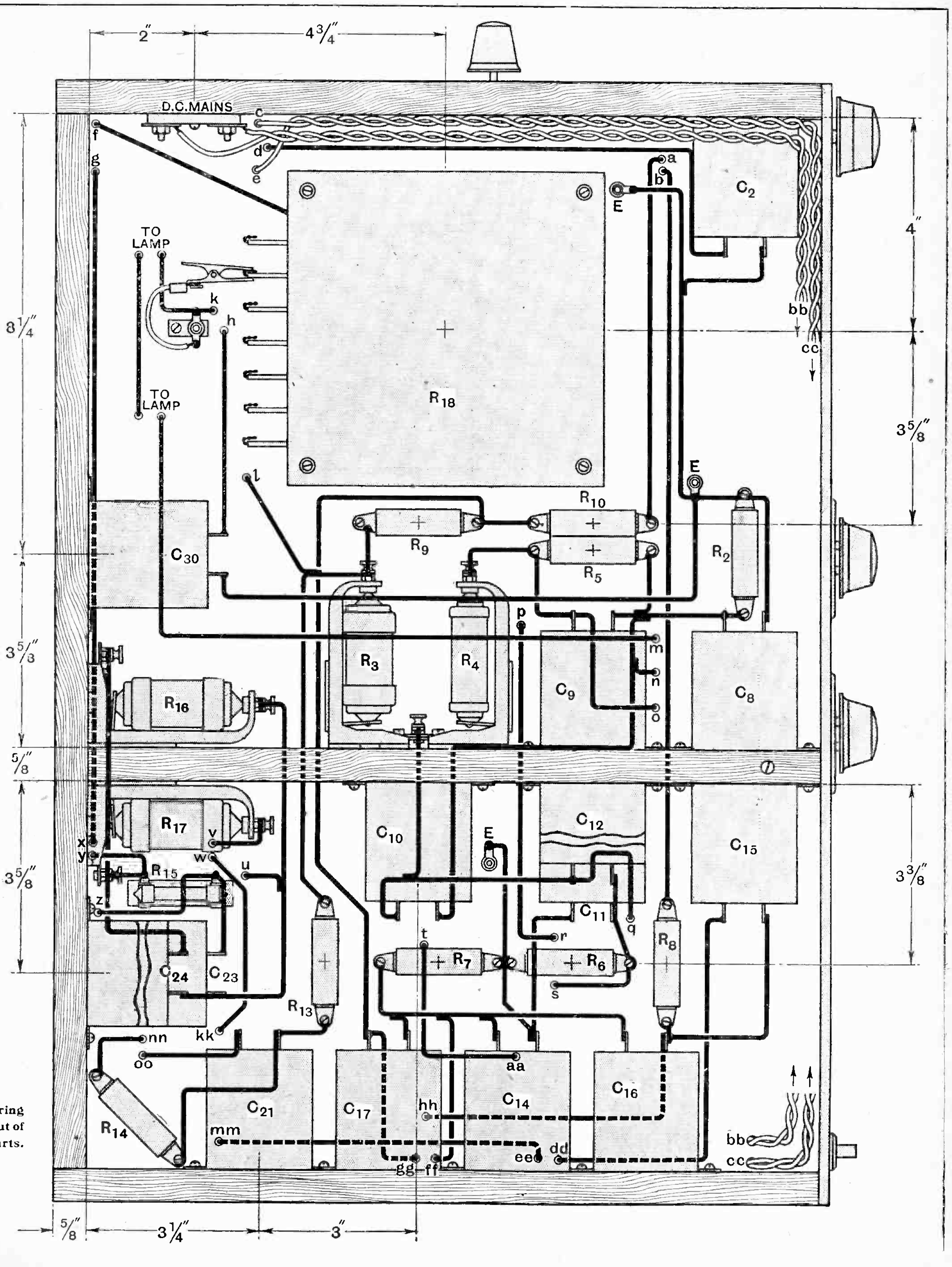


wiring
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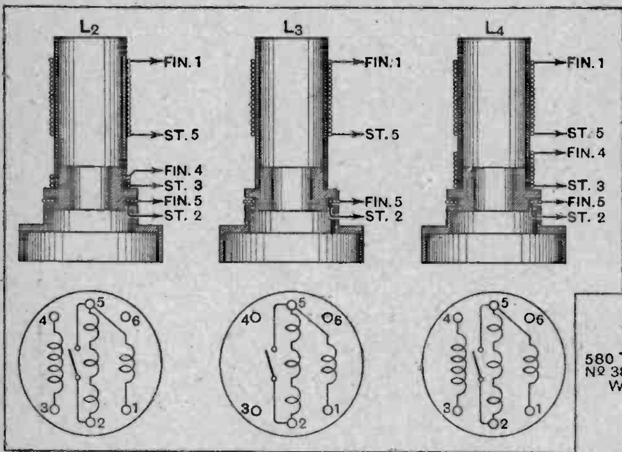
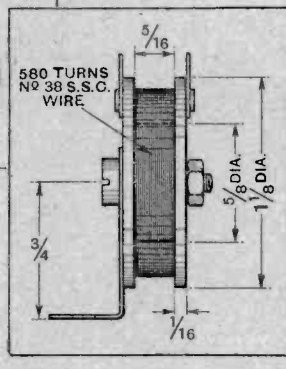



Terminal markings and coil winding data of the band-pass and oscillator coil ($L_4$). On the right are shown details of the aerial acceptor coil.



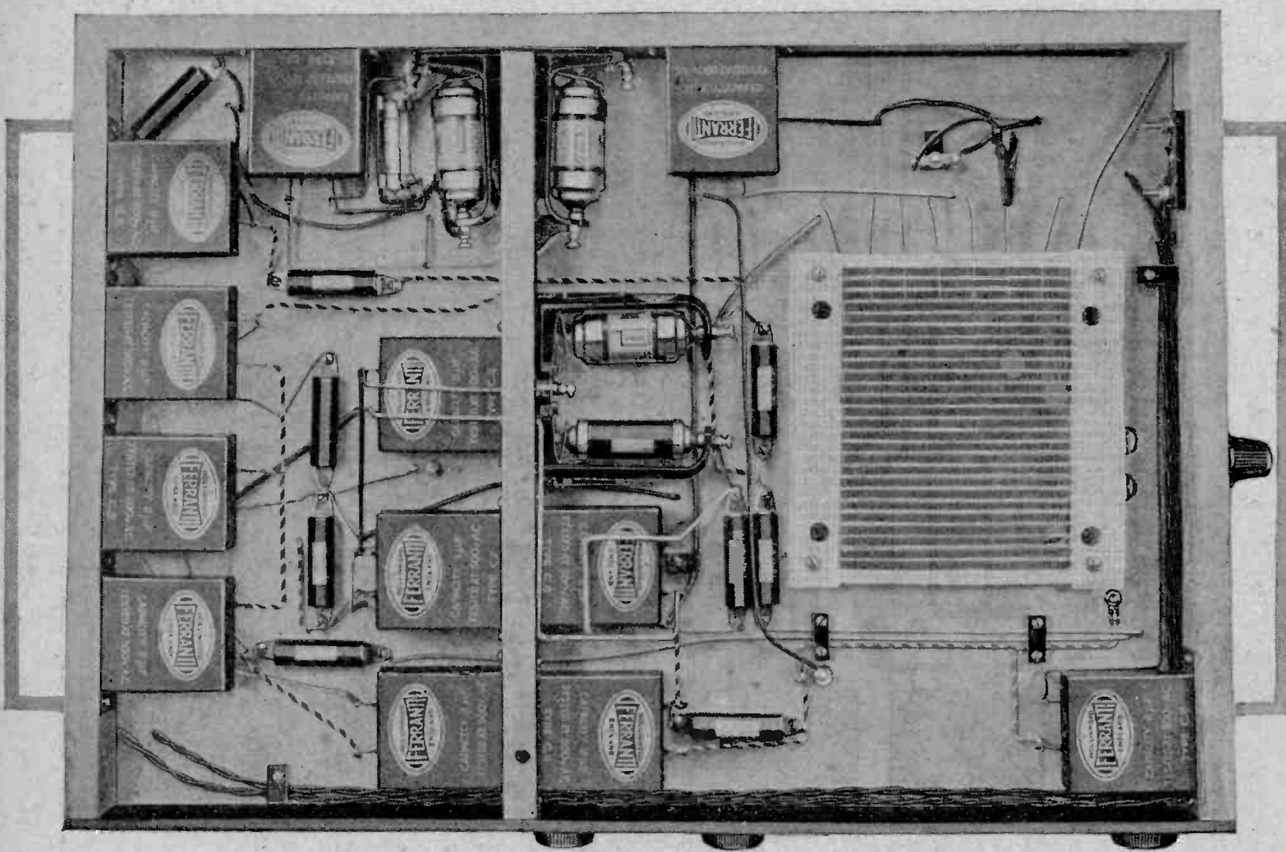

and the current adjusted by means of the tappings.

In Table I are given the voltages and currents at various points in the receiver, and it should be noted that they are applicable to any mains voltage, since the excess is always dropped in the resistance mat. It should be noted that the pentode voltages were measured from the negative mains terminal, whereas the voltages on the other valves were measured from the common earth lead. The second detector anode current of 2.3 mA. may appear low, but it is amply sufficient to allow of the pentode output stage being fully loaded.

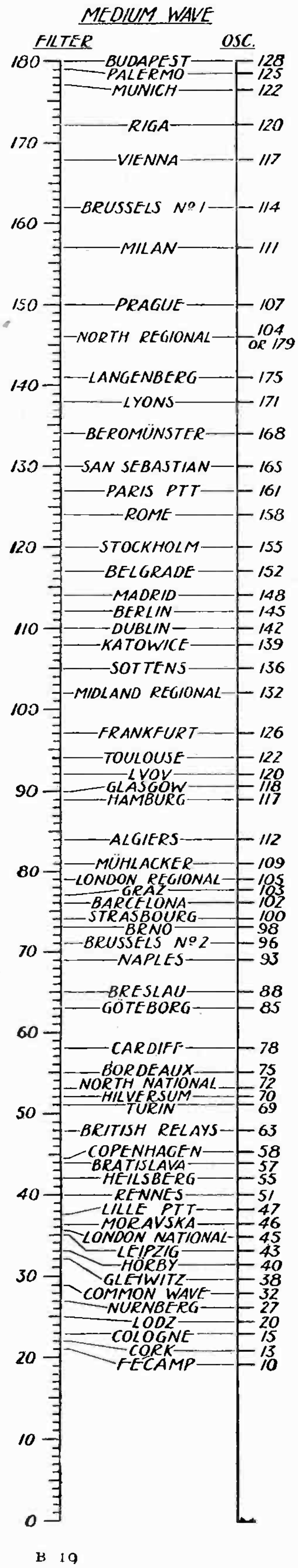
It should not be forgotten that, as all the heaters are in series, if one valve breaks none will light, and it will be necessary to test each one independently to find the faulty one. Similarly, if one of the carbon lamps is damaged, none of the valves will light; a broken carbon lamp is easily detected, however, since the whole filament can be distinctly seen. Under normal working conditions the valve cathodes work at a dull red heat, while the carbon lamps are really bright, although not at their full brilliancy.

### Initial Adjustments.

The initial adjustments are few in number and easily carried out. The local station should be tuned in and the ratio of the pentode output choke adjusted to give the correct load impedance for the particular speaker used. The coils in each I.F. transformer should be set well apart, and the small trimmers in the bases adjusted for the maximum response. The trimmers are actuated



Underside of the baseboard where the voltage dropping resistances, decoupling and smoothing equipment are situated.




**D.C. Super-Selective Five.—**

by small levers projecting from the bases, and these should be moved by a piece of wood or ebonite. Once these trimmers are correctly adjusted, they will not need touching again, and attention should next be paid to the coupling between the coils.

The selectivity and quality will depend very largely upon the spacing of these coils. Those in the first transformer should be set so that the amplification is at its maximum, and this usually occurs when the distance between the coil centres is about ¾in. to 1in. The distance between the coils in the second transformer will usually be somewhat less, for they are adjusted until the quality is at its best. In general, their distance apart should not be less than ½in., or there will be a distinct loss in selectivity.

TABLE I.

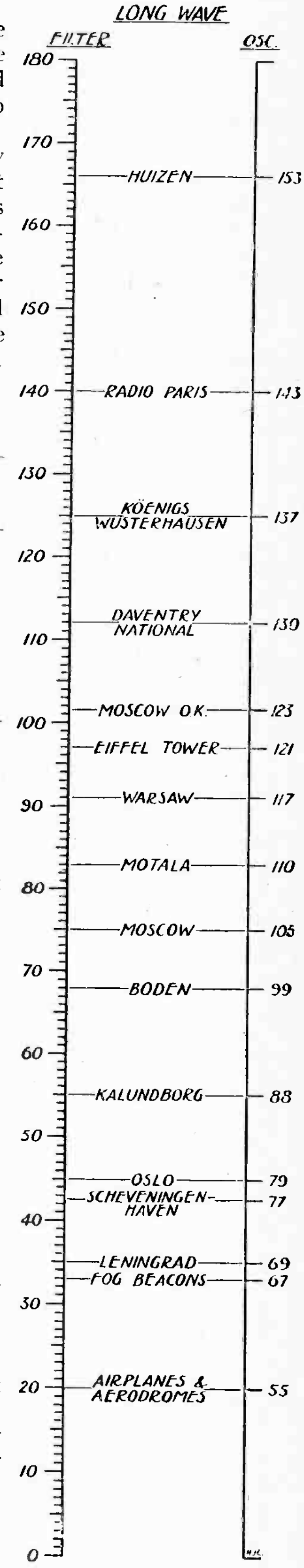
| Valve. | Anode Volts. | Anode Current. | Screen Volts. | Screen Current. | Grid Volts. |
|---|---|---|---|---|---|
| 1st Detector DC/SG | 112 | 5 | 44 | — | −2 |
| Oscillator DC/HL | 112 | | — | — | −3.6 |
| I.F. Amplifier DC/SG | 136 | 2.2 | 50 | — | −1.4 |
| 2nd Detector | 120 | 2.3 | — | — | 0 |
| Output DC/Pen. | 176 | 26 | 176 | 4.7 | −10 |

Mains voltage 206. Total mains current 0.54 ampere.
Internal resistance of voltmeter for H.T. and screen readings, 400,000 ohms; for grid bias readings, 100,000 ohms.

The ganging of the pre-selector should be carried out next, on the medium waveband, and at as short a wavelength as possible. A station on a wavelength of about 250 metres should be tuned in and the volume control set at maximum; each trimmer must then be turned until the signals are at their loudest. As a guide to this adjustment, it may be mentioned that on the original receiver the primary circuit trimmer was fully unscrewed, while the secondary circuit trimmer was screwed nearly fully home.

### Adjusting the Acceptor Circuit.

The only other adjustment required is that of the acceptor circuit $L_1C_3$, and this must be done on the long waveband. The purpose of the circuit is to eliminate C.W. interference due to stations working on the intermediate frequency, and the adjustment can only be carried out when such interference is experienced. In cases where no interference is found, obviously the circuit is not required, and so cannot be adjusted; in any case, until the adjustment can be carried out, the pre-set condenser should be fully screwed home. If now, when receiving on the long waveband, it is found that there is C.W. interference on all broadcasting stations, and that the note of the C.W. changes with the setting of the oscillator condenser, then the pre-set condenser should be adjusted until the interference just vanishes. The adjustment is quite critical, and should not weaken signal strength in the least; if it does, it is a sign that the condenser is set at too low a capacity, and the cir-



**D.C. Super-Selective Five.—**
cuit is tuned, not to the intermediate frequency, but to the signal frequency.

**Results.**

The receiver has been tested on a number of D.C. supply mains near London, and in every case was found to be quite free from hum, while its performance was equal to that of the A.C. model described a few weeks ago. At about twelve miles from Brookmans Park the stations listed in the charts were all tuned in; indeed, the first half hour of the test was responsible for twenty-eight of the stations. The selectivity was well up to standard, and Köenigswusterhausen could be received free from interference, while Sottens and the Midland Regional were quite separate and distinct. Mühlacker cannot be received without some interference from the London Regional at short distances from the latter station, but it should cause little interference at distances over 25 miles or so. Algiers and Barcelona, which are spaced 18 kc. on either side of the London Regional, can both be received without a trace of this station.

The sensitivity is such that numerous stations can be tuned in with a few feet of wire as an aerial, although the best results are naturally obtained with a good outdoor aerial. It should not be forgotten that if changes are made in the aerial, the pre-selector circuit will require re-ganging, otherwise the signal strength will be enormously reduced.

The quality is very largely dependent upon the loud speaker employed, although the set is not as critical as some in this respect, for the tone is under complete control by the adjustment of the I.F. transformers. The best results will be obtained when the speaker has a good high-frequency response; a speaker with a poor high-note reproduction will necessitate close coupling of the I.F. transformers in order to get good quality, with the result that the selectivity will be lower than the optimum.

*This receiver is available for inspection by readers at the Editorial Offices, 116/117, Fleet Street, E.C.4.*

# *AMERICAN TRENDS.*

## Visual Tuning and Automatic Volume Control.

By OUR NEW YORK CORRESPONDENT.

TWO new features which are beginning to make their appearance in American broadcast receivers are visual tuning and automatic volume control.

As a result of the great simplification which has taken place in the operation of modern radio sets, with their one-knob tuning controls, anybody, however unskilled, may now tune in whatever station the family desires—in theory. Actually, as all of us are acutely aware who do know how to tune a radio set, even of the one-knob type, and have a keen ear for music, most people seem to be satisfied when they have turned the tuning knob far enough to make the desired station audible. Result, an appalling noise due to the station being off tune. No amount of arguing and instruction seems to be of any use in curing these people. Hence visual tuning, which is available in two forms. In one form a meter is placed near the tuning knob, with instructions engraved on it to "tune for maximum swing." In the other form a little neon or other gas discharge pilot light, placed behind the dial, lights up only when a station has been properly tuned to maximum resonance.

**Automatic Volume Control.**

This is somewhat of a misnomer. It might better have been described as an automatic fading regulator. On first switching on the set, you arrange the control so that you get the degree of volume you want. The volume will never rise above that level, even if you tune through a powerful local. If you have been lucky enough to catch that distant station just at the moment when it has faded to its minimum, then when it begins to surge in strongly again your loud speaker volume will remain constant at the level to which you set it. Great stuff—if it works! The difficulty is that the devices are limiters; if the incoming signals fade *below* the intensity to which you set the volume, they can do nothing to boost the volume *up* to the predetermined level. However, half a loaf is perhaps better than none, even though most of the devices have complicated circuits and involve the use of an extra valve. But what is an extra "toob" to an American?

**Smaller Sets and Lower Prices.**

Another American trend this year is towards smaller sets and lower prices. On the subject of midget sets, which came in with a bang last autumn, *Radio Retailing* says: "Did the reputable, nationally known set concerns make money on midgets last year? To our definite knowledge all but three lost handsomely. In each of the cases of those who won, the circumstances were unusual and not likely to be repeated." American manufacturers this year are preparing to offer four- and five-valve midgets, with valves, for around £8.

o o o o

## KEMPE'S ENGINEER'S YEAR-BOOK FOR 1931.

REVISED under the direction of the Editor of *The Engineer*. This invaluable book of reference is so well known, alike to mechanical and electrical engineers, that anything in the form of a review seems superfluous. The thirty-eighth edition fully upholds the reputation established by its predecessors, and, as much of the matter remains constant from year to year, the Editors have wisely refrained from altering the pagination of the previous edition, but where additional data are required, this is given as addenda to the various sections. A classified Buyer's Guide completes the volume, which contains over 3,050 pages and many illustrations and diagrams.

Published by Morgan Bros., Ltd., and by Crosby Lockwood and Son, London, price 31s. 6d. net.

# "The Upper Register"

(Concluded from page 166 of previous issue.)

by N. W. McLACHLAN D.Sc., M.I.E.E. F.Inst.P

## The Possibilities of a Metal Cone.

IN the last instalment we discussed how the size of the cone and the mass of the coil influenced resonances. It was explained that when the apical angle was 130° the stiffness of the cone is reduced because it approaches the paper disc stage. Nevertheless, it is remarkable how a small degree of conicality, i.e., a slight divergence from the disc stage, enhances the stiffness and raises the resonance frequency. Measurement shows that the main symmetrical mode of the 130° angle cone, whose radius is 12 cm. (about 9 inches diameter at the mouth), occurs in the neighbourhood of 1,000 cycles. The apparent radiation resistance corresponding to this frequency is several times that of the standard size 90° cone at 2,000 cycles, since the damping or loss in the paper is less at 1,000 cycles than at 2,000 cycles. If the angle is increased until it is 180° we have a disc, and its resonance (two nodal circles) occurs at about 44 cycles.

Suppose we test a cone with an apical angle of only 60°, its diameter still being 9 inches. Although the cone is now stiffer than a 90° type, it is also heavier. Its major symmetrical resonance occurs at 2,200 cycles, which is only 10 per cent. higher than that of a 90° cone. Evidently the increase in stiffness has been almost balanced out by the increase in mass. Now we have cited the resonance frequencies corresponding to four different angles. If these are plotted on squared paper we obtain the curve shown in Fig. 13, from which it is seen that decrease in the apical angle below 90° has little effect in raising the resonance frequency owing to the accompanying increase in the mass of the cone. An indication of the stiffness of a 90° paper cone can be gained by comparison with a disc of the same material, which has the same resonance frequency as the cone, namely, 2,000 cycles per second. Remembering that we are dealing with the second symmetrical mode of the cone, the disc in question for a certain class of paper is about ⅜in. thick and is 33 times as heavy as the cone.

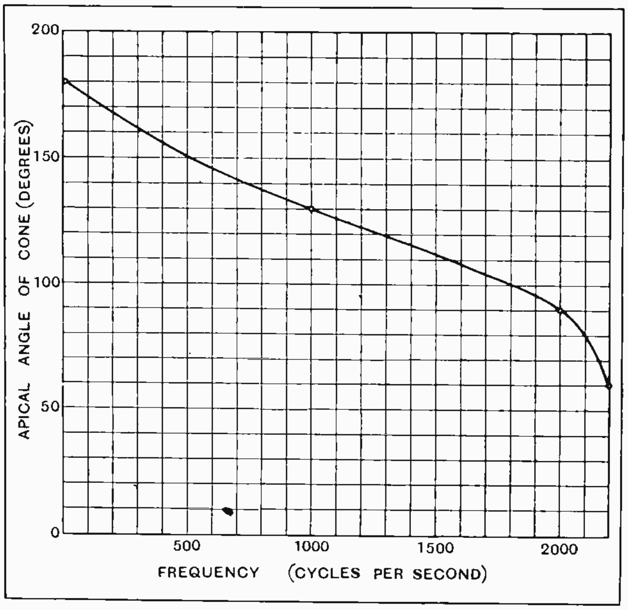



**Fig. 13.—Curve showing main resonance frequency of cones 12 cm. radius having various apical angles. The same class and thickness of paper were used throughout. When the apical angle is 180° the cone becomes a disc.**

So far as we have gone, the only method which we have discovered of raising the main resonance frequency beyond 2,000 cycles is to reduce the diameter of the cone. This leads us to consider the influence of the thickness of the paper upon the resonance frequency. As in the case where the diameter of the cone was reduced, we saw intuitively that the resonance frequency would increase. We now anticipate a similar result when the thickness of the paper is increased. In this instance our intuition is in error, as we shall see presently. Using paper of about 8 mils thickness, the resonance frequency of a standard cone is, as we have seen already, about 2,000 cycles. When the same type of paper 16 mils in thickness is used, the frequency is 2,100 cycles, i.e., only 5 per cent. difference. There is also another but lesser resonance at 2,700 cycles. Now this result may be rather surprising, but when the problem is examined from the viewpoint of the mechanical stresses in the cone it is quite in agreement with theoretical considerations, provided, of course, the paper is neither abnormally thin nor outrageously thick. Consideration of the stresses would take us well beyond the bounds of this article.

### Stresses in Conical Sheet.

It must suffice to say that in a disc or a thin bar the chief mechanical forces are due to bending, and the resonance frequency increases with the thickness. In a 90° cone this is not so. The 90° cone *approaches* the case of a cylinder. If we consider Fig. 14b and imagine it to be a short ring where each radius extends and contracts simultaneously, due to some driving force or other, the circumference of the ring will distend and dilate alternately with the force. At some frequency resonance occurs, and the corresponding sound output will be a maximum. If now the thickness of the ring be halved or doubled the maximum sound will occur at the same frequency; that is to say, the resonance frequency is independent of the thickness

**"The Upper Register."**—of the ring. In other words, the additional stiffness of a thicker ring is offset by its extra mass. Although the cone case is not entirely like this, the example serves to show the difference between a cone and a disc. In Fig. 14 diagrams are given illustrating the case of a cone loaded at the vertex. The load causes (a) the circumference at any radius to be stretched;[1] (b) the material at any section to be compressed; (c) a bending action. There are other stresses which we have left out of account, but the net result is to cause the cone to take up a shape indicated by the full lines.

It is hardly necessary to remark that these results are of considerable importance, but so far as augmenting the frequency of the major resonance is concerned we are still in a *cul de sac*. However, we now invoke the aid of a little theory. If the major resonance is not controlled by the paper thickness, on what does it depend? The quantity we seek is the velocity of propagation of *sound* in a bar of the paper. Suppose we had a paper bar 1 inch diameter and 5,700 feet long (slightly over a mile), and let this be hit at one end with a hammer. The listener with his ear at the far end of the bar would hear the hammer blow one second afterwards. That is to say, the velocity of sound in the paper is 5,700 feet per second, or about five times the velocity of sound in air.

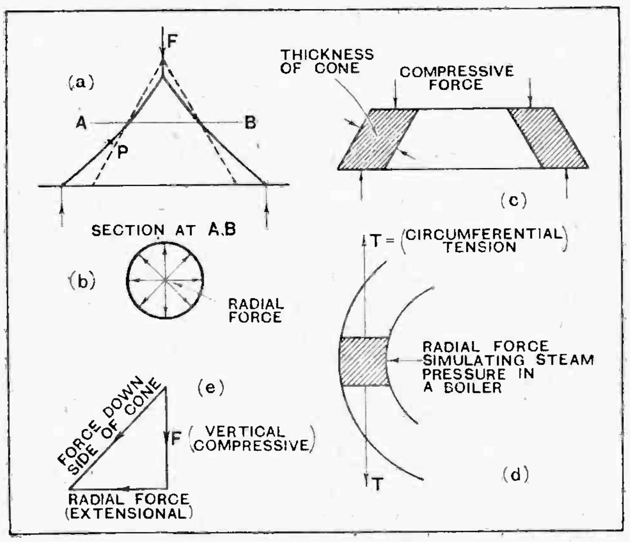



**Fig. 14.—Diagram illustrating forces acting on a cone disc load at the apex. In Fig. 14a, the vertical force F causes a force to act down the sloping sides of the cone. At any point, say P, the force can be resolved vertically and horizontally as shown at (e). The vertical force shortens the cone, whilst the radial force causes it to distend circumferentially. The general result (exaggerated) is that the cone takes up the sbape shown in (a). (c) is an enlarged view of a short vertical section of the cone, whilst (d) is a plan view of a portion of (c).**

To increase the resonance frequency of the diaphragm we need a material in which the velocity of sound is much greater than 5,700 ft. per sec. ($1.7 \times 10^5$ cm. per sec.). By studying a table of physical constants we see that the metals elektron, aluminium or its alloys, steel, copper, etc., all show sound velocities in excess of that in paper. A series of values of the velocity of sound $(E/\rho)^{1/2}$ in *bars* of these materials is given in Table 1. The velocity is practically the same for elektron, aluminium and steel.

Elektron[2] is the lightest, and for a given thickness its mass would be small. Steel is out of the running owing to its high density. As elektron sheet was not available, we can turn our attention to aluminium. The paper cited above had a density of 0.66, and if the thickness is taken as 10 mils (thousandths of an inch) the thickness of an aluminium diaphragm of equal mass (its density is 2.7) would therefore be $10 \times 0.66/2.7 = 2.5$ mils. The main resonance of a diaphragm of this material 9 inches in diameter would occur about 6,000 cycles. Moreover, *provided a metal diaphragm is satisfactory from an acoustic aspect*, the above argument shows the direction in which we might turn in order to extend the upper register beyond its present limit of about 4,000 to 6,000 cycles per second.

As I indicated in an article on transients in *The Wireless World*, April 3rd and 10th, 1929, paper cones of the usual dimensions do not reproduce frequencies above 6,000 cycles at a strength adequate to convey an entire sense of realism where very high audio frequencies are requisite, e.g., rattled coins, hand bells, hand clapping, pistol shots. This is where the metal cone might be expected to come to the rescue and give a naturalness which has been denied hitherto.

Following up the above suggestion, experiments have been conducted using aluminium sheets 1 and 3 mils thick. The dimensions of the diaphragms were identical with those shown in Fig. 2. In order to insert the lower register at a reasonable loudness level, the diaphragm was mounted on a rubber surround. The natural frequency of the diaphragm on the surround was well below audibility—about 10 to 20 cycles per second.

With 1 mil aluminium sheet, the general loudness level of reproduction was less than that obtained with a paper cone. Transients were accompanied by harsh, crackling noises and deformation of the diaphragm was visible to the naked eye—not deformation occurring at steady, audible frequencies. To obviate this undesirable behaviour it was essential to apply a coat of thick aeroplane dope to each side of the diaphragm. The reproduction was then quite pleasant, speech was good, but there was a definite attenuation in the upper register. This may have been due in part to the dope and to the lower register being adjusted to the same strength as that for a paper cone. There were no striking resonances and speech did not whistle.

With aluminium sheet 3 mils thick the crackling noises did not occur. The *overall* loudness level was a little higher than before, but definitely below the paper cone standard. The register from 200 to 2,500 cycles appeared to be absent—relatively, of course—and music lacked body. In fact, orchestral music was mainly bass and intelligibility. The former, i.e., the bass, is, of course, due to adjustment to give the paper cone level,

[1] This is reminiscent of hoop or circumferential tension in a boiler under steam pressure.

[2] The constituents of this alloy are:—Zinc 4.38%, copper 0.22%, aluminium 0.15%, silica 0.14% and magnesium 95.11%, so it is all but pure magnesium.

**"The Upper Register."**—

whilst the latter is evidence of a rise in the frequency of the second symmetrical mode as predicted theoretically. Transients were clearer, speech was hard, but not of the whistling variety. It also lacked body, which again indicated the absence of the 200- to 2,500-cycle register.

In general, therefore, the results were disappointing, but, nevertheless, in keeping with what one would expect from a material with lower losses and a higher resonance frequency (probably covering a smaller upper frequency band than paper resonance).

A metal cone of smaller radius—no rubber surround—might, possibly, be used in conjunction with an ordinary loud speaker to cover the 6,000- to 10,000-cycle band, thereby extending the frequency range. This, however, remains to be investigated.

We can now turn our attention once again to the three curves in Fig. 4. These represent the output at different frequencies with coils of different kinds. There is one feature common to the three curves and to those of Fig. 12, namely, the resonance at 2,000 cycles, which, as stated previously, is due to the cone itself. Another striking feature is the reduction in output at all frequencies with a paxolin tube. Its mass was 12 gm., as against 8 gm. for the coil and former of curve 1. The extra mass doubtless accounts in part for the reduction in output. The mass of coil and former in curve 2 is of the order of 1.8 gm. and the output above 900 cycles is augmented (there is a main diaphragm resonance at 900).

TABLE I.

| Material. | P. Density (gm. per Cubic Centimetre). | E. Modulus of Elasticity (Dynes per Square Centimetre). | $(E/\rho)^{\frac{1}{2}}$ Velocity of Sound. (cm. per second). |
|---|---|---|---|
| Paper (certain class) .. | 0.66 | $1.9 \times 10^{10}$ | $1.7 \times 10^5$ |
| Aluminium .. | 2.7 | $7.2 \times 10^{11}$ | $5.2 \times 10^5$ |
| Elektron .. | 1.8 | $4.5 \times 10^{11}$ | $5.0 \times 10^5$ |
| Steel .. .. | 7.8 | $2.0 \times 10^{12}$ | $5.1 \times 10^5$ |
| Copper .. | 8.9 | $1.25 \times 10^{12}$ | $3.8 \times 10^5$ |

**Showing $(E/\rho)^{\frac{1}{2}}$ the longitudinal velocity of sound in bars of different materials. E=Young's modulus of elasticity, $\rho$=density of material.**

### Coil Mass and Resonance.

The diaphragm cannot be regarded as a simple spiral spring loaded by the coil. If this were so, the variation in mass of the latter would be accompanied by alteration in the resonance frequency, whereas this remains in the vicinity of 2,000 cycles for mass variation from 1.8 to 12 gm. Undoubtedly the smaller mass is accompanied by a greater output because the coil has a greater axial motion for any given value of the current. But this conclusion would not necessarily hold if the resonance frequency were controlled by the mass of the coil, as in the case where the diaphragm behaved as a simple spring.

The absence of appreciable influence of coil mass on the resonance at 2,000 cycles is due to the mode of vibration of the cone departing from the disc type and tending to approach that of a cylinder. This is consistent with increase in output when the mass of coil is reduced.

Measurements of apparent radiation resistance have not been made above 4,000 cycles. Moreover, the frequency spectrum from which the letter "s" derives its whistling propensities has not been penetrated. Curiously enough, this particular consonant embodies a very wide frequency range from about 500 to 8,000 cycles per second, or even higher. The bulk of the energy lies between 3,000 to 8,000 cycles. Accentuation of a certain band of frequencies, say, 5,500 to 6,500 cycles per second, will result in unnaturalness.

To save misunderstanding, it should be observed that the preceding work refers to diaphragms having the dimensions given in Fig. 2. None of the paper diaphragms were treated with dope, and the paper used was of medium stiffness. The free lengths of the coil formers (neck portion) were a good deal greater than those used in practical reproducers, but this did not obscure the real issue. With the short necks used, the main symmetrical resonance frequency is elevated due to the added stiffness when the coil is much nearer the diaphragm.

In what precedes I have endeavoured to describe in a simple way recent research into the mechanical behaviour of conical diaphragms.[3] I always feel that the accession to inertia, being somewhat intangible to the reader, must be viewed by him with scepticism. This, however, has actually been measured, using different methods, and its existence demonstrated beyond dispute.

[3] See *Philosophical Magazine*, June and October, 1931.

## SUMMARY.


1. The upper register obtained with a coil-driven conical diaphragm is due to resonances.

2. For the standard size of diaphragm discussed herein (radius 12.2 cm. angle 90°), there are two important resonance frequencies both of which correspond to so-called centre moving symmetrical modes of vibration.

3. The first mode (one circle of minimum amplitude) occurs about 900 cycles per second and the second (two circles of minimum amplitude) about 2,000 cycles. The latter mode is the more powerful.

4. The frequency of the second mode is not influenced to a great extent by the mass of the moving coil. The upper register is, however, more powerful, the smaller the mass of the coil.

5. The frequency of the second mode is not seriously affected by varying the thickness of the diaphragm.

6. When a coil of moderate mass is attached to the diaphragm by a short neck, the added stiffness augments the frequency of the second mode somewhat and the upper register is extended.

7. The condition at the edge of the diaphragm, whether free, reinforced, or on a rubber surround, has no appreciable influence on the upper register provided the diaphragm is not too small.

8. If the radius of the cone is constant, the frequency of the second symmetrical mode increases with decrease in the apical angle from 180°. After 90° the frequency increases very slowly.

9. For any given apical angle, the frequency of the second symmetrical mode increases with decrease in radius of the diaphragm.

10. The frequency of the second symmetrical mode of a diaphragm of given radius is increased by the use of thin sheet aluminium. The reproduction of broadcasting is unsatisfactory owing to the lack of "body." This is caused by elevation in the frequency of the second mode whereby the register between 200 and 2,500 cycles is weakened whilst that in the 5,000 to 8,000 cycle region is strengthened.


*Two earlier instalments have appeared in our issues of 5th and 12th August, the article having been first received by the Editor on 11th March, 1931.*

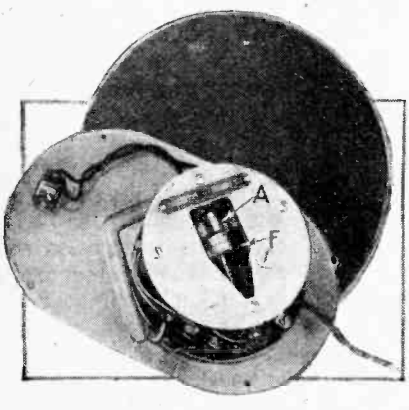
# Laboratory Tests on New Apparatus.

## Review of Recent Radio Products.

### B.T.H. GRAMOPHONE MOTORS.

For the coming season the British Thomson-Houston Co., Ltd., Rugby, and Crown House, Aldwych, London, W.C.2, are producing three types of electric gramophone motor, two of which are entirely new models. They are identified by the colour of their turntables as follows:—

*Synchro-Blue:* A synchronous motor (A.C. only) with a four-pole laminated armature geared to give a turntable speed

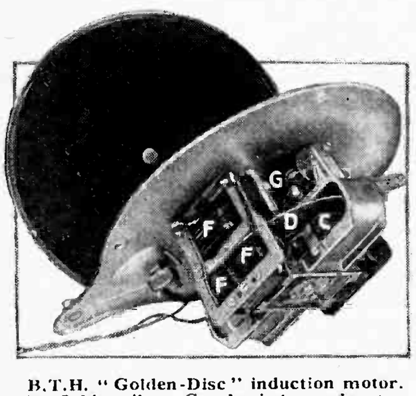



**B.T.H. "Synchro-Blue" motor, A, four-pole laminated armature; F, flywheel.**

of 78 r.p.m. on a 50-cycle supply. Due to the simplicity of the design (no governor is, of course, required), the price of this motor is the lowest of the series. A 10in. turntable is fitted and there is a starting switch, but no automatic stop switch.

It is necessary to start the turntable by hand before switching on the current. Experience will soon show the correct speed at which to switch on. Occasionally the motor may synchronise at half speed, when it will be necessary to switch off and start again.

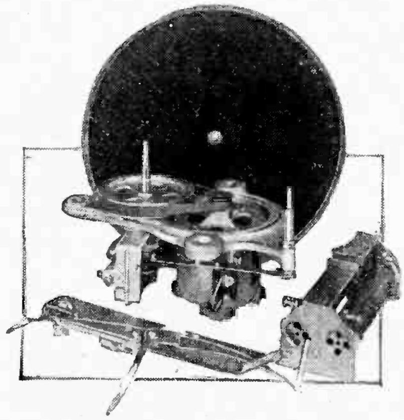
To ensure smoothness of running and absence of vibration, a small flywheel is mounted on the armature spindle. It is driven through a spring-loaded friction clutch by the armature, which is a floating fit on the spindle. The motor and turntable unit is attached to the top plate by a three-point coil spring suspension, and it is recommended that the motor board should be at least ½in. in thickness. Price 39s. 6d. Voltage range, 100 to 250 volts (50 cycles only).




**B.T.H. "Golden-Disc" induction motor. F, field coils; C, phasing condenser; D, disc motor; G, governor.**

*Golden-Disc:* Like the "Synchro-Blue," this model is for A.C. supplies only and is of an entirely new design. The motor is of the induction-disc type and is self-starting. There are two groups of field magnets, and their associated phasing condensers situated on diametrically opposite sides of the disc, the whole of the mechanism being assembled in a rigid die-cast frame. The speed of the rotor disc, which runs at turntable speed, is regulated by a governor, and the torque developed is of the order of 400 gram-centimetres.

The motor is fitted with an ingenious automatic stop switch, the mechanism of which is driven by a short rubber belt from the main spindle. It is not necessary to pre-set the stop, as the trip



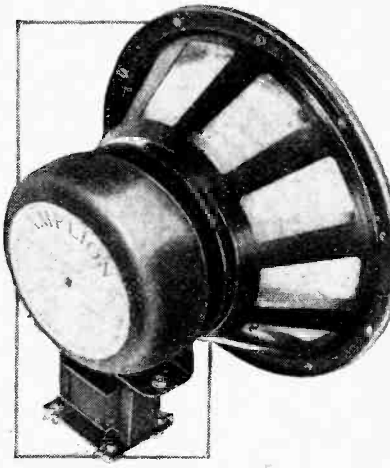
**B.T.H. "Standard-Red" motor for A.C. or D.C. supply mains.**

mechanism is arranged to come into operation with any type of terminal groove, whether of the stationary or eccentric variety. The tone-arm stirrup of the automatic switch is adjustable for both angle and height, and may be used with all types of pick-ups. Price, including automatic switch and 12in. turntable, £3 15s. Voltage range, 100 to 250 volts (40-50 cycles).

*Standard-Red:* This well-tried universal A.C. or D.C. motor is being continued, and the price, including regulating resistance, pre-set stop switch, and 12in. turntable, is 6 guineas. The voltage range of this motor is as follows: *D.C.*, 50 to 250 volts; *A.C.*, 100 to 250 volts.

### AMPLION TYPE M.C.6 LOUD SPEAKER.

This model is a permanent magnet edition of the model described in our July 15th issue in connection with the article on "Free field current." The 7in. diaphragm is corrugated, and is centred by a six-element radial spider glued to the inner surface of the cone



**Amplion type M.C.6 permanent magnet moving-coil loud speaker unit.**

near the apex. The coil impedance is of the order of 2.2 ohms at 400 cycles, and an output transformer is mounted on a bracket attached to the chassis. Three ratios are provided, for three-electrode output valves of approximately 2,000 ohms and 6,000 ohms, and for pentodes. The connections can also be adapted for a push-pull output stage.

The permanent magnet is of an unusual shape somewhat resembling a curling stone. It is 4½in. in diameter and 2in. deep.

The sensitivity was reasonably good, having regard to the small dimensions of the permanent magnet, but was less than that of the average mains-energised moving-coil loud speaker. Reproduction in the bass and middle register was free from audible resonances, and speech was natural and not too low-pitched. There was a sharp cut-off above 4,000 cycles, but this may have been in some measure due to the fact that the impedance of the output stage was lower than the optimum value for which the output transformer was designed.

The price of the unit, complete with output transformer, is 67s. 6d., and the makers are Messrs. Graham Amplion, Ltd., 26, Savile Row, London, W.1.

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### NEW RANGE OF TELSEN COMPONENTS.

For the coming season the Telsen Electric Co., Ltd., Aston, Birmingham, have introduced an extensive range of new components. The popular "Ace" model L.F. transformer is retained at the reduced price of 5s. 6d. for both 1 : 3 and 1 : 5 ratios, and the "Radiogrand" is available in 1 : 7 and 1 : 1.75 ratios at 12s. 6d.

There are three styles of output transformers, one with a multi-ratio, another with 1 : 1 ratio, and a third designed for use with pentode valves. The price is 12s. 6d. in each case.

Telsen L.F. chokes are divided into three classes, styled respectively L.F. inter-valve chokes, output chokes, and heavy-duty power grid chokes. The first class contains three models rated at 40 henrys, 100 henrys, and 125 henrys. Output chokes are available either tapped or plain, and have a rated inductance of 20 henrys. The heavy-duty power grid choke is a 40-henry model with a current limitation of 10 mA.'s of D.C.

Other new components now made include valve-holders, switches, H.F. chokes, pre-set condensers, loud speaker unit, differential and reaction condensers and resistances.

Tests were made on a few representative samples, the first to be dealt with here being the Radiogrand 1 : 7 model L.F. transformer. The primary inductance was measured with various amounts of D.C. flowing, and the following values were recorded :—

| D.C. in mA. | Inductance in henrys. |
|---|---|
| 0 | 10.6 |
| 1 | 10.55 |
| 2 | 10.45 |
| 3 | 10.3 |
| 4 | 10.0 |
| 5 | 9.25 |
| 6 | 8.6 |

With current values up to 4 mA.'s the inductance remained fairly constant, but with larger amounts of D.C. a sharp decline was noticed. Since this model will most likely be used in leaky grid detector circuits, it is doubtful if the steady anode current passing through the winding will exceed 4 mA. Best results will be obtained when a detector of comparatively low A.C. resistance is employed.

The measured inductance of the Power Grid L.F. choke was found to be as follows :—

| D.C. in mA. | Inductance in henrys. |
|---|---|
| 0 | 150 |
| 2 | 102 |
| 4 | 76 |
| 6 | 59 |
| 8 | 49 |
| 10 | 44 |

The rated inductance of 40 henrys is obtained when the D.C. flowing through the choke is of the order of the stated maximum amount. The resistance of the winding is 1,080 ohms. These values were obtained with a current of 1 mA. of A.C. flowing through the choke.

Thin bakelite is employed as the dielectric in the differential reaction condensers, of which three models are made, viz., 0.0001 mfd., 0.00015 mfd., and 0.0003 mfd. These are exceedingly compact, are fitted with single-hole fixing attachment, and have pigtail connections to the moving vanes. The measured capacity of a 0.00015 sample was found to be minima 11 and 8 micro-mfds. and maxima 0.000171 and 0.000184 mfd. respectively. The price is 2s. in each case.

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### "SUPREMUS" D.C. ELIMINATOR. Model D.120A.

In our test report on this eliminator, which appeared on page 96 of our issue of July 22nd last, the current values stated as being the conditions to obtain the marked output voltages refer to the intermediate voltage tappings only. The output from the power tap is virtually independent of these values, and was accordingly given in a separate table.

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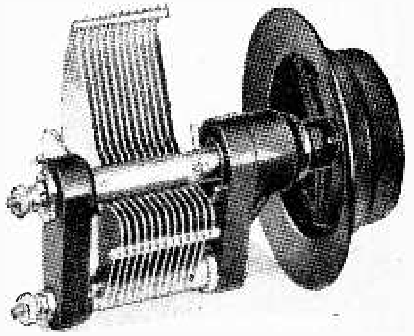
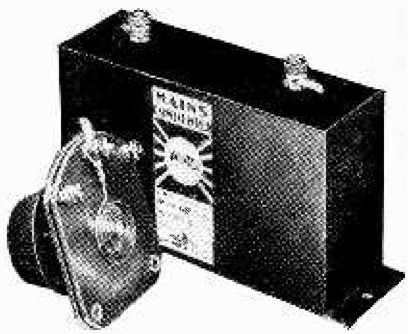
### SOME NEW FORMO CONDENSERS.

Some recent additions to the Formo range of variable and mains condensers include a variable condenser with built-in slow-motion drive, a differential reaction condenser with bakelite dielectric and a 6-mfd. mains condenser. The first-mentioned is fitted with aluminium vanes and moulded bakelite end-supports; the reduction drive being incorporated in the front bearing, which carries also the single-hole fixing bush. In common with all Formo condensers, connection is made to the moving vanes by means of a pigtail, which in the present case is concealed in the back bearing. Provision is made for direct drive, though this should rarely be required, since the reduction ratio is but 7.5 to 1. The measured values of the condenser were: minimum capacity, 12 micro-mfds., and maximum capacity 0.00049 mfd. It is rated as a 0.0005 mfd. size, and the price complete is 6s.



Formo 0·0005 mfd. condensers incorporating a slow motion drive.

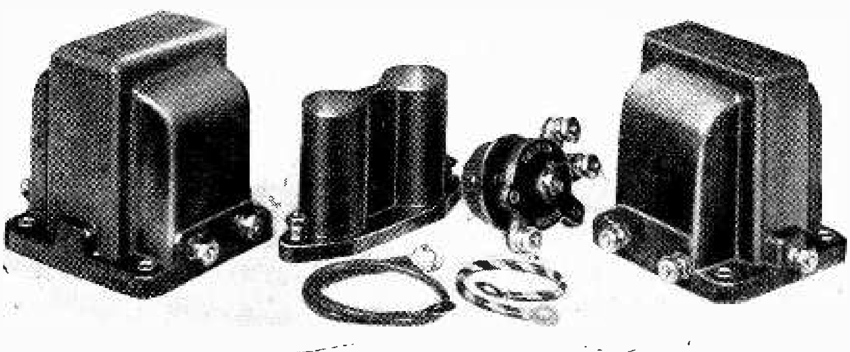
The differential reaction condenser, rated nominally as a 0.00015 mfd. size, is fitted with a spiral spring connection for the moving vanes, and, as mentioned above, has paxoline dielectric. The two maxima capacities were found to be 0.000159 and 0.000157 mfd., while the minima were 12 and 7 micro-mfds. respectively. The price of this model is 3s. 6d.



Differential reaction condenser and 6-mfd. (400-volt working) mains condenser. Two new Formo products.

In common with the smaller capacity mains condensers, a review of which appeared in these pages some time back, the 6-mfd. size is intended for use in circuits where the potential does not exceed 400 volts D.C. This figure is rarely exceeded in mains receivers, consequently the new model will prove a welcome component where a large capacity is needed, as the overall size is 4½in. × 2½in. × 1½in., and the price is 8s only.

The makers are Arthur Preen and Co., Ltd., Golden Square, Piccadilly Circus, London.



Some samples of the new range of Telsen components introduced for the coming season.

*Next Week's Set Review.*

*First details of the new*

*EKCO All-Electric Four-Valve Consolette.*

# Letters to the Editor.

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.

## TIME FROM THE MAINS.

Sir,—Your recent article on mains clocks was certainly very interesting; so, also, is Mr. K. Edgcumbe's letter in your issue of the 5th inst. Some funny things are going to happen, however, if, as he says, "the domestic clock becomes as much an anachronism as the domestic rain-water butt." I can only infer from his letter that he expects to find no mechanically driven clocks in the house of the future. If so, what will happen in the event of an interruption in power supply? Such interruptions are much more likely to occur with distant overhead transmission and with interconnection of stations. Our good friends at the generating station will, no doubt, be quick to point out that such breakdowns are infrequent, but nevertheless we have had two or three during the past eight months. Rather awkward if the power comes off during the early hours of the morning? All clocks, if self-starting, will show the same time; but just imagine sauntering down to the jolly old railway and being told on arrival there that the 8.20 left to schedule twenty minutes ago.

Even the stop-indicating variety of clock will not be of much help, as it is, I fancy, just a wee bit difficult to register the duration of the stop when there is no power left on the line. *Verb. sap.*: owners of synchronous clocks must not forget to wind up their watches, or be like the Scotsman and live near the kirk.

No, I don't think I have any reason to scrap my pulsynetic transmitter and its train of clocks. Even if the trickle charger has a temporary rest the floating accumulator will still carry on the good work. F. L. FRANKLIN.

"Blairgowrie," Broxbourne.

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Sir,—I was interested to read in *The Wireless World* Correspondence columns the letter from Mr. K. Edgcumbe regarding "Time from the Mains." Any of your readers who are unfortunate enough to have their homes illuminated with gas are not entirely barred from the advantages of electric time-keeping. Electric impulse clocks running from wireless accumulators can be made as easily as a wireless set with ready-made parts, or clocks can be purchased complete at less cost than a good spring-driven clock.

This type of electric clock costs only a few pence per year to run, with the advantages of correct time and no winding. The spring clock, as stated by Mr. Edgcumbe, is out of date, especially for the radio enthusiast who requires accurate time.

London, S.E.20. A. H. KEITH.

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## THE NIGHTINGALE.

Sir,—I notice with surprise Mr. Vandervell's letter in your July 29th issue, in which he rushes to the defence of a mighty corporation, too modest—or is it too conscience-stricken—to enter a defence on their own behalf, as I invited them to do. Still, Mr. Vandervell offers us first-hand evidence, whereas my complaint was admittedly based on hearsay, and accordingly I offer my grudging apologies to the B.B.C.—grudging because the verdict which should apply is the good old Scottish one of "Not proven" rather than that of "Not guilty."

It is evident from the third paragraph of his letter that your correspondent is a simple child of nature in whom there is no guile, and with childlike faith he believes that all others—even the B.B.C.—are like him. I hate to have to disillusion him; but does he really think that I have not heard the striking of the old village clock and the simple rustic noises which Gray immortalises in his "Elegy"? Did I not say that the original recordings were made in the woods and is it not possible, therefore, that these horological noises found their way on to the record then? Even had they not done so, it surely would not be beyond the technical resources of the recording company to provide another record with the extraneous noises thereon, nor beyond the artfulness of the B.B.C. to have superimposed them in the control room according to taste.

No, sir, this deliberate attempt of Mr. Vandervell to belittle the technical and histrionic abilities of the B.B.C. simply will not do. It is with the object of circumventing the wiles of these archdeceivers of women and children, these lewd and base fellows, that I am writing this letter. Why, I confess that they even deceived a hardened old sinner like myself. What a nincompoop they must have thought me! What a laugh they must have had at my expense! Is it likely, I ask myself now, that the B.B.C., with all their vast experience of low cunning and strange magics, would have their gramophone anywhere else but in one of the smaller studios with an extra instrument for the "effects" record? Is it likely that they, with their wide experience in all manner of wickedness, would be guilty of such a brainless crudity as that of lugging a portable gramophone to the woods, as I in my innocence at first supposed?

No, certainly it is not—not even for the purpose of providing jazz music to liven up the birds, although I *should* be interested, Sir, to know what is inside the case which appears in the photograph published in your May 27th issue; I mean to say, innocent people like myself might erroneously be led to believe that it was a portable gramophone or some similar piece of wickedness.

London. FREE GRID.

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## "NEW WINE IN OLD BOTTLES."

Sir,—We note, in an article entitled "New Wine in Old Bottles" in your issue for August 5th, 1931, a table indicating four years' progress in valve design in which mutual conductance figures for certain Osram 1931 valves are quoted.

We think that your readers' attention should be drawn to the fact that the mutual conductances quoted scarcely represent 1931 practice in Osram valves. For instance, in place of the H.L.210 type we would suggest the Osram H.L.2 would be a more accurate representation of 1931 valves, this type showing a mutual conductance of 1.5. The characteristics for the Osram H.L.2 were published in your issue for June 10th, 1931.

Again, the figure quoted for the Osram P.2 is that for an obsolete valve, the 1931 P.2 (which was actually marketed in December, 1930) exhibiting a mutual conductance of 3.5. An article reviewing the revised characteristics for the P.2 was given in your issue for April 8th, 1931.

In order to give a correct picture, therefore, we feel that the above facts should be made clear to readers.

London, W.C.2. F. E. HENDERSON.
(The General Electric Co., Ltd.)

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## VACUUM V. RADIO.

Sir,—I have read with considerable interest the article, "Wanted, a Vacuum Cleaner," by "Free Grid," in your issue of July 29th.

I am interested because I am a wireless enthusiast and at the same time own an electric cleaner.

I would like to ask "Free Grid" if he really thinks this article "unbiased."

In any home where they have a certain amount of cleaning to do this is usually done during the morning, when there is little or no radio activity.

One might also reply to "Free Grid": "Wanted, a wireless set which would be immune from interferences from such things as atmospherics, disturbances from trams and electric trains."

Although, as I said before, I have a wireless set and an electric cleaner, of the two I think I would prefer to have the cleaner with a clean home. I think it would be interesting to see Mr. and Mrs. "Free Grid's" faces after they had seen the dirt which could be got, by a really good cleaner, from their carpets in the space of a few minutes. This also, I feel sure, would be a "sight for the gods." E. F. WALTON.

London, W.12.

# READERS' PROBLEMS.

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

*Technical enquiries addressed to our Information Department are used as the basis of the replies which we publish in these pages, a selection being made from amongst those questions which are of general interest.*

### Accurate H.T. Measurements.

*On more than one occasion you have pointed out that an ordinary voltmeter, even of the high-grade, high-resistance type, will not give an absolutely accurate reading of the voltage applied to the anode of a valve from an eliminator.*

*I believe, however, that by following the correct procedure, it is possible to obtain a true reading, and I should be obliged if you would describe the method.*

Provided that the voltmeter takes less current than that normally passing in the anode circuit of the valve, it is possible to make an accurate measurement.

A suggested method of procedure is indicated in Fig. 1, from which you will see that a milliammeter is required in addition to the voltmeter. With the valve operating normally, a reading of its anode current should be made, and then the voltmeter should be joined between anode and cathode as shown. As a result of making this addition, the current indicated by the milliammeter will increase, and the voltage shown will not be that existing under working conditions.

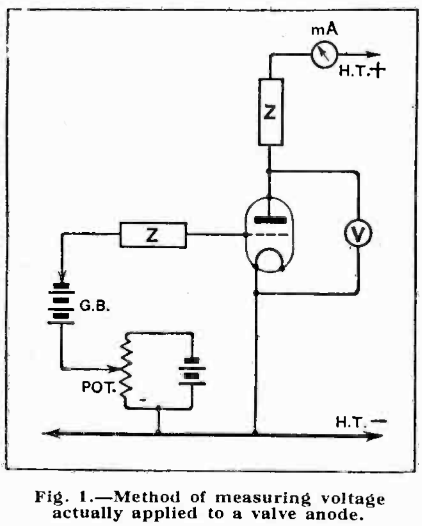


Fig. 1.—Method of measuring voltage actually applied to a valve anode.

The next step is artificially to restore anode current to its original value. This may be done in several ways; the valve filament may be dimmed; a series resistance may be inserted in the H.T. feed lead; or the grid circuit of the valve may be over-biased to the required extent, as indicated in the diagram.

When matters have been so adjusted that the milliammeter reading is normal, it may be taken that the voltmeter will indicate the normal working anode voltage of the valve when the original circuit arrangements are restored.

o o o o

### The Tin-opener Unnecessary.

*I have an American A.C. receiver with an anode bend detector feeding direct into the output stage. No provision is made for the use of a gramophone pick-up, and, if possible, I should make this addition myself.*

*Unfortunately, it seems almost impossible to obtain access to the wiring of the detector-grid circuit in order that the pick-up may be inserted in the usual manner, as the screening covers seem to be soldered. Is there any way of fitting the pick-up externally without the need for altering the internal wiring?*

We suggest that the easiest solution of your problem is to buy or make an adaptor to be interposed between the detector valve and its socket. Connections should be so arranged that the heater, cathode and plate connections of the valves remain unchanged, but the grid pin should no longer make contact with the socket.

With the adaptor in position, it will then be possible to connect the pick-up, with a volume control potentiometer and a bias battery, across the detector valve grid circuit.

o o o o

### Battery-fed A.C. Valves.

*It so happens that, although my house is not connected to an electric supply system, I have good facilities for charging accumulator batteries at negligible cost. I am wondering whether there is any real reason why I should not take advantage of the high efficiency of indirectly heated A.C. valves, and, as current consumption is of no great consequence, heat them with a large four-volt accumulator.*

*Will you please give me a word or two of advice on this subject, and, if possible, show how the heaters and cathode should be connected?*

Technically, there is not the slightest objection to your proposal, although, as the heater current consumption of a multi-valve set will be high, it will obviously be necessary to use short connectors of heavy gauge for these circuits.

With regard to connection, you will find no difficulty. If the cathode socket of each valve holder is joined to that heater terminal which is connected to L.T. negative, the valve may, from this point of view, be regarded as being of the battery type.

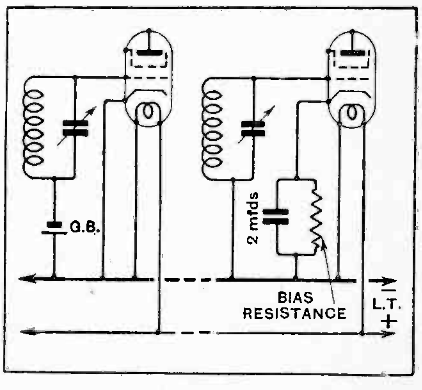


Fig. 2.—Methods of connecting indirectly-heated A.C. valves with an L.T. accumulator.

Although you are using batteries, it may, in certain circumstances, be advantageous to employ automatic bias, particularly for an H.F. valve of which the grid circuit is tuned by a ganged condenser with an insulated spindle. Accordingly, the connections for automatic, as well as for battery, bias are shown in our diagram (Fig. 2).

o o o o

### Earth Plates.

*I find that ordinary copper sheeting, which is generally recommended for use as an earth plate, becomes heavily corroded after it has been buried for a few months. It seems to me that this must introduce unnecessary resistance into the earth circuit; do you know of any other substance that would be better in this respect?*

The film of corrosion that forms on a buried copper plate is quite a good conductor, and is not a more-or-less insulating oxide, as you seem to imagine. Its resistance is at least as low as that of the surrounding earth, and we can hardly think that any better metal could be used for the purpose.

### Automatic Volume Control.

*Although my three-valve receiver has only one H.F. stage, I find that after dark a large number of Continental stations are received at sufficient strength to cause overloading. I have been considering the adoption of automatic volume control; but, as grid detection is used, the simplest and most obvious method is out of the question. But it seems to me that it should be possible, by fitting an extra control, to arrange matters so that, as signals increase in strength beyond a certain limit, the H.F. valve will be over-biased, and, in consequence, its sensitivity will be reduced. Will you please examine the enclosed circuit diagram, and say if the connections shown for this control valve are correct?*

A good measure of automatic volume control could be obtained by using an extra valve in the manner you suggest, but your circuit diagram is incorrect: the actual effect of an increase in signal strength would be to decrease—and not to increase—the negative bias applied to the H.F. valve.

In Fig. 3 we give a corrected diagram showing the essentials of an automatic control system, working on this plan that should be satisfactory in your case. The control valve acts as an anode bend rectifier; as its anode current tends to rise under the influence of a strong signal, the bias voltage developed across the resistance R, which is in series with the cathode and also common to the H.F. valve circuit, will also increase.

It depends on circumstances whether the range of control will be entirely adequate; if the H.F. valve is of the type consuming a relatively low anode current, it should be highly satisfactory.

Naturally, the bias resistance R should be of such a value that the H.F. valve is operating under best conditions when a signal of medium strength is "coming through." It will be easiest to make initial adjustments if this resistor is of the semi-variable type.

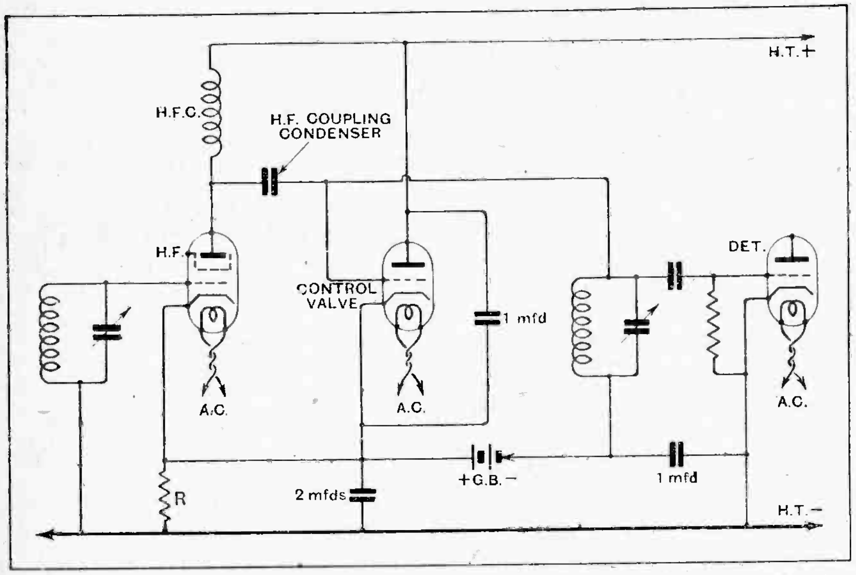


**Fig. 3.—An extra valve connected as an automatic volume control.**

○○○○

### No Help from H.F. Amplification.

*My present set consists of a power-grid detector, followed by a pentode with compensated output. A band-pass filter is included, and I think that I have embodied most of the suggestions made from time to time in your journal with regard to this type of short-distance "quality" receiver.*

*Results are good, but I am wondering if any improvement in quality could be effected by abandoning the use of reaction and fitting an H.F. stage.*

This is not an easy question to answer definitely, but we should imagine in your locality it would be quite unnecessary to use sufficient reaction to impair quality. If we are right in this, then it may be taken definitely that the addition of an H.F. stage would do nothing to improve reception of the local stations.

○○○○

### We Commit a *Faux Pas*.

(Referring to your previous correspondence.) . . . . *Since adding a two-circuit aerial tuner to my 1-v-2 receiver, as suggested in your recent letter, I find that the set, which was previously quite stable, oscillates uncontrollably at all wavelengths. Do you advise me to fit a neutralised coupling for the three-electrode H.F. valve, or is there some simpler way out of the difficulty?*

Your previous letter was answered on the assumption that your triode H.F. valve was already neutralised. We must apologise for leading you into trouble, but, as justification, must plead that the unneutralised triode H.F. amplifier is now so out of date that this assumption was almost permissible.

No doubt your set was originally stabilised entirely by the effects of aerial damping. When this damping was reduced by fitting a two-circuit aerial tuner it was only to be expected that hopeless instability would result.

We think that your best plan is to fit a screen-grid H.F. valve with the necessary screening between plate and grid circuits.

○○○○

### For the West Country.

*It is proposed to build a fairly economical set for use in Cornwall, where, as you well know, medium-wave transmissions are seldom received with consistency. Consequently, provision will be made only for long-wave reception.*

*Although the Daventry station is the main objective, reception of Continental transmissions is also desired. Do you think that it would be possible to do better than to adopt a three-valve H.F.-det.-L.F. circuit?*

*Any recommendations as to worth-while refinements would be welcomed.*

A 1-v-1 circuit should be highly suitable. An input filter should certainly be included, and, for this special purpose, we are strongly inclined to recommend that variable coupling between the component circuits of the filter should be provided.

Experience shows that, when conventional inductance-capacity ratios are employed in the circuits, tuning is rather perplexing when coupling is fixed at a value giving the usual band width of about 10 kilocycles. It is found better to employ, for long-distance work, a looser coupling giving sharper tuning; when strong signals are being received, quality of reproduction may be improved by using a closer coupling.

## FOREIGN BROADCAST GUIDE.

## RENNES (PTT)
**(France).**

Geographical position: 48° 7′ N., 1° 43′ W.

Approximate air line from London: 252 miles.

**Wavelength: 272 m. Frequency: 1,103 kc.**
**Power: 1.2 kW. (temporarily).**

Standard Time: Greenwich Mean Time. (*France adopts B.S.T.*)

**Standard Daily Transmissions.**

12.45 B.S.T., gramophone records; 18.15, relays PTT Paris; 20.30, own concert or relay of PTT Paris; concert by naval band relayed from Brest (Thurs.). The station seldom broadcasts on Fridays.

Call: *Allo! Allo! Ici la station de Rennes du Reseau d'Etat de Radiodiffusion;* between items: *Ici Radio PTT Rennes.*

Male announcer.

Closes down with usual French formula followed by *La Marseillaise.*

# The Wireless World

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

## *Hints Before the Show.*

THE Olympia Radio Show is now not many weeks distant, and a contributor to our correspondence columns in this issue reminds us that in previous years we have repeatedly found occasion after the Show to draw attention to the dissatisfaction shown by quite a large proportion of visitors to the Exhibition at the lack of information, particularly of a technical character, available at the stands of the respective exhibitors.

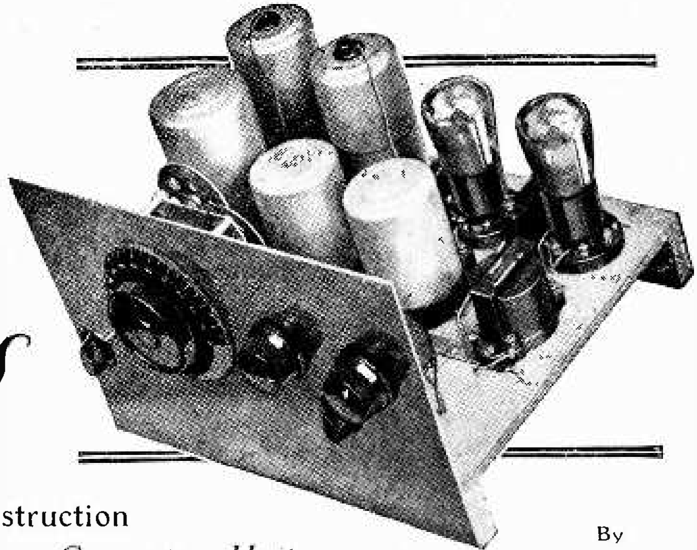
Our correspondent suggests that this year we should put in our plea for closer attention to this aspect of the Show by exhibitors in advance of the date, in order that they may profit by the hint and see to it that the stands are more adequately staffed with persons conversant with the exhibits which they represent. Last year, in commenting *after* the Show on a number of points which had come to our notice where there was room for improvement in the direction of increasing the interest of the public in the Exhibition, we referred especially to the fact that there appeared to be a tendency on the part of some stallholders to take on temporary staff with little knowledge of the apparatus displayed, and still less interest in recording the numerous expressions of opinion passed by the visiting public which, if collected and brought to the attention of a responsible head of the firm or the designer of the apparatus, might be of very great value to the firm in its future activities.

It seems to us that this is a point which is even more worthy of attention now than it has been in past years, because we expect that at the next Show there will be a greater variety of products and, consequently, more occasion for comment and expression of opinion on the various types by the visitors. We hope that there will be little occasion this year for visitors to complain that attendants on the stands of various manufacturers were unable to give any information as to the nature of the sets beyond a description of the external appearance, which, after all, is obvious to every visitor.

There is still great scope for the enterprising manufacturer in the direction of preparing detailed literature concerning each receiver model which he produces. There should be a book of instructions and a description available with every type of set, and in this respect we, as yet, fall far short of the example set us by many manufacturers abroad. Progress in this direction has been made recently, as a result, we believe, of our own recommendations, in that a number of manufacturers provide a complete circuit diagram of their receivers, fixed in some convenient position, such as in the lid of the cabinet, and so available for reference at all times. But a circuit diagram alone is not sufficient, and, if manufacturers would only realise it, an attractively prepared booklet would, in itself, go a long way towards creating confidence in a set and stimulating sales. At the same time, it would save endless enquiries, not to mention misleading replies at Exhibiton time, and a serious enquirer, if handed such a booklet, should find his questions relating to the receiver answered satisfactorily.

### In This Issue

# Short-Wave Superheterodynes!



## Practical Hints on the Construction of Autodyne Converter Units.

By F. H. HAYNES.

SHORT-WAVE reception with the straight regenerative detector has so many failings that were this the only method interest in the short-wave transmissions would undoubtedly cease. Much L.F. amplification is resorted to and the control of reaction is fierce and erratic. With more congestion in the short-wave ether than exists in the broadcast band, the poor degree of selectivity brings about interference troubles.

In about a month's time we shall be upon that period of the year when long-distance short-wave reception will be at its best, and short-wave superheterodynes put in hand now will be ready to take advantage of the good conditions of reception from the North American stations. Only a few components are required, and without much trouble consistent loud speaker reception can be obtained.

*RECENT months have seen a considerable increase in the number and power of the short-wave broadcasting stations. Most of these stations have a world-wide range and in particular much interest centres around the reception of the high power American short-wave transmitters relaying the New York programmes.*

*A short-wave superheterodyne attachment for use in front of a broadcast receiver may be quickly put together and requires only a few components such as are usually to hand. Details are given here of the various circuit arrangements, together with constructional hints on the making up of simple and inexpensive short-wave superheterodynes arranged for either battery or A.C. mains working.*

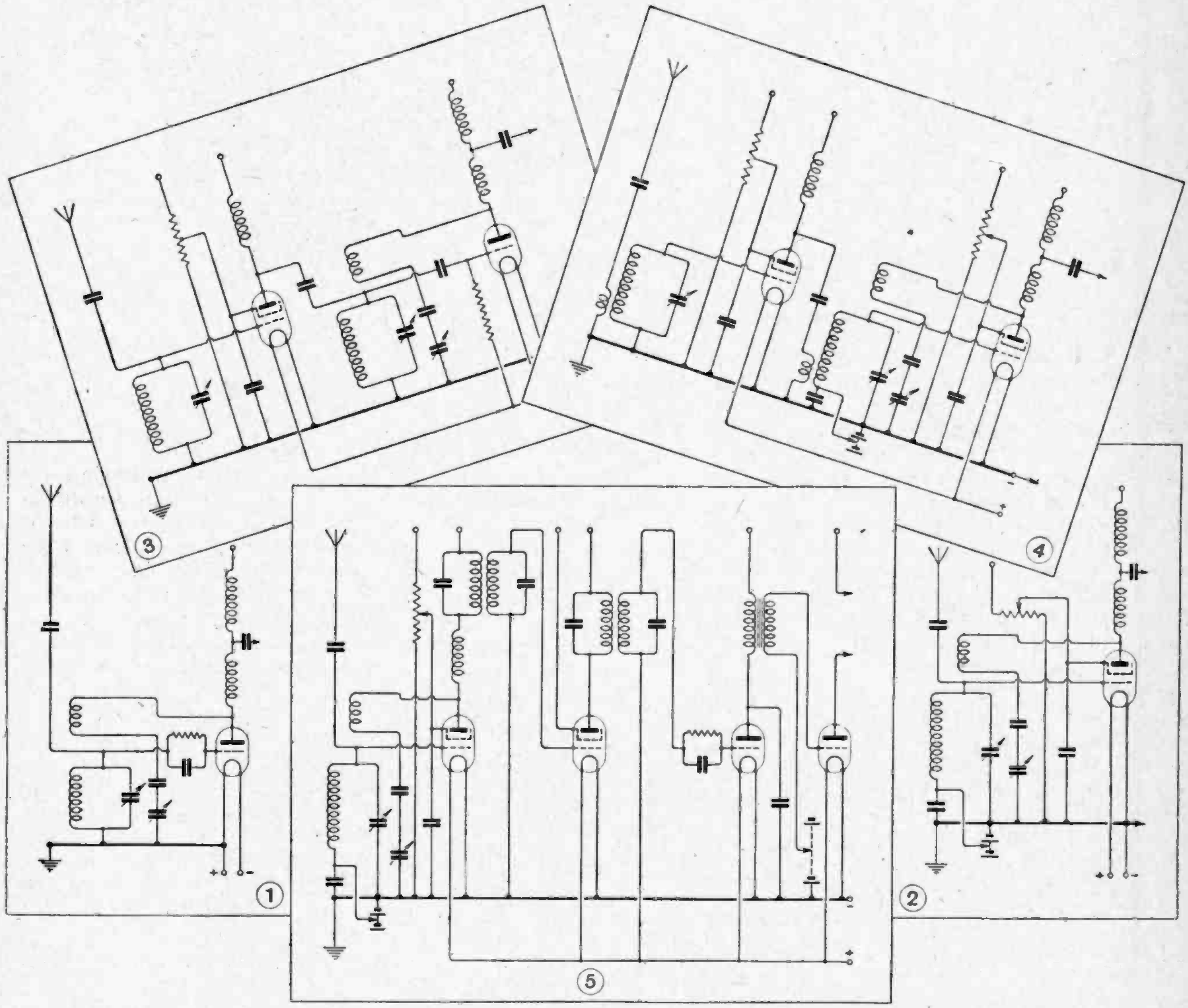
Using the H.F. section of a broadcast receiver as the intermediate amplifier of the superheterodyne, it is only necessary to introduce in front of its input terminals the first detector and oscillator. It is fortunate, however, that the provision of the long-wave tuning range on broadcast receivers further simplifies the construction of the short-wave adaptor. Normally a separate oscillator valve and tuned circuit is needed to beat with the incoming signal to produce the intermediate frequency, and while such an arrangement must be adhered to if the 300-metre wave band is being used in the intermediate amplifier, nothing is gained by the use of the separate oscillator valve when an intermediate wavelength of some 2,000 metres is used. In place of the separate oscillator the reacting detector serves equally well on wavelengths from 20 to 60 metres, provided the broadcast receiver is switched over to the long wavelengths. Thus the short-wave attachment can consist of but a single valve and possess single-dial tuning, while the use of the lower frequency of the long wavelengths as compared with the broadcast band gives greater selectivity.

Hence, the simplest type of autodyne or single-valve short-wave converter may take the form shown in Fig. 1. A triode valve is used as a leaky grid detector and derives its filament current from the battery of the broadcast set. In the anode circuit is the reaction coupling which, by virtue of the mutual inductance between the two coils produces a beat frequency with the incoming signal conveniently falling in the long-wave band. An H.F. choke of a few turns acts as a stopper in the short-wave band but passes on the heterodyne frequencies to the input of the broadcast receiver. A choke coil of normal size feeds the H.T. voltage into the circuit, yet acts as a stopper against the shunting of the input of the broadcast set. A simple circuit such as this, which is quickly put together, will, in front of a single H.F. stage, give fairly consistent reception of American broadcasts.

The detector efficiency of the leaky grid arrangement is poor at the ultra-short wavelengths, and the small signal voltage falling on the curve characteristic of a screen grid valve is an improvement on the triode. This form of anode bend detection requires critical working potentials, and after over-biasing the grid the best working point is found by a potentiometer connected to the screen (Fig. 2). In discussing short-wave circuits little can be said with certainty when based on prediction, and the best arrangement must be arrived at by

**Short-Wave Superheterodynes!—**
trial and error. Thus, in addition to testing all the circuits shown, the other possibilities, such as the use of separate oscillator, anode bend triode, and a leaky detector screen grid, all received attention.

Even with the superheterodyne, and bearing in mind the large range of frequencies covered in the short-wave band, selectivity may not be adequate, and the remedy leaky grid detector. This circuit gives satisfactory results. It may be improved by the anode bend detector arrangement shown in Fig. 4. Alternative methods of aerial and intervalve coupling are here shown by way of example, although the coupling shown in Fig. 3 might equally well be adopted. A screen grid H.F. stage preceding the detector does not bring about, on the short wavelengths, the cross-modulation difficulties met with




**1. The simplest form of short-wave converter for attaching in front of a broadcast receiver so that its H.F. stage becomes the intermediate amplifier. 2. An alternative arrangement in which a screen grid valve is used as an anode bend detector. The adjustment of the screen potential is critical. 3. Method of adding a screen grid H.F. stage in front of a leaky grid autodyne detector. 4. A generously designed converter unit using screen grid valves for H.F. amplification and anode bend detection. 5. Complete short-wave receiver incorporating band pass intermediate couplings tuned to a frequency of 150 kc.**

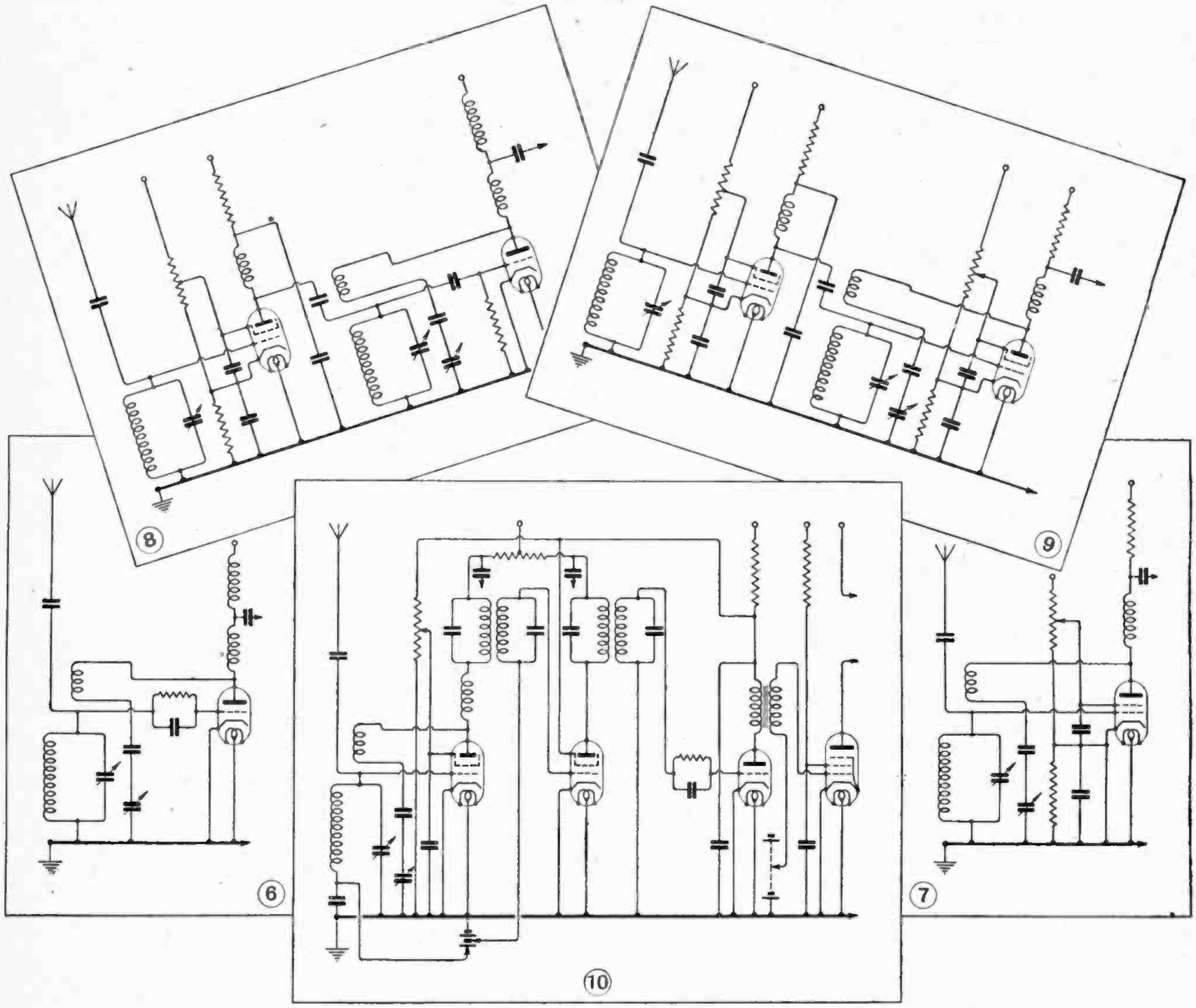
lies in the direction of arranging a selective band pass input to the long-wave amplifier and the addition of a short-wave H.F. stage before the autodyne detector. Some slight degree of H.F. gain results by the use of a preliminary H.F. stage, together with an improvement in selectivity, and, in addition, the reaction setting becomes constant over most of the tuning scale. The circuit is shown in Fig. 3, in which a screen grid H.F. valve precedes a in the broadcast band, probably owing to the fact that with such a small stage gain rectification in the H.F. amplifier is avoided. Another advantage of the H.F. stage is normally that of removing "blind spots," where, owing to the constants of the aerial, regeneration cannot be produced by reaction control. Such a difficulty, however, was not found to be present with the single autodyne valve. The average broadcast receiver is so

**Short-Wave Superheterodynes !—**

flatly tuned that a converter embodying an H.F. stage may be considered worth while.

If a special short-wave set is to be built, however, band pass intermediates may be used so that the selectivity given by the single autodyne valve becomes adequate. The circuit arrangement is shown in Fig. 5, while the methods of incorporating the additional details mediate amplifier close up to the point of regeneration.

Short-wave converters may be arranged for A.C. mains working, and the corresponding arrangements to those just discussed are shown in Figs. 6 to 10. It will probably be necessary in the case of an A.C. mains converter consisting of more than a single valve to equip it with a small full-wave valve rectifier, using a transformer carrying a winding supplying the heater current.




**Short-wave superheterodyne circuits using indirectly heated A.C. valves. 6. Simplest form of converter using a triode valve and deriving its current from the transformer and H.T. supply of the broadcast set. 7. Single valve arrangement using a screen grid valve as an anode bend detector. 8 and 9. H.F. stage preceding leaky grid and anode bend autodyne detector. A saving in components may be effected by using battery bias. 10. Complete mains operated set. H.T. and heater current can be drawn from an existing receiver and the output circuit can be left associated with the loud speaker.**

shown in Figs. 3 and 4 are obvious. The intermediate couplings are tuned to 2,000 metres (150 kc.) and are adjustable over a limited range to compensate for mistuning brought about by circuit conditions. Adjustment is provided in the amount of coupling between the primary and secondary circuits as a control of both the selectivity and the amplification, so that it is easily possible with suitable coupling to bring the inter-

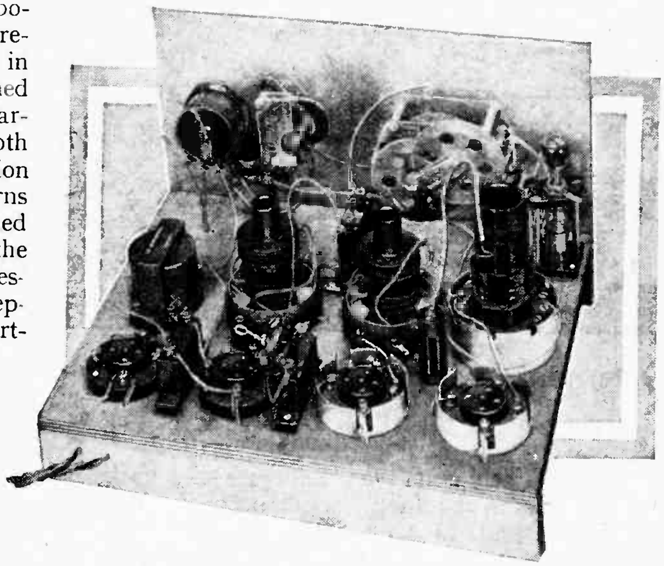
Receivers have been built following the general circuit arrangements of Figs. 5 and 10 covering a wave range of 18 to 70 metres. They follow the simplest process of construction, while, if the broadcast receiver is sufficiently selective, and the construction of a converter only contemplated, the necessary practical details for making up a one- or two-valve unit can be readily gleaned.

*COMPONENTS USED.*

*As a guide to the selection of suitable components, some of which embody special constructional advantages, the following list shows the types employed:—*

| | |
|---|---|
| *Tuning condensers, 0.0003 mfd., with slow-motion drive (fitted with special high-ratio reduction wheels)* | *(G.E.C.)* |
| *Reaction condenser (0.0001 mfd.)* | *(Utility, Wilkins & Wright)* |
| *Series aerial condenser* | *(J.B.)* |
| *Two-range short-wave coils and 150 kc. intermediates* | *(Colvern)* |
| *Intervalve transformer* | *(Igranic)* |
| *Small capacity condensers* | *(Dubilier)* |
| *Valve holders* | *(W.B.)* |

By way of special components the important requirement is a tuning coil in which the reaction and tuned circuit turns are suitably arranged to produce smooth regeneration. The position and number of reaction turns is critical. A single-tuned circuit will not cover the range of wavelengths necessary to permit of the reception of all the principal short-wave stations. To avoid the use of plug-in coils a switch is made use of to short-circuit part of the winding. Careful adjustment is required when making a two-range, short-wave coil, as "blind spots" in the lower tuning range are readily created by the in-circuit turns linking with the out-of-circuit section, whether this be left open or short-circuited. Only a single reaction winding is used on the two wave ranges. Short-wave coils are usually unshielded, or at the best housed in screening compartments with the other apparatus associated with the tuned stage. In this case a totally screened coil is used, which greatly facilitates the construction of the set, effective screening being essential. Care must be taken, however, with the connecting leads when using an H.F. stage, and, while the use of metal compartments would be the safest process, an H.F. stage can be effectively arranged, using the screened coils; but it is not the object of the present article to deal at length with the practical details of the H.F. short-wave amplifier. *(To be concluded.)*



**An easily built short-wave superheterodyne wired for use with battery valves. Screening covers are removed from the short-wave coil and the intermediates.**

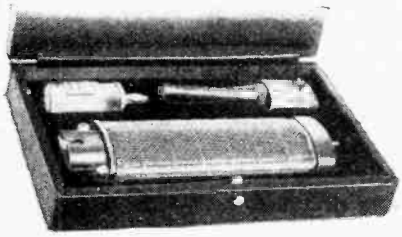
# EDISON BELL CONDENSER MICROPHONE.

THE principle of this microphone, which is described in British Patents Nos. 263,300 and 324,152 by P. G. A. H. Voigt, differs considerably from that of conventional condenser microphones.

Instead of the usual stretched diaphragm, a foil diaphragm wrapped round a centre electrode of elliptical cross-section is employed. The thickness of the air gap is irregular, and the natural frequency of the system is said to vary from 16,000 to 30,000 cycles. The air cavity communicates with a chamber which may be filled with calcium chloride if desired.

The most important advantage of the form of construction adopted is that the microphone responds to sound-waves arriving in any direction, and, if placed edge-on to the wave front, is not responsible for any appreciable reflection. In this position, however, there is a possibility of error at high frequencies where the width of the microphone is comparable with the wavelength of sound, and for purposes of calibration it is desirable to set the microphone surface at right angles to the wave front.

The disadvantage of this type of microphone would appear to be the comparative insensitivity. A full orchestra produces a peak voltage of about 2.5 millivolts with a polarising voltage of 200. Consequently a high degree of amplification is necessary, and exceptional precautions must be taken to guard against valve and battery noises. Further, the screened leads between the microphone and the amplifier must be kept as short as possible, since their capacity is in parallel with the microphone capacity. Increasing the length of the leads from 3ft. to 12ft. reduces the output from 2.5 to 0.7 millivolt. Full directions for setting up the microphone and constructing a suitable amplifier are given.

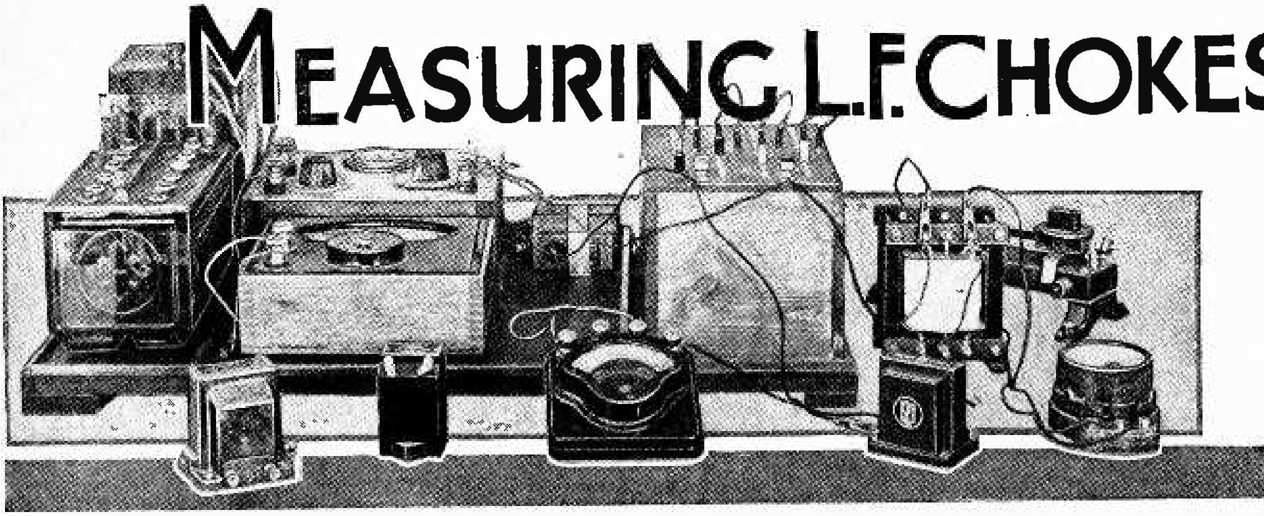


**Edison Bell condenser microphone, cable connector and spare calcium chloride.**

The response curve is level from 32 to 300 cycles, falls off by about 40 per cent. between 300 and 800 cycles, and then continues horizontal from 800 to 8,000 cycles. The drop in level is caused by the change from isothermal to adiabatic working conditions in the air cushion as the frequency is raised.

Those who have the requisite technical skill will find this instrument a useful tool in experimental work. It is priced at 6 guineas, and is made by Edison Bell, Ltd., Glengall Road, London, S.E.15.

# MEASURING L.F. CHOKES



## Some Methods for Determining the Inductance of L.F. Chokes Carrying D.C.

By H. B. DENT.

SINCE quality reproduction depends largely upon the correct adjustment of the impedances in the anode circuits of L.F. amplifying valves and, in some measure, upon the relationship between the respective impedances of two or more components forming any one circuit, it is obvious that, unless exact values are known, the attainment of a high standard of reproduction is possible only by the rather unsatisfactory trial and error methods.

One of the most vacillating components with which we have to deal is the low-frequency choke wound on an iron core, since its inductance may change considerably with any alteration in the value of the D.C. flowing in the winding. This reservation is advisable, for it is possible to design a component of this type which will maintain sensibly a constant value of inductance despite wide variations in the polarising current. It is only by actual measurement under conditions corresponding to the state obtaining in practice that a true idea of the performance of these components can be judged, and the purpose of this article is to discuss some methods whereby the inductance of L.F. chokes can be measured with a reasonable degree of accuracy.

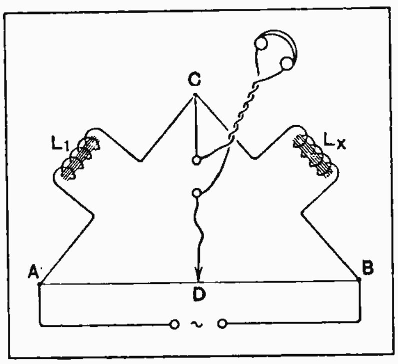



Fig. 1.—Simple bridge circuit for comparing inductances.

*NOW that such strides have been made in the design of all-mains receivers, the choice of a choke having the correct characteristics for any particular purpose becomes a matter of increasing importance. As the inductance of a choke changes according to both the D.C. and A.C. passing through its windings it is necessary to know its performance under these varying conditions. The methods discussed here are within the scope of those possessing a few pieces of simple apparatus.*

Although the measurement of inductance is not a difficult matter, it cannot be achieved by simple makeshift apparatus, especially if it is desired to obtain a series of readings for the purpose of examining the performance of a choke when carrying a direct current in addition to the A.C. component. It is possible to obtain a very approximate idea of the impedance by a comparative method, using the simple bridge described recently in this journal[1] for the measurement of resistance and capacity.

This is arranged as in Fig. 1, where $Lx$ is the choke, or a transformer primary of unknown value, and $L_1$ is a choke whose inductance is known. The method of operating the bridge is exactly the same as for resistance measurement; indeed, the conditions are somewhat parallel, since actually we find the relationship between the respective impedances of the two components. If the frequency of the A.C. energising the bridge is known, then the approximate inductance of $Lx$ can be calculated from the simple equation:

$$Lx = \frac{BD}{AD} L_1 \quad \ldots \quad (1)$$

provided the supply frequency is lower than the resonant frequency of the choke. Few chokes resonate, by virtue of their own inductance and distributed capacity, below 500 cycles.

Now let us consider something a little more practicable and, by means of which reasonably accurate results can be obtained without recourse to expensive apparatus. The circuit arrangement is shown in Fig. 2, and the method of operation consists of balancing the resistance R with the reactance of the choke coil L.

[1] *The Wireless World*, April 22nd, 1931.

**Measuring L.F. Chokes.**—Assume for the moment that the terminals XY are joined, the battery B and milliammeter being omitted from the circuit.

### Valve Voltmeter Need Not be Calibrated.

The resistance and the choke are connected in series and supplied from a source of A.C. derived from the transformer. The electric supply mains can be employed for this purpose, and the secondary of the transformer should give between 4 and 6 volts. A valve voltmeter is then connected in the manner shown with a throw-over switch to connect the meter either across the choke or across the resistance. The resistance is adjusted until the voltmeter indicates that the A.C. voltage across L is the same as that across the resistance R. Comparison must be made after every alteration of the resistance, since this naturally affects the voltage distribution in the circuit.

Incidentally, the valve voltmeter need not be a calibrated instrument, as it is employed only as an indication of balance. The simplest arrangement will suffice, provided it is sensitive. An L or H.L. type valve is suitable, and the milliammeter in the anode circuit should give a full-scale deflection with 1 mA. The valve should have sufficient negative bias to limit the anode current to about 0.1 mA. when no A.C. is applied to the grid. An important point to bear in mind is that the applied A.C. must not attain a value that will cause grid current to flow. If the valve is biased to $-4\frac{1}{2}$ volts, for example, it will be safe to apply up to 3 volts R.M.S. to the grid.

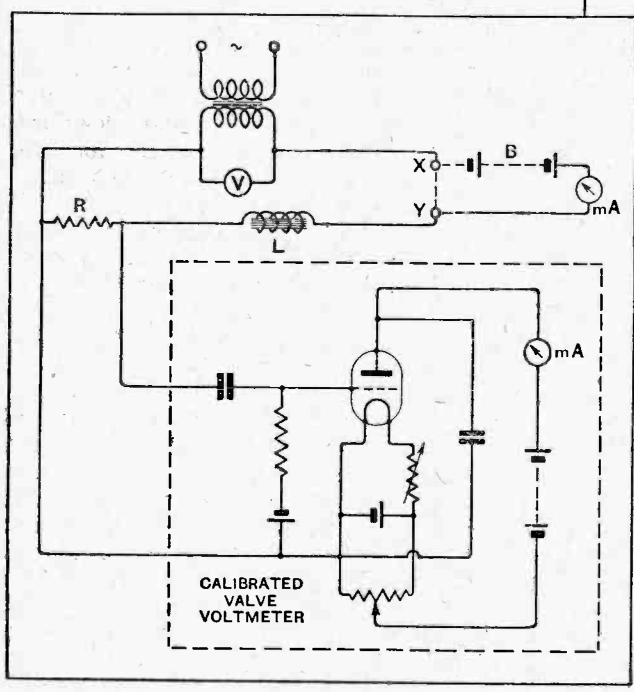



Fig. 3.—When L.F. chokes passing large direct currents are to be measured this arrangement is preferable to that in Fig. 2.

As the A.C. voltage across either the resistance or the L.F. choke under test at the condition of balance is one-half of the secondary voltage of the mains transformer, the output voltage from this component must not be more than double the maximum A.C. voltage the valve will accept. If a tapped transformer is not available, then a resistance can be included in the output circuit to absorb any excess voltage or to reduce the output to a value suitable for the needs of the movement.

The important part of the apparatus is the resistance R. It must be adjustable to the maximum amount likely to be required. Assuming the supply frequency is 50 cycles per second, then a total value of some 30,000 ohms will enable measurements of inductance up to about 100 henrys to be attempted.

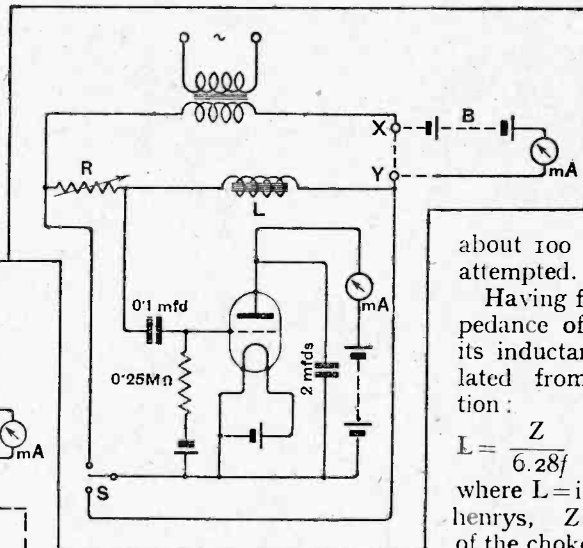



Fig. 2.—Practical method for measuring inductance of L.F. chokes passing a few milliamperes of D.C.

Having found the impedance of the choke, its inductance is calculated from the equation:

$$L = \frac{Z}{6.28f} \quad \cdots \quad \cdots \quad (2)$$

where L = inductance in henrys, Z = impedance of the choke, F = supply frequency. This assumes that the impedance is sensibly the same as the reactance of the choke, and in the majority of cases this assumption is justified if we are satisfied with reasonably accurate results. It ignores the D.C. resistance of the winding, as the impedance includes both the reactance and the ohmic resistance of the choke. If the D.C. resistance is small compared with the reactance, as in the majority of cases it will be, then the inductance value calculated from this equation will be sufficiently accurate for most purposes.

### Measuring Chokes of High D.C. Resistance.

In the case of chokes with rather low inductance, but a fairly high D.C. resistance, it will be necessary to take into consideration the second factor and calculate the inductance from the following equation:

$$L = \sqrt{\frac{Z^2 - r^2}{(6.28f)^2}} \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad \cdots \quad (3)$$

where $r$ is the D.C. resistance of the choke.

When the performance of a choke carrying D.C. is being investigated, the polarising current can be injected into the circuit by opening the link across XY and connecting in the circuit a battery and a milliammeter. A resistance may be included to control the current, or the voltage of the battery varied, whichever happens to be more convenient. The high value of the resistance R will prove rather troublesome if currents much in excess

**Measuring L.F. Chokes.**—
of a few milliamps. are to be passed round the circuit, and the battery B is likely to assume unwieldy proportions.

Since it will most certainly be required to deal with chokes capable of carrying a direct current of some 100 milliamps. or so, the following method has much to commend it. It demands, however, a calibrated valve voltmeter and a reliable A.C. voltmeter reading up to about 10 volts. The circuit arrangement is shown in Fig. 3. In this case we have a resistance R in series with the choke, the A.C. passing through both and supplied from a step-down transformer across the secondary of which is connected to an A.C. voltmeter.

The valve voltmeter is connected permanently across the resistance, which should be non-inductively wound, so that it measures the A.C. voltage developed across this resistance. Now, knowing the value of the resistance and the voltage developed across it, the current can be calculated by Ohm's Law. This gives us the total A.C. current in the circuit, and if we know the A.C. voltage driving this current round the circuit, the total impedance can be found from Ohm's Law also.

To find the inductance of L, equation (2) can be used, and the resultant values will be sufficiently accurate for most practical purposes, more especially if R and the D.C. resistance of the choke are small compared with its reactance. When we are dealing with chokes of comparatively high inductance, R will rarely exceed 2,000 ohms, whereas the reactance may attain some 30,000 ohms or more. The voltage of the polarising battery B is kept within reasonable proportions, since chokes capable of carrying 100 milliamps. are usually of fairly low inductance, and it is possible to reduce R to a few hundred ohms.

The value of the A.C. voltage will vary for different chokes, as it is a good rule to endeavour to make all measurements with the same initial amount of A.C. through the choke. Some advantage might be gained by maintaining the current at a constant level throughout in every case, but this would demand a continuously variable A.C. supply, since the impedance falls, as a rule, with every increase in the value of the polarising current.

Where a higher order of accuracy than attainable with the simplified equation (2) is desired, the inductance can be calculated in the following manner:

$$L = \sqrt{\frac{Z^2 - (R+r)^2}{(6.28f)^2}} \quad \ldots \quad (4)$$

where $R$ = the value of the series resistance in ohms.
$r$ = the D.C. resistance of the choke in ohms.
$Z$ = total impedance found by measurement.
$L$ = inductance in henrys.
$f$ = supply frequency.

The accuracy of the results obtained by this method depends largely upon the sensitivity of the valve voltmeter, the accuracy of the A.C. voltmeter, and the percentage deviation from true values of the resistances used at R. Unless these are all of a fairly high order of accuracy, there will be no point in adopting equation (4), since the errors introduced elsewhere will more than swamp the error occasioned by ignoring the D.C. resistance in the circuit. For close results, the valve voltmeter should be capable of recording difference in A.C. potential of the order of 0.01 of a volt, the resistances should be correct to 1 per cent., and the same order of accuracy should be present in the A.C. voltmeter. If these conditions can be attained, then all measurements should be well within 5 per cent. of the true values.

## SEMI-GANGED TUNING.

THE opinion is now sometimes expressed that if the ideal of perfect single-dial tuning control cannot be achieved, due to its cost or for technical reasons, a more or less imperfect "ganged" system is at least preferable to individual tuning of each circuit.

With reservations, there is a good deal to be said in favour of this attitude. It means, of course, that relatively inexpensive mechanically linked variable condensers, with, perhaps, roughly matched coils, can be used, and a set planned on these lines might possibly be actually cheaper to build than one requiring two or three slow-motion condenser dials.

The obvious drawback is that such a receiver will call for one or more external trimming condensers, and the acid test of its practical utility is whether these trimmers require constant adjustment; if they do, little real advantage over separate controls will have been gained. On the other hand, if tuning of the various circuits runs so well "in step" that there is hardly any perceptible divergence over, say, 20 per cent. of the total frequency range, such an arrangement seems to be worth while, as a fairly strong signal on a frequency differing perhaps by as much as 50 per cent. from the position at which an accurate trimming adjustment was last made would be heard at sufficient volume to act as a "landmark" for readjustment.

Experience shows that a good semi-ganged receiver with reasonably—but by no means perfectly—matched circuits is quite easy to operate when once its peculiarities have been mastered. It is a great advantage if matters can be so arranged that the trimmer control is immediately adjacent to the main condenser knob. For this reason it is obvious that the principle works more satisfactorily in a set with two tuned circuits than in a multi-stage receiver.

It is unfortunate that the tuning of band-pass filters by this method cannot be advocated, even when economy is vital. This type of circuit calls for the very best and most accurately matched coils and condensers, and it cannot be considered as really satisfactory unless practically perfect tuning is maintained over the whole tuning coils when once initial adjustments have been properly made. There is, however, the possibility of combining a filter built up with high-grade components with an H.F. amplifier of less expensive type, each being tuned by a separate condenser assembly.

# CURRENT TOPICS

## Events of the Week in Brief Review.

### "BROADCASTING HOUSE" FOR FRANCE?

French listeners, according to our Paris correspondent, are bewailing the fact that their country possesses no palace of radio like England, Germany, and other European Powers. The authorities are reminded also that a suitable model for a *radio maison* is being sought in Stockholm; that Oslo has a similar project in view; that Vienna is negotiating for the fine buildings belonging to a bank recently bankrupt, and that Rome is designing a special home of broadcasting.

Considering that our friends across the Channel have not yet succeeded in establishing a central broadcasting organisation, we think that house-hunting talk is decidedly premature.

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### A NEW ONE.

Excuses offered by eleven Bristol "pirates" ranged from unemployment to *the absence of grid bias.*

oooo

### PORTUGAL BEGINS BROADCASTING.

The first attempt in Portugal to provide a regular broadcasting service is now being made by Abilio Nunes dos Santos, Lisbon. The station, which is private, carries the call-sign CT1AA, and is now operating on 291 metres, with a power of 2 kilowatts. Regular programmes are given on Mondays, Wednesdays, and Saturdays from 10.20 p.m. to 12.20 a.m. On Thursday an additional 42.9-metre transmission is provided, with announcements in Portuguese, French, English, German, and Italian.

oooo

### ITALY'S "BROADCASTING HOUSE."

The "palace of broadcasting" now under construction in Rome is to be officially opened on April 21st, 1932.

oooo

### A RADIO APPETISER.

In a certain restaurant at the Paris Colonial Exhibition a radio receiver is tuned permanently to Radio Paris. A few days ago, reports our Paris correspondent, the diners were entertained with a talk on "Chronic Inflammation of the Intestines."

oooo

### MORE RADIO SHOWS.

The Irish Wireless and Gramophone Exhibition is to be held in Dublin from September 28th to October 3rd.

The Belgian Radio Show will hold sway in the Palais du Cinquentaire, Brussels, from October 17th to 26th.

Spain will stage a radio show at Madrid during September.

The Milan show dates are October 10th to 18th; the Bucharest show will open on August 30th and will run for a month.

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### WHAT THE MICROPHONE HEARD.

The dangers of the unguarded microphone are illustrated by our French contemporary, "Le Haut Parleur," in relating an amusing incident which occurred recently during the relay of a speech by a Cabinet Minister. Interrupted in the midst of his eloquent address by a burst of prolonged applause, the statesman glanced out of the window and the listening millions heard him remark: "Mon Dieu! How it rains!"

### THE OTHER MAN'S LOUD SPEAKER.

"Could not the use of earphones be made obligatory for at least some hours during the day?" wrote a correspondent last week in the *News-Chronicle*.

oooo

### CALIBRATION SIGNALS FOR AMATEURS.

At the suggestion of the Post Office, a special transmission of calibration signals for the benefit of amateurs is now carried out by the National Physical Laboratory, Teddington, on the first Tuesday in March, June, September, and December, commencing at 9 p.m. (G.M.T.).

This standard frequency transmission is made on a frequency of 1,785 kilocycles per second (i.e., 168.6 metres). The announcement "CQ de G5HW" is followed by a continuous dash, the whole lasting ten minutes. This procedure is repeated six times, i.e., at 2100, 2110, 2120, 2130, 2140, and 2150.

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### A NEW SUPER LOUD SPEAKER.

The U.S. Navy Department has recently purchased for experimental purposes two Hoovenaire sound system units for use in aviation communication. In a recent test at the Lakehurst, N.J., airship station, a communication read from the ground into one of the units was heard and copied aboard the dirigible "Los Angeles" while she was at an altitude of about 3,000ft. with engines running. In a second test a speech transmitted into one of the units was heard and copied, in the face of a 20-knot counter wind, at a distance of eight miles. A second speech was heard and copied at a distance of eighteen miles with a wind of 20 knots in the line of transmission.

In the Hoovenaire system (writes our New York correspondent) the amplified microphone currents actuate a novel form of valve which admits more or less compressed air into the throat of the loud-speaker horn. It is claimed that much less electrical amplification of the microphone output is required than for any other public address system, and no other public address system tried by the U.S. Navy Department came anywhere near comparing favourably with the Hoovenaire system.

oooo

### AUTOMATIC HOSPITAL SET.

It is regretted that Mr. F. W. Smurthwaite's name was misspelt in our issue of August 12th in the description of the receiver installed by Mr. Smurthwaite at the Tooting Bec Hospital.

oooo

### "STATE" BROADCASTS.

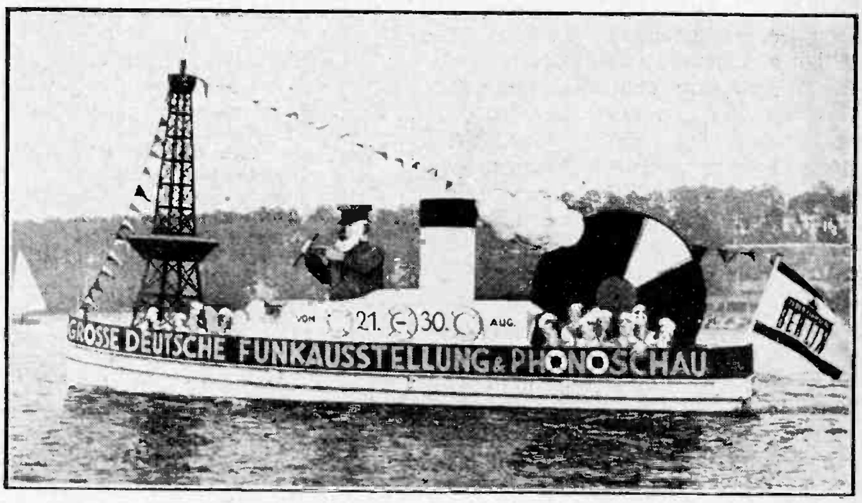
On good authority we learn that the German Government is considering the initiation of a "State" broadcasting hour at frequent intervals for the purpose of issuing decrees and acquainting listeners with the home and foreign political situation. We wonder whether some of the "turns" will be furnished by the income-tax collectors!

oooo

### MASTS TO WITHSTAND GALES.

Although the new Trieste broadcasting station is already functioning, our Italian correspondent reports that the official opening will take place during the first week of September. The wavelength is 247.7 metres, and the power 15 kW. The interval signal is in the form of a chime.

Great difficulty was experienced in building suitable masts at Trieste to withstand the onslaught of the tempestuous winds from the Adriatic Sea. The masts now in position are constructed to withstand a gale of 180 miles per hour.




THE LAST WORD IN RADIO AFLOAT.—"Kapitän Funk" is here seen aboard his vessel, which is plying the waterways of Germany to spread the good news of the Radio Exhibition now being held in Berlin.

# Ekco R.S.3

# ALL-ELECTRIC CONSOLETTE

## Single Dial Tuning with Station Identification Scale.

A COMPLETE departure from their previous sets and embodying many radically new features not to be found in other receivers, the new four-valve Ecko model represents a considerable advance in radio design and fashion. Simplicity of operation has been the governing influence, and, as a result, the number of controls has been reduced to three, being the tuning adjustment, volume control, and tone regulator.

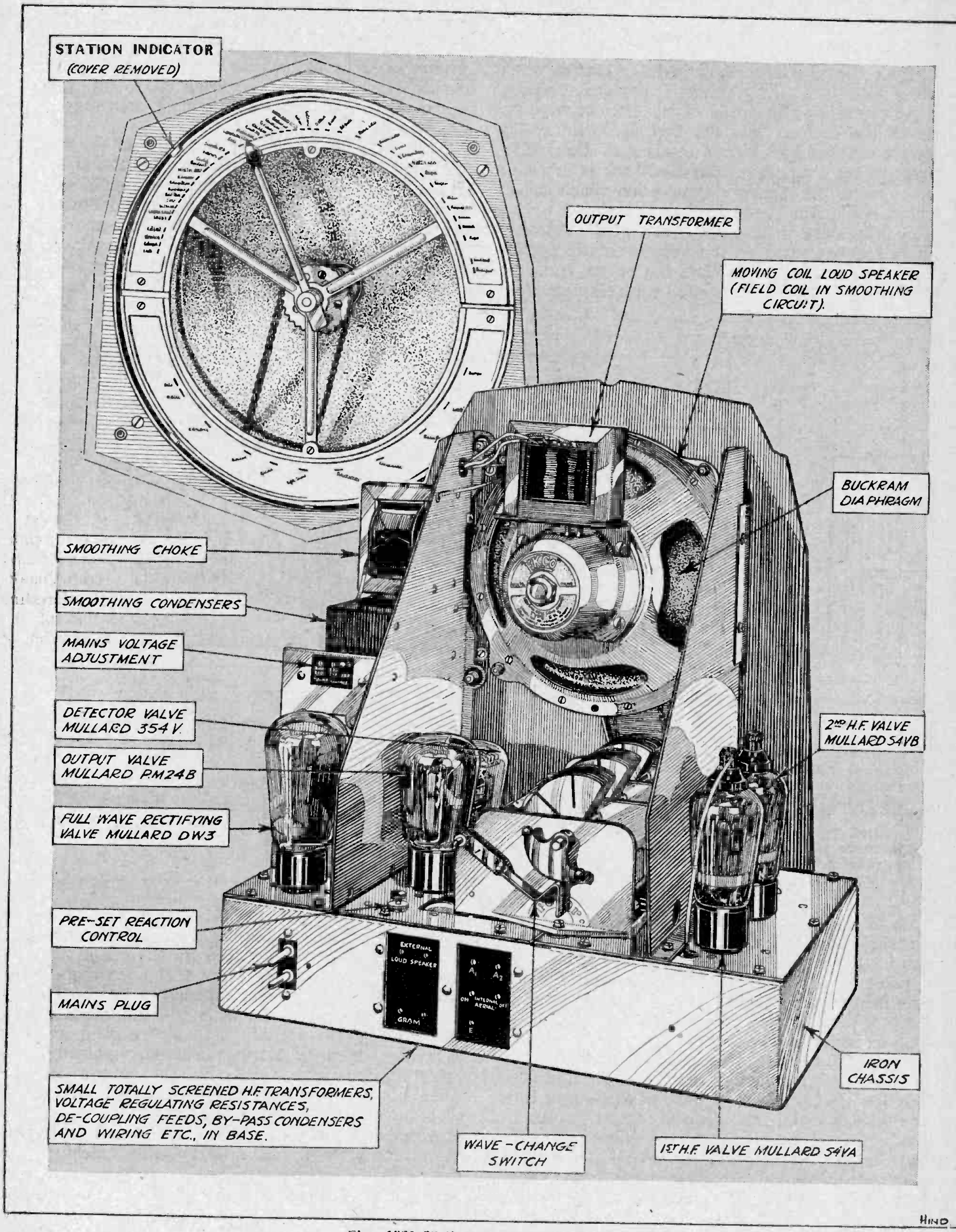
The outstanding feature is the station indicator taking the place of the graduated disc, a legacy of pre-broadcasting days. In the place of the inconvenience of dial readings, a pointer travels around the edge of the loud speaker grille and points by name to the station being received. While reference charts to station settings are all very useful, the making of the cross reference is troublesome, there is always doubt as to the correctness of the indication. A set that bears direct readings not only takes into account the relative tuning positions, but is based upon a knowledge of the stations that can be heard, relieving the user of the troublesome business of deciding which stations may be neglected. As the single tuning control is operated the pointer traverses the station scale, and on completion of the medium waveband automatically switches over to the long-wave range. At the point of switching over, there is a small interval where the pointer passes behind a cover, and, in this position, where no station is indicated, the gramophone pick-up is thrown into circuit. In addition, therefore, to the direct indication of station identity, wave change and gramophone to radio controls are dispensed with. Very different is this method of tuning from the one where perhaps two dials may need to be operated, giving an indication in divisions or, at the best, approximate wavelength, owing to the inclusion of a reaction control.

**SPECIFICATION.**

*Four-valve A C.-mains operated set.*
*Two transformer coupled H.F. stages with compensation for constant reaction.*
*Two wave ranges with automatic switching including the introduction of gramophone pick-up operated from tuning control.*
*Single knob tuning with station indicating scale.*
*Volume control applied both to aerial and biasing circuits.*
*Ganged tuning condensers and switches.*
*Leaky grid detection.*
*Transformer L.F. coupling to power pentode output valve.*
*Moving coil loud speaker. Full-wave valve rectification. Chassis built on iron frame. Bakelite cabinet.*
*Valves: Mullard S4VA, S4VB, 354V, PM24B, DW3 rectifier.*
*Price 24 Guineas. (Available 1st September.)*

By the use of two H.F. stages, in which the properties of the tuned circuits have been carefully adjusted, the control of reaction is avoided, regeneration pulling its weight all round the dial making the set as sensitive as possible without self-oscillation being encountered. Transformer coupling is used in the H.F. stages, followed by a leaky grid detector, transformer coupled to a power pentode. Mullard valves are used throughout, and are the S4VA, S4VB, the 354V, the PM24B pentode, and the full-wave valve rectifier used in this all-mains operated model is the DW3. Several interesting features are revealed from close examination of the circuit, indicating not only an up-to-date knowledge of principles, but the carrying out of that essential to successful design, laborious tests by trial and error. This is evidenced in the volume control, the H.F. intervalve couplings, and the constant reaction arrangement. For instance, the control of volume is effected by a single 5,000-ohm potentiometer, connected in the cathode return circuit of the pair of H.F. valves. Increase in the value of this resistance advances the negativeness of the grid bias and reduces the effectiveness of the valves. Such a method of volume control in itself is objectionable, as a strong signal now falling on the curved characteristic of the over-biased valves gives distortion and interference by rectification. This condition is avoided, however, by connecting one end of the potentiometer across to the aerial so that as the grid bias is increased a shunt is applied between aerial and earth, weakening the initial signal applied to the grid.

Short-circuiting switches are applied to the long-wave sections of the H.F. couplings, but it is interesting to note the inclusion of a shunt condenser across each primary long-wave section, the aim probably being

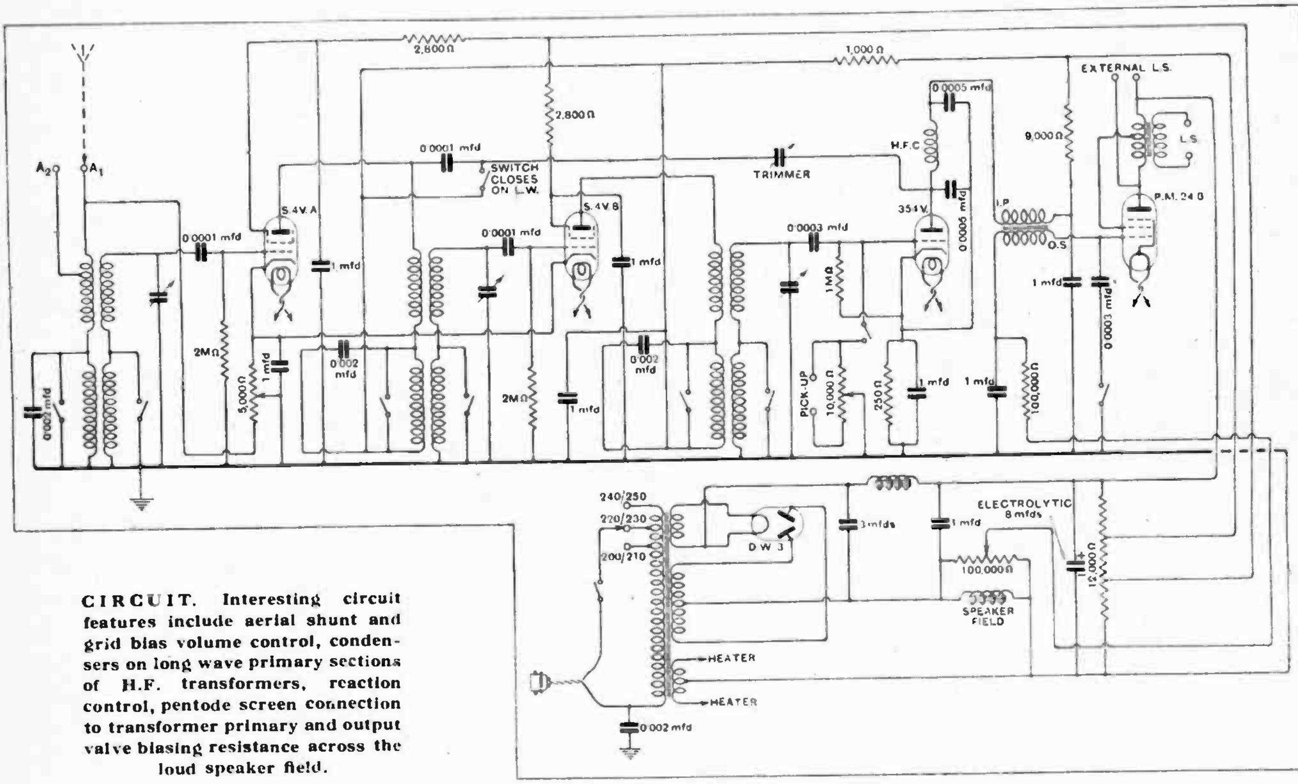



Ekco 1931-32 Consolette. Model R.S.3.

**Ekco R.S.3. All-Electric Consolette.**—

that of making the set no more sensitive on the long waves than on the broadcast band. In this way self-oscillation, which usually occurs when switching over to the long waves, is avoided. Again, there is a stabilising adjustment of feed-back between the anode of the detector and the first H.F. intervalve coupling controlled by a pre-set condenser. On switching over to the long waves this feed-back is taken to earth, owing to the greater magnification which occurs with circuits tuned to the higher wave range. A potentiometer is included in the grid circuit of the detector, which is gang operated on the volume-control spindle coming into operation to regulate the output from the gramophone pick-up as the switch contacts pass from wiring. The cabinet, which is artistically shaped, is of bakelite moulding. Unlike wood, bakelite for cabinet work never shows signs of wear, though it is highly costly in the matter of tools when large and detailed mouldings are considered. An oxidised copper grille provides a mounting for the station indicator.

On test the station-getting properties of the set were found to be entirely up to the standard of two H.F. stage receivers. In daylight, under average conditions, only local British stations are received on the broadcast band, but, as is usual, the long wave stations come in well. After dark stations came in at close intervals around the scale, their identity at once being recognised from a nearby clue on the indicator. Volume control is



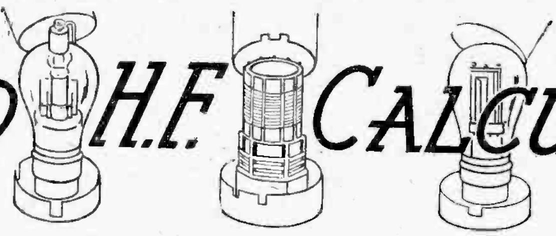

**CIRCUIT.** Interesting circuit features include aerial shunt and grid bias volume control, condensers on long wave primary sections of H.F. transformers, reaction control, pentode screen connection to transformer primary and output valve biasing resistance across the loud speaker field.

medium to long wave, at the same time bringing negative biasing in the cathode lead into operation.

Bias for the output pentode is obtained from a tapping point on a resistance connected across the loud speaker field winding which forms part of the smoothing circuit. A potentiometer bridges the H.T. supply, delivering measured voltages of 180 and 70 to the anodes and screens of the H.F. valves and 275 to the anode of the pentode. Decoupling resistances are introduced in most leads. Down the primary of the output transformer there is a potential drop of some 25 volts, and into this primary is tapped the screening grid of the pentode, an arrangement which produces the necessary tone correction required with the pentode output valve.

Sheet iron, stiffened by bending, is used for building up the chassis, a base compartment housing the coils, resistances and condensers and shielding most of the smooth and does not produce the marked change of tone so often met with. Heterodyning on distant station reception was greatly reduced by the use of the tone control switch, but it was felt that even more severe adjustment of tone would not be out of place. The cost of running per 1,000 hours is 5s., multiplied by the number of pence per unit. Quality is good, carrying a full deep bass without drumminess, combined with a bright upper register. Mains hum is inappreciable, and when not tuned into a station the set is sufficiently silent to suggest the advisability of fitting some form of visual indicator, such as a pilot lamp to illuminate the station scale or loud speaker grille. Being attractive from the artistic standpoint, mechanically unique and electrically reliable, this 1931-32 model at 24 guineas is likely to prove exceedingly popular in the coming season.

# SIMPLIFIED H.F. CALCULATIONS



## Charts for Rapid Measurement of High-frequency Amplification.

By W. A. BARCLAY, M.A.

THE art of wireless communication is peculiar among scientific pursuits in that it offers an ideal combination of theory and practice, and the close connection between the two is nowhere more evident than in the H.F. amplifier. The general principles which govern the performance of amplifying valves have been reduced to formulæ which have been published in the pages of this journal, and experimental evidence has been brought forward which confirms to a high degree the accuracy of the theoretical results.

Until a few years ago the best results in H.F. amplification were secured by "neutralising" the grid-anode capacity of the amplifying triode; by this means the precise amount of this residual capacity was rendered unimportant in determining the actual degree of magnification. With the advent of the screen-grid tetrode, on the other hand, when used in straightforward or unneutralised circuits, the value of this residual capacity—now many times smaller than in the case of the triode—became of supreme importance in determining the amount of amplification to be expected. In this connection readers are referred to the informative articles by W. I. G. Page, on "The Modern H.F. Valve," where these and other kindred matters are fully discussed.[1]

*WITHIN the past two years much valuable information on the subject of high-frequency amplification has appeared in this journal, and the broad principles of the subject are by now fairly well known. The effective stage magnification of an H.F. valve, together with its coupling, can be predicted accurately enough using certain accepted formulæ, but the mathematics concerned, although simple, are somewhat tedious. With a view to reducing the labour of calculation to the minimum, the author has devised a number of ingenious alignment charts from which design and performance of the H.F. amplifier can be readily gleaned.*

### The Importance of Anode-grid Capacity.

A knowledge of all the ramifications—and they are extensive and peculiar—of H.F. amplification is a matter exclusively for the research worker; for the ordinary amateur it will be sufficient to understand the broad principles, and to be able to predict roughly the effects likely to follow any adaptation of them which he may wish to realise in practice. Unfortunately for the average wireless user, it is extremely difficult to present even the "broad principles" of H.F. amplification without recourse to algebra, while the moment we descend to realities—the "concrete case" of the text-books—we are immersed in masses of figures which, to the layman, appear merely a chaotic tangle, without form and void. He may be aware, vaguely, that amplification depends somehow on the residual grid-anode capacity of the valve, and, given time, could doubtless hunt up the formula which deals with the subject. But in most cases the quest does not proceed further, no attempt being made to substitute actual numerical values in the formula, so that no light is shed on the insistent question, "What degree of amplification should I expect from *my* circuit?" The reason is, simply and solely, that the average wireless enthusiast is an enthusiast for wireless and not for arithmetic, and that the "dogwork" which would be entailed by any attempt to translate the formula into working figures necessarily demands far too much time, even if the inclination were not lacking. (A typical calculation of this sort lies beside the author at the moment of writing; two sheets of notepaper covered with figures—in one of which, he regrets to say, a misplaced decimal point caused a ten minutes' extra "spot of bother" before it was located.)

### Alignment Methods.

Now, it is precisely with a situation of this sort that the modern principle of "alignment" is so peculiarly fitted to deal. It is no news to readers of this journal that alignment charts may now be constructed which reveal at a glance (that is to say, by one single application of the index-line) quite complicated numerical relations between several different variables. Cases of "four-variable alignment" have been described by the writer on several former occasions;[2] here it is proposed to apply the same methods to some of the formulæ dealing with H.F. amplification. As usual, in order to make use of the diagrams, no actual acquaintance with the formulæ themselves is even needed—the charts containing all that is necessary to ascertain precise numerical results for particular conditions which could only be otherwise obtained by dint of much hard figuring. While they should thus be of service to the practical constructor, it is hoped and believed that

[1] *The Wireless World*, July 24th and 31st, 1929.

[2] For a description of the four-variable alignment principle see *The Wireless World*, December 3rd, 1930.

for the research worker, too, they may prove of material assistance in the elimination of much tedious arithmetic.

It is not intended in this article to present a comprehensive survey of the principles of H.F. amplification, but rather to point the way to a better understanding of what has already been written. All that will be attempted here is to recapitulate—however briefly and incompletely—a few of the salient points so far as may be necessary for the proper interpretation of the accompanying charts.

The screen-grid valve has now come into such great favour as an H.F. amplifier that the advantages of the triode in this capacity are occasionally apt to be overlooked. Nevertheless, the merits of the modern neutralised triode are very real, especially in regard to selectivity. It will usually be possible to design a transformer of optimum turns ratio to work with a triode, whereas with screen-grid valves this is seldom possible owing to their comparative lack of selectivity.

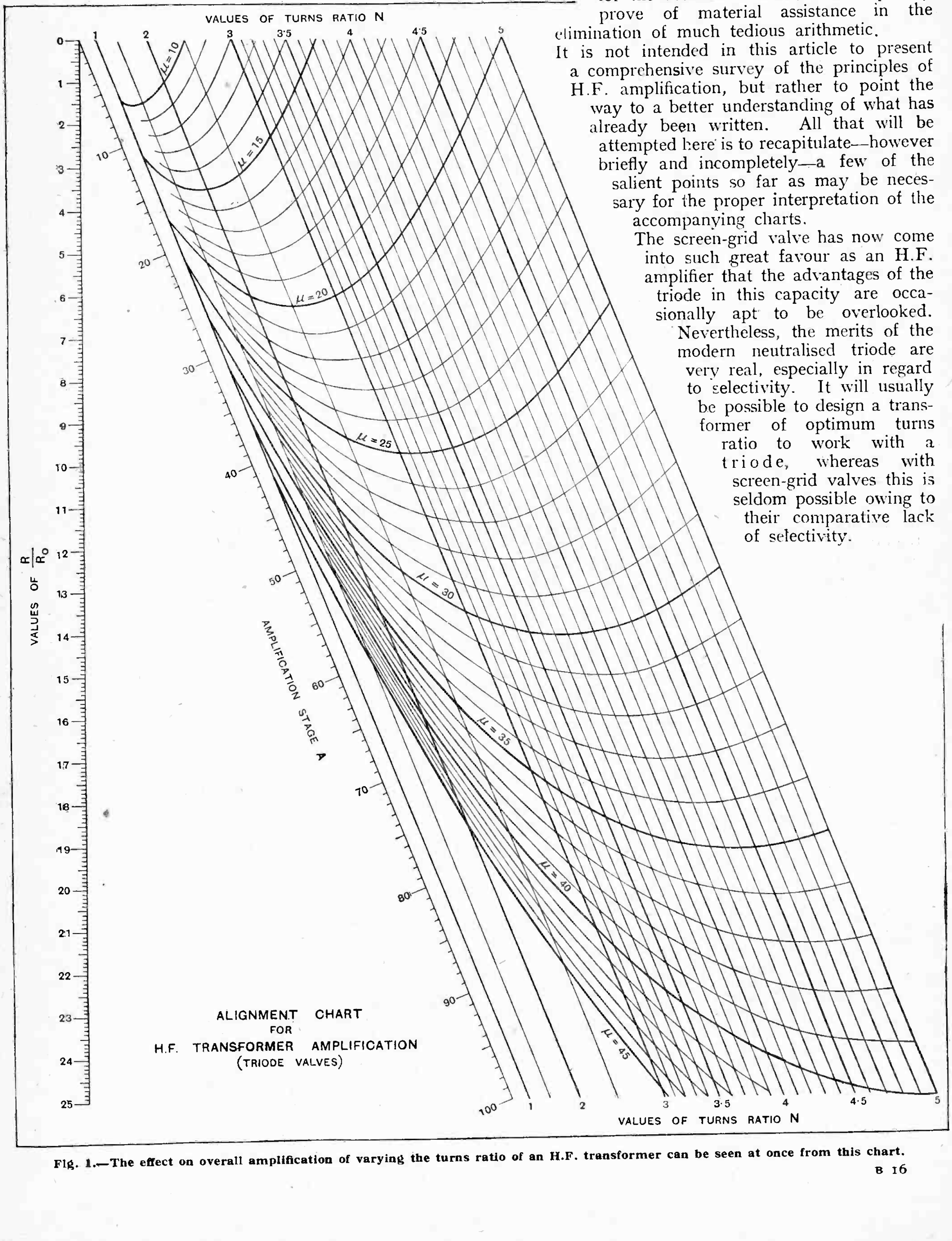



**Fig. 1.—The effect on overall amplification of varying the turns ratio of an H.F. transformer can be seen at once from this chart.**

**Simplified H.F. Calculations.—**

**Amplification of Neutralised Triode.**

In this article, however, the question of selectivity will not be discussed, and we shall confine ourselves strictly to the estimation of the overall stage amplification. For the case of the neutralised triode, this is given approximately by the formula

$$A = \frac{\mu NR}{R + N^2R_0} \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

in which N denotes the turns ratio of the transformer, A the overall amplification of the stage, R the dynamic resistance of the secondary, and $R_0$, as usual, the A.C. plate resistance of the valve under the working conditions.

To illustrate this formula over the range of values likely to arise in practice with triode valves, the four-variable alignment chart of Fig. 1 has been prepared. This chart is designed on similar lines to that for low-frequency transformer amplification, described by the writer in a recent issue of this journal.[3] To use the chart, the appropriate value of the ratio $\frac{R}{R_0}$ for the working conditions is first sought upon the left-hand scale. Next, a point is found on the right-hand network, situated at the intersection of the particular curve and slant line, which correspond respectively to the given values of $\mu$ and N. On joining these two points by the usual index line (which, of course, does not require actually to be drawn on the diagram), the value of the stage amplification is immediately read off.

As an example, let us consider a neutralised triode for which $R_0 = 25{,}000$ ohms and $\mu = 32$. If this be worked in conjunction with an H.F. transformer of dynamic secondary resistance, $R = 290{,}000$ ohms, and turns ratio 4.3 : 1, it is seen that $\frac{R}{R_0} = 11.6$. Hence it is readily found that the overall stage amplification is 53.

The effect on the overall amplification of varying the turns ratio may be easily studied by means of this chart. In the above example, for instance, it would be found slightly more advantageous (from the point of view of amplification) to use a slightly smaller turns ratio. It will, indeed, be readily seen that when this ratio $N = 3.4$, the value of the corresponding stage amplification A is 55, which is the maximum that can possibly be secured with the given values of R, $R_0$ and $\mu$. At this point the index-line through $\frac{R}{R_0}$ is a tangent to the curve for $\mu = 32$, and 3.4 is thus the optimum turns ratio to which the transformer should be designed. Readers who followed the description of the previous chart for L.F. transformers should have no difficulty in applying the present one to meet the various analogous problems which arise in H.F. triode amplification.

The chart of Fig. 1 brings out very well the essential dependence of the overall stage amplification A upon the values of $\frac{R}{R_0}$ and $\mu$. The optimum value of turns ratio for use with a given value of $\frac{R}{R_0}$ is found, as we have seen by drawing the tangent through $\frac{R}{R_0}$ to meet the given $\mu$-curve, the point of contact giving the required N-line. It will be found that if any particular value of $\frac{R}{R_0}$ is selected, all the tangents drawn from it to the various $\mu$-curves will meet them along one and the same N-line. In other words, the optimum value of turns ratio associated with any value of $\frac{R}{R_0}$ is entirely independent of $\mu$. This, of course, is in accordance with theory, since it is well known that for maximum amplification with a neutralised triode, the optimum turns ratio is given by the relation

$$N = \sqrt{\frac{R}{R_0}}$$

the corresponding actual stage magnification being given by $A = \frac{1}{2}\mu \times N$.

**H.F. Performance Factor.**

We may now introduce a chart to illustrate the useful conception known as the "H.F. Performance Factor," and its relation to the more usual so-called "valve constants," $R_0$, $\mu$ and $g$. The H.F. Performance Factor was described some time ago as "a true figure of merit for an H.F. valve used with an H.F. transformer of optimum ratio." This H.F. performance factor is defined as

$$\frac{\mu}{\sqrt{R_0}} \times 100,$$

and may be denoted by the symbol F. In making use of it, care must be taken to ensure that the proper optimum transformer is used with the valve; thus the performance factor is no criterion of the valve *per se*, but only in conjunction with the transformer which, for it, is the best.

It is thus apparent that F is a secondary constant of the valve whose value depends on those of $R_0$ and $\mu$. In this respect it is similar to $g$, the mutual conductance, which latter quantity, when expressed in milliamps. per volt, is related to the other constants $R_0$ and $\mu$ by the equation $g = \frac{\mu}{R_0} \times 1{,}000$.

The formal similarity of these defining equations for F and $g$ permits of their simple representation by alignment in an exceptionally convenient form. It is found possible to construct a chart which will relate by a single setting of the index-line the numerical values of the four variables $R_0$, $\mu$, F and $g$. This chart is reproduced in Fig. 2, and possesses the remarkable property that *any straight line drawn across it meets the four scales in corresponding values*. Thus, if any two of the four quantities are known, the corrresponding values of the remaining two may be found in alignment with them. For example, if $\mu = 60$ and $g = 1.5$ mA. per volt, $R_0$ must be 40,000 ohms, and the H.F. performance factor will be 30.

[3] See *The Wireless World*, July 8th and 15th, 1931.

**Simplified H.F. Calculations.—**

**Maximum Stage Amplification.**

We have seen that the value of F for any valve may be conveniently found by simple alignment on the chart of Fig. 2. The same chart may also be used to find the maximum possible amplification which can be secured when using a neutralised transformer circuit of optimum turns ratio whose secondary has a dynamic resistance of known value R.

We know that, where N is the optimum turns ratio,

$$A = \tfrac{1}{2}\mu \times N \quad \text{or} \quad A = \tfrac{1}{2}\mu \times \sqrt{\frac{R}{R_0}}$$

This formula may, by substituting the symbol F in accordance with its defining equation, be written

$$A = \frac{F}{100} \times \sqrt{\frac{R}{4}}$$

and this latter relation, as it happens, may be very simply read off the chart of Fig. 2 as follows. Having found on the left-hand (resistance) scale the point corresponding to one-quarter of the given dynamic resistance, let this be joined to the value of F, as previously found on the H.F. Performance Factor Scale. The required value of A will now be found on the right-hand (voltage amplification) scale, in alignment with these two quantities. It will be observed that in this secondary use of the chart, the two outer scales are used for $\frac{R}{4}$ and A instead of for $R_0$ and $\mu$.

For example, with the valve considered above ($R_0 = 25{,}000$ ohms and $\mu = 32$), the value of F is immediately found to be 20. The maximum possible amplification to be obtained from this valve, when used in combination with a transformer of optimum ratio and secondary dynamic resistance, 290,000 ohms, will be found by aligning F (=20) with $\tfrac{1}{4}$R (or 72,500 ohms), thus giving A=55. This value is, of course, the same as that otherwise found above for the same data by Chart 1.

*(To be continued.)*

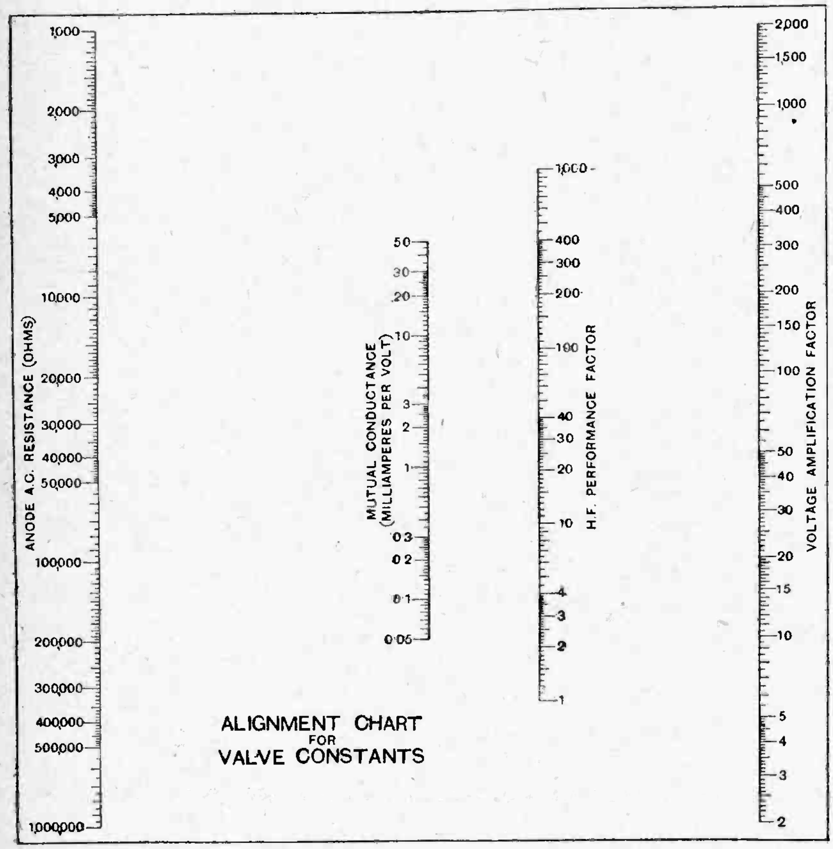



**Fig. 2.—Knowing the effective characteristics of the H.F. valve, the H.F. performance factor $\left(\frac{\mu}{\sqrt{R_0}} \times 100\right)$ can be read off. This chart can also be used for calculating stage gain.**

# REMOTE TUNING CONTROL SYSTEM.

## Adding Tuning Capacity by Means of a Mercury Break and Relay.

A RELAY and associated apparatus for the remote or automatic tuning of a receiver by switching a pre-set capacity across a coil by means of a mercury tube switch is shown pictorially in Fig 1.

It will be seen that a permanent L-shaped magnet is mounted at the back of the relay, and the cores of A and B, being in contact with one pole of the magnet, form a return of the magnetic path to a gap in which is placed the armature. This being pivoted in the centre, only one end at a time is attracted to the cores. Extending from the armature is a rod carrying the mercury tube switch (or switches, in the case of several circuits), the rod at the same time making contact with one of two spring blades, and completing the circuit to coil A or B and a signal lamp.

In operation, the selector button is pressed, and current flows through coil B. This has the effect of neutralising the magnetism in the core, and the armature at this end is repelled. At the same time, as the core of A retains its magnetism, the other end of the armature is attracted, and the mercury tube mounted on the extending rod tilts over, thus switching a pre-set condenser capacity to the low potential end of the tuning coil.

Connection is now made by the rod to the other spring contact in readiness for the operation of the control button when it is desired to select another station, or

**Remote Tuning Control System.—**
switch off, and at the same time completes the circuit to a signal lamp which lights up and indicates that that particular button has been pressed. It will be noticed that as soon as the armature is repelled and attracted, the circuit is broken, and current ceases to flow through the coil.

The pressing of the control button energises coil A; the armature is repelled at this end and attracted at the other by the magnetism of the permanent magnet in the core of B, and all the circuits are immediately broken. Where several relays are used, it is only necessary to have the one control button, as all the control coils can be wired to this. The mercury switch has three connections for a medium-wave station, but for a long-wave station only two connections are used, the wire *a* to the mercury tube being left out. The illustration also shows the circuit of a four-valve receiver to which the system has been applied for automatically switching the mains to set, and the selection of three pre-determined stations. More, of course, may be fitted if required. Where volume control is desired, this can be effected at the loud speaker, although the writer prefers a fixed volume at a natural level. E. M. M.

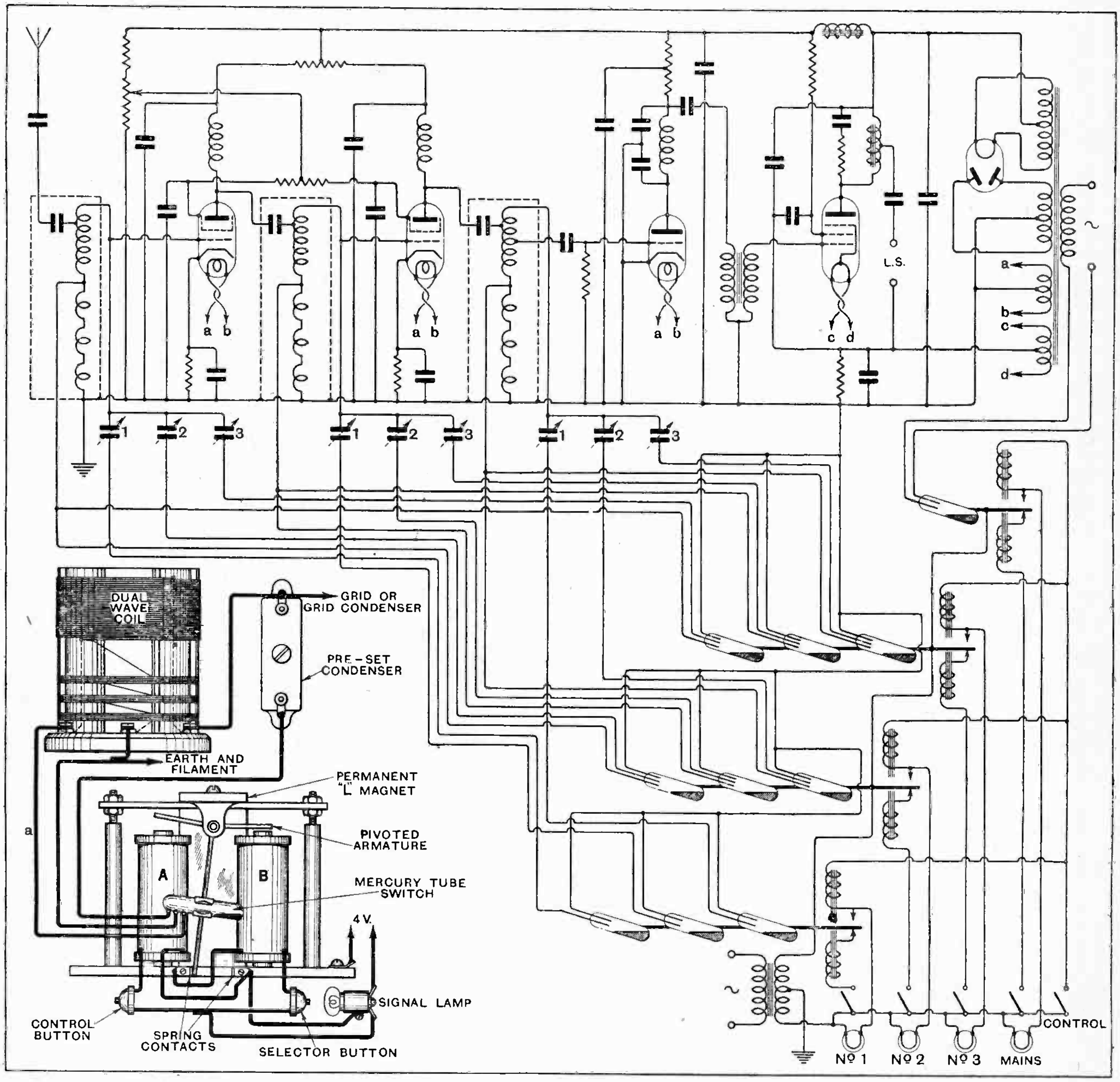
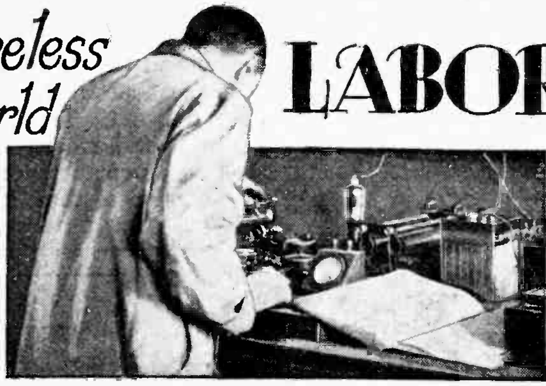



**Fig. 1.—Pictorial diagram of relay and mercury switch together with circuit diagram of 4-valve receiver.**

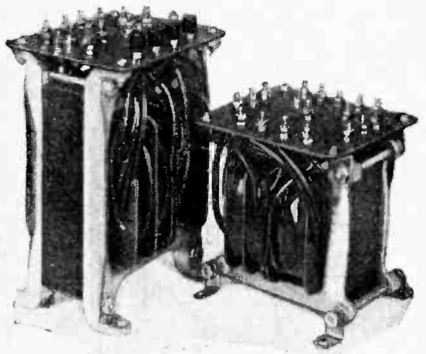
# Wireless World LABORATORY TESTS



Review of New Radio Products.

### "SOUND SALES" TRANSFORMERS FOR SUPER-SELECTIVE SIX.

"Sound Sales," Tremlett Grove Works, Junction Road, Highgate, London, N.19, have just introduced two mains transformers designed especially for the Super-Selective Six receiver. The principal difference between the two models is that in one case provision is made for field excitation of a moving-coil loud speaker. Field current is obtained by increasing the H.T. by 100 volts, it being assumed that the field coil would form a part of the smoothing equipment.



"Sound Sales" mains transformers for the Super-Selective Six Receiver.

Both transformers are built on generous lines, the insulation is of a high standard, and the workmanship is well above the average. The primary winding is tapped to suit supplies of 200, 220 and 240 volts at 40 to 60 cycles, and provision is made for the use of either a 4-volt or a 5-volt type rectifying valve. In the case of the larger model the H.T. secondary is arranged to give either 275+275 volts R.M.S. for normal use, and 375+375 volts R.M.S. where field current for the loud speaker is desired.

Tests made under the normal conditions of use show that the output voltages are sensibly the same from both models, and particular care has been taken to adjust the L.T. voltages under full load conditions to meet the requirements of the Super-Selective Six. With the rectifier delivering the current required to operate the set, the measured voltage across its filament was 5 volts, while the L.T. 4-amp. winding showed 4.03 volts, and the 1-amp. L.T. winding 4.05 volts.

The various terminals are mounted on a small panel, and each set is clearly marked. In operation on full load the transformer remains perfectly cool, and there is no trace whatsoever of mechanical hum, showing that the core is well assembled and tightly clamped.

The larger of the two models costs £2, while the price of the other style is 36s., and either can be confidently recommended for use in the set for which they are designed.

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### HUNT'S POLYMET ELECTROLYTIC CONDENSERS.

These condensers are available in two styles; the one with a single-hole fixing for permanent attachment, and the other with a bayonet-type cap. In all cases the condensers must be mounted in a vertical position, since they contain free electrolyte, which might not completely cover the anode if mounted in any other manner. There is no possibility of the solution leaking, and it is for electrical reasons only that the vertical mounting is advised. The device consists of a specially formed aluminium anode, immersed in a special solution, and sealed in a metal container. The metal case is the negative pole of the condenser, consequently it can be in electrical contact with a metal chassis. The anode is brought out through an insulated bush at the base of the case, and this must be connected always to the positive of the D.C. supply.

Before the device will function as a condenser it must be "formed," a process which takes a matter of five to ten minutes, and may be left until the receiver, amplifier or eliminator is ready for use. During the initial forming process the current passing through the condenser may reach some 20 to 30 mA.s, depending upon the voltage of the supply. Our tests show that the initial current is maintained for a very short period, and within a few minutes drops to about 1 mA. or less, and on a 200-volt D.C. supply the leakage current, after 10 minutes forming, remained steady at about 0.2 mA.

Hunt's Polymet 8-mfd. electrolytic condenser for D.C. circuits.

The special features of the condenser are: High voltage breakdown, low electrical leakage, robust construction, immediate and complete recovery from the effects of over-voltage when normal conditions are restored, small size and freedom from leakage of solution, with adequate venting arrangement.

Two models of each type are available, the one with a working voltage of 350 D.C. and made in 4-mfd., 4+4-mfd., 8-mfd. and 16-mfd. sizes, the prices being, for single-hole fixing, 10s., 14s. 6d., 10s. 6d. and 14s. 5d. respectively. The others are rated at 400 volts working potential, and are made in 4-mfd., 4+4-mfd. and 8-mfd. sizes only, the prices being respectively 10s. 6d., 12s. and 11s.

These condensers are of American manufacture, and are marketed in this country by A. H. Hunt, Ltd., Tunstall Road, Croydon, Surrey.

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### MAGNUM MINIATURE VOLUME CONTROL.

This new Magnum volume control is exceedingly compact, measuring $1\frac{1}{2}$in. in diameter and with a depth of $\frac{3}{4}$in. only. The resistance element consists of a specially prepared material, and contact is made by means of a rocking disc, a feature which has been embodied in other Magnum products of a similar nature for some time past.

New Magnum volume control of compact design.

The new model is available in 0.5 and 2 megohm sizes, and is, of course, of the potentiometer type. It is fitted with a single-hole fixing bush, and, complete with knob, costs 5s. The makers are Burne-Jones and Co., Ltd., 296, Borough High Street, London, S.E.1.

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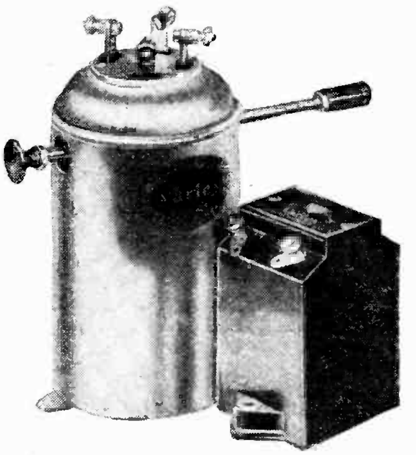
### VARLEY H.F. COIL AND NICHOKE II.

The new Varley H.F. coil is a companion model to the Constant Square Peak Coil, its inductance having been adjusted to facilitate the ganging of all tuning condensers. This coil is suitable either for tuned anode or tuned grid circuits, and a reaction winding is incorporated.

The medium wave coil is tapped one-third down from the grid end, and this may be used either as the connecting point for the preceding valve, or for the grid connection for the detector stage.

The wave-change switch is mounted so that it falls in line with the corresponding switch on the band-pass coil unit, thus enabling these two switches to be linked



Varley H.F. intervalve screened coil and Nichoke II L.F. choke.

together by the special extension rods provided. A sealed aluminium case completely encloses the coil, but the screen is not electrically connected to the coil, and must be earthed separately. The price complete is 8s. 6d.

The new Nichoke II is an L.F. choke, the core of which consists of a nickel-iron alloy. It is rated to carry 50 mA. of D.C. and has a nominal inductance of between 14 and 20 henrys, according to the amount of D.C. passing through the winding.

Inductance measurements were made at 50 cycles with various amounts of D.C. flowing, the A.C. being maintained at 1 mA. throughout the test. The values found are given below :—

| D.C. in mA.s. | Inductance in henrys. | D.C. in mA.s. | Inductance in henrys. |
|---|---|---|---|
| 0 | 15.3 | 30 | 14.5 |
| 5 | 15.3 | 35 | 14.3 |
| 10 | 15.2 | 40 | 14.0 |
| 15 | 15.1 | 45 | 13.5 |
| 20 | 15.0 | 50 | 13.0 |
| 25 | 14.8 | — | — |

It can be seen from the above figures that the inductance is not greatly influenced by the D.C. polarising current; indeed, the choke possesses the qualities of the constant inductance type. Its D.C. resistance is 450 ohms. The price is 10s. 6d., and the makers are Varley (Oliver Pell Control, Ltd.), 103, Kingsway, London, W.C.2.

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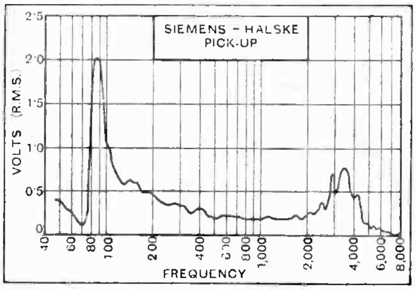
### SIEMENS-HALSKE PICK-UP.

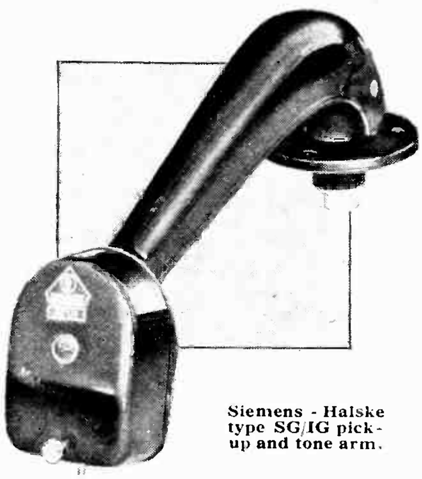
The movement is of the well-known "half-rocker" type, in which the pick-up coil surrounds the armature. The latter is pivoted near the lower pair of pole pieces and is damped at its upper extremity by rubber pads mounted in die-cast blocks attached to the upper magnet poles.




Voltage output characteristic of the Siemens-Halske pick-up with Columbia "Talkie" needle.

The damping is commendably light, and the pick-up follows the standard test records without any difficulty down to 50 cycles.

The voltage output characteristic is of excellent general form, and shows remarkable uniformity in the middle register. In the upper register it is strengthened by a resonance at 3,500 cycles, which is followed by a rapid cut-off to 5,000 cycles, above which the output is negligible. Thus an adequate high-frequency response is obtained without needle scratch.



Siemens - Halske type SG/IG pick-up and tone arm.

In the bass there is a sharp tone-arm resonance at 85 cycles which produces a desirable rising characteristic down to that frequency. From 85 down to 70 cycles there is a rapid cut-off, but there is an appreciable recovery between 70 and 50 cycles.

The tone arm is a light bakelite moulding of pleasing design. It is comparatively short (8 inches), and no special precautions have been taken to obtain the best possible needle track alignment. Nevertheless, the performance will be satisfactory in this respect if care is exercised in deciding on the correct position for the tone arm pivot hole.

The pick-up is made by the well-known firm of Siemens-Halske A.G. of Berlin, and supplies are obtainable in this country from Messrs. W. B. Savage, 292, Bishopsgate, London, E.C.2. The price of the model illustrated is 45s., but the pick-up movement only can be obtained at the price of 38s.

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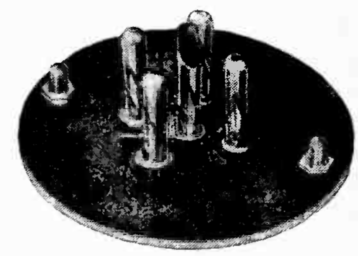
### CLIX PANEL MOUNTING VALVE HOLDER.

This new Clix valve holder is intended for use in chassis-type receivers in which the bulk of the wiring is carried below the panel. The sockets on the valve holder are of the helically slotted type, and, possessing a certain amount of resilience, enable the valve to be inserted with greater ease, and there is less strain



Helically slotted sockets are fitted on this Clix panel mounting valve holder.

on the valve pins than in the case of the solid-type sockets. These are made in four- and five-pin types, the prices being 5d. and 6d. each respectively.

The makers are Lectro-Linx, Ltd., 254, Vauxhall Bridge Road, London, S.W.1.

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## Catalogues Received.

Watmel Wireless Co., Ltd., Imperial Works, High Street, Edgware.—Descriptive folder dealing with a new wire-wound potentiometer and wire-wound power resistances.

Edison Swan Electric Co., Ltd., 123-5, Queen Victoria Street, London, E.C.4.—20-page booklet dealing with the range of Tungar rectifiers and battery charging equipment.

Radio Instruments, Ltd., Purley Way, Croydon.—Booklet describing the new Parafeed L.F. transformer, giving curves showing the amplification over the audible scale with some selected circuit arrangements.

Burne Jones and Co., Ltd., Magnum House, 296, Borough High Street, London, S.E.1.—Illustrated folder describing the Magnum Regional One receiver and the Regional Crystal set.

The British Blue Spot Co., Ltd., 94 and 96, Rosoman Street, Rosebery Avenue, London, E.C.1.—Illustrated leaflets describing the Blue Spot range of loud speakers and gramophone pick-ups.

*Next Week's Set Review.*

***The New Gecophone Compact Three-valve A.C. Set.***

# ... OR A MULTI-VALVE SET?


## A Radio Missionary who Found a Convert.

By J. GODCHAUX ABRAHAMS.

AS he switched off the set I said to him: "What you want is a new receiver." He looked up at me. "Why, what, how much, and when?" was his curt reply.

"All in good time," I answered. "The main reason is that except for initial outlay this two-valve hook-up of yours is probably costing you more per annum than a thoroughly reliable honest-to-goodness five- or six-valve receiver fed from your alternating current electric mains" And this immediately started the argument.

Very rudely, he thought, I informed him that my recollection of the playroom had worn off; it was some time since I had toyed with an instrument such as his. I recalled having discarded a similar receiver some three years previously, in view of cost of upkeep. It had been used as a standby for the local programme only, but even in this casual rôle it had been condemned as a luxury. Although apparently cheap, these small sets simply lapped up battery "juice."

First, the accumulator. Quite a small item. Was it? It cost him sixpence to one shilling to recharge; the variation in price depended on the individual honesty of the local electricians. Roughly, this regular outlay amounted to anything from £1 10s. to £3 for the twelve months. Again, his high-tension batteries—he was using two small sixty-volt type in series—enjoyed a very short life. They cost twelve shillings and sixpence each, ye gods! and lasted about four months. Another £3 15s. to add to the annual bill or a minimum total of £5 5s. Not so much, admittedly, but what did his receiver achieve? He was able to listen to transmissions from the local National and Regional stations; with a fair amount of reaction a more-or-less acceptable programme could be captured from Paris, and with that self-same reaction set to a point when only with bated breath he dared remove his fingers from the condenser dials he could hear—and then not too clearly—a few broadcasts from somewhat more distant and powerful stations.

This was the strong point of my argument in favour of a multi-valve set. Was there any doubt that in the event of his desire to tune in transmissions other than those offered by the home studios, the owner of the two-valver was sadly handicapped? Possibly, when the purchase had been made the vendor had glibly reeled off a log of transmission which in favourable circumstances could be pulled in. "In favourable circumstances" constituted a valuable saving clause behind which the dealer completely shielded himself and found protection against eventual complaints. (Unfortunately for the tyro, exaggerated claims are still of frequent occurrence.)

"But would I enjoy a concert more because it was broadcast 800 miles away than if I received it at relatively close quarters from my local station?" A palpable hit, but I was prepared for it. I countered with another question. "If the home programme for a given evening does not suit you, what is your alternative? A poor outlook. With a more powerful receiver you would extend your range greatly. That distant concert you mentioned, if chosen, would be within your reach, as would many others, thus giving you a liberal choice of entertainments on any day at any time."

### Baby or Rolls-Royce?

"My little two-valve set does all I require of it."

"Within your present horizon; but increase your limits and a larger field is open to you. On the day you find that with the same ease in handling a receiver you can tune in at your own sweet will one or more of a dozen different broadcasts of interest to you and your family, irrespective of distance, the variety in the wireless fare offered to you from so many sources will whet your appetite, perhaps even tickle a jaded palate. Like Oliver Twist, you will ask for more; the multi-valve receiver can gratify these legitimate desires. Your two-valve set cannot. You do not—or should not—expect a 'baby' to do what a Rolls-Royce was specially built to achieve."

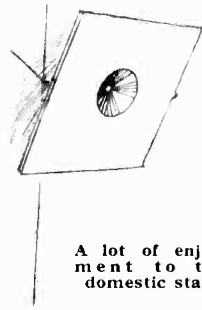
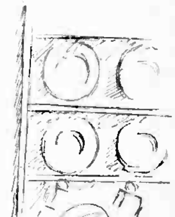
"I don't, but the Rolls-Royce is not required for the short trips—I mean the local transmissions."

**. . . Or A Multi-valve Set.—**

"The comparison does not hold good, for the use of the multi-valve receiver fed from the mains costs no more for the reception of near-by transmissions than it does for distant broadcasts. There is no meter attached to the mileage bridged by the set. The simile is correct, nevertheless, in the sense that the multi-valve offers you the power to roam at your leisure over the Continent of Europe, whereas with your present toy you are tied down to close quarters. It is just that reserve of latent power, not necessarily always used, but there when required, which means all the difference. You do not need it at all times, but if called upon to pick up a broadcast under adverse conditions you are not compelled to throw up your hands helplessly and moan: 'What *do* you expect from *this* set?' With a well-designed multi-valve set your sphere of action is considerably enlarged. You acquire with it that Rolls-Royce feeling in wireless and still have the satisfaction of knowing that although you are getting the best out of radio you are not indulging in an unnecessarily extravagant and unwarranted luxury. Surely, as a listener, if anything should tempt you into buying or constructing a worth-while receiver it is the knowledge that, failing the local programme, you may turn to Rome, Madrid, Berlin or Copenhagen, or visit in turn, just as you please, studios at Paris, Prague, Barcelona, Warsaw, Amsterdam, Brussels, Madrid, Bucharest or Oslo. With such an instrument at hand these trips from possibilities or probabilities become realities; they are accomplished facts at the turn of your wrist.

**An Anæmic Affair.**

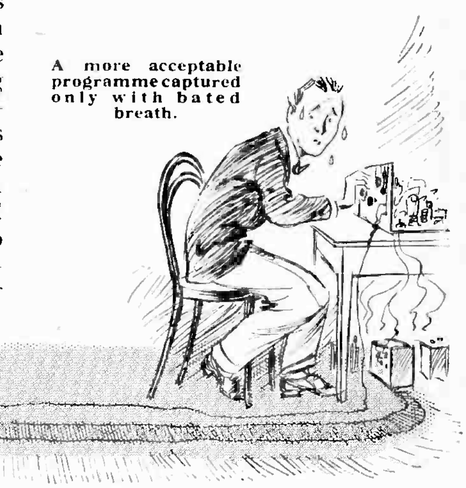
"Further, need I stress the point as to quality of production? With such a receiver, if you listen to a large orchestra broadcasting a symphony concert, or if you tune in to the relay of an operatic performance, you will 'live' the impression that you are actually seated in the hall or theatre; with this plaything of yours you can never aspire to obtain much more than a penny-whistle interpretation. It is an emasculated and anæmic copy of the real thing. Besides, a further advantage. In this room you are using a small loud speaker; it is in keeping with the instrument that feeds it. Listen to a similar broadcast through a receiver such as I have in mind, and a good moving-coil speaker. Is there any comparison to be drawn between the two? May I add a further benefit—an important one, I think—that of being able to hear the transmissions in more than one room at the same time. Couple up another loud speaker to your set and the result will be disastrous, but the addition of another speaker or so to a multi-valve receiver will make no appreciable difference in strength of signal. In my own home I have brought even the kitchen into the wireless net. Musical programmes, and especially the variety hours, provide a lot of enjoyment to the domestic staff. By means of a switch they can tap the programme as and when they desire. It does not affect my reception and it gives pleasure to others."


A lot of enjoyment to the domestic staff.

"And the cost of upkeep? Could I afford it?"

"The cost is ridiculously low in relation to the extra benefits derived. You would not hesitate to use an extra electric bulb in your home; most probably, in the course of an evening you switch on many without giving them a second thought. I find, from experience, that my wireless set is used about three hours daily. If we assume that this period is an average, the cost of feeding most multi-valve sets from the mains should not exceed more than two units of electricity per

A more acceptable programme captured only with bated breath.

**. . . Or A Multi-valve Set.—**

week. If we take the unit at sixpence—a generous estimate—or even if we say that your bill would be increased by £3 10s. or £4 for the whole year, the cost would still be less than what you are to-day paying for the upkeep of your modest two-valve set."

"And then the B.B.C. licence?"

"Not B.B.C. but the P.M.G.'s licence, a mistake made by so many people. You pay ten shillings yearly to the Post Office authorities—not to the B.B.C.—for the privilege of possessing a wireless receiving station. Bear in mind that this permit allows you to listen to any foreign transmissions you may pick up in the ether *in addition to the home broadcasts*. In passing, you might like to know that for the 10s. paid your B.B.C. programmes work out at about three a penny. But that self-same licence entitles you to secure more. With a multi-valve receiver you are enjoying the full benefit of the concession so cheaply granted to you by the Postmaster-General. Do you realise the extra enjoyment you get for your money?"

"Yes, I do see the advantages, but what about cost?"

"A question to be left to your own conscience; it depends on the length and depth of your stocking or on the size of your overdraft at the bank. Get the best you can afford; it pays in the long run and you will not regret it. Build a receiver if you can. There is no moment so supreme as that reached by the home constructor when, having connected the final lead, he pulls out the switch to bring the new instrument into action. That first burst of music brings its own reward. You get that pat-yourself-on-the-back feeling of having accomplished something. The man who walks into some big stores, orders Model No. so-and-so, and pushes a cheque—if they will accept it—or cash across the counter, misses one of the greatest pleasures in radio. Remember that if you have purchased reliable components they will never be wasted, for at any future time if you wish to 'pep up' your receiver, bring it up-to-date, and thus follow the trend of progress, most of the units will find a place in the new circuit. It may mean the addition of some improved gadgets, but the foundation of the structure holds good."

**What Radio has to Offer.**

"And when?"

"Soon as possible; you are missing much in the meantime. You put me in mind of a man who potters wearily about a miniature flower-bed when he could roam at random and with full freedom through Kew Gardens. Stop playing with that toy and buy or build yourself something worth while which can amply demonstrate what radio has to offer."

"Lead me to it."

# *Letters to the Editor.*

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.**

### *TECHNICAL SALESMEN.*

Sir,—For several years past your paper has contained correspondence *after* the Annual Radio Show, complaining of the general absence from most stands of both the necessary technical salesmen and the equally necessary technical data such as performance curves, etc., etc.

May I, therefore, get my plea in *before* it is too late that exhibitors should realise that the show is held *not* for the public to be able to admire bevies of beautiful maidens with exposed silk-clad knees, dressed in natty uniforms, and made up like chorus girls, *but* to enable the radio-minded public to find out things of a technical nature generally that will help them to a choice of sets, components, etc., in the coming winter.

*Every* stand should have two or three of the firm's best experts, plus a reinforcement of their best salesmen to finish the work the experts have begun, and every set exhibited should have an overall performance curve with a stated loud speaker, and every speaker and component should have such curves and technical details available for inspection and discussion with the experts, as are necessary to enable a proper judgment to be made by the public.

Even now, there is far too much buying of radio instruments on pretty looks (like furniture) instead of on performance, the only thing that matters. SUPER SIX.

Edgware, Middlesex.

### *GOOD REPRODUCTION.*

Sir,—Now that Mr. Hartley has let us know that he is getting "reproduction," even the "good" being redundant (he makes no reference to my suggestion that "reproduction" cannot be obtained when the source of sound output is a small aperture), I am afraid that I am not qualified to accept his invitation to hear his set. I suggest that Sir Henry Wood or Dr. Adrian Boult would be more qualified than I.

I have never claimed such results myself; indeed, my own speaker certainly does not give "reproduction." As Mr. Hartley is so definite concerning his own results, I feel sure that had I, on hearing his set, any comments to make (which Heaven forbid), they would receive no consideration whatever.

May I call to mind that my first effusion was prompted by a desire for fair play for such articles as "Inexpensive Quality," which are very useful to people like myself, who cannot afford the luxuries of Mr. Hartley, but who still desire to obtain the best results in their power. I trust Mr. Hartley will not deny us this privilege.

I am sure that this discussion can have no more interest for your readers as far as my part is concerned. If Mr. Hartley can give us any details on how to improve our own reception I think it would be of more interest than splitting hairs *re* "quality" and "reproduction."

Before closing, may I thank Mr. S. C. Kirk for his correction? Stereoscopic obviously does relate to vision, and I shall in future use stereophonic, although I expect someone will come forward with an objection to that. It is surprising how careful one has to be. C. L. YELLAND.

London, S.E.15.

Sir,—I have read with great interest the lengthy correspondence in your journal on the subject of "Inexpensive Quality," and the opinions on reproduction.

Reading Mr. Hartley's letter in your issue of August 12th, I notice that Mr. Yelland is accused of having a receiver giving "reproduction." How awful!

May I point out to our expert Mr. Hartley that his receiver *must* be coloured or doped to his personal taste, and, inasmuch as a 100 per cent. perfect duplication of any performance is most impossible—especially so with a modest 5 watts—I would strongly advise him to gather together all his present apparatus, speaker included, and consign same to the dustbin, and then come to hear my outfit. I have the finest receiver created—every radio fan has, too.

Start again, Mr. Hartley, with the knowledge that you will lose quite a lot and also incidentally *gain* a trifle.

Mr. Hartley remarks in your issue of May 6th that he listened to the broadcast of the "Ninth" at the Queen's Hall, and also listened to the same work on the spot. He is convinced he lost nothing. Oh!

Now, Mr. Hartley, where did you sit at the Queen's Hall? With the orchestra, or riding astride one of the microphones? Surely you are sufficiently expert to know that, wherever you were, the sound that reached your ears was of a totally different colour from that impressed upon the microphones? It is quite definite that the microphones heard quite a lot more than you did. Further, was the volume of sound where you were sitting equal *precisely* to the mere 5 watts you have at home? Also, has your wee room the same acoustic properties of the Queen's Hall? Mr. Hartley, you lost a *shocking* lot. Your hyper-critical musical ears are just like mine and all others—they forget.

I heartily agree with Mr. Cosky, and would further refer to his analogy of the raw and retouched photographs. Both of these can be enlarged, and, after such process, still convey to the human eye a very good idea of the subject taken by the camera. Both kinds are "just like the real thing," but neither can compare with the perspective of the human eye. The same applies to radio reception. "Just like the real thing" music can be obtained with a mere 1 watt, and also with a bank of valves with cherry-red anodes giving perhaps 100 watts, but comparing either with the original is sheer nonsense.

Mr. Hartley appears to be the usual radio enthusiast—perhaps a little more wealthy than the average. They all, like myself, have the "one and only." The reason is obvious—personal taste. Such a state of affairs will continue as long as the good old *Wireless World* is about, reporting on new valves with sky-high mutual conductances, ourselves alike to be tempted, and Mr. Cosky's shop open to sell them!

But perhaps Mr. Hartley is not interested in any further improvements in valves, etc., for the betterment of reception. Quite possibly he may have a receiver and speaker of his manufacture (valves, too), and contemplates presenting such to the Science Museum. Who knows?

He has already let out a great secret, i.e., that the output valve must be correctly matched to the loud speaker impedance by a suitable output *transformer*. Most clever and ingenious! If Mr. Hartley uses this method, *my* opinion of his reproduction is very definite. H. J. CLARKE.

London, E.11.

[Further correspondence on this subject is not invited.—Ed.]

*VACUUM V. RADIO.*

Sir,—In the words of "Pro Bono Publico" and "Indignant Ratepayer," I crave the indulgence of your columns in order to protest against the base and baseless insinuations of uncleanliness on the part of Mrs. Free Grid and myself, for Mr. E. F. Walton's statement that he would prefer "a clean home rather than a wireless set" can mean nothing else. It is scarcely likely that your correspondent's grandmother possessed one of these devices, and yet if Mr. Walton's argument is pursued to its logical conclusion she and all her generation stand guilty of uncleanliness.

Apart from this, however, why should we put up with the disturbing noises of vacuum cleaners, for to argue that these machines are only used for a short period in the morning when the number of the B.B.C.'s listeners is comparatively small, is simply to ignore the rights of minorities, and to reveal an utterly selfish attitude of mind which is all too prevalent nowadays. If all owners of vacuum cleaners agreed to use their apparatus during the same period each day there would be less cause for complaint, but as it is, each day since I drew attention to this nuisance, my post-bag has been literally bursting with letters from readers whose enjoyment of the service broadcast each morning at 10.15 a.m. is hopelessly spoilt.

According to these letters—most of which come from suburban areas of large towns—the interference due to these devil-machines is almost continuous throughout the morning and early afternoon.

It is not as though there did not exist a remedy which the makers of vacuum cleaners could apply to their wares. In my opinion, the creation of noises in the ether by a defective vacuum cleaner should be made as much a legal offence as is the creation of noises in the air by a motor vehicle fitted with a defective silencer, and the owners and manufacturers of both these disturbers of the peace should be prosecuted with the utmost rigour of the law. FREE GRID.

London.

*A.C. V. D.C.*

Sir,—In your issue of August 12th "Free Grid," in a paragraph headed "A.C. versus D.C.," states that rotary converters to enable A.C. receivers to be used on D.C. mains have quite recently made their appearance upon the market.

As pioneers in the development of small machines for radio purposes, we would like to point out that the M-L D.C. to A.C. rotary transformer was on the market as far back as the beginning of 1929, at the time when the A.C. all-mains receiver was first produced in this country.

This was the first converter made which was suitable for operating these receivers from D.C. supplies, and was exhibited at Olympia and Manchester in that year.

R. H. WOODALL, A.M.I.E.E.,
Rotax, Ltd.

*THE AMATEUR.*

Sir,—On my return from abroad I have, naturally, in order to pick up the lost threads, taken up the recent issues of *The Wireless World.*

I was interested in particular with that of July 1st. I refer to your Leader, and Captain Eckersley's "slating" of the radio amateur. If it is not too late to resuscitate this matter I would crave some of your valuable space on behalf of the radio experimenter.

As one that has been associated with radio long before the inception of the modern application of this science—broadcasting—I think that I may be entitled to say a few words about this subject.

There is one very definite statement about the past value of the radio amateur which is indisputable. I refer to his use in the Great War. As one of the original officers of the wireless service of the British Expeditionary Force, I can vouch for the fact that it was recognised that a very large percentage of the wireless operators of the rank and file were drawn from the radio amateurs.

At a later date, as the War progressed, this nucleus of radio amateurs formed the officers as the wireless services increased in strength. Their services thereby were indisputably of great value.

Quite apart from this there is not the slightest doubt that the amateurs have been of considerable value to the art.

In conclusion, may I be allowed to correct Captain Eckersley's remarks as to the initiation of the first broadcasting.

I claim the responsibility for the first broadcasting which was not as a mere stunt, but as a regular service. I inaugurated this during the War, in 1917, at the Wireless Training Centre, Worcester, when I broadcast a regular radio gramophone recital to the outlying radio units of the Royal Engineers that were undergoing training at that centre. This can, no doubt, be verified, and reference has already been made in the past to this in the National Press. H. de A. DONISTHORPE.

London, S.W.5.

## BOOKS RECEIVED.

*Air Law Review.* Vol. II, No. 2. April, 1931. The official journal of the American Academy of Air Law and the American Section of the International Committee on Wireless Telegraphy. This number contains articles on the Origin and Development of Radio Law by W. J. Donovan, and on the Regulation of Amateur Radio Communications by P. M. Segal. Published in Vermont, U.S.A.

*Kennrufe der Rundfunksender.* A list of 183 European broadcasting stations, arranged in alphabetical order and giving the geographical position, wavelength, opening, interval and closing signals of each. Pp. 192. Published by Rothgiesser and Diesing A.G., Berlin, price R.M.2.

# BROADCAST BREVITIES

*By Our Special Correspondent.*

### Economy.

The first stupefaction produced at Savoy Hill by the recommendations of Sir George May's Economy Committee is now wearing off, and the Corporation are taking stock of the enormous cuts which would be necessary in all directions if nearly half a million pounds were sacrificed during the coming year.

oooo

### Empire Broadcasting to Cease?

Empire broadcasting experiments, it is to be feared, would be abandoned at once if the Committee's recommendations took effect. Programmes would undoubtedly suffer in quantity and variety, if not in quality. And already there are vague fears among the staff of all-round salary cuts.

oooo

### Rolling in Wealth.

Whether the Economy Committee's suggestions are adopted or not, they have served to reveal that the Corporation has been enjoying a period of monetary prosperity in striking contrast to the general state of the national finances. That the figures are fairly given no one can doubt, for is not one of the Committee a member of the firm of auditors who keep a watchful eye on the Corporation's accounts?

oooo

### Triumph for Talks Department.

For better or for worse, the educationists and talks enthusiasts have seized the National transmitters. The immediate results will be felt on and after August 31st, when the National programme each evening will consist of solid talk from 6 to 8 p.m., with the saving exception of twenty minutes of the "Foundations of Music."

oooo

### Two Hours of Talk.

This lively period will be mapped out as follows:—

The first news will be broadcast at 6 p.m.; the "Foundations of Music" will follow at 6.30; the usual reviews of books, plays, music, and the cinemas will be given at 6.50 and will continue until 7.30, when "a more serious talk"—to quote the B.B.C.—will be given until 8 o'clock.

oooo

### Why the National?

It is not that the talks are likely to be dull or uninstructive, but criticism is bound to centre on this short-sighted policy of subjugating the National wavelengths to the aims of an extremist group.

"National" is the correct term for those transmissions, including that of 5XX, which alone are heard in practically every part of the country; such transmissions should be varied and representative of all that is going on in the British ether.

oooo

### Unpleasant Surprise for Newcastle.

Vast numbers of licence-holders rely solely on 5XX for their instruction and entertainment. Many Newcastle listeners, owing to the failure of the recent synchronisation test, are among this number, and I fancy that they will soon regret clamouring for the National programme at a time when the engineers were trying hard to provide them with the brighter transmissions of Northern Regional.

oooo

### University of the Ether.

With the Talks Programme itself few will quarrel. The tendency to specialise is becoming more marked. Six main subjects have been chosen, and each will be treated in sequence on a given night of the week from September to March.

#### FUTURE FEATURES.

**National (261 and 1,554 metres).**

AUGUST 30TH.—Concert from the Casino de Knocke.

AUGUST 31ST.—Promenade Concert.

SEPTEMBER 1ST.—Song recital by Paul Robeson.

SEPTEMBER 4TH.—Promenade Concert.

**London Regional.**

AUGUST 30TH.—Orchestral concert from Grand Hotel, Eastbourne.

AUGUST 31ST.—"The Romantic Young Lady," a play.

SEPTEMBER 3RD.—Promenade Concert.

**Midland Regional.**

SEPTEMBER 1ST.—"The Philosopher in the Apple Orchard," adapted from Anthony Hope's story by Harcourt Williams.

**North Regional.**

SEPTEMBER 2ND.—A Blackpool Night's Entertainment.

**West Regional (Cardiff).**

SEPTEMBER 5TH.—Concert by Victors at the Royal National Eisteddfod of Wales, Bangor, 1931.

**Glasgow.**

SEPTEMBER 1ST.—Harry Gordon (the Man frae Inversnecky) and his Company.

**Belfast.**

SEPTEMBER 5TH.—Running commentary on the International Ulster Grand Prix Motor Cycle Race.

Their scope is indicated by their titles: Industry and Trade, Literature and Art, Science, The Modern State, Education and Leisure and Languages.

Here we have a University of the Ether, and if the "5XX-ite"—whether he be in the Highlands of Scotland or the wilds of Cornwall—is happy about it, why should a grumble escape us, who can still tune over to the Regional?

oooo

### Television from a B.B.C. Studio.

I dropped into the "warehouse" last Wednesday morning to see the Baird people giving their first transmission from a B.B.C. studio. A portable television transmitter was in use, employing, instead of the revolving disc, a large-diameter drum carrying on its periphery thirty little mirrors each set at a slightly different angle. The scene was thus scanned by a reflected beam of light.

oooo

### Face Powder.

The effect was dazzling in the literal sense of the term. Being at the transmission end of the experiment, one could only conjecture how the scenes were coming through on the televisors.

It was amusing to watch an actress powder her nose before approaching the microphone.

oooo

### Tram-made Static.

The tramway interests are becoming alarmed at the "goodwill" they are losing as a result of electrical interference with broadcast reception. As a shrewd Scottish observer has pointed out, the trams are out to serve the public, and the same public needs consideration when listening at home to the broadcast programmes.

oooo

### £5 per Tram.

I hear that a campaign on a large scale is being started by South London tramway concerns to stifle interference at its source. Tests are being conducted with air core chokes of varying sizes, and it is believed that a suitable type has now been evolved. It takes the form of a helix some 11in. in diameter with asbestos spacing between the turns. These "suppressors" could be supplied wholesale at about £5 each—not a very large price to pay for the goodwill of the travelling public.

oooo

### Microphones at the Queen's Hall.

"Why five microphones?" asked a curious promenader at the Queen's Hall last week.

Five microphones are used in the interests of correct balance, but only three are in use at any given moment. These are placed in line immediately behind and at varying distances from the conductor. Only one is in circuit at a time, the choice depending upon the volume of sound.

Two microphones can also be seen, one on each side of the orchestra. Their function is to pick up the delicate string tones which often escape the microphone in front.

oooo

### A Model Comedy.

Budding playwrights whose ambitions may, it is hoped, turn towards the invention of radio comedies should listen to "The Romantic Young Lady," by the Spanish writer, Sierra, which will be produced in the studio on August 31st and September 1st. This is the type of romantic comedy of which the B.B.C. would gladly see more from British authors, as there is a definite demand for the lighter kind of radio drama.

oooo

### A Tragedy?

From the Savoy Hill Postbag:—

"I ave a lisense since four years and ave not heard nothing."

# READERS' PROBLEMS

Replies to Readers' Questions of General Interest.

*Technical enquiries addressed to our Information Department are used as the basis of the replies which we publish in these pages, a selection being made from amongst those questions which are of general interest.*

### Checking Push-pull Valves.

*After reading your recent article on the subject of push-pull amplification, I have been endeavouring to check the output valves of my own receiver, which embodies this system. It is found that the valves, when tested separately, consume respectively 20 and 21 milliamperes, but together they take only 30 milliamperes.*

*Can you explain this apparent discrepancy, and say whether it is likely that the valves are sufficiently well matched for good results?*

It seems certain that you have made your test in an incorrect manner—probably by removing one valve while measuring the anode current of the other. We would stress the necessity for checking anode current exactly in the manner described in the article to which you refer. By adopting your own method, misleading results are obtained, as, when the load of one valve is removed, there will, naturally, be a rise in eliminator voltage.

o o o o

### Insensitive Pick-up?

*So far as radio reception is concerned, my 2-v-1 receiver is highly satisfactory, but when a gramophone pick-up is inserted in the detector grid circuit volume of reproduction is definitely inadequate. Can you suggest where I should look for the trouble?*

If the detector-grid circuit is properly modified for gramophone reproduction with the correct value of negative bias, it may be concluded that the pick-up itself is at fault.

It should be realised that some pick-ups are less sensitive than others, and it is quite usual to find that, when followed by two amplifying stages of comparatively low gain, volume is inadequate.

You might step-up the pick-up voltage output by using a transformer between this component and the grid of the valve. Other expedients that suggest themselves are the use of a pentode output valve, an intervalve coupling giving more magnification, or, of course, a more sensitive pick-up.

### Artificial Loading.

*My three-valve set, of which the input filter circuit is shown on the attached diagram, works entirely satisfactorily with my own aerial-earth system, but on attempting to operate it with a short aerial—all that is available at my present temporary abode—I find that the filter peaks are unequal.*

*From information already published, I gather that the trouble is due to insufficient aerial loading. I have a 25,000-ohm rheostat; would it be possible to connect this in such a way that an artificial aerial load could temporarily be introduced?*

Yes; if you connect the variable resistance in the manner shown in Fig. 1, it should be possible to adjust aerial loading so that a symmetrical tuning curve may be obtained.

We take it that you have assured yourself that the "ganging" of the filter circuit tuning is correct and that mistuning is not responsible for the effect you have noticed. It will hardly be necessary to point out that this operation should be carefully done before attempting to put the artificial loading resistance into use.

### Battery and Eliminator Combined.

*When using an accumulator H.T. battery in series with an eliminator to increase the output of the latter, at which end of the circuit should the battery be connected?*

Generally speaking, the negative terminal of the battery should be joined direct to the receiver, as otherwise all the cells will be at high potential with respect to earth.

o o o o

### Fully Loaded.

*For local station reception I use a det-L.F. set with a transformer coupled triode output valve, which seems normally to be just fully loaded. At any rate, overloading does not take place except on deeply modulated passages or when reaction is applied to excess.*

*In these circumstances, do you think any advantage would be gained by fitting push-pull output valves?*

So far as volume is concerned, no gain is to be anticipated. The main advantages likely to accrue are greater freedom from hum and a reduced tendency towards L.F. reaction.

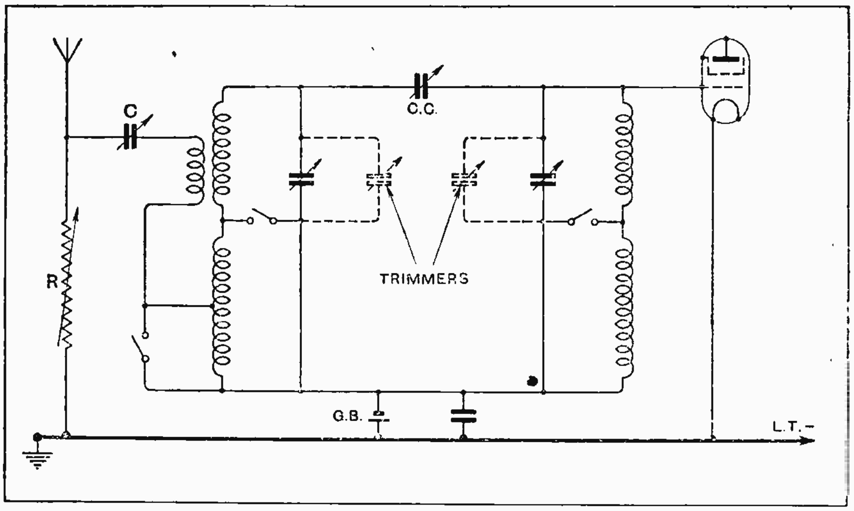



Fig. 1.—Connections of a variable resistance (R), by means of which artificial loading may be applied to a filter circuit.

### Mains Periodicity and Hum.

*I propose to alter my three-valve set for mains operation. Is it likely that the local 100-cycle A.C. supply will introduce more hum than a conventional 50-cycle system?*

No. On the contrary, the output of a rectifier working on a 100-cycle supply should be rather easier to smooth.

oooo

### Three Wave Ranges.

*I wish to build an H.F.-det-L.F. receiver to cover a continuous tuning range of from 200 to 2,000 metres. From experience with a number of sets having separately tuned circuits, I know that by taking care it is just possible to do this in the usual two steps, but when ganged tuning (which is to be included in my new set) is employed it seems necessary to have such high minimum capacities across the circuits that this becomes quite impossible with normal tuning condensers.*

*Can you show me a method of connecting the wave-range switches that will not require the use of any special components? It is intended to use an input filter and a parallel-fed H.F. coupling.*

For switching a three-range tuning system we doubt if you could better the scheme shown in Fig. 2; ordinary switches of the change-over type may be used, but, of course, they must have a central "off" position.

With regard to our circuit diagram, we have not indicated any method of coupling the filter circuits, as this does not of necessity affect the question to any great extent.

oooo

### Insufficient Feed Capacity.

*My "Lightweight Portable" receiver, which has been built in accordance with the description published in your issue of July 8th, works satisfactorily at the bottom of the tuning scale, but the reaction control becomes ineffective on wavelengths greater than about 300 metres. What is likely to be the cause of this?*

Failure to obtain proper reaction control is most probably due to the use of an unsuitable or defective detector valve; to excessive losses in the tuned circuit; or, most likely of all, to the fact that the reaction feed condenser $C_1$ has too small a capacity. We recommend you to make sure that this semi-variable condenser is of the maximum capacity specified: if there is any doubt, you should try the effect of connecting a small extra capacity in parallel with it.

oooo

### Choke and Loud Speaker.

*Will you please give me a hint on choosing a suitable choke for use with a given type of loud speaker in a filter output circuit.*

Briefly, it is desirable that an output choke should have an inductance under working conditions at least five times greater than that of the loud speaker with which it is to be operated. This inductance ratio is not very critical.

Even when no D.C. is passing through the windings, very few loud speakers have a greater inductance than 3 henrys.

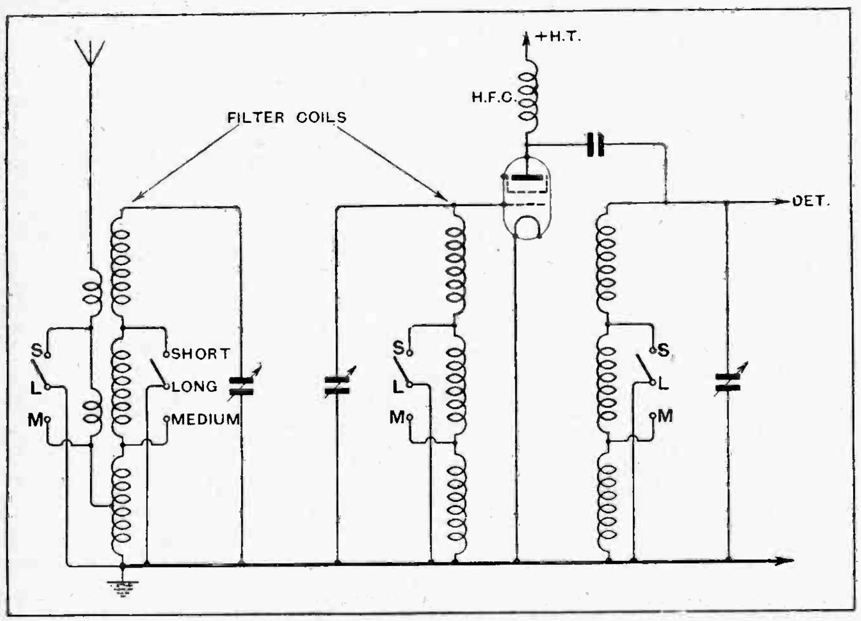



**Fig. 2.—The simplest method of wave-band switching when three separate wave ranges are included in a receiver.**

Perhaps we should warn you that some difficulty is likely to be experienced in obtaining satisfactory "single-knob" tuning over all three ranges, but this difficulty should not be insuperable if great care is taken in the construction of the coils and if the best available tuning condensers are used.

## FOREIGN BROADCAST GUIDE.

# LILLE (PTT)

**(France).**

Geographical position: 50° 39′ N., 3° 0′ E.

Approximate air line from London: 150 miles.

**Wavelength: 265.2 m. Frequency: 1,130kc.**
**Power: 1 kW. (temporarily).**

Standard Time: Greenwich Mean Time.
*(France adopts B.S.T.)*

**Standard Daily Transmissions.**

09.00 B.S.T. gramophone records (Sun.); 12.30, concert; 13.30, news; 17.15, relay of PTT Paris; 20.00, main evening programme; 22.00 dance music (Sat.).

Opening and closing signal melody: *Le P'tit Quinquin* (played on a musical box).

Call: *Allo! Allo! Ici Radio PTT* (phon: *Pay-Tay-Tay) du Nord à Lille;* between items: *Ici PTT Lille.*

Male and female announcers.

Closes down with usual French formula followed by *La Marseillaise.*

### Superheterodyne Operating Conditions.

*It is generally agreed that the type of first detector used in the latest superheterodynes described in* The Wireless World *needs a fairly large input for reasonably distortionless detection.*

*Clearly, as there is no preceding H.F. amplifier, this condition cannot exist so far as long-distance reception is concerned, but, nevertheless, it is urged that a modern superheterodyne gives reproduction of at least as good quality as any other comparable set.*

*Can these apparently conflicting opinions be reconciled?*

It is a mistake to imagine that the first detector of a superheterodyne is normally dealing with a very small H.F. grid voltage. As the oscillator valve output is fed into this circuit, the average working voltage is actually quite considerable, although, as you say, the signal voltage may be extremely small.

oooo

### Broadcasting Wave Ranges.

*Will you please give me a word of advice as to the most suitable wave range for a broadcast receiver which is to be taken abroad? Is it essential that the long-wave band should be covered?*

With hardly an exception, long-wave broadcasting is confined to Europe, and, generally speaking, the ability to receive wavelengths above 600 metres is seldom of advantage in any other continent.

In cases like this, we generally advise a set capable of receiving the normal broadcast band and also short wavelengths from 15 or 16 metres upwards.