The Wireless World AND RADIO REVIEW

VOLUME XXIX

JULY 1st—DECEMBER 30th, 1931

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The Amateur and the Professional.

THE correspondence recently published in *The Wireless World* on the subject of the value of the amateur has aroused even more general interest than we anticipated. In this issue we publish a letter from Capt. P. P. Eckersley, the former chief engineer of the B.B.C., on the subject, and, since one or two comments made by him appear to challenge statements which have appeared in this journal, we feel that it is incumbent upon us to reply.

Capt. Eckersley rightly points out that the Marconi Company conducted telephony transmissions from Chelmsford in 1919, but he would not, we think, deny that it was the amateurs who first approached the Postmaster-General for permission for some station to conduct *regular* telephony transmissions, and that the Marconi Company obligingly undertook the task on behalf of *the amateur radio societies* after the permission had been granted to *them*, so that there appears to us to be no inaccuracy in a statement that the amateur in this country initiated regular broadcasting.

Capt. Eckersley gives the names of a number of pioneers whose achievements are now historical, and he decries the suggestion that any of these should be described as amateurs. Sir Oliver Lodge, who in 1894 put together what was probably the first complete wireless receiver, would, we believe, be the first to admit that these early experiments were a recreation and a hobby in no way connected with the more serious investigations which he was carrying out at that time. Hughes, to whom our science owes so much, was a professor, not of electrical engineering, but of music. Graham Bell can best be described in his own words which occur in a published paper, "I was only an amateur at electricity, but I was very much struck with the idea . . ."

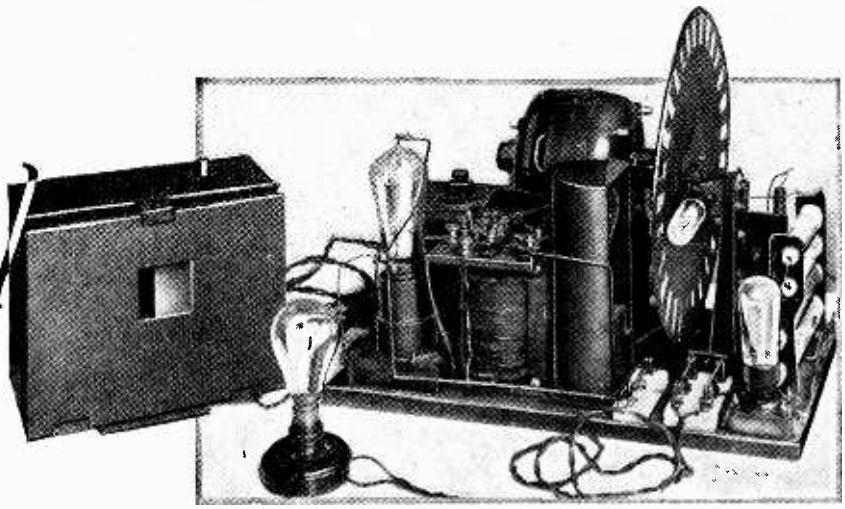
Reverting to more recent times, we have the example of E. H. Armstrong, of super-heterodyne receiver fame, whose most famous contributions to wireless were made before he even contemplated joining the ranks of the professional.

Can any evidence be produced to challenge the amateur's claim to have effected the first transatlantic communication on waves of the order of 180-200 metres and again on much shorter waves at a time when these waves were regarded as uncommercial?

It seems unnecessary to cite a long list of those who, starting as amateurs, have been absorbed into commercial radio, but a final comment on Capt. Eckersley's letter seems desirable to draw his attention to the implication which his letter contains that when he, as chief engineer of the B.B.C., so freely recruited technical assistants from the ranks of the transmitting amateurs, he made an error of judgment. Alternatively, if those who joined him have done useful work it seems ungracious and most unlike "P. P. E." not to acknowledge a debt, however small it may be, to the transmitting amateurs who supported him in his pioneering days at the B.B.C.

In This Issue

The Photo Cell



The Principles and Properties Explained.

By H. R. RUFF, B.Sc.
(Engineering Laboratory, The British Thomson-Houston Co., Ltd.)

THE photo-electric effect was discovered by Hertz in 1887, and was studied by Hallwachs and Elster and Geitel, who carried out considerable work in the manufacture of cells, using the alkali metals which give photo-electric response to visible light. In 1912 they began to sensitise their cells by passing a glow discharge in hydrogen, and, in fact, many cells on the market at the present day differ very little from these early cells. Just recently, however, considerable advances in photo-electric cell theory and design have been made.

Any atom of matter is regarded as consisting of a nucleus surrounded by a number of electrons, the number of the electrons and the orbits in which they travel varying according to the substance. The theory is that in electrical insulators each electron is bound to a certain atom, or group of atoms, while with electrical conductors certain electrons are free to move within the bounds of the conductor. The action of these electrons can be compared with that of gas molecules, moving in a hollow cylinder and bumping against the edges. These electrons are not all moving with the same velocity. A few will be moving very quickly and a few slowly, the remainder approaching the mean velocity. For electrons to escape from the metal they must possess sufficient energy to break through its boundary. The energy which an electron must possess to pass through the boundary is different for each metal, but is constant for pure specimens of each metal. There are two ways by which electrons in a metal can acquire this energy:—

(a) By the heat energy of the atom itself, this forming the basis of the thermionic valve.

(b) By the impact of external electromagnetic radiation, giving the photo-electric effect.

MANY new industries owe their existence to the recent developments in the performance of the photo cell. Among other things the success of talking films may be directly attributed to the production of sensitive photo cells giving stable working. There are innumerable industrial applications. As a preliminary to considering the many ways in which the photo cell may be used this article describes its properties and construction.

There is a very puzzling difference between the thermionic and the photo-electric emission of a metal. It might at first be expected that since raising the temperature increases the energy of electrons, these electrons would be ejected by less potent electromagnetic radiation when the body is hot than when it is cold.

Actually, both the number of electrons emitted, and their velocity when emitted, due to incident electromagnetic radiation, are practically constant over a wide range of temperature, and from this fact follows the first law of photo-electric emission. This is that the quantum of electromagnetic radiation striking a metal must possess sufficient energy to raise the energy of the photo electron to a higher value than the work function of the metal before any photo-electric emission will take place. If the energy of the quantum of energy is less than this value, thousands of such quanta can bombard the metal for centuries without ejecting photo electrons. For example, a quantum of blue light possesses greater energy than a quantum of red light, and for some metals the quantum of blue light will be able to cause photo emission, while that of red light will not, even although the blue light might be very weak and the red light very intense.

The longest wavelength that light can possess and still cause photo emission from a metal is known as the photo-electric threshold of that metal. The second important law of photo-electric emission is that, if a beam of monochromatic light is thrown on to a metal, the number of electrons emitted is directly proportional to the intensity of that beam. If two such beams fall on the metal, then the resultant photo emission is the sum of emission resulting from each beam acting alone, and thus if a metal is under the influence of light from a given source, and the light from that source is doubled

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in quantity but unchanged in quality, the resulting photo emission of the metal will be represented by an amount double the original.

All substances have a photo-electric threshold beyond which electromagnetic radiation can cause the ejection of electrons. With metals this causes a photo-electric current to flow, but with insulators the result is usually improved conductivity. This is the basis of the photo conductive devices such as the selenium cell, which is so often confused with the photo-electric cells. Selenium is an element lying at the border between conductors and insulators, and has the useful property that its resistance changes considerably when light is thrown on to it.

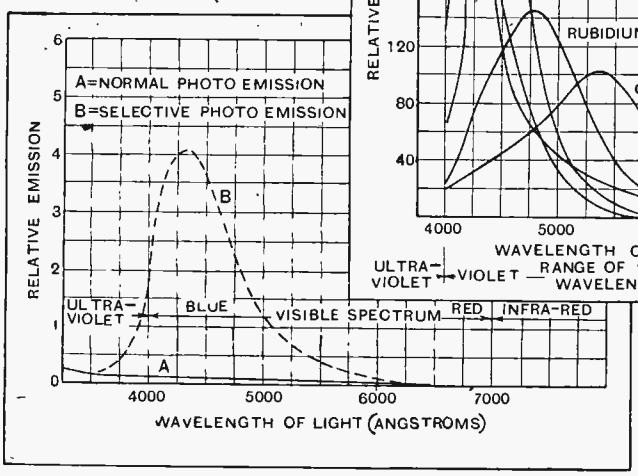


Fig. 1.—Curve showing the response of a potassium cell over the wavelengths of light through the visible spectrum.

The metals which give a photo emission under the influence of visible light are few in number. For the construction of photo-electric cells sensitive to visible light with cathodes of a pure metal, the choice is limited to the alkali metals, lithium, sodium, potassium, rubidium, and caesium, together with the alkaline earth metals barium and strontium.

In describing the characteristics of the photo emission of photo-electric cell cathodes, a number of curves will be given showing the relative emission from the cathodes for equal energy of light of different wavelengths. The wavelength of the light will be given in Angstrom units along the horizontal axis, an Angstrom unit being one hundred millionth part of a centimetre, and the relative height of the curve for different wavelengths of light gives the relative response of the cell to light of those particular colours. The visible spectrum extends from 4,000 Å. to 7,000 Å. from blue to red, as shown in Fig. 1.

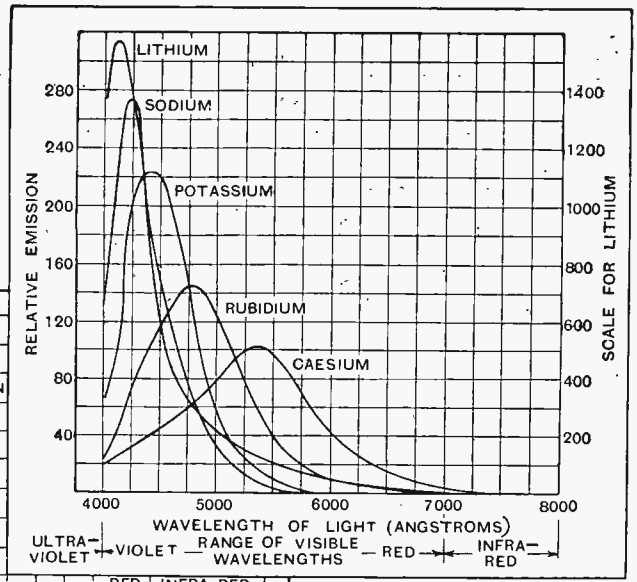


Fig. 2.—Wavelength-sensitivity curves for the alkali metals. (*Miss Seiler, 1920*)

Fig. 1 shows the shape of the wavelength-sensitivity curve characteristic of the alkali metals. The curve shown is characteristic of a potassium cell. Curve "A" is known as the "normal" emission of the cathode, and the relatively enormous peak of curve "B" is known as its "selective" emission. The presence and magnitude of this peak, which resembles very closely a resonance curve of an electrical circuit, are dependent upon the mode of incidence of the light. It is completely absent if the cathode is plane, and the light is incident normally upon it. The cathode surface of the modern photo-electric cell is, however, matt, and this peak always appears, and the photo-electric emission of the alkali metal to visible light is largely due to this peak of "selective" emission.

Fig. 2 gives the relative wavelength-sensitivity curves

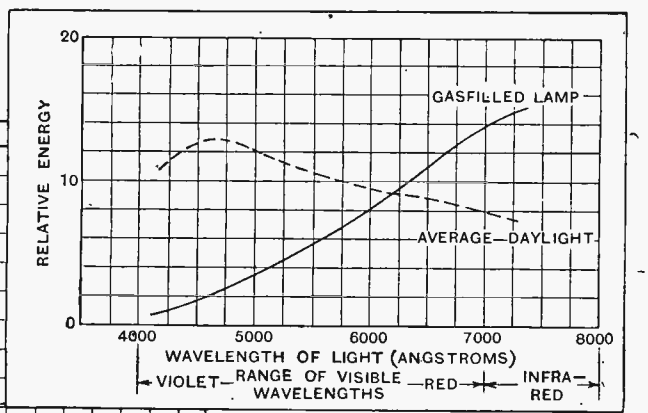


Fig. 3.—Curve showing the approximate relative energy of light of different wavelengths as emitted from a gasfilled lamp and as present in daylight.

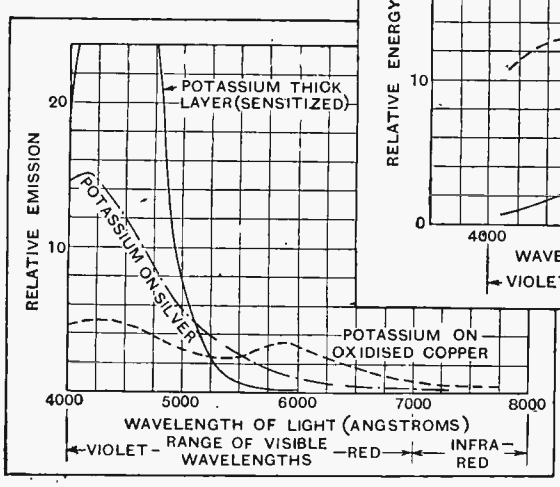


Fig. 4.—The emission curves of photo-electric cells in which the cathode consists of a thin potassium film on silver and copper. (*N. R. Campbell*)

of the alkaline earth metals. In Fig. 3 are given curves showing the relative energy of light of different wavelengths present in light from a gasfilled lamp and from

The Photo Cell.—

daylight respectively. It will be seen that with all the alkali metals much of the radiation, particularly in the case of the gasfilled lamp, will be ineffective in causing photo emission.

As will be seen from Fig. 2, caesium possesses sensitivity farther into the red end of the spectrum than any other metal, but caesium in bulk is a very difficult substance to use as a photo-electric cell cathode, since it possesses a high vapour pressure at normal temperatures and it is almost impossible to prevent the ultimate distillation of a conducting layer on to the stem or other insulator separating the cell electrodes. Also, its total photo-electric emission is lower than that of the other alkali metals, and thus for some time the most popular photo-electric cell for sound reproduction and general work usually had a potassium cathode. This cathode was sometimes sensitised by passing an electric discharge in hydrogen, and the cell output was increased by filling the cell with an inert gas and increasing its emission by the ionisation of this gas. The output obtained from these cells in a sound reproducer was, however, small, and many attempts were made to increase it.

The "sensitising" of the potassium cathode by passing an electrical discharge in hydrogen, improved the emission of the cathode surface, and rather tended to move the photo-electric threshold of the metal farther towards the red end of the spectrum, but the great improvement in the photo-electric emission came with the striking discovery of the photo-electric emission of thin films of the alkali metals. The thin film photo-electric cell forms a member of the group of engineering articles depending for their action on the effects of extremely thin films of substances. When a covering film of alkali metal was made extremely thin, so thin as to be invisible, it was found that the response of the cell to an electric lamp had increased considerably, and that the photo-electric threshold had moved distinctly towards the red end of the spectrum.

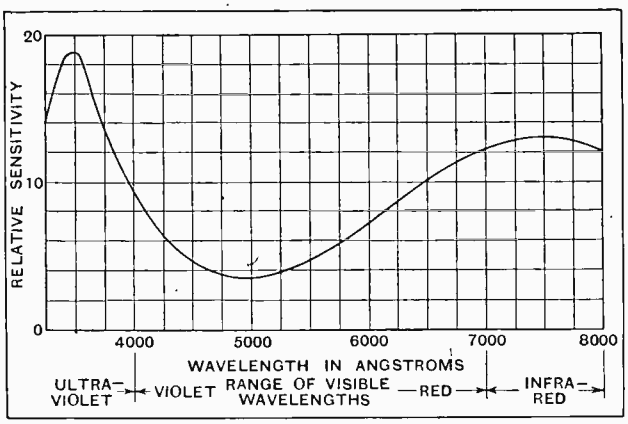


Fig 5.—Sensitivity curve resulting from the use of a thin film of caesium. By the use of a thin film in place of caesium in bulk the sensitiveness has been enormously increased near the infra-red region of the spectrum.

The next improvement came with the introduction of an electronegative binding layer between the photo-active material and the base. This had the effect of decreasing surface forces, enabling the electrons to escape much more easily, moving the photo-electric threshold of the alkali metal much farther towards the red end of the spectrum, and causing the appearance of another peak. Fig. 4 shows typical curves of thin films for a potassium cathode, a potassium on silver cathode, and potassium on oxidised copper.

The thin film caesium cells introduced by L. R. Koller show wavelength sensitivity curves vastly different from that of caesium in bulk. A curve typical of these cells is given in Fig. 5, and it will be seen that the characteristic peak of caesium at 5,500 Å. has disappeared and a large peak has occurred right at the red end of the spectrum, extending into the near infra-red region.

Fig. 6 shows the wavelength-sensitivity curves of five caesium-on-oxidised silver cells taken at random from a batch of 200 cells.

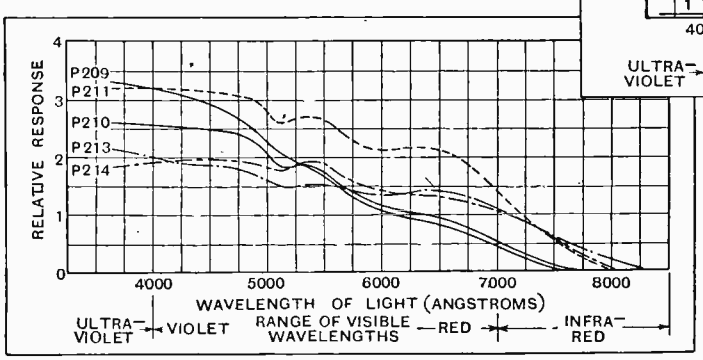


Fig. 6.—Wavelength-sensitivity curves of five B.T.H. photo-electric cells, numbers P.209 and P.210 were rejected for film use, while numbers P.213 and P.214 are quite satisfactory owing to their sensitiveness in the infra-red region. Cell number P.211 is particularly sensitive.

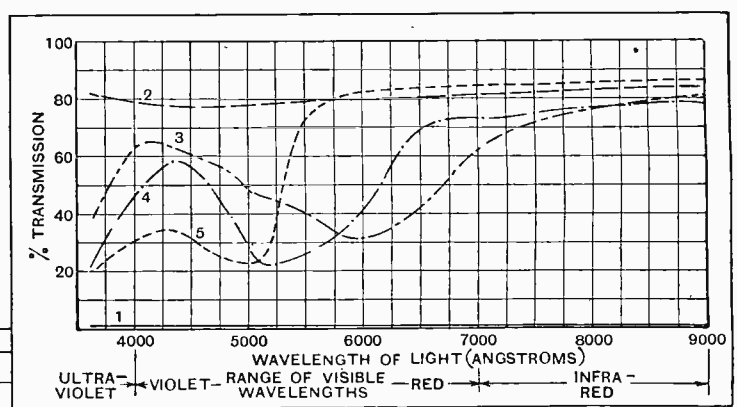
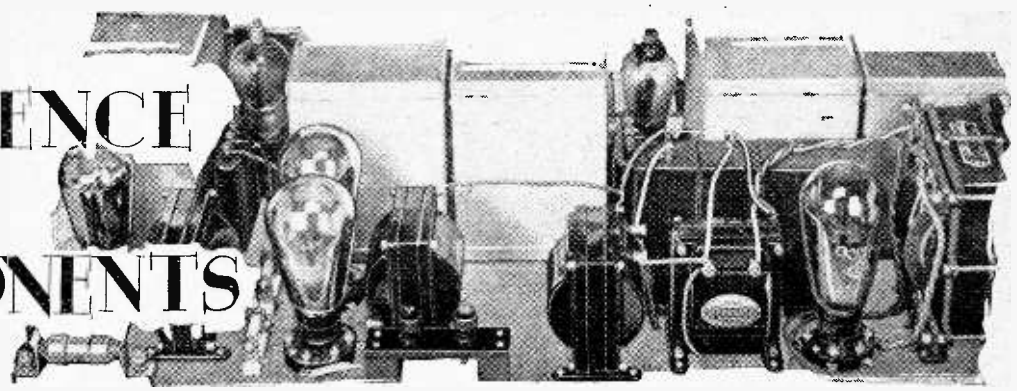


Fig. 7.—For talking-film reproduction red sensitivity is particularly advantageous. The curves show the values of light passed on various wavelengths for (1) ordinary exposed film, (2) clear film, (3) bluish film to represent intense daylight, (4) red film for fireside scenes, (5) light amber-coloured film.

For sound-film reproduction, red sensitivity is particularly advantageous. Fig. 7 shows the relative transmission of some common film to light of different wavelengths. The response of the cell depends upon the difference in the light transmitted by clear and fully exposed film.

(To be concluded.)

The Influence of Components on Quality



Some of the Obscurities in Receiver Design.

IT is seldom that the opportunity occurs to test several receivers against each other on the same loud speaker. Speaking at random, it might be said that there would be no difference if the power output (loudness) from the speaker were the same for each receiver tested. But strange things happen in radio and kindred apparatus, and when two receivers of different design are tested on a good loud speaker, they invariably appear to be quite different. That is to say, the quality of reproduction from the loud speaker is not the same for each receiver. In this article the effect on quality of changing the systems of coupling, stage by stage, from aerial to loud speaker is discussed in simple terms.

RECEIVER performance can be predicted from a consideration of the values of the components used, and the purpose of this article is to show how various modifications can influence the ultimate output from the loud speaker. Starting with the aerial and high-frequency side, including valves, there are two systems which are usually employed: (*a*) the usual tuning scheme with coils and condensers, (*b*) band-pass filters. In case (*a*) two courses are open: (1) to use a single H.F. valve and low-loss coils, thereby giving high magnification and selectivity per stage; (2) to use several H.F. valves and coils with fairly flat tuning.

Selectivity and Quality.

Where low-loss coils are used the tuning is sharp, but this cuts into the sidebands and the effect at the loud speaker is to reduce the upper audio frequencies. This means that the reproduction is not so crisp, speech is less intelligible and not reproduced with brilliance and naturalness. In a word, the output from the loud speaker tends to be muffled or stifled, unless the latter has a very powerful upper register.

This muffling effect is largely removed by using several valve stages with circuits of higher resistance, since the sidebands are less attenuated and the resultant or overall tuning curve of the receiver is squarer and covers a wider frequency range for the same degree of selectivity for combating interfering stations, as shown by Fig. 1.

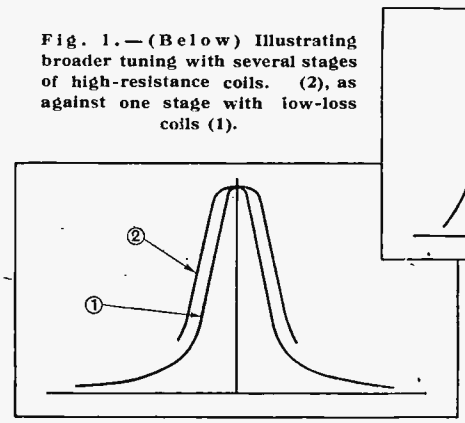


Fig. 1.—(Below) Illustrating broader tuning with several stages of high-resistance coils. (2), as against one stage with low-loss coils (1).

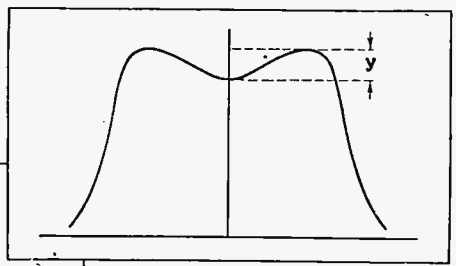


Fig. 2.—(Above) Illustrating the accentuation of the upper audio-frequencies in certain band-pass filters. The additional amplification at *y* is useful in offsetting defects in the L.F. side of the receiver.

Now, this attenuation of the upper frequencies is a serious matter, although, of course, as mentioned above, it can be offset by a suitable loud speaker. However, there are many loud speakers which require a tolerably uniform input or even a slight accentuation of the upper register. In this case we must turn our attention to band-pass filters. With certain of these the higher frequencies are slightly accentuated, as illustrated by the curve of Fig. 2. Also, as is very well known to readers of this journal, they give much better selectivity than ordinary tuned circuits of the low-loss type. If, therefore, two receivers with identical detector and L.F. circuits are compared (1) with low-loss coils, (2) band-pass filter, the reproduction from the latter will be more brilliant than that from the former, as shown by the curves of Figs. 1 and 2. In making this statement I am assuming that the detector does not throw back a large load on the low-loss coil, thereby flattening its tuning appreciably.

So much for the high-frequency side of the receiver. On the subject of detectors, it is clear, from various articles in this journal during the past twelve months

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or so, that anode bend is definitely in the background, whilst grid rectification holds sway. The assumption is made in what follows that the anode voltage on the detector and the grid bias are adequate to prevent appreciable harmonics arising from rectification.

Valve Input Capacity.

When the detector is followed by a resistance-capacity coupling to the next valve there will probably be a slight falling away in the upper register. This is due to the input impedance of the following valve, as illustrated in Fig. 3, which introduces the effect of a capacity across the grid leak. Actually this capacity is fictitious, but it simulates a leak of current through the valve due to the capacity between grid and anode. In general, with a power valve this effect is not serious unless several valves are used in parallel. In practice, however, it is usual to have two resistance-capacity stages, i.e., detector followed by a note magnifier. In this case, if the note magnifier gives large amplification the influence of the feedback capacity across the grid leak, plus that of the power valve on the next grid leak, may reduce the upper register appreciably. Such a combination following a low-loss H.F. circuit would sound woolly unless the speaker had a powerful upper register.

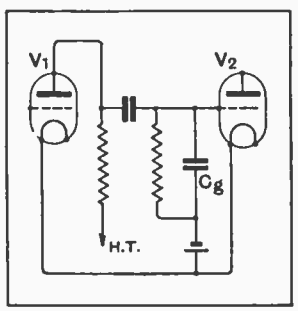

Fig. 3.—The condenser C_g is the grid-to-filament capacity plus the effective capacity thrown back by the valve V_2 due to the capacity current which flows from grid to anode.

When the detector is followed by a transformer the results depend upon the design of the latter. A transformer with a 1 to 8 ratio usually means a drop at the upper frequencies due to capacity of the secondary winding unless the A.C. resistance of the detector is adequately low. If anode-bend detection is used, the detector resistance is high and the upper audio frequencies suffer, due to the transformer capacity. With grid-leak detection the valve resistance is usually fairly low and the effect of capacity is not so marked. When the valve resistance is high and the transformer primary inductance low high note loss results.

If the transformer has a lower ratio, say, 1 to 4, resonance occurs between the capacity of the winding and the leakage inductance, giving an increase in the upper register which is decidedly useful in counteracting the effect of high selectivity circuits.

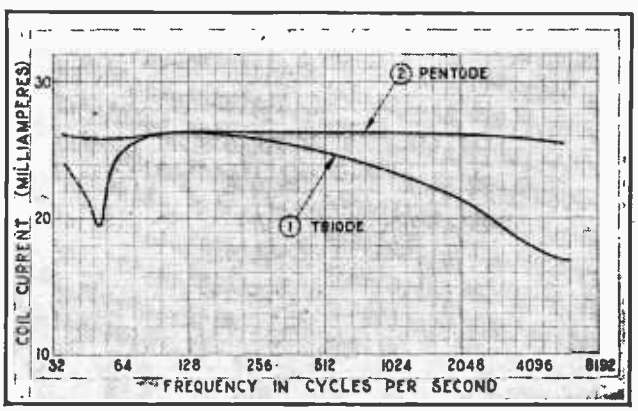

Fig. 5.—Pentode *versus* triode. The current in the speech coil plotted against frequency.

So far as the loud speaker is concerned, its output depends upon the design, but can be modified by the choice of transformer. If a high-ratio transformer, e.g., 25/1 or 40/1, with a low primary inductance is used, the lower register will suffer because too large a proportion of the current is used to magnetise the core (owing to the small number of turns or to lack of iron). This can be understood more readily by reference to the equivalent circuit of the transformer-coil combination shown in Fig. 4. The primary of the transformer is in parallel with the coil circuit. If, therefore, the resistance of the primary at low frequencies is low, it will shunt or by-pass current from the coil circuit.

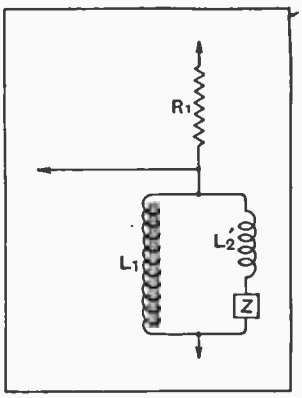

Fig 4.—Diagram showing equivalent circuit of transformer (simplified). L_1 = primary inductance; L_2 = leakage inductance; Z = equivalent to moving coil; R_1 = primary resistance.

When the loud speaker has a prominent low-frequency resonance, such a transformer having a small primary of only moderate inductance may be useful in curbing it.

If there is a large leakage of magnetic flux between the primary and secondary windings of the transformer, the upper register suffers. The leakage inductance is in series with the coil and reduces the current at high audio frequencies. Again, this is sometimes useful when the loud speaker has too powerful an upper register. Even with a 10/1 ratio, if the primary inductance is high, the leakage inductance will reduce the upper register. On the other hand, the bass register is improved by the increased primary inductance. From a quality viewpoint it is clear that the turns ratio and the primary inductance must be varied to suit the loud speaker.

The article has been confined to the effects of certain components in either raising or lowering the tone of a receiver. There are other effects which have not been introduced, namely, the production of harmonics by the components. These are created by transformers and valves unless due care is taken, but such effects are beyond our present purview.

It is of great interest to compare a band-pass H.F. unit with a low-loss coil H.F. unit using the same low-frequency portion of the circuit. The gain in upper register—provided the loud speaker has an upper register, and most of the modern coil drives have—is quite marked and very

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pleasing on certain loud speakers. On others the whistling is rather distressing, but, of course, it can be reduced in the usual way with a condenser either alone or in series with a suitable resistance. Where possible it is preferable to effect corrections of this nature as early in the L.F. amplifier as possible, since the removal of the excess voltage from the L.F. and power valves permits a greater grid swing and therefore a greater ultimate output can be handled.

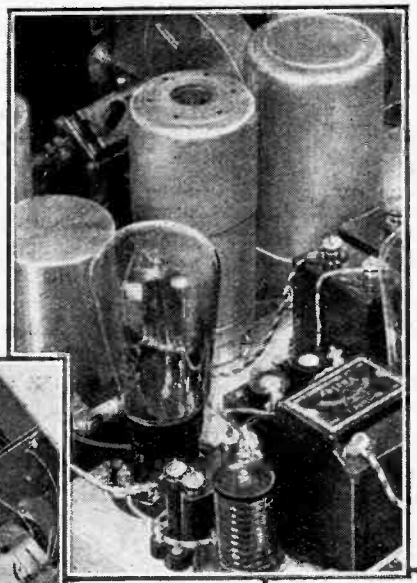
Finally, a word might be added about the A.C. resistance of the power valve. Where the resistance swamps the impedance of the loud speaker there will be substantially constant current at all frequencies. In a moving-coil speaker with high-resistance coil this means a decided improvement in the upper and lower registers and in the reproduction of transients. The enhanced reproduction of transients is due in part to the valve resistance swamping the loud speaker reactance at high frequencies, thereby enabling a more rapid rise in current, but also to the greater output at such frequencies by virtue of currents greater than in the case of a low-resistance triode.

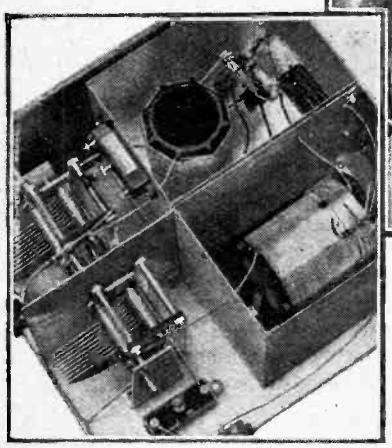
With a pentode care should be taken that the resonance of the diaphragm on its surround is well below audibility. If it falls at 100 cycles the constant-current condition of the pentode will accentuate it very forcibly and speech will degenerate into a series of barks. The difference between triode and pentode is illustrated in Fig. 5. With the low-resistance triode, serious resonances introduce radiation resistances large enough to reduce the current, thereby lowering the output. But with the high-resistance pentode the current at resonance is much greater and the output is correspondingly enhanced. This will be appreciated more readily when it is realised that the additional resistance (due to radiation mainly) introduced when a diaphragm resonates on its surround is of the order 10,000 ohms. This explains the large reduction in current when using a triode.

For reed-driven speakers it is necessary to consider the frequency of the reed. When this is high a low-resistance triode and a band-pass circuit are good. When the frequency is low a triode of moderate resistance and a band-pass circuit give good results. However, there is no intention to be dogmatic, and the reader is doubtless capable of choosing the components which satisfy his own musical taste.

Finally, no mention has been made of smoothing gear as used for all-mains working. This would take us beyond the scope of the present article. However, it will be quite clear to the reader that unless the smoothing is adequate the effect of feedback may be to boost the bass or some kindred effect depending upon the degree and sign of the reaction. The effects of insufficient decoupling between the stages is often overlooked when the evils of feedback are not rendered obvious by L.F. oscillation actually occurring.

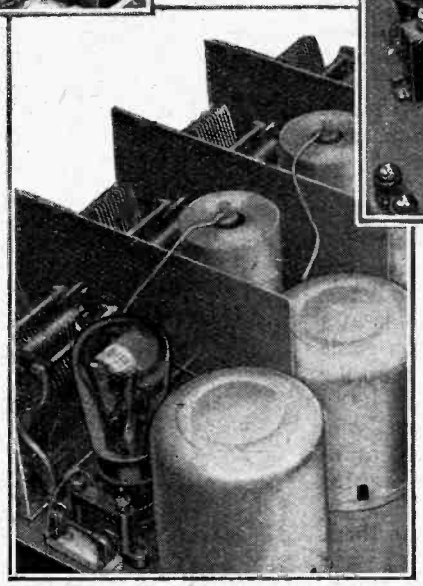
N. W. McL.





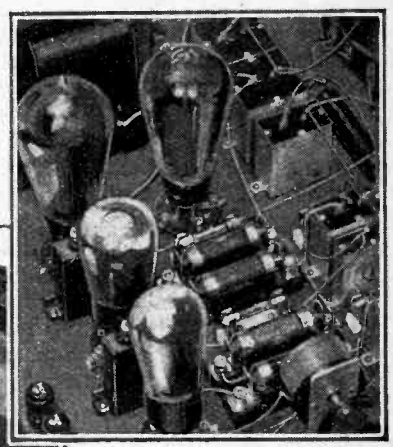
Band pass circuits give selectivity with quality.

(Above) The L.F. transformer ratio must be considered in relation to the detector valve.



Guard against the use of unsuitable values for the components in a resistance coupling amplifier.

(Below) A Selective receiver in which side-band cutting is avoided.



EXPERIMENTAL WIRELESS.

IN THE JULY NUMBER.

The Design of High Frequency Transformers.
Thermo-junctions at High Radio Frequency.
Change of Amplification with Frequency in Resistance Coupled Amplifiers.
Calibrating Short-wave Receivers Using a Super-regenerative Circuit.

Unbiased

by Free Grid

"Superhets" in Disguise.

MY reputation as a prophet concerning future radio developments is growing apace, and lately several of the forecasts which I made some months ago have been realised. Those of my readers who have not dozed off may probably recollect that eight months ago I foretold that the superheterodyne would soon be staging a come-back, and would enjoy such popularity as it has never known before. Not only has this journal led the "come-back" since October of last year and been subjected to the sincerest form of flattery by its contemporaries, but manufacturers are moving in this matter, and from several "private views" which I have had lately I can definitely state that this form of receiver will be present in great numbers at the Olympia Exhibition, which opens on September 18th next.

To the completely non-technical mind they will not necessarily be self-evident at the Exhibition, and a large number of them will be masquerading under such titles as "Band Pass," "Band Selector," etc., although, of course, sets which do bear these high-falutin names are not of necessity superheterodynes. However, from what I have seen I can definitely say that if you come across any set bearing one of the titles mentioned the odds will be in favour of it being a superheterodyne.

I am informed that a large number of these sets are not waiting for the Olympia Show, but will be on the market some weeks before then. Whether the manufacturers are scared of the American invasion or not I do not know, but I *do* know that they are showing more enterprise and activity at present than at any time previously. Perhaps a little competition is not such a bad thing after all, and if, as the manufacturers allege, the American sets that are coming over are all junk, then, of course, there is no need for them to get all hot and bothered about it. I must say, however, that certain British manufacturers do seem to be getting "all damp behind the ears," as one American manufacturer, at present staying at Claridge's, picturesquely put it to me the other day.

Talking of superheterodynes reminds me that an enormous number of people have written to me asking whether it is true that the Stenode Radiostat is really a specialised form of superheterodyne. I do not think that I am likely to get involved in an action for libel if I say that this certainly is so, just as the "Super Selective Six" recently described in *The Wireless World* is a specialised form of superheterodyne.

What is a Valve?

An interesting discussion recently arose at a well-known radio society of which I am an honorary member concerning the correct method of naming or describing sets in terms of the number of valves used. The

I was assailed on all sides.

great point at issue was, whether a set consisting of one H.F. stage, detector and two paralleled output valves should rightly be called a three-valve set or a four-valve set. The point, in my opinion, is quite an important one where the general public is concerned, as the old superstition of basing the general performance of a set upon the number of valves used still persists in the minds of the general public in spite of the fact that it has several times been severely condemned by this journal. I expressed myself strongly in favour of putting the set into the three-valve class, and boldly stated that if it were put in the four-valve class, then the "Pre-Selection A.C. Three," which was recently described by this journal, ought by right to be called the "Pre-Selection A.C. Four," since, of course, it actually embodies four valves.

Now, it so happened that the Society in question had built this particular receiver, and the fact that I cited it as an example was simply due to the fact that I noticed it on a side table. One of the members immediately jumped up, and in a rather sarcastic speech invited me to point to the fourth valve. I jerked my pipe in the direction of the underside of the baseboard, and to my surprise not a solitary member saw my point, and I was assailed on all sides. The fourth valve was, of course, the Westinghouse metal rectifier, and, as I explained to the members of the club, if that instrument is not a valve, I should like to know what is. This naturally immediately brought on a discussion as to what is, and what is not, a valve, although, in my opinion, there can be no doubt about the matter.

I really think, however, that it is high time not only that the set manufacturers but also the various designers who give tongue in the technical Press should come to an agreement upon this matter.

The "Pre-Selection A.C. Three" is rightly named, of course, since no rectifying valve, whether it be of the metal, chemical, or hot cathode variety, should count, since it has to do solely with the source of power supply. Two sets which I have in mind, however, are the "Band Pass Four," which appeared last July, and the "D.C. Band Pass Five," which appeared five months ago. Both sets are identical in that they actually have two H.F. stages, a detector and two push-pull output valves, but which title is the more correct?

D.C. MAINS THREE

Final Constructional Work and Initial Testing.

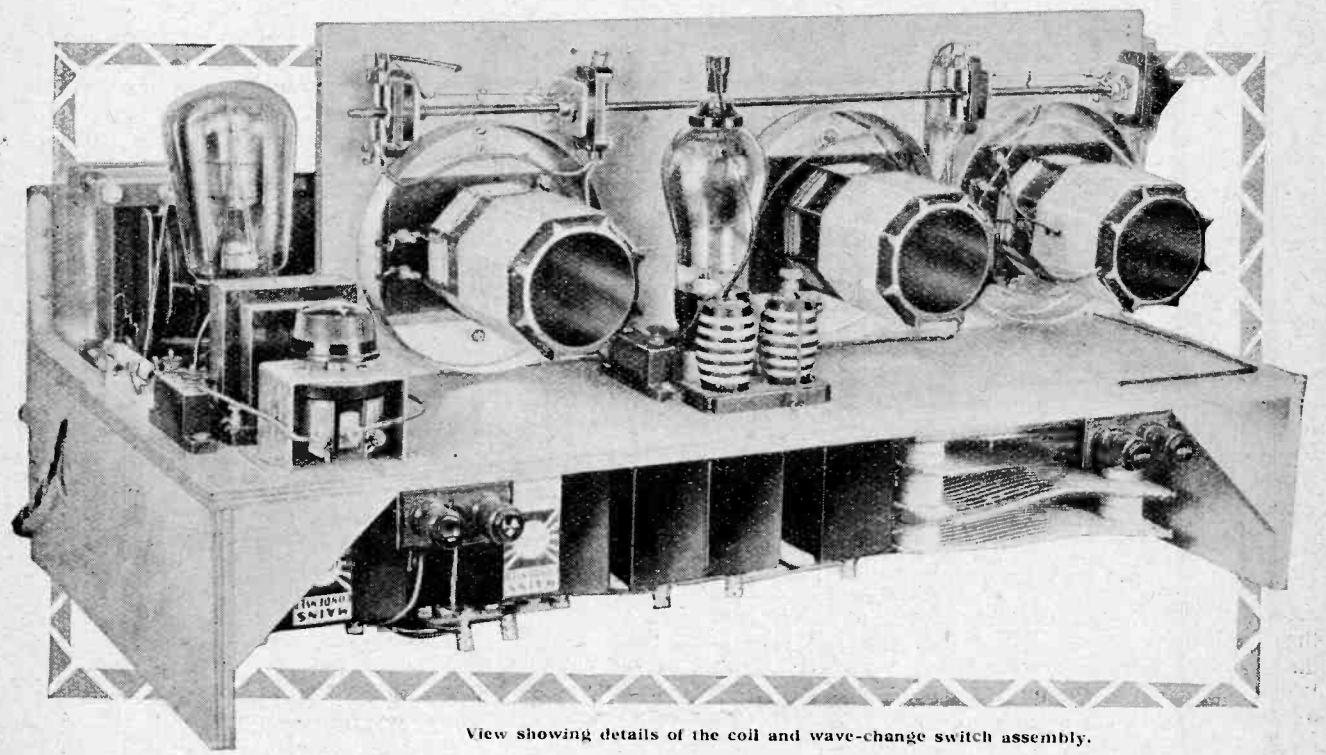
By H. B. DENT.

(*Concluded from page 674 of previous issue.*)

THE assembly of the components and the wiring is a perfectly straightforward job and hardly calls for comment or advice. Although any deviation from the published layout might be courting trouble, the writer realises that some constructors may have a number of parts available which could be used in this set. Providing these parts have sensibly the same qualities as their counterparts recommended here, there seems no reason why they should not be utilised. If need be, the coils can be replaced by a set similar to those used in the "Pre-Selection A.C. Three," in which case the performance of the set will be governed by the "goodness" of the coils used.

When the constructional work is finished, and before the initial test takes place, the flexible lead must be connected to the correct tapping on the resistance R_{13} for the voltage of the supply mains. The tapping point to which the main H.T. anode supply lead is connected represents the condition for a 200-volt supply main. This lead remains permanently connected, irrespective of the mains voltage, provided this is not less than 200 volts. The remaining tappings merely provide extra resistance for higher mains voltages so that under all conditions the anode voltage to the various valves is always the same. The correct tapping for various supply voltages of from 200 to 250 volts is given in the sketch on page 672.

When making the first test, the small grub-screw on the flexible connector should be loosened and the coupling condenser CC set at minimum. Then rotate the star-shaped wheels on the Polar "Tub" condenser in a clockwise direction until it can be felt that the trimmer is just engaging. The aerial volume control—differential condenser—should be adjusted so that the moving vanes fully engage with the lower set of fixed vanes, and with the set switched on it should be

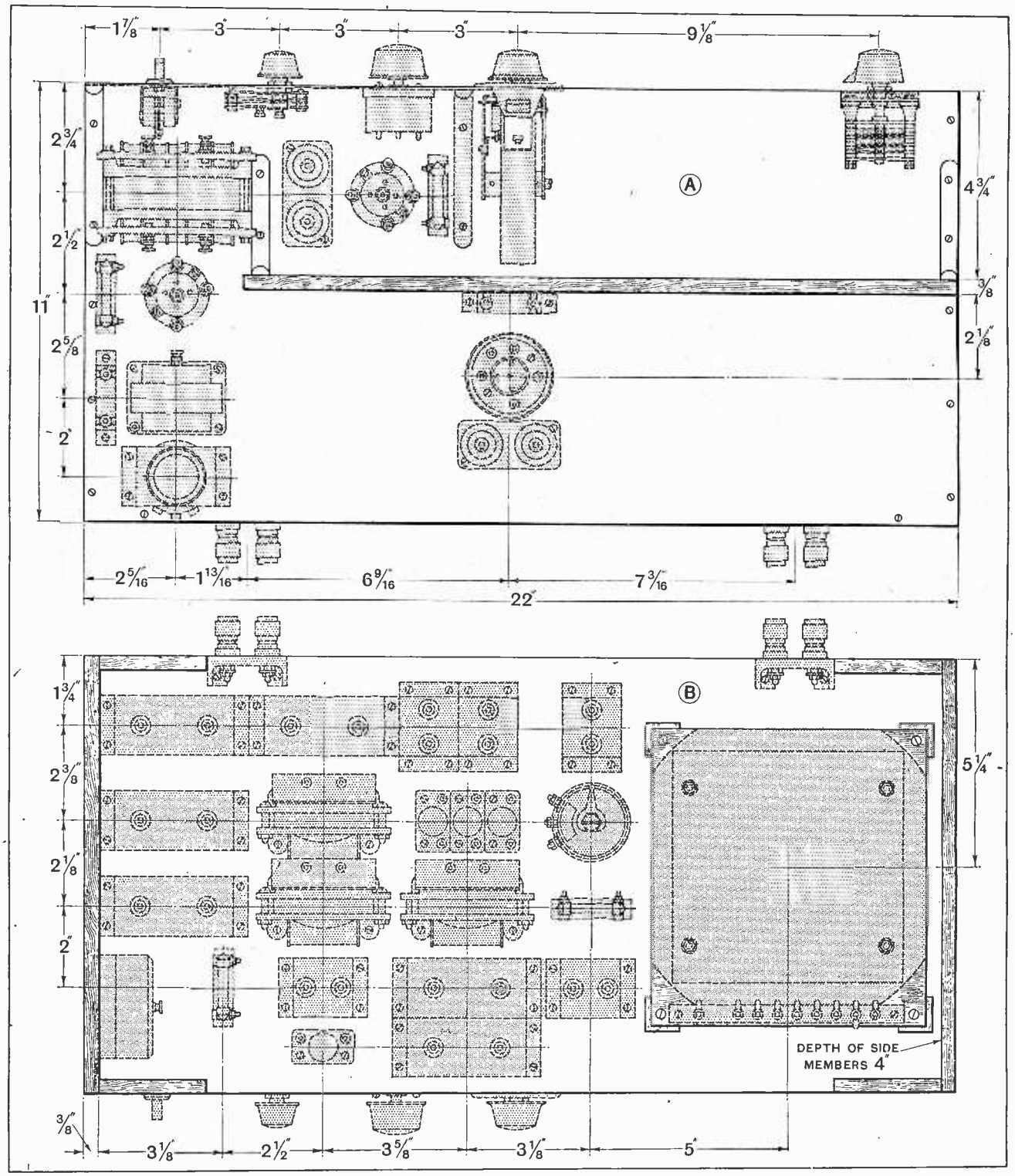


View showing details of the coil and wave-change switch assembly.

D.C. Mains Three.—

possible now to receive signals, though not necessarily at full strength.

The adjustment of the small built-in trimmers is the first and most important operation, and too much care cannot be devoted to this operation. A comparatively weak signal will afford the best means of adjustment, and it is best to choose one between 300 and 400 metres.

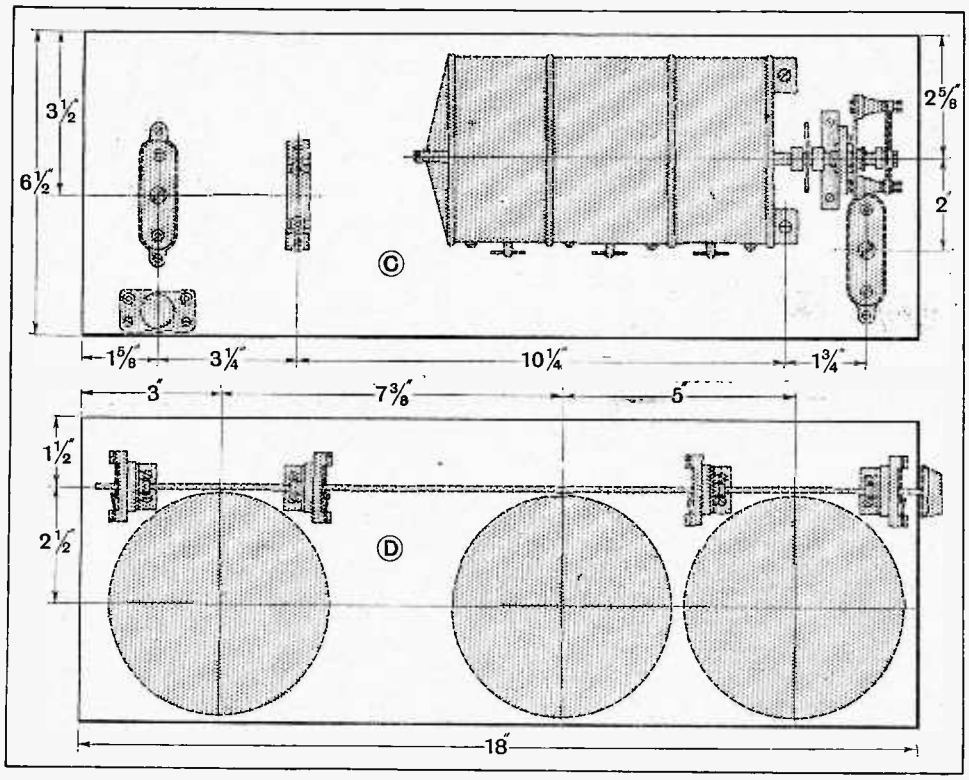


Layout of the components on the top (A), and (B) the underside of the baseboard.

B 12

D.C. Mains Three.—

Alternate adjustments can be made to the trimmers and the tuning condensers until one is absolutely sure that signals are at their maximum. The main tuning condenser can now be turned to the zero mark on the dial and the small coupling condenser fixed firmly to the main condenser by tightening up the grub-screw, after first noting that this is set at minimum also.



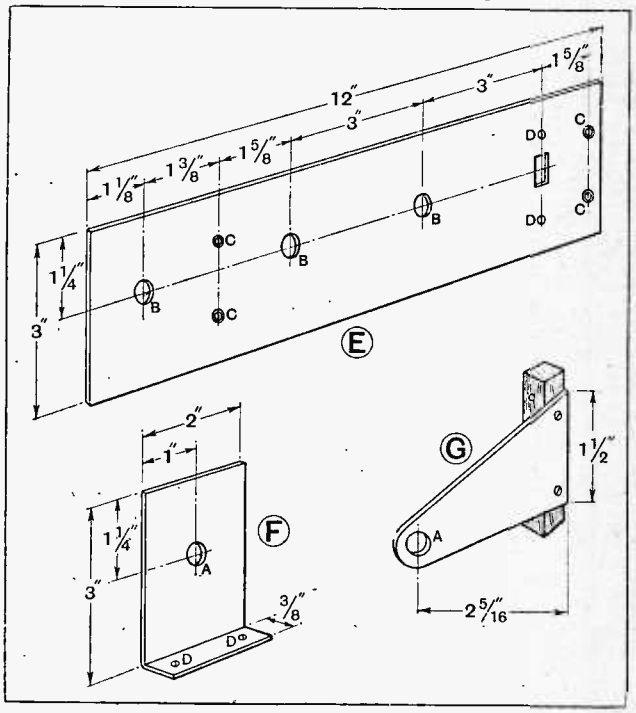
Details of the components mounted on the vertical sub-panel; (C) the front side, and (D) the rear side.

Volume Control and Reaction Adjustments.

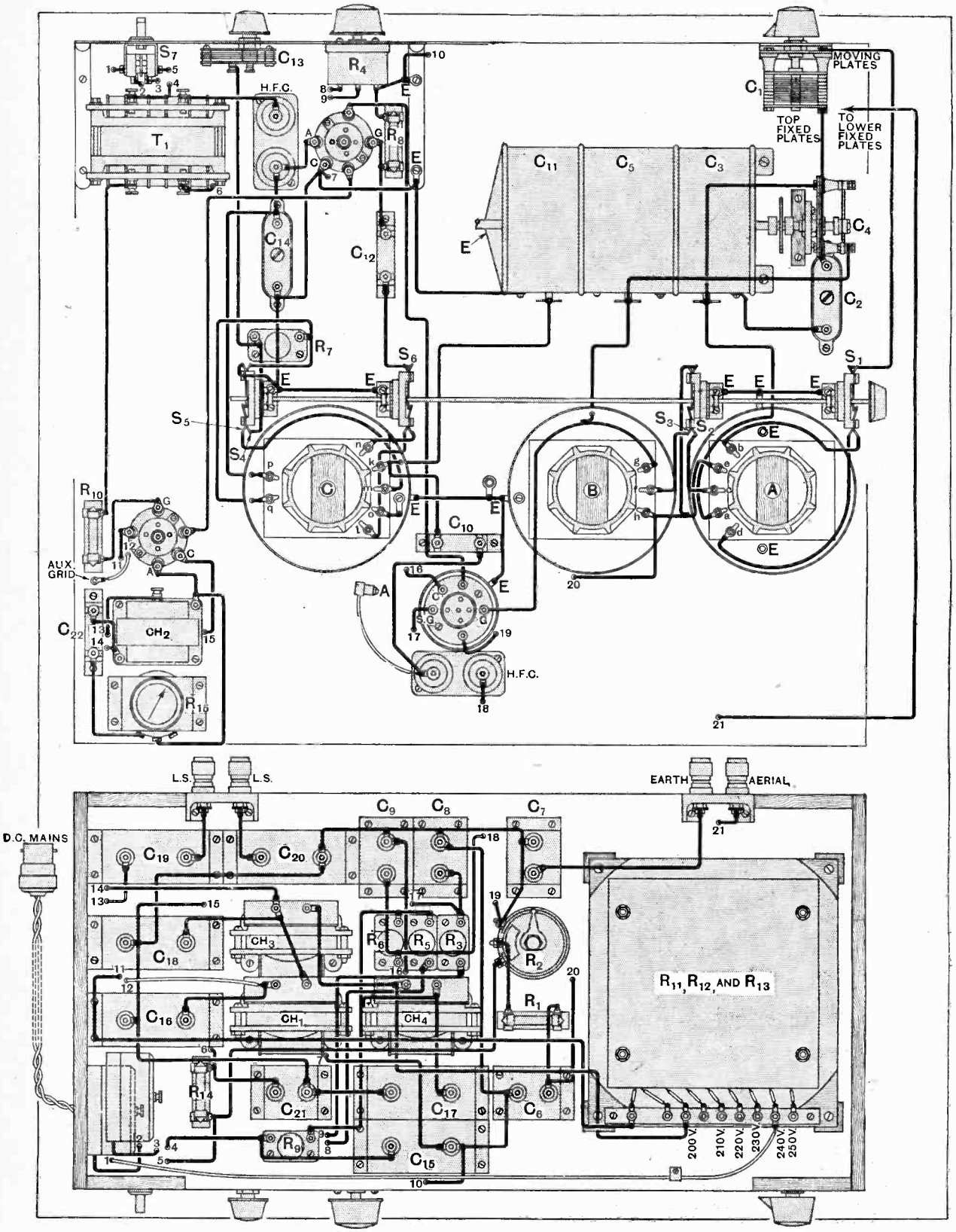
There remains now only the adjustment of the aerial semi-variable balancing condenser C_2. A signal of fair intensity should be tuned in and the differential condenser turned down until signals are at minimum. Without disturbing any other control; adjust the semi-variable condenser until signals are once again at maximum. The signal strength should be very much less than before this adjustment was made, but it is the minimum that can be obtained without disturbing the tuning of the aerial circuit. Any further reduction in signal strength must be made now by means of the potentiometer controlling the screen voltage to the H.F. valve.

Before concluding, it may be of interest to describe a somewhat perplexing difficulty which was experienced with the reaction control on the long waves, although it functioned in a perfectly normal manner on the medium waveband. It was observed that the initial movement of the reaction condenser C_{13} did not result in any noticeable increase in signal strength, and, although a setting was reached eventually when the set oscillated, the familiar beat note was absent. At this stage the sensitivity was disappointing, but on further increasing the reaction capacity a change in the nature of the self oscillations took place, sensitivity returned to normal, and a beat note could be produced. Careful investigation revealed a rather perplexing state of affairs; it appeared that the early oscillations were on an entirely different wavelength to that to which the set was tuned. These oscillations choked the detector valve, and as a consequence the sensitivity was impaired. Investigation pointed to the fact that the detector stage was oscillating at the natural frequency of the reaction circuit.

No doubt there are many ways of combating this evil, and, although the one suggested here may not be ideal, it serves its purpose, does not unduly complicate matters, and is relatively cheap. A 1,000-ohm resistance R, is connected in series with the reaction coil and its condenser. This entirely damps out the



Details of the panel drilling, the volume control (F) and variable coupling condenser (G) brackets. A = 7/16in. dia., B = 3/8in. dia., C = 1/8in. dia. and countersunk, D = 1/8in. dia.

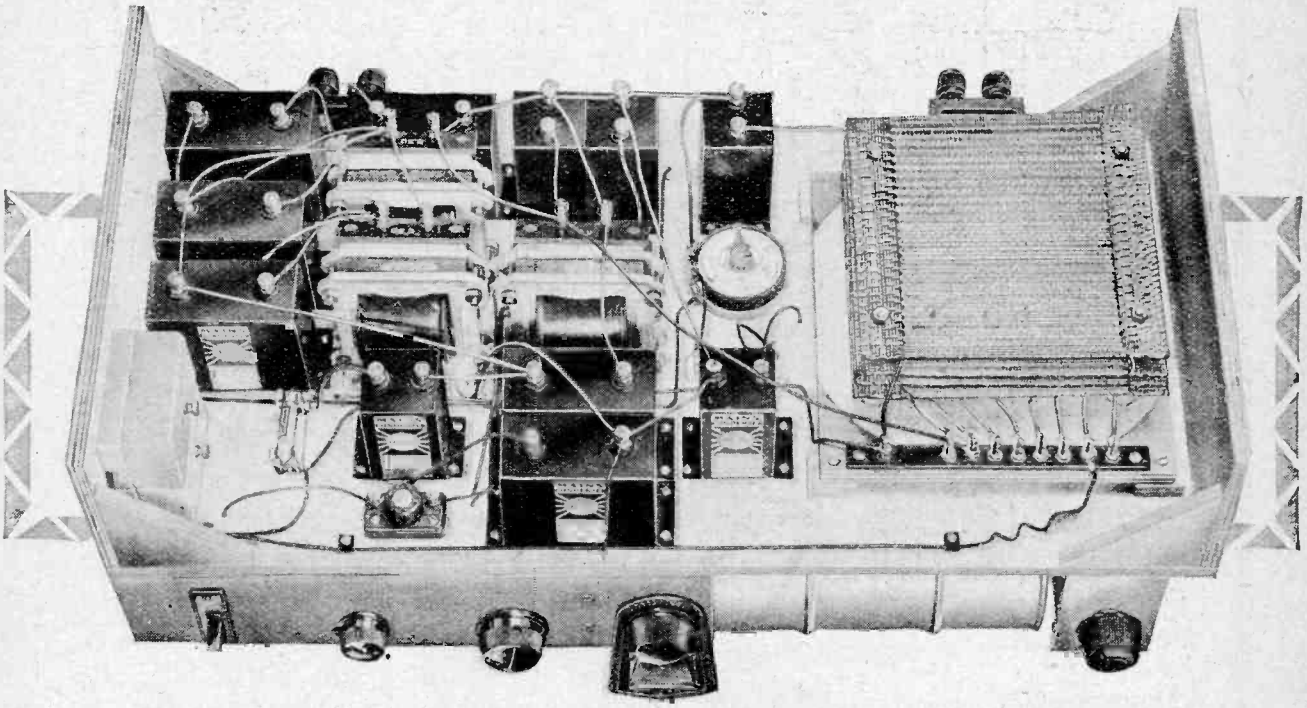


The practical wiring plan.

B 14

D.C. Mains Three.—

short-wave oscillations, brings the sensitivity back to normal, and enables regeneration to be obtained in the correct manner. The resistance is a hindrance to reaction on the medium waveband, and the simplest way of overcoming this effect is to short-circuit it. Fortunately, there is a spare contact on the wave-change switch (S_1) associated with the H.F. circuit, so that a 1,000-ohm resistance is the only additional component wanted.



View of the underside of the baseboard showing position of the fuses, mains resistance, and the H.T. smoothing equipment.

In the diagram on page 672 the leads to the L.F. chokes and to the heater of the pentode are incorrectly shown. These leads should be reversed.

(This receiver is available for inspection at the Editorial Offices, 116, Fleet Street, London, E.C. 4.)

IN NEXT WEEK'S ISSUE:

DESCRIPTION OF AN INEXPENSIVE LIGHTWEIGHT PORTABLE RECEIVER.

Interior unit of the "Lightweight Portable."

Designed for the motorist, traveller, or holiday maker, this eminently practical little set embodies a two-valve detector-L.F. circuit with throttle-controlled reaction. In spite of its compactness, an adequate range is obtainable, even when operating with a built-in frame aerial.

Low cost and easy construction are features of the receiver, for which ready-made components only are needed.

LIST OF PARTS REQUIRED.

2 Variable condensers, solid dielectric, 0.0005 mfd.	(Polar "Trimmer" Type)
1 Slow-motion condenser dial	(Ormond Miniature Type)
1 Fixed condenser, 1 mfd. ("Helsby"; British Insulated Cables, Ltd., Prescot, Lancs.)	
1 Fixed condenser, 0.0003 mfd. with grid leak clips	(Dubilier, Type 620)
1 Fixed condenser, 0.002 mfd.	(Dubilier, Type 620)
1 Semi-variable condenser, 0.0001 mfd. maximum	(Formo)
1 Grid leak, 2 megohms	(Dubilier)
2 Valve holders	(W.B.)
1 H.F. choke	(Telsen)
1 L.F. transformer	(Varley Nicore II)
1 Fixed resistance, 400 ohms	(Watmel)
2 Plug sockets, with insulating bushes	(Clix)
1 On-off switch	(Bulgin, Type S.42)
2 Spade terminals	(Clix)
2 Wander plugs	(Clix)
1 L.T. accumulator, 2 volts	(Ever Ready, Cat. No. 2123)
1 H.T. battery, 54 volts	(Ever Ready, Cat. No. W.14)
1 pair headphones	(Ericsson)

Case, wood, screws, wire, sleeving, etc.

Current Topics

News of the Week in Brief Review.

COPENHAGEN'S WIRELESS SHOW.

A wireless exhibition will be opened in Copenhagen next August.

oooo

NEW HIGH-POWER STATION FOR CENTRAL GERMANY.

Work on the station to be erected at Wiederau, about 12 miles from Leipzig, is about to begin.

oooo

ADVERTISING IN U.S.A.

"Radio advertising has become a serious rival to Press advertising in America," said a well-known publicity director on his return from the United States. Indeed, it seems hard to escape from advertisements in that country; even infants are impregnated with the spirit, and we have heard of a small boy who on first seeing a rainbow in the sky, enquired of his father, "Say, pop, what does that advertise?"

oooo

"RANJI'S" NEW SET.

Bedi Port, Kathiawar, India, which is under the jurisdiction of H.H. Jam Sahib Shri Ranjitsinhji Vibhaji, better known in this country—at all events by those who can remember the '90s—as "Ranjitsinhji" the cricketer, is to have a new Marconi wireless station for communication with ships at sea. The transmitter operates on I.C.W. with an aerial output of 1½ kW., and the receiver has the exceptionally large wave-range of 15 to 22,000 metres.

oooo

AT THE WORD OF COMMAND.

At the electrical "House of Magic" in Schenectady is exhibited a receiver which can be switched into action merely by saying "Go ahead now" (or other four-syllabled exclamation), and can be stopped in a similar manner.

Another exhibit is an instrument for registering the power of the human voice though, incidentally, we learn that this was put out of action by a Schenectady woman reprimanding her husband while within range of the apparatus.

oooo

THE FIGHT CONTINUES.

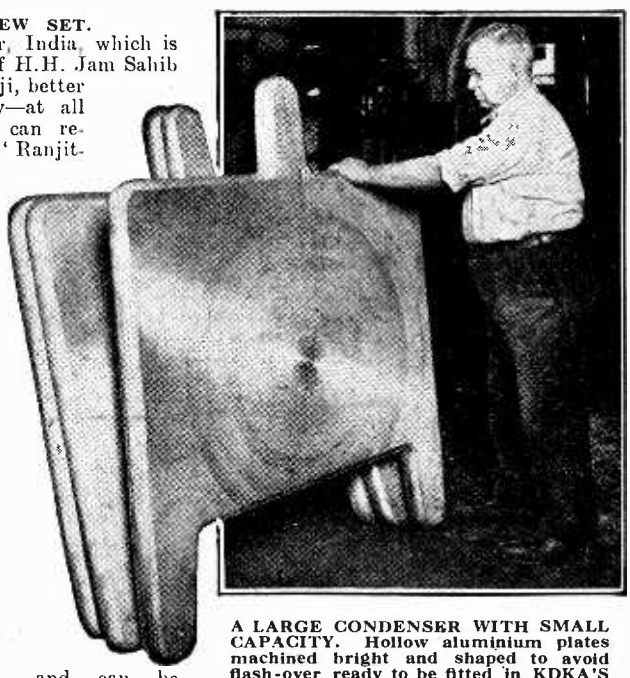
We hear from our Paris correspondent that the dispute, mentioned last week, between the Dutch censor of broadcasting and the Vara Company continues with increasing bitterness. On June 10th Vara had arranged a programme to commemorate the memory of the Italian Opposition leader, Matteoti, alleged to have been killed by Facists seven years ago, which was to be followed by a two minutes' silence. The Central Commission of Controls, it is stated, not only forbid the speeches, organ solos, etc., but even the silence.

oooo

THE HAGUE'S INTERVENTION INVOKED.

This action has aroused considerable excitement; the Vara called for "an extraordinary congress" at The Hague to consider the means to be adopted "for struggling against the censorship," a debate is announced in the Second Chamber, the company is organising public meetings of protest in Amsterdam and Rotterdam, and on June 11th a procession of 10,000 marched through the streets of The Hague bearing placards inscribed "Down with the Wireless Censor!"

It is, perhaps, noteworthy that, on the same day on which the programme was suppressed in Holland, the Belgian Association "Resef" freely broadcast a speech about Matteoti.



A LARGE CONDENSER WITH SMALL CAPACITY. Hollow aluminium plates machined bright and shaped to avoid flash-over ready to be fitted in KDKA'S new transmitter.

HEAVY (?) PENALTIES FOR PIRATES.

"Clandestine Transmissions" are being relentlessly suppressed in France. A police tribunal of the Seine has recently fined or "imprisoned" three amateurs for using unlicensed transmitting and receiving sets. One of these was fined 50 francs and the other two, in addition to a fine of 100 francs, were condemned to eight days' imprisonment with "sursis." This sentence is not so severe as it looks. Imprisonment with "sursis" (reprieve) is common in France, and the term in gaol is only served on the paper in which the sentence is recorded.

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OFFICIAL SHORT-WAVE TESTS.

The 81st series of short-wave tests organised by the French Meteorological office will be carried out on July 11th, 18th and 25th. These will follow much the same lines as previous tests, the first two Saturdays being reserved for preliminary work, while on July 25th the principal tests will take place.

The preliminary tests start at 09.00 G.M.T. from Lyons FYS on 5,000 kc/s followed by Paris FLE on 4,081 kc/s, and 8,162 kc/s, then Paris FLJ on 9,200 kc/s, and finally Lyons FYS on 11,450 kc/s.

Each transmission lasts for ten minutes, and consists of a series of É's in morse in the middle of which is sent a distinguishing group of five figures. Each station follows the other at five-minute intervals, so that, after the first five minutes, there will be two stations operating simultaneously. The series will be repeated at 13.00, 17.00 and 21.00 G.M.T.

The main tests on July 25th are similar, but the respective series will begin at 09.00, 11.00, 12.00, 13.00, 15.00, 16.00, 17.00, 18.00, 20.00, 21.00, 22.00 and 23.00 G.M.T. Forms for reports on the reception of these tests may be obtained from the Director, Office National Météorologique, rue de l'Université 196, Paris.

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VATICAN STATION.

The Pontifical Academy of Science announces that it will transmit the "Giornale Radiofonico" twice daily at 11.00, Central European time on 19.84 metres and at 20.00 on 50.26 metres. The Academy receives correspondence from all parts of the world on scientific questions.

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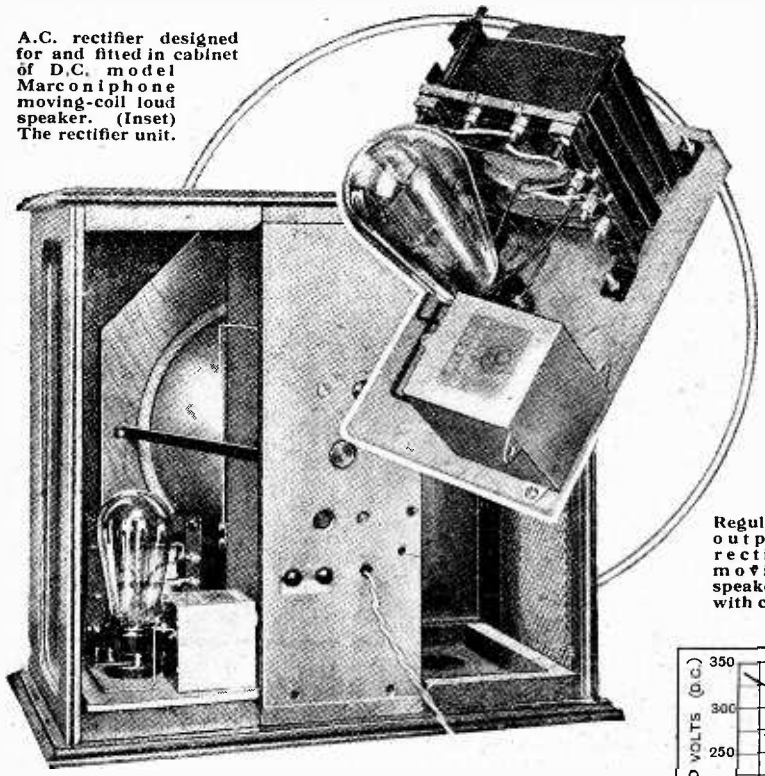
GERMAN RADIO TRADE PUSH.

The German radio industry does not seem to be affected by the prevailing trade depression. According to a recent survey, Germany is exporting 50 per cent. of her output of wireless valves and accessories, and is also finding a foreign market for 20 per cent. of her factory-built sets.

LOUD SPEAKER RECTIFIER

Brief Constructional Details of an A.C. Unit for a D.C. Moving-coil Loud Speaker.

WHEN a change is made in the nature of the electric supply from direct to alternating many small problems arise concerning the adapting of the wireless equipment used hitherto to meet the new conditions. Of these, that of obtaining a suitable D.C. supply for the field winding in a moving-coil loud speaker is equally as important as any other, and it was to meet this contingency that the small unit illustrated here came into being. It was designed for a particular case, namely, for a D.C. model taking 100 mA.s at 200 volts, which had now to be operated from a 240-volt 50-cycle A.C. supply.



A.C. rectifier designed for and fitted in cabinet of D.C. model Marconiphone moving-coil loud speaker. (Inset) The rectifier unit.

Transformer Construction.

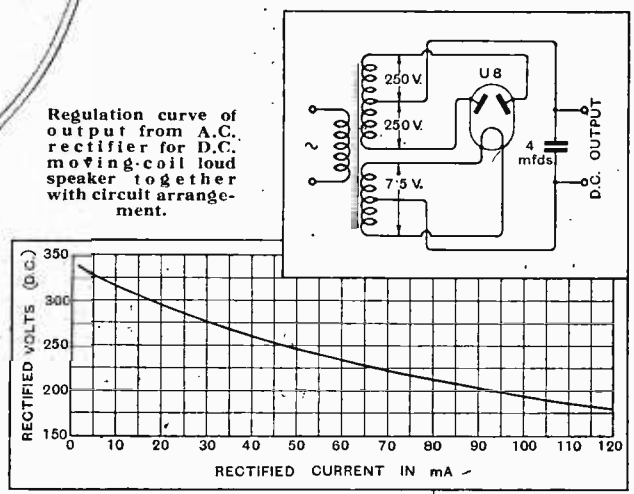
A transformer giving 250+250 volts and 7.5 volts with a centre tap was required to enable a Marconi or Osram U.8 rectifier to be employed. The construction of this transformer is relatively simple. No. 4 size stampings built up to a core size of 1½ sq. in. are used, and the various coils wound on a basis of 6 turns to the volt. The primary consists of 1,440 turns of No. 28 enamelled wire, and the high-voltage secondary has 3,080 turns of No. 36 enamelled wire with a tapping at the centre; i.e., at the 1,540th turn. No. 18 D.C.C. wire is used for the filament, which has 46 turns with a tapping at the 23rd turn. A few layers of Empire cloth wound on between each winding serves as the insulating medium. A paxolin bobbin is used on which to wind the coils.

The amount of wire required is approximately 9 oz. of No. 28 enamel, 8 oz. of No. 36 enamel, and 8 oz. of No. 18 D.C.C.

Most readers will be acquainted with the method of assembling the core as it has been described in detail from time to time in these pages. It will suffice to say that the "T" and the "U" pieces are assembled alternately so that the air gaps do not all fall adjacent to each other. The core should be clamped as tight as possible, and the special cast-aluminium end plates reviewed in these pages some time ago can be recommended for this purpose.

Arrangement of the Circuit.

The other components required comprise a valve holder and a 4-mfd. condenser tested to 1,000 volts D.C. These three components are connected in the manner shown in the diagram accompanying the regulation curve. It will be seen that at 100 mA.s the rectified voltage is a shade under 200 volts.



Regulation curve of output from A.C. rectifier for D.C. moving-coil loud speaker together with circuit arrangement.

With the average type of cabinet loud speaker there should be ample space available to accommodate the unit inside the cabinet so that the size of the baseboard and the disposition of the components must be left to the constructor.

Burndept MERRYMAKER TWO

A Fully Equipped Receiving Installation at an Attractive Price.

THE demand for simple low-priced receivers has been met in the past by a variety of nondescript sets assembled, for the most part, from components of foreign origin. There is now available a British-made set, built by a firm of long standing in the wireless industry, which should completely fill the requirements of the man with only a limited sum available for wireless equipment.

The Burndept Merrymaker Two is a completely self-contained receiver designed for operation from an outdoor aerial. It is housed in a neat dark oak cabinet, with the principal controls at the front. A self-contained loud speaker is mounted behind a sloping grille, and the H.T. and L.T. batteries are both enclosed in the back of the cabinet. The whole outfit, including valves and batteries, sells at £5 15s.

The two-valve circuit comprises a leaky-grid detector with reaction, transformer coupled to a three-electrode power valve. The moving-iron type loud speaker is connected directly in the anode circuit of the power valve, and the unit is provided with adjustment for obtaining maximum sensitivity.

The tuning coils are well designed and are mounted on a built-up paxolin former. An air-dielectric condenser is employed for tuning, while paxolin-dielectric condensers are used for reaction and in the aerial circuit. The series aerial condenser is invaluable as a means of compromising between range and selectivity and should ensure freedom from interference between regional stations under all conditions. At a distance of 5 miles from Brookmans Park, for instance, complete separation of the two transmitters was possible with about one-third of the aerial condenser in circuit, while at a distance of 15 miles the whole of the condenser could be included without causing overlapping of the programmes.

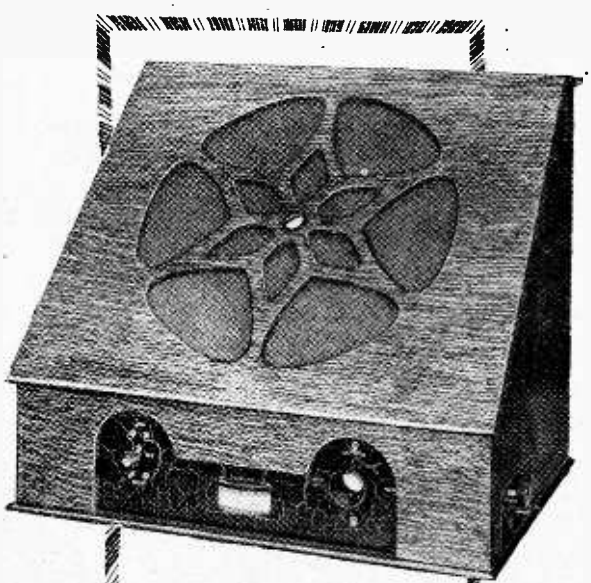
On a good outdoor aerial the sensitivity is fully sufficient to receive two or three of the more powerful Continental stations, but the ability to make full use of the maximum range of the set is naturally dependent on local requirements as regards selectivity. Inside a radius of 8 or 10 miles from the local regional stations it would be difficult to increase the range and volume by means of the selector (aerial condenser) control without allowing the local station to spread over any foreign stations that might be received.

The long-wave range gives Daventry 5XX with certainty, and Radio Paris can also be received at fair volume by careful adjustment of reaction.

With only two valves, and the restrictions imposed by considerations of H.T. current consumption, the designers have wisely decided to arrange that the bulk of the acoustic output is in the middle and upper register, where a given expenditure of electrical energy gives the greatest return in volume of sound. No attempt has been made to achieve a spurious bass response by means of resonances, and the reproduction, particularly of speech, is clear and bright, without hollowness.

A single dry battery provides 100 volts H.T. and 3 volts bias for the output valve. The connections are very simple, and there are only three coloured leads to this battery. The total current taken from the H.T. section is approximately 7.5 milliamperes, so that the battery should be good for at least 250 working hours or about three to four months' normal service. The L.T. current is 0.3 amp., and the 20-ampere-hour accumulator will require recharging fortnightly, assuming four hours' use per day.

To summarise, the Burndept Merrymaker Two can be relied upon to bring in the B.B.C. programmes clearly, and without interference, in all parts of the country, while under favourable conditions there is the possibility of receiving two or three foreign programmes. The initial outlay is small, and the running costs low.



SPECIFICATION.

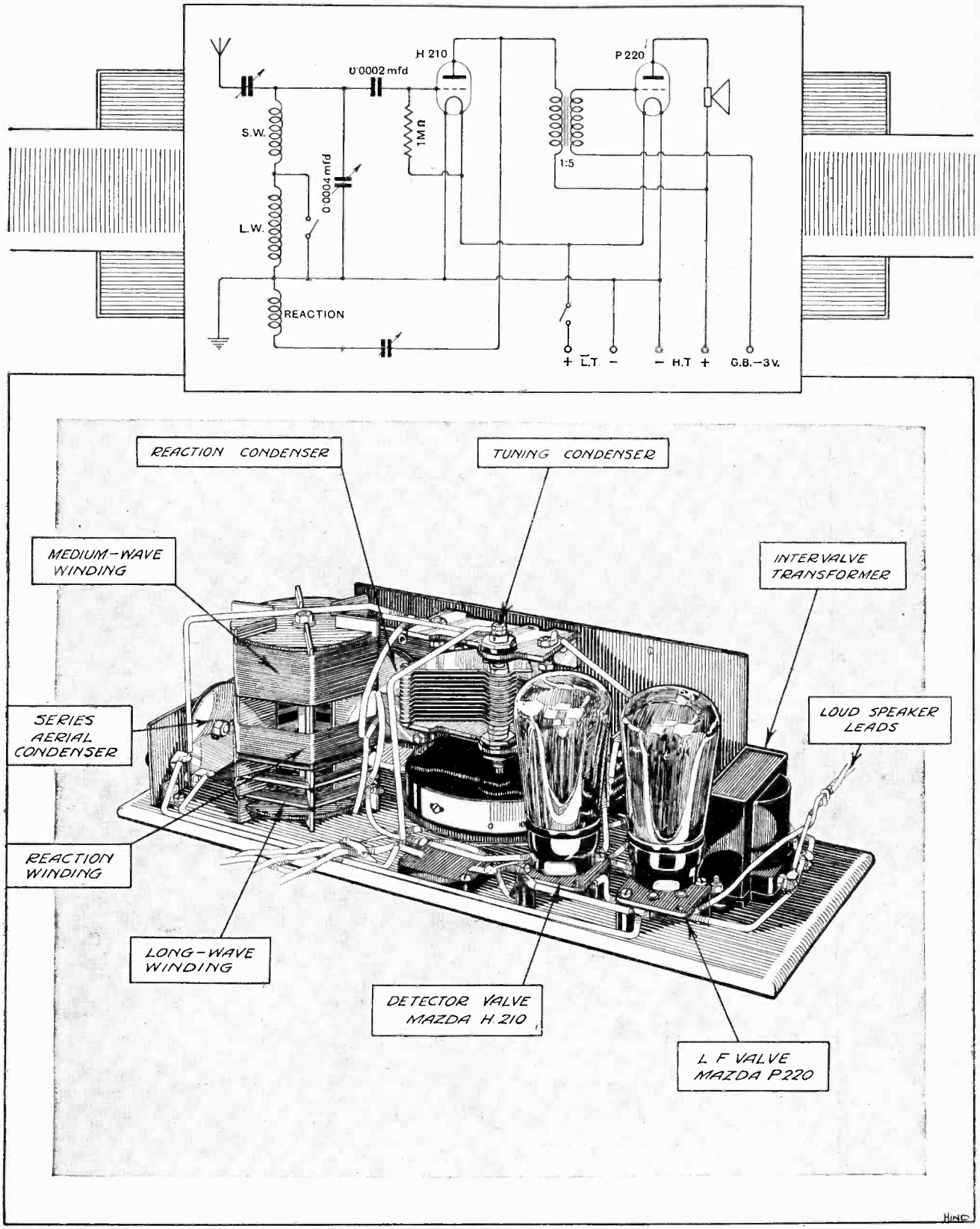
CIRCUIT: Two valves. Reacting leaky grid detector, transformer coupled to power output valve.

CONTROLS: (1) Tuning. (2) Reaction. (3) Selectivity (series aerial condenser). (4) Combined wave-range and on-off switch.

PRICE: £5 15s. including valves, combined H.T. and grid bias battery and 2-volt 20 a.h. accumulator.

MAKERS: Burndept Wireless Ltd., Blackheath, London, S.E.3.

Next Week's Set Review:—
THE NEW GECOPHONE D.C. ALL-ELECTRIC RECEIVER.



Circuit diagram and chassis layout in the Burndept Merrymaker Two.

RELAY SERVICE REGULATIONS

Post Office Control of Wireless Exchanges.

POST OFFICE regulations governing the setting up of "wireless exchanges" are given below. During the past few months much attention has been given to the development of the radio relay service which, briefly, consists of the distribution of broadcast programmes by line connections from a central receiving equipment, the charge for this service usually ranging between 1s. 6d. and 2s. 6d. a week. The popularity of the trouble-free and inexpensive mains-operated set may defeat the growth of the relay service, yet, on the other hand, non-technical listeners may appreciate the reliability which the line connection should offer. Listeners will judge the service by the quality of reproduction provided, bearing in mind that, at the most, only a choice between two programmes is available.

Summary of Conditions Governing the Establishment of Wireless Exchanges.

Besides the usual conditions of the standard wireless receiving licence, the special agreement would provide :—

1. That the Postmaster General should have the right of purchase on "tramway terms," on three months' notice expiring on December 31, 1932, or at the end of any subsequent year, such right to cover the acquisition of the plant and apparatus at the central receiving station, the distributing wires (so far as they were not already the property of the Post Office) and any apparatus provided on subscribers' premises.

"Tramway terms" may be summarised briefly as the value, at the date of purchase, as plant and apparatus in situ exclusive of (1) any allowance or compensation for past or future profits, compulsory sale, goodwill, or the cost of raising capital, (2) any payment in respect of the unexpired term of contracts for renting Post Office wires (except a proportionate rebate of prepaid rental), or (3) any other consideration whatsoever.

2. That the whole equipment must be maintained in satisfactory working condition, and that the Postmaster General shall have the right of inspection of all or any part of it by authorised officers of the Post Office at all reasonable times. That all apparatus used shall be of British Manufacture.

3. That the Wireless Exchange shall distribute only programmes received from public Broadcasting Stations, and shall not itself originate any programme or item for distribution.

4. That the Postmaster General shall have the right to prohibit the distribution of any specific programmes at any time.

5. That the Postmaster General shall have the right to suspend or take over the service in time of national emergency.

6. That each subscriber connected with the Exchange shall hold a separate wireless receiving licence. A similar licence must be held in respect of the Central Receiving Station.

7. That any distributing wire which has caused interference with Post Office telephones, or telegraph circuits, shall be removed, whether or not the position of such wires has been agreed to beforehand with the local Post Office engineer.

8. That a list of the original subscribers to the exchange shall be furnished by the promoters to the Head Postmaster of the district in which the central station is situated, supplemented by a monthly return showing the additions and alterations thereto.

9. That a diagram of the wireless receiver with full particulars of anode current supply and voltages intended to be used at the Central Receiving Station shall be submitted with the application to establish an exchange.

IN BRIEF.

(1) Right of purchase by the Post Office without compensation and on three months' notice.

(2) Apparatus subject to inspection.

(3) Only broadcast programmes to be distributed.

(4) Each subscriber shall hold a wireless receiving licence.

(5) Earth return circuits prohibited.

(6) The Post Office cannot allow the use of their poles for carrying lines nor can they assist in the obtaining of wayleaves.

10. The following technical conditions must be met on the distributing system :

(a) Between the anode circuit at the Central Exchange and the outgoing distributing wires from that exchange a suitable step-down transformer must be provided.

(b) Where a "battery eliminator" is to be used a suitable condenser must be inserted between the anode of the final amplifying stage, and the primary of the step-down transformer. (This involves conditions equivalent to the "filtering" of the steady anode current from the primary of the transformer).

(c) The use of the "earth" as a return circuit in the distributing wire network is prohibited.

(d) In order to prevent interference with telephone and telegraph communications and with the reception of the wireless programmes by licensees having independent wireless receiving sets, the wires between a sub-amplifying station and a subscriber should as far as possible be erected remote from, or at right angles to, existing telephone or telegraph wires, or wireless aerials.

11. The Postmaster General is not in a position to grant wayleaves for distributing wires, nor can he allow the use of Post Office poles for the purpose of carrying such wires.

12. He is prepared, however, to consider the question of providing on a rental basis the wires between the main receiving station and the sub-amplifying stations (but not those sections of the distributing network between a sub-amplifying station and the subscriber's premises) in which case the following conditions will apply :—

(i) The electrical pressure to be used in the final amplifying stage shall not exceed 150 volts, and each individual circuit between the Central Exchange and the sub-amplifying points must be shunted by a resistance of 600 ohms. at the sending end, and the alternating voltage across the resistance must not exceed 1.4 volts;

(ii) amplification used at the receiving end must not be sufficient to pick up cross-talk from adjacent Post Office circuits on the same or neighbouring routes in such a way as to make the messages audible in the broadcast subscriber's instrument;

(iii) for the purpose of measuring the voltage a Moullin voltmeter or other form of calibrated valve voltmeter shall be provided.

Interchange of Programmes.

Sir John Reith, after his visit to America, appears to be in favour of an increase in the number of programmes interchanged with U.S.A., though the scope for relaying American programmes to British listeners is much narrower than that for British programmes retransmitted in U.S.A. So many American-sponsored programmes barely conceal their advertising side, and any form of advertisement is contrary to the B.B.C. policy. A programme with items given by "Libby McNeill," the "Dodge Orchestra," or even "Amos n' Andy," is palpably drawing attention to some proprietary article or motor car.

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The Financial Aspect.

Nevertheless from a purely commercial point of view, the advantage is apparently on the side of sponsored programmes which bring in to the broadcasting companies more revenue than mere licence fees. The B.B.C., after eight years' working, owns to a revenue, from licence fees, of about £1,000,000, whereas Mr. W. S. Paley, the president of the Columbia Broadcasting System of America, has recently stated that after only three years his company is reaping in about $16,000,000 a year from the sponsors of its programmes.

oooo

Empire Short-wave Station.

Savoy Hill is up in arms against the suggestion that has been made that the extra £35,000, which will be handed over by the Post Office as the increased share of licence fees, should be devoted towards the erection of an Empire station at Daventry, as the expenses of the Regional scheme and all the commitments in respect of Broadcasting House will more than swallow up the present revenue.

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Lukewarm Response from Colonies and Dominions.

A year or so ago there was a general feeling in this country that an Empire broadcasting service should be pushed forward with all possible speed, but after negotiations had been established between the Home Government, the Colonies and the B.B.C. to discuss this matter, the response from overseas has proved somewhat disappointing, and the eagerness of the Colonies to participate in an Empire broadcasting service does not seem sufficiently keen to inspire an overwhelming desire on their part to contribute towards the necessary expenses.

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The Scottish Regional.

Scotsmen are not altogether satisfied with the present broadcasting service and openly state that if the B.B.C. wishes to see the number of licences increased in the North, the service must be considerably improved. Savoy Hill admits that an entirely satisfactory service over the large areas of Northern Scotland and the Western Islands has always been a matter of difficulty, as, owing to the mountainous nature of this part of the country, a good service during both daylight and the hours of darkness can only be given on the longer wavelengths.

By Our Special Correspondent.

Falkirk may remedy this defect so far as a large portion of the total population of Scotland is concerned, but I learn that the B.B.C. is considering several additional schemes for relaying the Regional programmes from Falkirk, if necessary, from various points in the more northerly districts, but that nothing will be done until the full effect of the new station is known.

oooo

Musical Criminals.

Outrages committed under the guise of music seem to be on the increase. On two or three recent occasions when tuning in I have heard that deservedly popular song, "In Old Madrid," mutilated and jazzed in an utterly shameless manner, and even the works of Wagner and other masters do not escape the profane hands of jazz-mongers. Surely there is enough musical tripe available for hashing up without degrading old and much-loved favourites to such base purposes.

oooo

Sacrilege and Torture.

Possibly, however, the art of writing pure melody has perished, or those who turn out modern dance music may be so absorbed in the subtle methods of "song plugging" that they have no time for originality, but must desecrate music which, by the grace of God, will live long after their malpractices are dead and forgotten. I must admit, however, that they are not the only offenders. Even serious composers have been known to take such beautiful melodies as the "Londonderry Air" or "Cherry Ripe" and torture them with modern discords, entirely foreign to their natural simplicity, until they become well-nigh unrecognisable and wholly repulsive.

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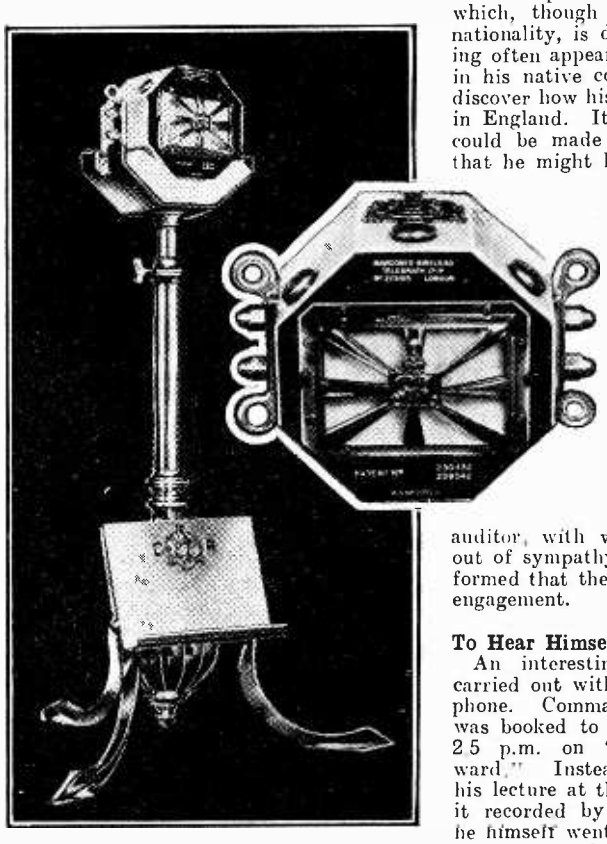
The Unlucky American.

Mr. Charles N. Feidelson, editor of the *Age Herald*, Birmingham, Alabama, was distinctly unlucky on the day he obtained an audition at Savoy Hill. Mr. Feidelson has been a professor of elocution and possesses a soft southern accent which, though it naturally betrays his nationality, is decidedly pleasing. Having often appeared before the microphone in his native country, he was curious to discover how his voice would "go down" in England. It was hoped that a record could be made on the Blattnerphone so that he might hear exactly how his own voice sounded, but here his troubles began, as he found the instrument dismantled. I understand that he first recited some of his own poetry which, my informant tells me, sounded very well, with a total absence of that sing-song booming so commonly heard when poets recite their own works, but this was followed by other verse selected by his auditor, with which he was obviously out of sympathy, and he was politely informed that there was little chance of an engagement.

oooo

To Hear Himself Speak.

An interesting experiment has been carried out with the aid of the Blattnerphone. Commander Stephen King-Hall was booked to give a talk to schools at 2.5 p.m. on "Tracing History Backward." Instead of actually delivering his lecture at the appointed time, he had it recorded by the Blattnerphone while he himself went to a schoolroom at Tooting where, unknown to any of the pupils, he heard his own voice reproduced, and, after the lecture was over, was introduced to the assembly as the speaker to whom they had all been listening.



THE KING'S NEW MICROPHONE. His Majesty will use the microphone for the first time when opening the King George Hospital at Ilford on July 18th. The Marconiphone Company manufactured the instruments.

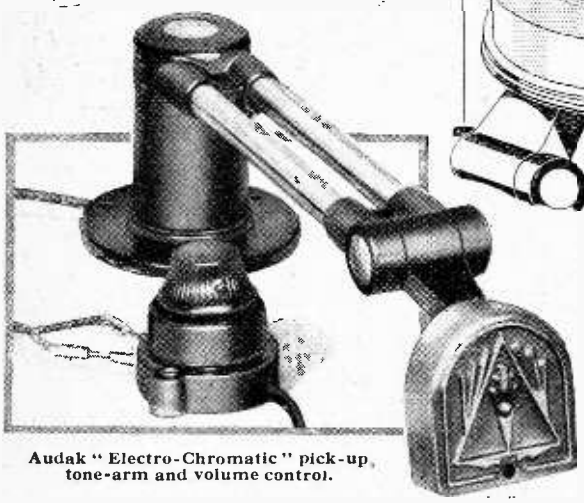
WIRELESS WORLD LABORATORY TESTS

A Review of Manufacturers' Recent Products.

"AUDAK" GRAMOPHONE PICK-UP.

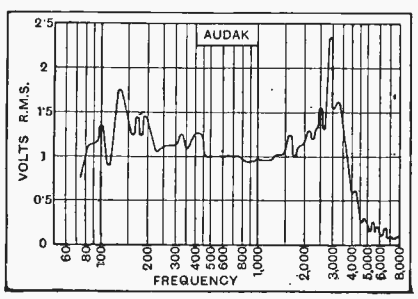
Made by the Audak Company, of New York, this pick-up is obtainable in this country through Messrs. Claude Lyons, Ltd., 40, Buckingham Gate, London, S.W.1.

The workmanship is of a high standard, and the tone-arm bearings are free, but without any trace of play. To facilitate needle replacement the pick-up



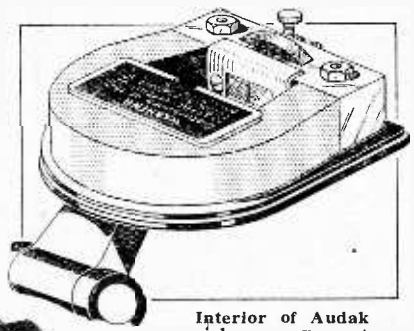
Audak "Electro-Chromatic" pick-up, tone-arm and volume control.

is swivelled near the head, rubber stops being provided to prevent jarring of the movement. The length of the tone-arm is 9¼in., and should give reasonably good needle-track alignment in spite of the fact that the pick-up is not set at an angle with the tone-arm.



Characteristic curve of the Audak "Electro-Chromatic" pick-up with Columbia Ideal needle.

The characteristic curve shows that the movement is sensitive, the average output being in excess of 1 volt R.M.S. The high-frequency resonance in the particular model tested occurred at approximately



Interior of Audak pick-up movement.

3,000 cycles, and was followed by a fairly sharp cut-off, though some response was recorded up to 8,000 cycles. This should ensure that needle scratch is kept within bounds. Record wear is negligible, and the test records are followed down to 75 cycles before the needle shows signs of leaving the groove.

The pick-up is supplied complete with volume control and the price is 6 guineas. We understand, however, that a limited quantity is available at 4 guineas.

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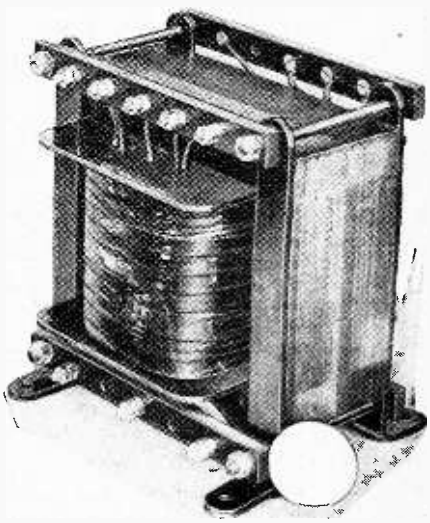
"QUALITY UNIT" MAINS TRANSFORMER.

Quality reception demands a high anode voltage, and the essential component when setting about the design of a quality set is a mains transformer carrying high-voltage, heavy-current windings together with the other necessary windings feeding filament and heater circuits. The "Quality Unit" recently described is a typical example of a class of receiver popular amongst amateurs to-day, and with the exception of a mains transformer can be built with components that are generally to hand.

A mains transformer, styled type BT3x, has been produced for this receiver by W. Bryan Savage, 292, Bishopsgate, London, E.C.2. It carries a 500+500-volt, 100 mA. winding for the high-voltage output, and this is conveniently tapped at 465+465 volts, in order that the design may be followed exactly as given, and even more generous equipment added later without need for change of transformer. In addition, there is the 7.5-volt 2.5-amp. output for the U8 rectifying valve, a 6-volt 2-amp. winding for the LS6A valve, as well as 4 volts 3 amps. for the heaters of three A.C. valves. Connected in a receiver, all voltages were correctly maintained. There was no mechanical hum, and the temperature rise after one hour's work was inappreciable. Although a simple form of construction is adopted with a view to producing a low-priced component, the performance was found to be satisfactory. The price of this mains transformer is 56s.



Savage transformer for use in making up a quality output stage. Dimensions can be estimated by comparison with the half-crown shown along side.

o o o o

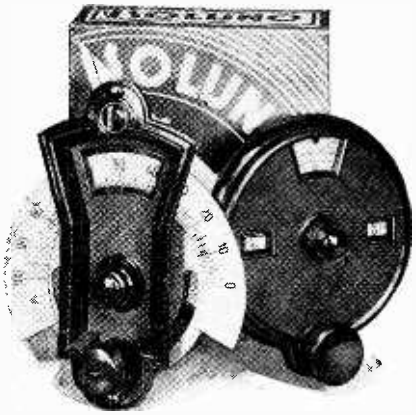
NEW "ISO" DIALS.

The "Iso" range of dials and bakelite knobs is distributed in this country by Geo. Robinson and Son, Ltd., River Plate House, South Place, London, E.C.2. In all there are some twenty-

four different types, ranging in price from 4d. to 12s. 6d. each.

The "Isoluno" vernier dial comprises a handsome moulded bakelite panel plate on which is carried the dial mechanism and an illuminating lamp. A semi-circular ivorine scale, engraved 0-100, is fitted, and a feature of interest is the provision of a small switch, immediately above the aperture, for controlling the dial lamp. The price of this model is 5s. 6d.

For those who favour the plain vernier-type dial for fixing on the front panel, there are many styles listed. The prices range from 2s. 3d. to 3s. 6d., according to shape and size. A typical example



"Isopress" 100 dial, and the attractive "Isoluno" vernier dial, with illuminating lamp and switch.

of this pattern is the "Isopress" No. 100 dial. This is 4in. in diameter and has a 12 : 1 reduction drive. The dial is engraved 0-100, there being two semi-circular dials—one for left-hand drive and one for right-hand drive. This model costs 3s.

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CELESTION PICK-UP.

In connection with the review of this instrument on page 666 of the June 17th issue, it should be noted that the price is £2 17s. 6d. and not £3 15s. as stated. The response curve was taken on open circuit, and the resonance at 4,000 cycles is consequently at maximum. This resonance is considerably reduced when a volume control potentiometer of 250,000 ohms is connected in parallel with the output terminals.

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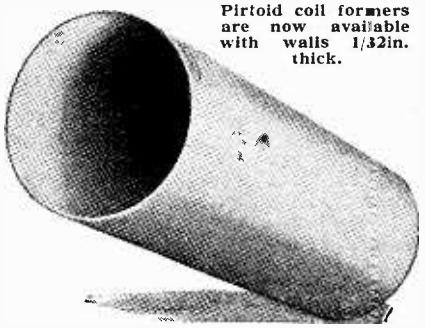
NEW PIRTOID COIL FORMERS.

With the view to reducing the dielectric losses of coils wound on cylindrical formers, H. Clarke and Co. (Manchester), Ltd., Atlas Works, Old Trafford, Manchester, now supply their Pirtoid bakelised tubing with much thinner walls than hitherto. In the latest types the thickness is $\frac{1}{32}$in. only, but despite this they are exceedingly robust.

These formers are available normally in sizes ranging from 1$\frac{3}{4}$in. to 4in. outside diameter and in lengths of from 2in. to 9in. Prices vary according to size. For example, a 3in. tube 4in. long costs 1s. 4d., while one of the same length but 1$\frac{3}{4}$in. in diameter is listed at 8d.



Pirtoid coil formers are now available with walls 1/32in. thick.

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A 10 FT. LOGARITHMIC HORN.

To meet the requirements of the increasing numbers of enthusiasts who are turning their attention to exponential horn loud speakers, the Scientific Supply Stores, 126, Newington Causeway, London, S.E.1, have produced a *papier mâché* horn approximately 9ft. 6in. in length, having a flare 4ft. 4in. in diameter. The throat in diameter is $\frac{5}{8}$in., and the rate of increase of cross-sectional area gives a theoretical "cut-off" at 88 cycles. In practice the horn gives good reproduction of frequencies below this value, though the amplitude may not attain the theoretical maximum.

The horn is mechanically strong and is built in three sections, so that it is easily dismantled and can be taken through normal doorways. Where space does not permit the use of the full length, the first two sections alone will be found to give excellent results.

Tested in conjunction with a Baldwin balanced armature unit, the loud speaker was found to be extraordinarily sensitive, and with an input of less than 500 milliwatts from a simple three-valve set the volume was sufficient to be heard in all parts of a three-storey building. The horn seems particularly well adapted for experiments with moving-coil units.

The price is £4 15s., and Baldwin balanced armature units are available at 25s. 6d.

Scientific Supplies exponential horn. Although nearly 10ft. in length, it is easily dismantled and can be taken in sections through any normal door.

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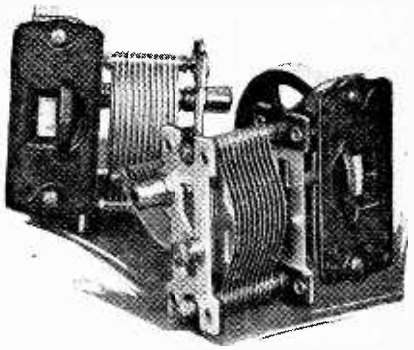
VOLTRON CONDENSERS.

The condensers dealt with in this review are described officially as the Type A6,



Voltron right- and left-hand type condensers fitted with slow-motion drum drive.

and are constructed entirely from aluminium. The pair illustrated comprise one left-hand type and one right-hand type condenser; both are fitted with geared drum drives and moulded bakelite escutcheon plates. They are intended for independent operation, as provision has not been made for simultaneous control in a convenient manner.

The measured minimum capacities were found to be 17 micro-mfds. in each case, and the maximæ 0.000461 mfd. and 0.000456 mfd. respectively. Each condenser has a rated value of 0.0005 mfd.

The moving vanes are supported by two bearings, and the contact with the rotor is made through the back bearing. This appears to be quite satisfactory, as a test failed to reveal the slightest trace of noise due to the friction contact.

The makers are the Voltron Co., Ltd., Ponders End, Middlesex, and the price of the Type A6 is 8s. 6d., including drum drive. The price of each condenser without drive is 4s. 6d.

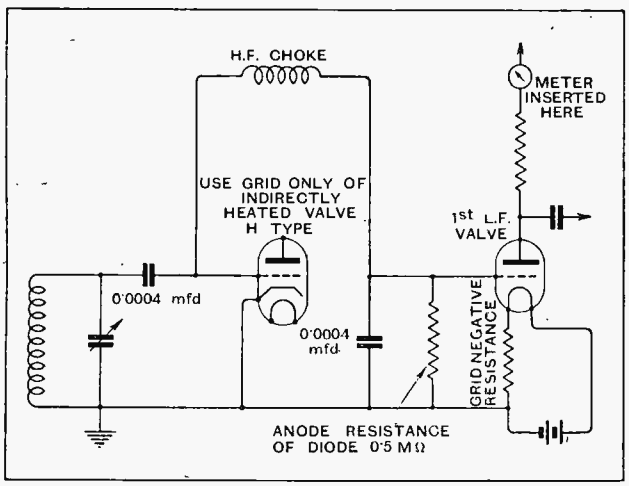
Letters to the Editor.

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.

A NEW DEVELOPMENT IN POWER GRID DETECTION.

Sir,—In the June 10th issue of *The Wireless World* I notice an article by Mr. Colebrook which is unfortunate from my point of view, because I have an article which should have been in print this week. However, it is very interesting to find Mr. Colebrook writing about a thing which I have had in use for the last six months with considerable success. In my particular case I do not employ the same arrangement as Mr. Colebrook, but use one as shown in the diagram, where the grid negative to the succeeding valve is supplied by the drop of voltage in the anode resistance of the diode due to the carrier wave; additional grid negative can, of course, be supplied by any of the usual methods. In this way the linearity of the diode tends to be increased, while the damping on the circuit preceding it is decreased. The advantages of the circuit arrangement are what one would expect; that is to say, considerable improvement in selectivity and sensitivity without the addition of any further adjustments or complications.



By using the circuit shown in the diagram, a meter inserted in the anode circuit of the first L.F. valve will, in effect, indicate the amount of rectified current or voltage.

B.B.C. H. L. KIRKE.
June 16th, 1931.

LOUD SPEAKER MAGNETS.

Sir,—The letter by Dr. N. W. McLachlan in your issue of May 6th, 1931, gives a generally useful criterion of the performance of a magnet intended for a moving-coil loud speaker. It is of interest to note that $B_g^2 V_g f_s$ as given is equal to 8π times the magnetic energy in the material of the conductor forming the moving coil. This is directly proportional to the square of the force applied to the diaphragm per unit power supplied to the coil, as shown below :—

i = current in coil.
R = resistance of coil.
P = power dissipated in coil.
l = length of conductor.
a = cross section of conductor.
V = volume of conductor.
ρ = specific resistance of conductor.
F = force applied to diaphragm.
M.E. = magnetic energy in the conductor.
B_g = flux density in gap.

Then :—

$$F = B_g i l = B_g \sqrt{\frac{Pl^2}{R}} = B_g \sqrt{\frac{P\,al}{\rho}} = B_g \sqrt{\frac{P\,V}{\rho}}$$

$$\therefore \frac{F^2}{P} = B_g^2 V \frac{l}{\rho} \qquad \therefore \frac{F^2}{P} = \frac{8\pi}{\rho} \text{M.E.}$$

Since $\text{M.E.} = \frac{B_g^2 V}{8\pi}$ in air.

It is important, however, not to confuse this with the overall efficiency of the system, which depends not only on the driving force, but, among other things, on the relationship between the mass of the moving system and that of the coil. If the latter is above a certain value then the efficiency falls.

Further, a very large coil will have a high inductance-resistance ratio, which will cause a falling off in the current at high frequencies. KOLSTER-BRANDES, LTD.

W. S. Percival, Research Dept.

THE VALUE OF THE AMATEUR.

Sir,—I see that Mr. F. G. Kay has been bold enough to state his opinion that the amateur has contributed nothing towards the progress of radio.

Your paper, widely read by amateurs, gives him that dignified rebuke which no doubt you feel he deserves. Nor do you rely upon your own judgment. Dr. Eccles supports you in saying that all minor improvements and most inception was due to the amateur.

Then again, your correspondent, Mr. Skinner, begs to be allowed to inform Mr. Kay that one of the first broadcasting stations in England was run almost entirely by persons who had originally been amateur-experimenters. May I crave your indulgence to deny this statement?

Also Mr. Marcuse says that the first broadcasting came about by amateur effort. No! Mr. Marcuse, the first broadcasting (Chelmsford, 1919) was initiated by the professional, H. J. Round, and was shut down by that equally professional person, the Postmaster General.

Mr. Nickless says that a large percentage of the B.B.C. technical staff is recruited from the ranks of amateur transmitters. I wonder if this is true, and if any of the research development people and the directing heads of the technical side were ever amateur transmitters? If so, they have kept their past from me.

Truly, though, it is only facts which are interesting. I am not informed, and this letter is to elicit the facts. The great initiations were the first induction experiments, the illustration of electric waves by experiment, the fundamental wave formulae, the grounded aerial, the coherer, the crystal, tuning, the rectifying valve, the triode and the reversion to short waves after the valve. It is almost impossible to believe, however, that Dr. Eccles would like Faraday, James Clerk-Maxwell, Hertz, Marconi or Lodge to be described as "hams." The minor improvements are legion and cannot be listed.

Personally, I think the amateur has been of great value, inasmuch as, in the mass, he gives us a vast quantity of statistical information. I do not think, truly, he can claim powers as an initiator only because he has been valuable as an observer. Further, one who begins as an amateur frequently ends as a valuable professional. I hope the amateur movement will always be encouraged and supported.

In the end might one put in a plea for common sense and goodwill? If we are amateurs or professionals ought we not all be glad to be of help in however small a way? And ought we not to be proud of recognition when it comes our way? Proud for ourselves, our colleagues and those whom we serve? But if there is going to be a debate ought we not to investigate facts? P. P. ECKERSLEY.

London, W.3.

Sir,—To answer all the charges of "intolerance," "hatred," "wild statements," "shortsightedness," and so forth, that were levelled against me in your issue of June 10th by outraged amateur transmitters would take much more space than can be spared for airing views on a subject which my critics are rapidly turning into a cheap brawl. amateur transmitters *v.* F. G. Kay. Incidentally, I thank Mr. Hum for his remarks, but would like to confess that I am not nearly such an ignoramus as he would evidently like me to be, even though I am a mere listener.

I still uphold the statement that caused all the rumpus.

Amateur transmitters have not been responsible for the high technique of 1931 radio. They may have pioneered the way in the early years, but that is all. It was the same with the steam locomotive and the aeroplane, for instance. Amateur enthusiasts pointed the way, but it was the financial resources and the brains of the commercial concerns which made these inventions universally useful.

Now as to my alleged selfishness. Over a hundred years ago "The greatest good is for the greatest number" became a political war cry. To-day it is an internationally accepted truism. The aim of broadcasting is to provide entertainment for the masses, not to provide scientific data for the few.

Perhaps I may just say a few words about my own small experience of amateur transmitters. I believe they are supposed to promise to experiment with some aim in view. With some of them I say emphatically that this is a "blind." One "ham" whom I knew said he studied the effect of sunspots on transmission and reception. It was generally rumoured that his material was "lifted" from a popular book on the subject. This gentleman's principle object was to gain a varied assortment of highly decorative QSL cards and to write numerous letters in a prostituted form of English to fellow transmitters.

I think that most sensible persons will agree that it is hardly fair for several million people to forgo their entertainment so that a score or so can indulge in this sort of thing.

Before closing I should like to say how really pleasant it was to read the restrained and sensible letters from Mr. Marcuse and Mr. Lawler, and the Leader of the June 17th issue.

F. G. KAY.

Hampstead, N.W.3.

GOOD REPRODUCTION.

Sir,—It seems to me that one or two of your correspondents have not appreciated the point of my letter in your issue of May 6th. In that I did not criticise your contributor for showing how to get the best out of cheap equipment, but I did, in effect, say that the results, when obtained, would not be *good* reproduction. With "inexpensive quality" I am not concerned, as I consider this tag absurd. Quality never was and never can be inexpensive; my letter was headed "Good Reproduction," and I outlined what I considered this called for.

I should like to reply to your three correspondents' letters. "Rendisle" must not think that the Wireless Military Band and the B.B.C. Dance Orchestra are, in my opinion, not good broadcasts, *as such*. If O'Donnell would play Sousa marches, for example, I would like them and his band, but when he plays odd movements from Tschaikowski's Sixth Symphony the results are deplorable. Again, Jack Payne did "With My Guitar" delightfully, but his version of Ravel's "Bolero for Orchestra" and his concert arrangement of "Song of the Dawn" were musical nightmares; so I say, let the cobbler stick to his last, O'Donnell to military band music and Jack Payne to dance numbers.

Now for "Veritas." His last paragraph is dealt with above, and I have nothing else to say to him except that it is unfortunate that he lets the cat out of the bag by telling us that his room is 10ft. by 6ft., *and has padded walls* (I hope he will soon be cured), and that he chose a pseudonym which has long been associated with a certain form of artificial light, namely, gas, the use of which is bound to produce a certain amount of "hot air."

I am not sure that I have caught the drift of Mr. Pratt's letter, but I may be able to clear up one or two points for him. My opinions on loud speakers have been formed as a result of testing nearly every loud speaker that is, or ever has been, on the market, not in the home, but in the laboratory, and I have already said that moving-iron loud speakers are surprisingly good *within their limitations*. That, however, is as far as I will go, because it is so obvious to anyone who does know anything about music that, at present, the listener does not get a reproduction of the sound that goes into the microphone, and it is my contention that the fault does *not* lie with the B.B.C.

In putting extracts (4) and (5) from my letter together I suppose he infers that *he* was amused because *I* boasted of my reception, but here he has undoubtedly "dropped a brick." If extract (4) be read with its context he will find that I am defending the quality of the B.B.C. transmissions, and not boasting of the quality of my reception. "It seems that everyone, even criminals and those that criminally criticise, make errors in carrying out their plans, and" Mr. Pratt "should have been so careful with his letter that he did not stultify himself with his own pen."

I will agree with Mr. Pratt that "M.C. reproduction is accepted by many as the nearest approach to good quality obtainable through our congested ether," and, in fact, I will add that it happens to be my own opinion, too, but it is also my opinion that none of the moving-coil loud speakers on the market, nor any of those described in *The Wireless World* or elsewhere, are good enough for a critical musician. I may be wrong, but that is what I think.

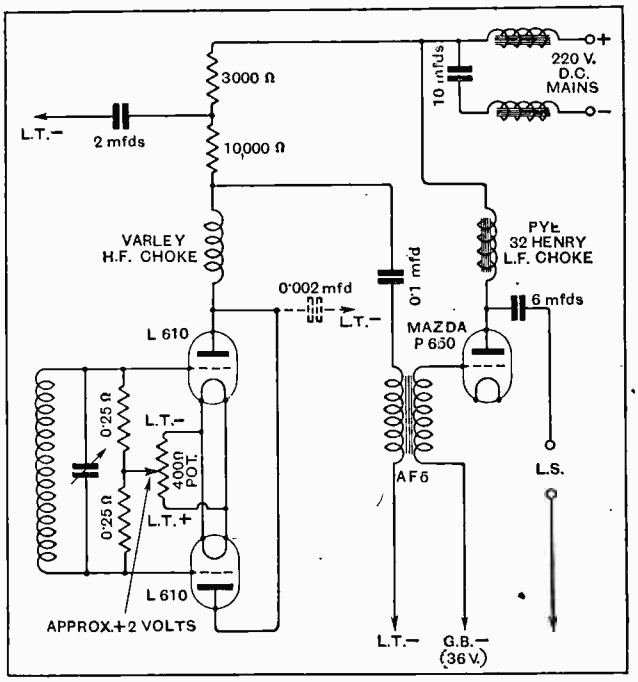
Finally, I have no "secret of reception." I gave, in my letter, what I considered one required for really good reception. If Mr. Pratt likes to make, or have made, a receiver, amplifier and loud speaker to conform to these requirements then he will have really good reproduction. Until he does he won't have it, and that is all there is to it.

H. A. HARTLEY.

Isleworth, Middlesex.

AVOIDING DETECTOR DISTORTION.

Sir,—With reference to the article by F. M. Colebrook, on "Avoiding Detector Distortion," in the May 20th issue of *The Wireless World*, it may be of interest to you to learn that I had previously modified my detector circuit to the push-pull grid rectification circuit mentioned in the article, the idea having been inspired by your previous articles describing the Science Museum Receiver. A diagram of my detector and L.F. circuit is appended. On testing this circuit, it was found that the

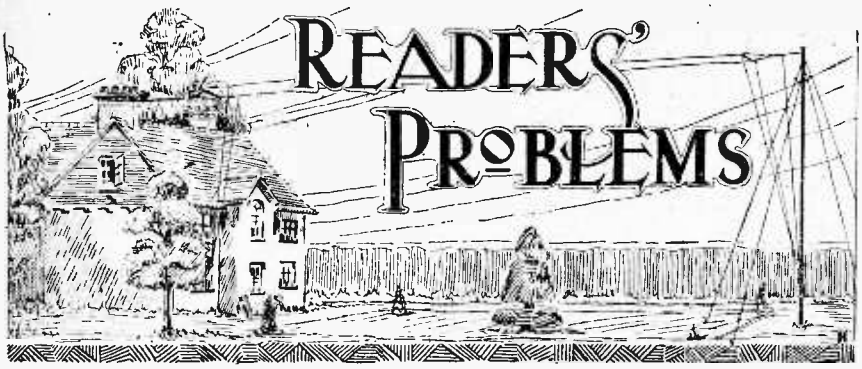


general quality, particularly of the high notes and the "s" sounds in speech, was improved out of all expectation. In fact, the "s" sounds are now almost natural on my 66R loud speaker. Sensitivity is also greatly improved.

It has been found necessary, however, to omit altogether the usual "H.F. by-pass" condenser, shown in dotted lines on the circuit diagram, otherwise violent and continual oscillation, presumably of the detector stage, occurs at a supersonic frequency, though this oscillation, curiously enough, ceases on breaking the filament circuit of either of the 2 S.G. valves preceding the detector stage. Bearing in mind that this phenomenon has only occurred since modifying the detector stage, I would welcome any comments that you could make on it.

In conclusion, I would like to say how much I appreciate *The Wireless World*, and consider that it is the only wireless periodical that treats its subject in a systematic and thorough manner.

E. C. H. FEATHERSTONE, Lieutenant, R.N.



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.

Power Transformer Defect.

It is found that the various voltage outputs of my eliminator power transformer have increased sensibly since the component was first put into use: do you think that this will be due to the fact that a short-circuit has developed across a number of the primary turns, thus reducing the reactance of this winding, and allowing an increased primary current to flow?

No; almost invariably the effect of a short-circuit across a part of the primary winding is to bring about a reduction in secondary voltage, and not to increase it.

We can only think that your comparative voltage measurements have been taken under different conditions as to load, or, alternatively, that the mains supply voltage has changed.

The insertion of a suitable resistance in series with the mains and the primary winding will prevent the possibility of damage to the valves; as you apparently have access to an A.C. voltmeter, the right value for this resistance can easily be determined by trial and error.

o o o o

Contrary to Regulations.

It would seem to be quite possible to connect a half-wave rectifying valve directly to A.C. mains without the intermediary of the usual power transformer. By omitting this component the cost of an eliminator would be greatly reduced; will you please tell me if there is any serious objection to this plan?

Theoretically, there is no need for a transformer if it is assumed that the mains voltage is suitable for application to the rectifying valve, or if some limiting device be included in the circuit. But in practice this plan is seldom adopted, and is not countenanced by official regulations and recommendations; by using a double-wound transformer of the usual type, the receiving apparatus can be effectively isolated from the earth and mains supply, and the risk of damage through short-circuits is greatly reduced. Moreover, we think that you over-estimate the economy effected by omitting the H.T. transformer. It should be pointed out that, in any case, a step-down transformer is practically essential for heating the rectifier valve filament, and the extra cost of an H.T. winding is not very great.

o o o o

D.C. Bias Battery Eliminator.

Although 240-volt D.C. mains are available, I do not at present use this source of supply for feeding my set, excepting indirectly for charging H.T. and L.T. accumulator batteries. Will you please tell me, if it is possible, how to obtain grid bias voltage from the mains. I have a 10,000-ohm resistance, with a number of tappings, which I believe would be suitable. A maximum bias voltage of about 30 is required.

Grid bias voltages can be obtained from a D.C. mains supply, although it is rather unusual to do this, except in the case of a set deriving H.T. current—and often L.T. as well—from the same source.

In Fig. 1 we give the circuit of a simple eliminator, which should prove quite satisfactory. Your 10,000-ohm resistance will serve as a potentiometer.

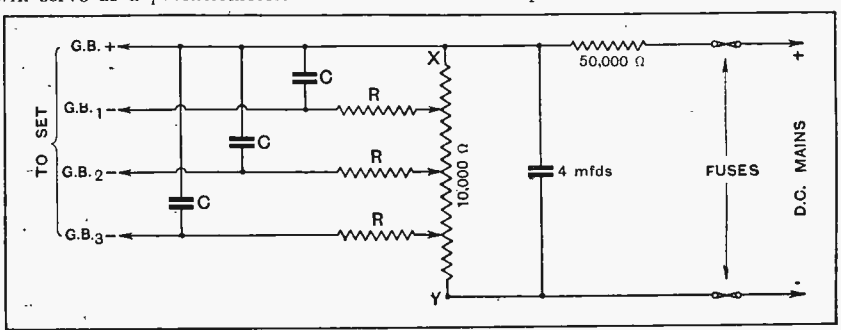


Fig. 1.—Simple grid bias eliminator for D.C. mains. Assuming a 240-volt supply, 200 volts are absorbed by the 50,000-ohm resistance, leaving 40 volts for bias purposes across the tapped potentiometer.

By arranging matters as shown, a voltage drop of 40 volts will exist between the points X and Y on the potentiometer; this is rather greater than you require, but it is as well to have some latitude, and by choosing this voltage a limiting resistance of a readily obtainable value may be used. There will be no difficulty in determining the actual voltages applied from the various tappings if it is realised that the potential drop between X and Y is strictly proportional to the amount of resistance in circuit. For example, if the G.B.2 tapping be made at the centre point, a voltage of 20 will be applied.

o o o o

Superheterodyne Input Filter.

In the article in which The Wireless World "Super-Selective Six" was described it was urged that a capacity-coupled filter would be unsuitable for the input circuit, as its use would tend to introduce long-wave interference. Am I correct in assuming that these strictures apply only to the type of filter coupling in which the two circuits are linked by a large condenser which is common to both?

Yes; the type of filter in which the component circuits are linked by a small condenser joined between their high-potential ends will not be responsible for long-wave interference troubles.

o o o o

Gramophone Volume Control.

It seems that, in almost all modern radio-gramophones and receiving sets with provision for the use of a pick-up, volume is controlled by a potentiometer shunted directly across the pick-up. In my own set, which comprises an H.F. stage followed by a detector and two low-gain resistance-coupled stages, this operation is effected by means of a potentiometer in the anode circuit of the detector—this valve, of course, becomes an L.F. amplifier when the set is used for gramophone work.

Do you think that it would be possible to improve upon my existing arrangement by adopting what seems to be the more conventional plan?

This is largely a matter of convenience. Provided that your detector valve, when negatively biased to act as an amplifier, can accept the maximum voltage impressed on its grid by the pick-up without overloading, there is not the slightest reason why the arrangement you are using should be unsatisfactory. We cannot think that any benefit would result from making a change, unless this valve is at present being overloaded.

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AND RADIO REVIEW

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An Urgent Obligation of the B.B.C.

SINCE the earliest days of broadcasting in this country the skill of designers has been severely taxed in the endeavour to produce receivers operating satisfactorily on both the long and medium wavelengths, and the production of such sets has been costly in the extreme as compared with what it would have been if receivers had been required to function only on a single wavelength band. The time has now come when our manufacturers have perfected dual wavelength receivers, and nowhere else in the world has such an exacting job been attempted with such gratifying results. To-day the manufacturers are in the position of being able to reap the reward of their endeavours by producing these dual wavelength sets at low prices whilst giving the purchaser the benefit of the falling costs of production.

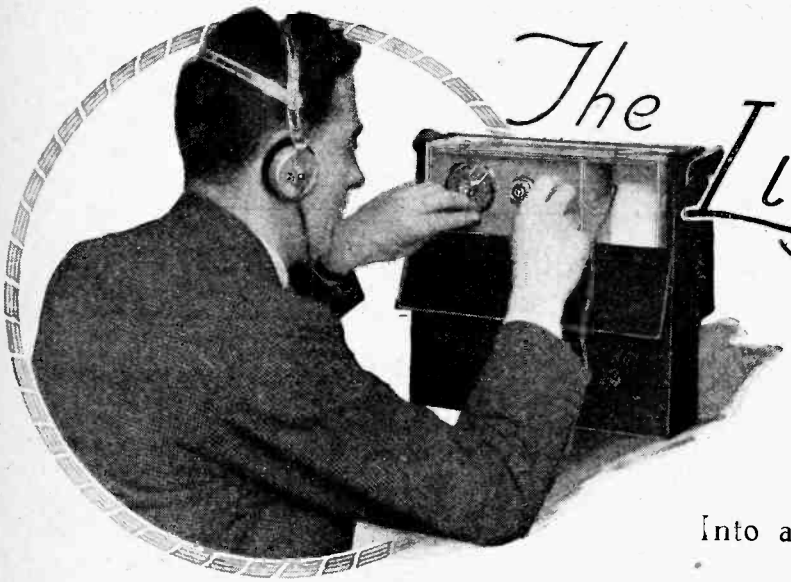
But to what end has the British manufacturer grappled with this handicap in design and production? The answer, in our opinion, rests entirely with the B.B.C. The early policy of broadcasting here has saddled the B.B.C. with a very grave responsibility, yet instead of maintaining the importance of the long-wave station, the B.B.C., as we have pointed out repeatedly in these columns, has tended during past years to make the long-wave transmitter merely a distributor of scrappy information, combined with a duplication of programme matter sent out from the shorter wavelength stations. So serious is the position that we gather that manufacturers here are considering whether it is worth while to continue to provide for long-wave reception at all in their future receivers.

The policy of the B.B.C. in this respect is, in our view, the most disastrous "let down" for the British set designer which could have been devised even if it had been deliberately carried out by the B.B.C. having this object in view. The B.B.C ought not to be in a position to juggle with its policy in such a way as to harass the British manufacturer and add to the already serious enough difficulties which he has had to contend with in adapting his receivers to those constantly changing conditions over which neither he nor the B.B.C. have any control.

But, apart altogether from these considerations, the long-wave station is indispensable over vast areas of the country, besides which it is regarded abroad as representing British broadcasting by reason of the fact that its superior range makes it audible all over Europe. Just as it has been the duty of the British manufacturer to supply receivers capable of receiving the long-wave station, so is it now the imperative duty of the B.B.C. to provide essential programmes for which these sets have been designed.

The proper attitude for the B.B.C. to adopt would be at once to make the programmes of 5XX so attractive and distinctive as to be indispensable to the listener. It should be a one hundred per cent. national transmitter, and cease to act merely as an alternative for the medium-wave programmes.

In This Issue



The Lightweight Portable

A Compact and Inexpensive Receiver Designed to Fit Into a Gramophone Record Carrier.

By H. F. SMITH.

EVER since broadcasting began, it has been the custom of the lay Press to depict the use of portable wireless receivers in all sorts of unsuitable and even absurd situations. Indeed, the writer feels that he has rather missed a journalistic opportunity, and, to be in the fashion, should have linked up with the latest craze; by fitting a couple of shoulder straps to the little set to be described in this article, it might aptly have been described as the "Hikers' Two," and would then have been accorded nation-wide publicity.

All this clap-trap has rather tended to bring into undeserved disrepute the practice of listening to broadcasting when away from home, and the average sensible citizen is inclined to think that the only advantage of a self-contained set is that it may be moved from one room to another. In this opinion he is surely wrong; occasions sometimes arise when a portable receiver is really desirable, but hardly often enough to justify the purchase of an expensive multi-valve outfit.

Ignoring the question of cost altogether, it is a fact that most of these sets are rather too heavy and bulky for transport in these days of "travelling light." What seems to be needed is a genuine lightweight set, which can be carried without any trouble, occupies hardly any space, and is cheap enough to build for occasional and intermittent use only. Obviously, it will not compare, in the matter of performance, with more ambitious sets, but there is no reason why it should not satisfy all reasonable requirements.

For a receiver of the kind with which we are concerned, it is, practically speaking, hardly necessary to consider any other circuit arrangement but a detector-L.F. combination. Worth-while H.F. amplification is ruled out on the score of excessive bulk, while, for the same reason headphones are infinitely better than a loud speaker. Provided that good control of reaction can be obtained, the range of such a set is extraordinarily good, thanks largely to the efficiency of modern valves. If the signal pick-up of the frame is found to be inadequate, as it may be in remote districts, a rudimentary external aerial may be added to make good any deficiency in signal strength. Under fair conditions, a modern high-power broadcasting station should be well received at considerably more than fifty miles' distance in daylight on the built-in frame aerial alone. At night time Continental transmissions may often be heard under the same conditions.

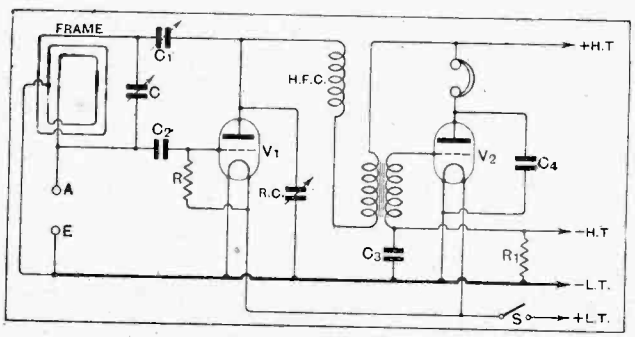


Fig. 1.—Complete circuit diagram. C, tuning condenser, 0·0005 mfd.; C_1, reaction feed condenser, semi-variable, 0·0001 mfd. max.; C_2, 0·0003 mfd.; C_3, 1 mfd.; C_4, 0·002 mfd. R.C., reaction condenser, 0·0005 mfd.; R, grid leak, 2 megohms; R_1, bias resistance, 400 ohms.

Reference to the accompanying circuit diagram will show that the regenerative detector valve is connected in a throttle-controlled "Hartley" circuit. This is an arrangement that has been popular with *Wireless World* readers for some time, and experience shows that, judged on a combined basis of simplicity, effectiveness, flexibility, and smoothness of reaction control, it is impossible to devise anything better. Anode circuit impulses are fed back to the grid circuit through the small semi-variable condenser C_1, the actual amount of reaction feed-back being controlled by varying the by-pass effect of condenser R.C.; as the value of this capacity is reduced, a greater proportion of the total available H.F. energy is deflected through the feed condenser. The centre-tapped frame aerial acts as a combined tuned grid coil and reaction winding.

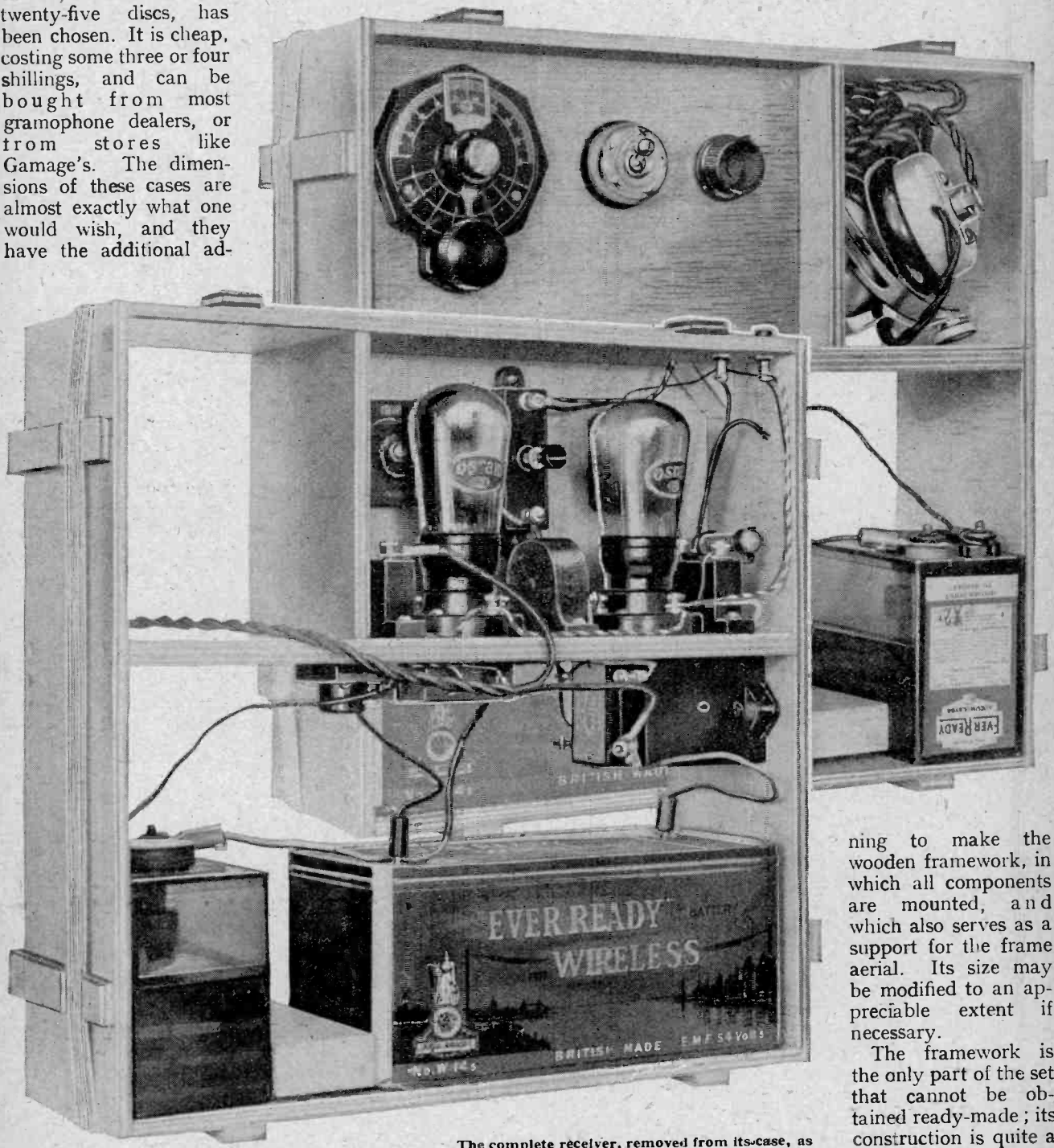
The Lightweight Portable.—

There is nothing unconventional about the transformer-coupled output valve, except that free bias is included. By doing this, an extra battery is avoided, and the advantage of more or less automatic compensation for variations in H.T. voltage is obtained.

As a container for the set, a gramophone record carrier, intended to hold twenty-five discs, has been chosen. It is cheap, costing some three or four shillings, and can be bought from most gramophone dealers, or from stores like Gamage's. The dimensions of these cases are almost exactly what one would wish, and they have the additional advantage of being neat, light, and inconspicuous; they are quite strong enough to withstand ordinary usage.

Internal measurements of the case actually used are approximately 12¼in. in height and width by 3¾in. in depth. So far as can be ascertained, these dimensions are more or less standardised, but prospective builders of the set are advised to check this point before beginning to make the wooden framework, in which all components are mounted, and which also serves as a support for the frame aerial. Its size may be modified to an appreciable extent if necessary.

The framework is the only part of the set that cannot be obtained ready-made; its construction is quite a simple task for the



The complete receiver, removed from its case, as seen from front and back. Note that the bias resistance and large by-pass condenser are secured to the under-side of the baseboard; also mounting of the L.F. transformer.

The Lightweight Portable.—

amateur, but no doubt the local joiner would undertake the work for a few shillings if desired. As shown in Fig. 3, in which full details are given, plywood is used throughout; the thickness of the panel is ¼in., and this is set back from the front to allow a clear inch of space for the condenser knobs and switch, which project from the front. It will be found advisable to assemble the baseboard, panel, and vertical partition (which forms a compartment for the head phones) as a separate unit, and to secure this in position with wood screws after mounting and wiring the components.

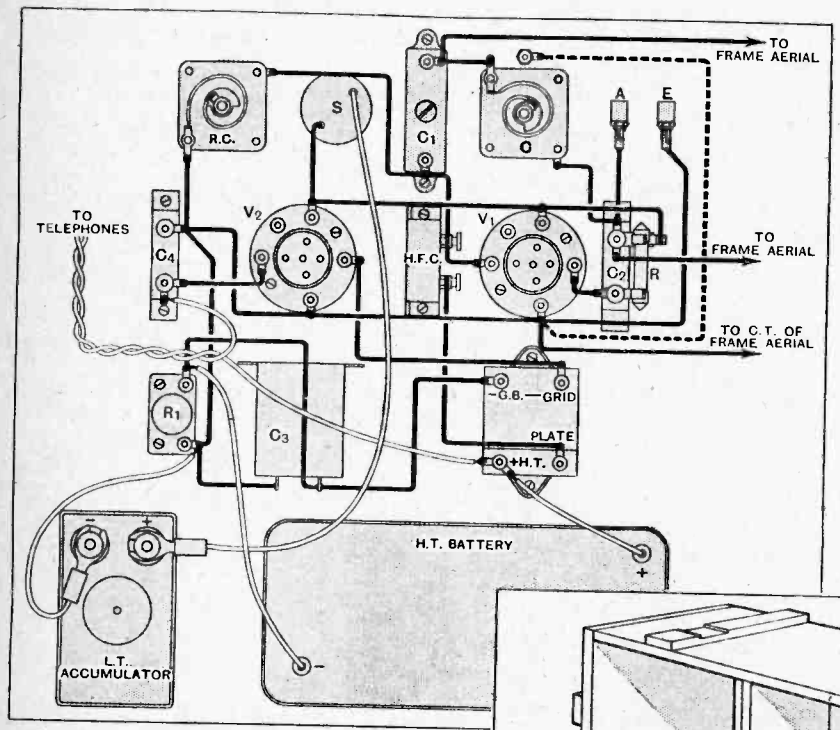


Fig. 2.—Practical wiring plan, with components as nearly as possible in their actual relative positions. An earthing connection for the tuning condenser screen plate is shown in dotted lines.

A series of slotted wooden blocks are secured to the outside of the frame to act as supports for the loop aerial, which consists of eighteen closely wound turns of No. 24 D.C.C. wire, tapped at the centre point.

At this juncture it should be pointed out that no provision for long-wave reception is made, as experience shows that the average user of this type of set does not need it.

The fitting of a second frame winding in such a restricted space is a matter of some difficulty, and, if the alternative method of loading the frame is adopted, signal pick-up will be rather poor. However, the second plan is the better of the two, and should certainly be adopted if it is expected that the set will be used for reception of 5XX at considerable distances with an added external aerial; in these circumstances the use of a loaded frame is, of course, quite sound practice.

All components, except the batteries and L.F. transformer, are mounted on either the baseboard or front panel; it has been considered unnecessary to prepare the usual dimensional layout diagram, as positions will vary if one or more parts of different size to those chosen by the writer are used. In any case, the relative positions are clearly shown in the accompanying illustrations, and layout is not of vital importance in any detector-L.F. set.

There are, however, one or two points that should receive attention. It is desirable to wind the aerial towards the rear of the frame, so that it will be some distance away from the operator's hand, thus avoiding capacity effects. Similarly, a tuning condenser dial with a metallic screening plate that may be directly earthed is a refinement that is definitely worth while; the only real drawback of the throttle-controlled Hartley circuit is that both ends of the tuned grid circuit are at high oscillating

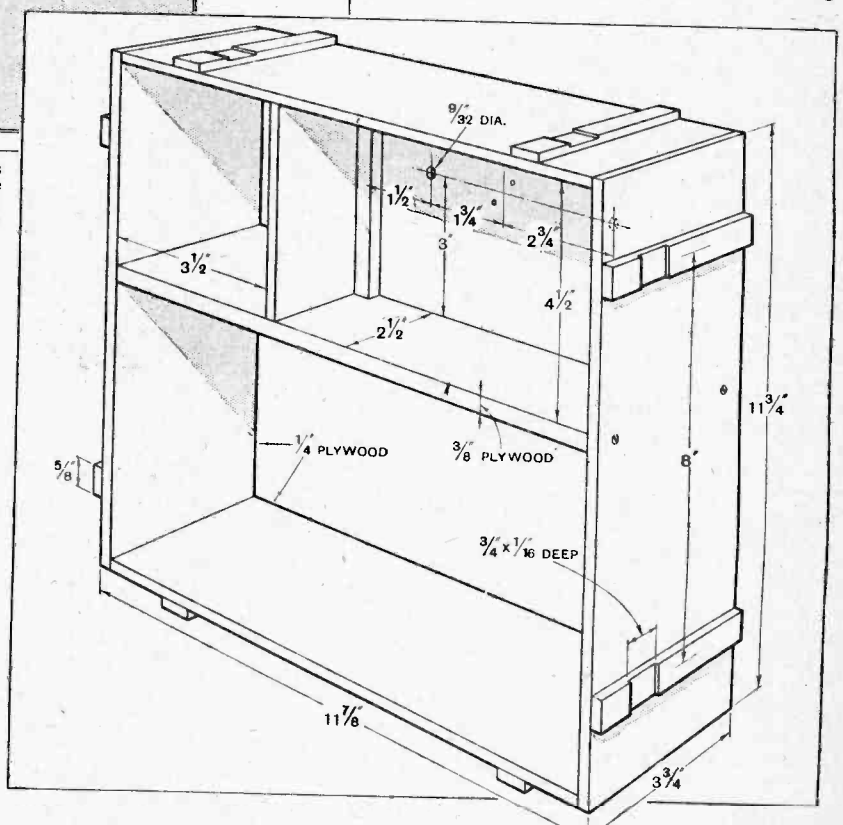


Fig. 3.—Constructional details of the wooden framework, as seen from the back. Position of holes for the panel components may need slight alteration if the opening of the container actually used is different from that of the original case.

LIST OF PARTS REQUIRED.

2 Variable condensers, solid dielectric, 0.0005 mfd. .....(Polar "Trimmer" Type)
1 Slow-motion condenser dial (Ormond Miniature Type)
1 Fixed condenser, 1 mfd. ("Helsby"; British Insulated Cables, Ltd., Prescot, Lancs.)
1 Fixed condenser, 0.0003 mfd. with grid leak clips.....(Dubilier, Type 620)
1 Fixed condenser, 0.002 mfd. (Dubilier, Type 620)
1 Semi-variable condenser, 0.0001 mfd. maximum .....(Formo)
1 Grid leak, 2 megohms .....(Dubilier)
2 Valve holders.....(W.B.)
1 H.F. choke .....(Telsen)
1 L.F. transformer .....(Varley Nicore II)
1 Fixed resistance, 400 ohms .....(Watmel)
2 Plug sockets, with insulating bushes ....(Clix)
1 On-off switch.....(Bulgin, Type S.42)
2 Spade terminals .....(Clix)
2 Wander plugs .....(Clix)
1 L.T. accumulator, 2 volts (Ever Ready, Cat. No. 2123)
1 H.T. battery, 54 volts (Ever Ready, Cat. No. W.14)
1 pair headphones .....(Ericsson)
Case, wood, screws, wire, sleeving, etc.

This list gives the actual components used in the construction of the set. There are certain instances where alternatives of other manufacture may be introduced, but readers must take into account the quality and suitability as regards dimensions when adopting a substitute.

potential, and hand-capacity effects will be troublesome unless these precautions are taken.

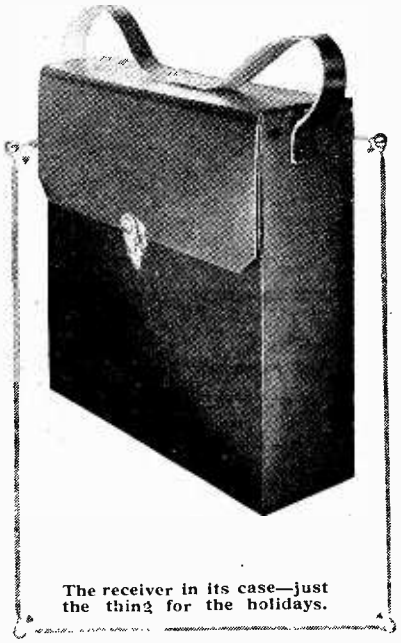
As the L.F. transformer is screwed to one of the vertical frame members, and is not a part of the receiving unit, it will be necessary to complete the wiring of this component after the main assembly has been placed in position.

Regarding the choice of valves, it is permissible to use "general purpose" types, with A.C. resistances around 20,000 ohms, for both detection and L.F. amplification, but a good specimen of the "L" class will generally be preferred for the latter function. The valves actually used by the writer are Osram H.L.210 and L.210; any radical differences in characteristics may necessitate a change in the value of R_1 (the bias resistance) but, as a matter of fact, these free bias devices are largely self-compensating. For instance, if an output valve of higher impedance be substituted, anode current will be less, and so bias voltage developed across the resistance will fall, as it should do.

Operation of a set with throttle reaction differs from the more conventional arrangements in that sensitivity is increased as the reaction condenser is *decreased* in capacity. To make the initial adjustments, it is best to set this condenser so that its fixed and moving vanes are about half-enmeshed (or a little more) and then to manipulate the semi-variable feed condenser knob (C_1) until the set is just oscillating. The adjusting screw of C_1 may then be locked in position, as control of regeneration can now be effected entirely by the throttle condenser R.C. This preliminary adjustment should preferably be carried out when the set is tuned to a wavelength of about 300 metres.

If the set is to be used on rare occasions only it may be preferred to substitute dry cells for the L.T. accumulator, which, of course, will need periodical recharging whether it be used or not. Information on this subject was given in the "Hints and Tips" section of *The Wireless World* for June 24th, where it was shown that the valve filaments might with advantage be connected in series.

If occasion arises to use an external aerial-earth system it should be realised that quite a short length of aerial—some 10 or 15 feet—will generally be enough. There is ample room inside the container to accommodate coils of suitable wire, which may be fitted with plugs ready for insertion into the sockets provided. If a long aerial is ever used it should be connected through a small fixed condenser of about 0.0001 mfd.; otherwise, the tuning range of the set will be unduly restricted by the addition of an excessive aerial capacity.



The receiver in its case—just the thing for the holidays.

It is as well to select a pair of phones which may be folded up easily and quickly so that they will fit into the somewhat limited space that is available for them. The phones used in the set illustrated have been found particularly convenient.

An H.T. pressure of 54 volts, as supplied by the battery specified, is quite high enough, but no harm is done by substituting a normal 60-volt battery, provided it can be fitted in.

(This receiver is available for inspection at the Editorial Offices, 116-117, Fleet Street, London, E.C.4.)

TESTIMONIAL FOR THE AMATEUR.

A STATEMENT made some years ago by Dr. Eccles, F.R.S., was recently quoted in these columns to give support to the claims of the amateur to have contributed in no small degree towards the development and rapid progress achieved by wireless and broadcasting.

Recently we have come across another testimonial which gives further support to the claims of the amateur. Professor E. V. Appleton, F.R.S., speaking at the British Association Meeting at Bristol in 1930, referred to the work of the amateur in some detail and stated: "Here I would like to observe, in passing, that no subject seems to have been more fortunate in the assistance rendered to it by amateur experimenters than that of wireless transmission. It is agreed by those best qualified to form an opinion that it was the amateurs who discovered the extraordinary suitability of very short waves for long-distance propagation."

MAKING THE MOST OF THE L.F. TRANSFORMER

Simplified Calculations for the Choice of Correct Valve and Turns Ratio.

By W. A. BARCLAY, M.A.

THE low-frequency transformer has had a chequered history. In the pre-broadcasting era it was, of course, used in most receivers, but towards the end of 1923, as the problem of securing quality in telephonic reception commenced to assume importance, it began to be the subject of much criticism. It is interesting to find that in a lecture to the Radio Society of Great Britain in October of that year Mr. H. A. Thomas used these words: "It is owing to the fact that valves may so easily be hooked together by iron core transformers in cascade, and also that the average wireless enthusiast is rarely a musician, that little, if any, research in the improvement of articulation has been attempted by the experimenter." In the following years much attention was paid to other methods of coupling low-frequency valves, and the L.F. transformer fell into some disfavour. Little by little, however, it came to be realised that the alternative methods of L.F. amplification were by no means immune from peculiar disadvantages of their own, and that, when properly designed and efficiently used, the transformer was invaluable for its own special functions.

The modern principles of L.F. transformer amplification were set out in 1924 by D. W. Dye in a masterly series of articles in *Experimental Wireless*. Before this epoch, in what might be called the "dark ages," most experimenters had to be content to hook up an "Ora" valve (of blessed memory) with a "hedgehog" transformer (Government surplus) and hope for the best. With the limited apparatus then available, the proper adjustment of transformer to valve was for most a counsel of perfection, and interest chiefly centred in the production of satisfactory signal strength ("with phones on the table"). Only within recent years, since the demand for quality reception provoked the development of the high-class instruments now upon the market, has the experimenter been able to benefit from the theory. Indeed, an examination of the receivers on view at the recent exhibitions went to show that L.F. transformer amplification is now almost standard practice.

The performance of the coupling unit as a whole depends as much upon the amplifying valve as upon the transformer, and it is impossible to study the action of the two apart. It will be the object of this article to describe two alignment charts which illustrate usefully the effect of each of these factors upon the total magnification realised by the stage. These charts provide in compact form a sort of "ready-reckoner" by which the performance of L.F. transformer coupling may be readily estimated under varying conditions, and by means of which, also, the best values of valve constants, transformer ratio, etc., may themselves be rapidly estimated in order to secure any required standard of performance.

To make use of these charts, no familiarity with the underlying theory need be presupposed; nevertheless, before entering on a description of their properties, it will be convenient to sketch in briefest outline the elementary principles of L.F. transformer action.

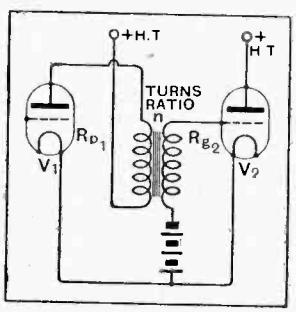


Fig. 1.—Connections of L.F. transformer.

The Simple Theory.

In the first place it is usual to make some simplifying assumptions which can be modified later. For the present, then, we neglect (*a*) the effect of resistance in the coil windings; (*b*) losses due to magnetic leakage in the generated flux, and (*c*) the reactive effect of the magnetising current. The transformer is then more or less "ideal," and if it be connected between the valves V_1 and V_2 as in Fig. 1 we may regard it abstractly as acting in the plate circuit of V_1 precisely as would a resistance equal to the resistance in the secondary circuit divided by the square of the turns ratio. Now, the windings being themselves assumed to be without resistance, this secondary circuit resistance is, of course, the input resistance of the valve V_2 and is commonly of fairly large amount—usually some hundreds of thousands of ohms. This high value is usually achieved by the introduction of

Making the Most of the L.F. Transformer.—

grid bias voltage, the resulting thermionic action in the valve allowing only an infinitesimal current to pass in the grid circuit. If we denote the A.C. plate resistance of V_1 by R_{p1}, and the A.C. input resistance of V_2 by R_{g2}, we can substitute for the circuit of Fig. 1 (as far as alternating currents in the anode circuit of V_1 are concerned) that of Fig. 2. Here the resistance $\frac{R_{g2}}{n^2}$ represents the fictitious load in the primary due to the existence of R_{g2} in the secondary, so that the total effective resistance in the anode circuit is $R_{p1}+\frac{R_{g2}}{n^2}$.

If E_{g1} denote the impressed alternating E.M.F. on the grid of V_1, μ being as usual the amplification factor, the E.M.F. operating in the primary circuit will be, in effect, μE_{g1}. It is now evident that the fraction of this voltage expended across the transformer will be

$$\frac{\frac{R_{g2}}{n^2}}{R_{p1}+\frac{R_{g2}}{n^2}}$$

of the whole. Putting $v =$ this voltage across the primary terminals, we thus have

$$v = \frac{\frac{R_{g2}}{n^2} \times \mu E_{g1}}{R_{p1}+\frac{R_{g2}}{n^2}}, \text{ or } \frac{\mu E_{g1} R_{g2}}{n^2 R_{p1} + R_{g2}}$$

But, owing to the "transforming" properties of the instrument, the voltage across the secondary coil is n times that across the primary. If, then, E_{g2} denote this secondary voltage, which is that applied to the grid of V_2, we shall therefore have

$$E_{g2} = nv = \frac{n\mu E_{g1} R_{g2}}{n^2 R_{p1} + R_{g2}}.$$

Writing S for the ratio $\frac{E_{g2}}{E_{g1}}$, or the "stage gain" in voltage of the whole coupling, we arrive at the equation

$$S = \frac{E_{g2}}{E_{g1}} = \frac{n\mu R_{g2}}{n^2 R_{p1} + R_{g2}}.$$

This formula is a very instructive one, and is, indeed, fundamental in transformer working under the limitations noted at the outset. Unfortunately, it is not one of the simplest type, and perhaps on that account is not so well known as it might be. In order to facilitate its use, and, more important still, to enable readers to visualise at a glance the relations which the various symbols bear to each other, the alignment chart of Fig. 3 has been designed. On this diagram, ranges for individual values of μ, n, S and the ratio $\frac{R_{g2}}{R_{p1}}$ are shown, so that the effect of varying each upon the others may be studied separately, and at a glance—no calculation at all being necessary.

Alignment Chart for "Ideal" Transformer.

The chart is an example of "four-variable" alignment, in which the numerical relations between four variables may be demonstrated by a single application of a straight-edge. The two lower scales bear respectively numbered graduations for the ratio $\frac{R_{g2}}{R_{p1}}$ and for S. In the upper part of the diagram is a numbered network of straight lines and curves, the lines representing values of the turns ratio n, while the curves give values of μ. *A straight line joining the appropriate value of* $\frac{R_{g2}}{R_{p1}}$ *to the point of intersection of the given n-line and* μ*-curve will meet the* S *scale in the required value of stage magnification.* Suppose, for example, that the anode A.C. resistance of V_1 is 20,000 ohms, its magnification factor 6, and the A.C. input resistance of V_2 1 megohm. Further, let the turns ratio of the transformer be 5. We first find the value of the fraction $\frac{R_{g2}}{R_{p1}}$, which in this case is 50. Joining this value to the point in which the line $n = 5$ intersects the curve $\mu = 6$, we readily find that the theoretical stage gain is 20.

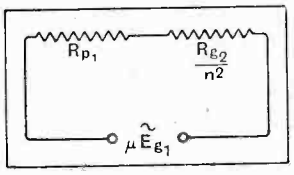


Fig. 2.—Equivalent circuit of L.F. transformer neglecting the effects of magnetising current. The secondary load appears as an extra resistance in the primary circuit.

It will be seen that we have here a very convenient means of studying just how the stage gain is going to be affected by any change in the values of the valve or transformer constants. If, for example, a greater turns ratio, say $n = 6$, is used for the same μ, the resultant amplification will increase slightly, being now 21, and we can see further that the maximum possible stage gain with this valve will be secured when the turns ratio is in the neighbourhood of 7. The total stage gain under these conditions is, however, only slightly over 21, and it will be realised that little advantage has been gained by increasing the turns ratio beyond 5. It is probable, indeed, that many disadvantages will accrue by so doing, as the effects of resistance, self-capacity, etc., which we have neglected in this account, all come into greater prominence as the windings are increased.

If we are dealing with a given transformer, so that the turns ratio is fixed, the chart shows the manner in which the stage gain depends on the values of μ and the ratio $\frac{R_{g2}}{R_{p1}}$. Each of these quantities, of course, depends on the valve V_1, so that we have thus a rapid means of comparison between valves for use with this transformer.

Other Uses of the Diagram.

The utility of the chart is not, however, confined merely to finding the stage gain. Unlike the formula which it is designed to illustrate, it is quite universal in principle, and can be used equally readily to find any one of the four quantities μ, n, S and $\frac{R_{g2}}{R_{p1}}$ when values for the other three are known. For instance, we might wish to find the necessary transformer ratio to secure a stage gain of 40 using a valve of $\mu = 9$, the ratio $\frac{R_{g2}}{R_{p1}}$ being 80. Joining the equivalent points on the two

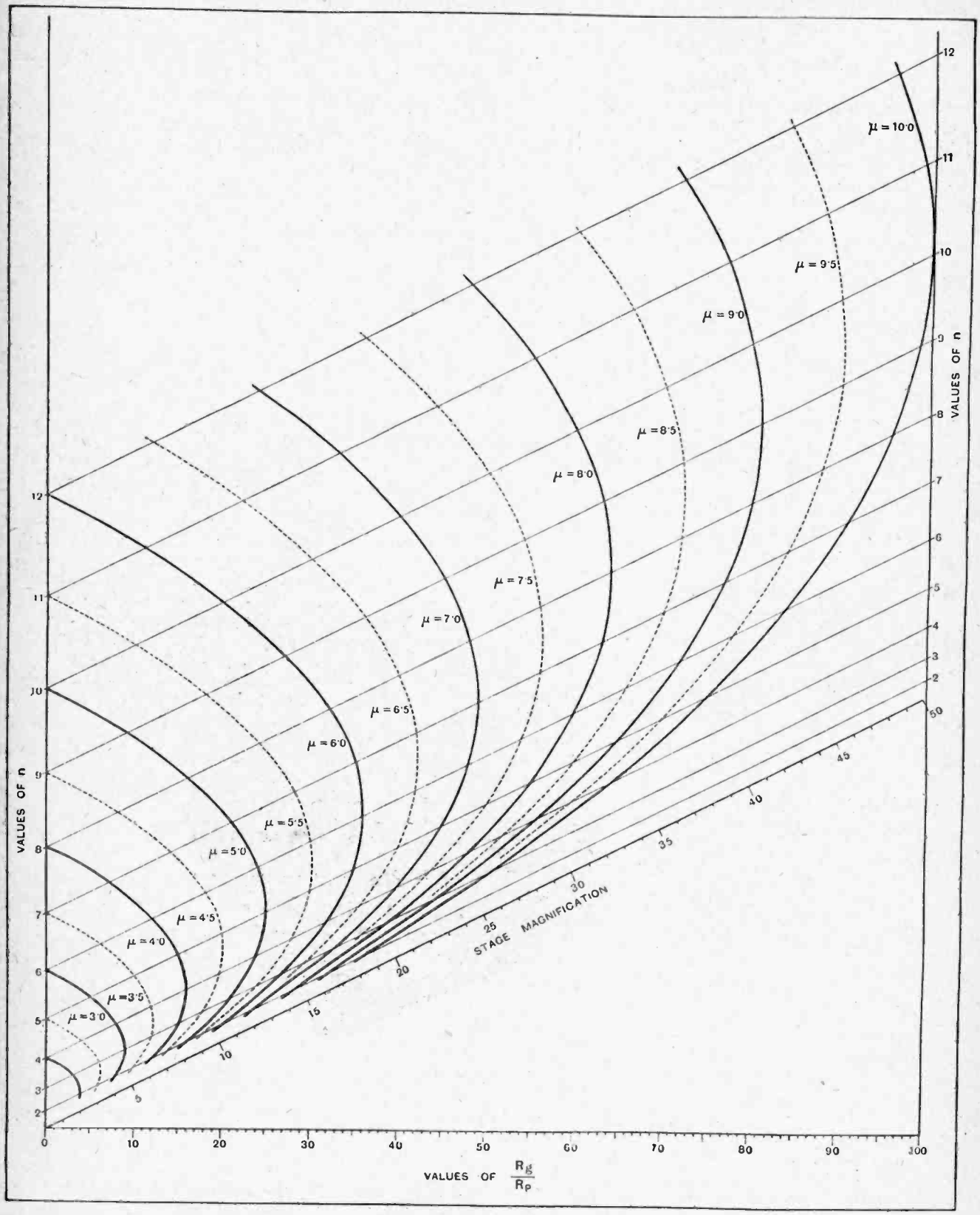


Fig. 3.—Alignment chart for L.F. transformer amplification.

Making the Most of the L.F. Transformer.—

left-hand scales, and producing to meet the network, it is found that the curve for $\mu = 9$ meets the index line in *two* points, corresponding to the transformer ratios 8 : 1 and 10 : 1. Each of these would, theoretically, satisfy the requirements, but practically, of course, the smaller would be chosen as indicated above. If it should happen that the position of the index line does not intersect the required μ-curve at all, this would simply imply that a larger value of μ must be chosen if the desired magnification is to be obtained.

Space does not permit mention of all the interesting features brought out by this chart. In particular, the effect of varying the factor $\frac{R_{g2}}{R_{p1}}$ should be noted. The passage of any considerable current in the secondary is equivalent to reducing the value of R_{g2}, the input impedance of V_2, with consequent reduction of amplification. On the other hand, the smaller the plate A.C. impedance, R_{p1}, of V_1, the greater will be the stage gain. As the value of $\frac{R_{g2}}{R_{p1}}$ is increased, however, the resulting stage gain does not increase indefinitely, but will be found to approach a definite limit determined by the particular values of μ and n in use.

The considerations dealt with above have all referred to the case of the " ideal " transformer. Although useful in giving a preliminary estimate of performance, they yet require to be somewhat modified in order to furnish a more reliable approximation to actual conditions. This modification will be discussed in the next part of this article. *(To be concluded.)*

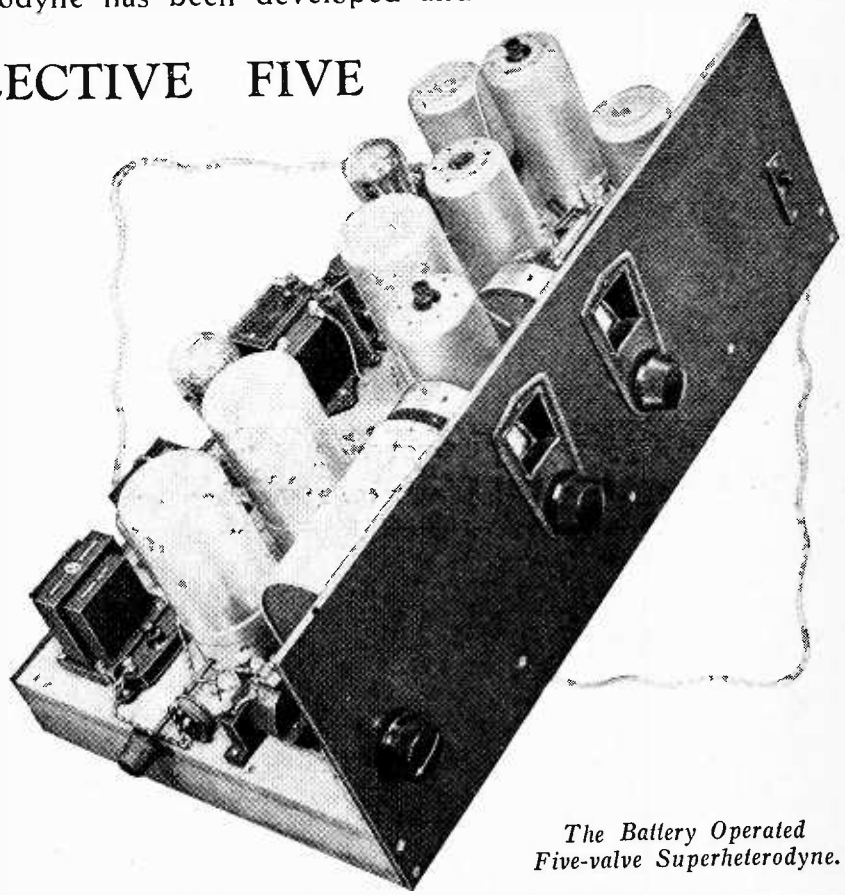
Complying with requests received from a considerable number of readers, a battery model of our new superheterodyne has been developed and is to be described in NEXT WEEK'S ISSUE.

THE SUPER-SELECTIVE FIVE

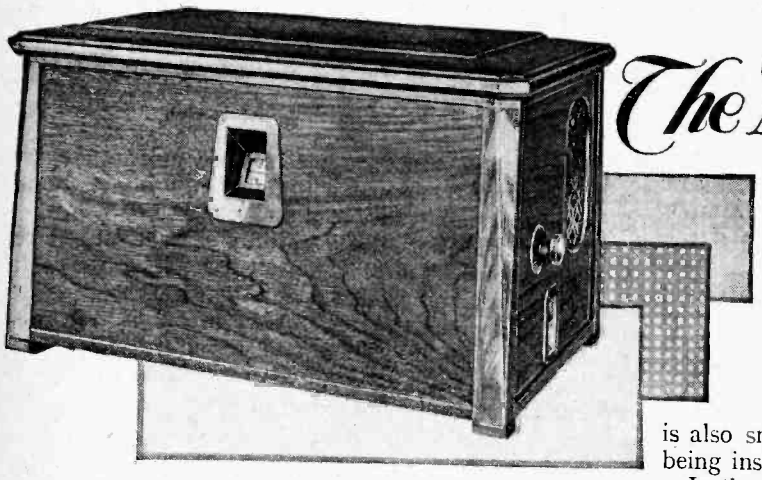
THE spontaneous popularity achieved by *The Wireless World* Super-Selective Six, a superheterodyne receiver for use on A.C. mains, has created a pressing demand for a similar set designed for operation from batteries. The new receiver, which has five valves, is provided with band-pass aerial tuning, a new non-radiating frequency changer, a special circuit for cutting out long-wave interference, and, while being highly selective, is arranged to avoid sideband cutting, with its attendant distortion. Entirely new-type valves are used which have not been previously employed in any receiver. It is fitted with two tuning controls, and a calibration chart has been prepared, showing station settings. The most sensitive superheterodyne yet devised, combining quality with selectivity.

LISTS OF PARTS REQUIRED.

1 L.F. auto transformer, 7 : 1 .. (Varley Nicore)
1 L.F. choke, 20/30 henrys .... (R. I. Hypercore)
1 Two-gang condenser, 0.0005 mfd. and drum dial ..... (Polar Tub)
1 Variable condenser, 0.0005 mfd. and drum dial ..... (Polar Universal)
1 Grid leak, 0.1 megohm ..... (Ediswan)
1 Grid leak, 0.25 megohm ..... (Ediswan)
1 Porcelain grid leak holder ..... (Bulgin)
3 Fixed condensers, 0.0001 mfd. .. (Dubilier 620)
2 Fixed condensers, 0.001 mfd. .... (Dubilier 620)
4 Fixed condensers, 0.1 mfd., 400v. D.C. test ..... (Dubilier, Type BB)
3 Fixed condensers, 1 mfd., 400v. D.C. test ..... (Dubilier, Type BB)
2 Fixed condensers, 2 mfd., 400v. D.C. test ..... (Dubilier, Type BB)
1 Fixed condenser, 4 mfds., 400v. D.C. test ..... (Dubilier, Type BT)
1 Pre-set condenser, 0.0005 mfd. max... (Polar)
1 Resistance, 600 ohms ..... (Watmel)
3 Resistances, 10,000 ohms ..... (Watmel)
1 Resistance, 20,000 ohms ..... (Watmel)
2 Resistances, 30,000 ohms ..... (Watmel)
1 Resistance, 50,000 ohms ..... (Watmel)
1 S.G. cell, 0.9v. ..... (Siemens)
1 G.B. battery, 16½ volts ..... (Siemens, G3)
1 D.P. 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)
8 Ebonite-shrouded terminals .... (Belling Lee)
1 Bakelised panel, 21in. × 8in. × ⅜in.
1 Bakelised terminal strip, 21in. × 2in. × ⅜in.
1 Baseboard, 21in. × 12in.
4 Wander plugs ..... (Lisenin)
Sleeving, copper foil, wire, screws, wood, etc.



The Battery Operated Five-valve Superheterodyne.



The New Gecophone

D.C. ALL-ELECTRIC FOUR-VALVE RECEIVER

ALTHOUGH the design of A.C. mains receivers tends to follow more and more closely on conventional lines, there is still a refreshing diversity of opinion as to the best circuit arrangement for operation on D.C. supplies. Of course, the broad principle of connecting filaments (or heaters) in series is almost universally accepted in the interests of economy, but with regard to smoothing and other essential details every new set that makes its appearance shows points of difference. The new G.E.C. set, though straightforward enough in its basic design, includes many interesting features, of which the inclusion, judging purely by results, would appear to be entirely justified.

When describing an A.C. or battery receiver, it is usual to ignore the filament circuits, or at any rate to dismiss them in a few words. But when a D.C. supply is to be used this part of the circuit becomes of vital importance; even if we neglect all technical difficulties, the question of operating costs must certainly be considered. Whatever we do, a considerable amount of energy must inevitably be dissipated as heat, and it is up to the designer to reduce this wastage as much as possible.

A Long-range Mains-Operated Set with Two H.F. Stages and Ganged Tuning Controls.

SPECIFICATION.

GENERAL: Four-valve long-range receiver for operation with an open aerial on D.C. supplies, 195-250 volts.
CIRCUIT: Two transformer-coupled tuned H.F. stages; grid detector, followed by transformer coupled pentode with choke output to loud speaker. Series-connected filaments.
CONTROLS: Single-knob tuning control; reaction; input volume control; on-off switch.
PRICE: £25 complete.
MAKERS: The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2.

The directly heated valve filaments of the Gecophone "All-Electric D.C. Four," with which we are now dealing, are, as already implied, connected in series; those valves consuming considerably less than the maximum current are shunted by a parallel resistance of low value which passes the surplus. The output valve, which takes the heaviest current, is also shunted (but by a high resistance), so that a path is provided for the anode current of all preceding valves.

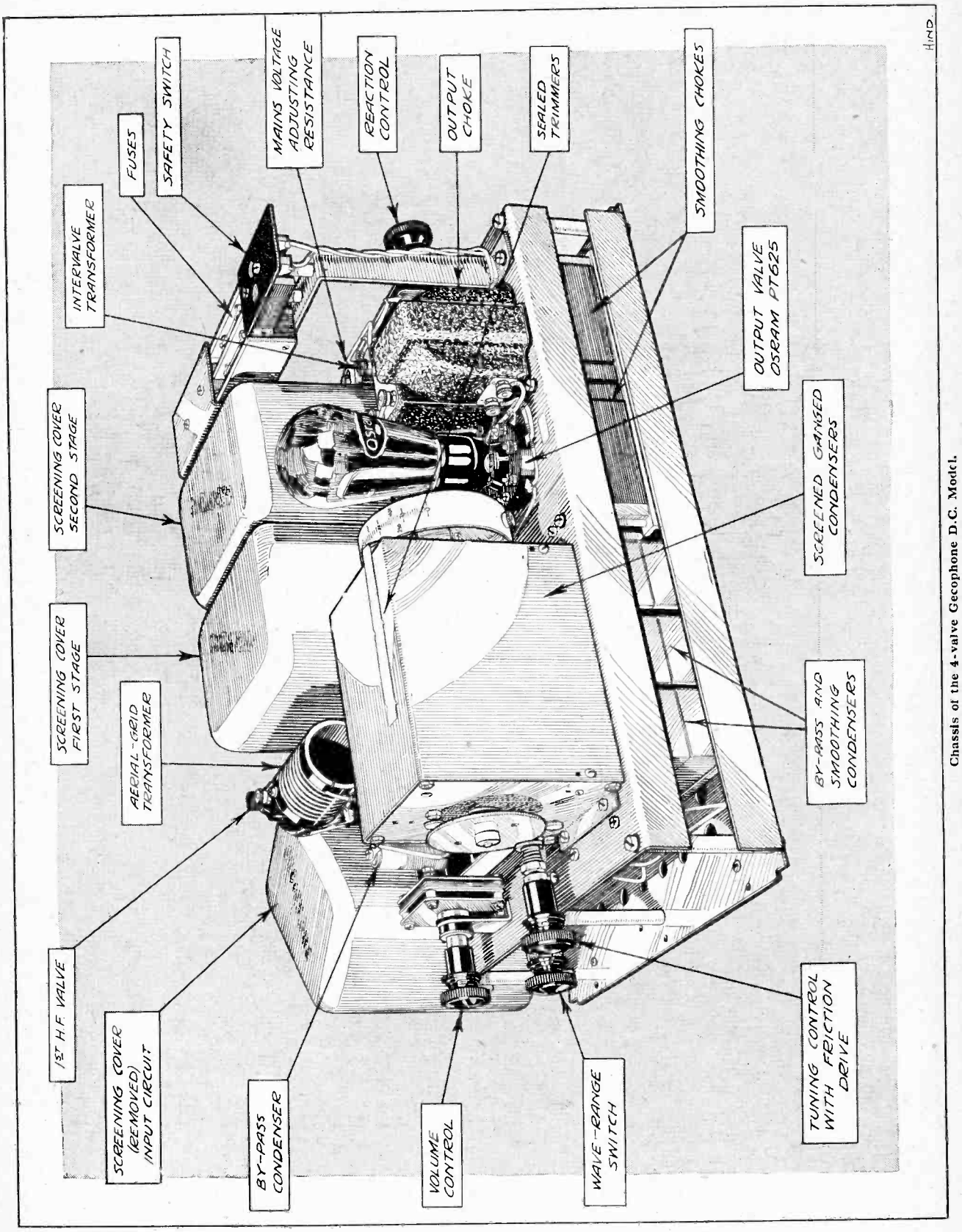
Filament circuit smoothing is effected by a pair of low-resistance chokes of special design, one of which is inserted in each mains lead, in conjunction with the usual high-capacity condensers. High-tension current is also smoothed by the same system, no extra choke being inserted in the anode supply leads.

In the main D.C. circuit are included fuses, a voltage-absorbing resistance, a double-pole on-off switch, and another switch acting as a safety device, which is automatically interrupted when the receiver cabinet lid is opened.

All H.F. circuits are coupled by double-wound transformers with tuned secondaries. With regard to the input circuit, this method confers the important advantage of complete isolation between mains and aerial-earth system, in a manner that often proves to be more satisfactory than the alternative plan of fitting blocking condensers in the aerial and earth leads. The H.F. valves work with zero grids, while the detector, operating on the grid principle with a relatively high anode voltage, is biased positively, as is usual when valves of the "battery" type are employed. Incidentally, it may be mentioned that the valves used in this receiver —Osram S.215, H.210, PT.625—are specially chosen with regard to constancy of filament characteristics for D.C. operation, and bear an identifying mark.

Reaction between anode and grid circuits of the detector is controlled by a differential condenser with an earthed rotor, and coupling between this valve and the pentode is effected by a directly connected transformer. The loud speaker, which is shunted by a tone-correcting condenser and resistance, is fed through a choke-capacity filter. A pressure of about 150 volts is applied to the output valve anode and screening grid.

With regard to details of construction, the set is similar to the battery and A.C. models made by the same firm, and which have already been described in these pages. Here we have an illustration of the advantages of modern production methods; it would clearly be economically impossible to set up the machinery for making so many—and such well-finished—intricate parts unless a large output could be absorbed. But in



Chassis of the 4-valve Gecophone D.C. Model.

The New Gecophone.—

spite of the fact that most of the chassis parts, and many of the electrical components, are interchangeable between the various models, there is no suggestion of compromise; indeed, the present D.C. set might have been designed *ab initio* for its special purpose.

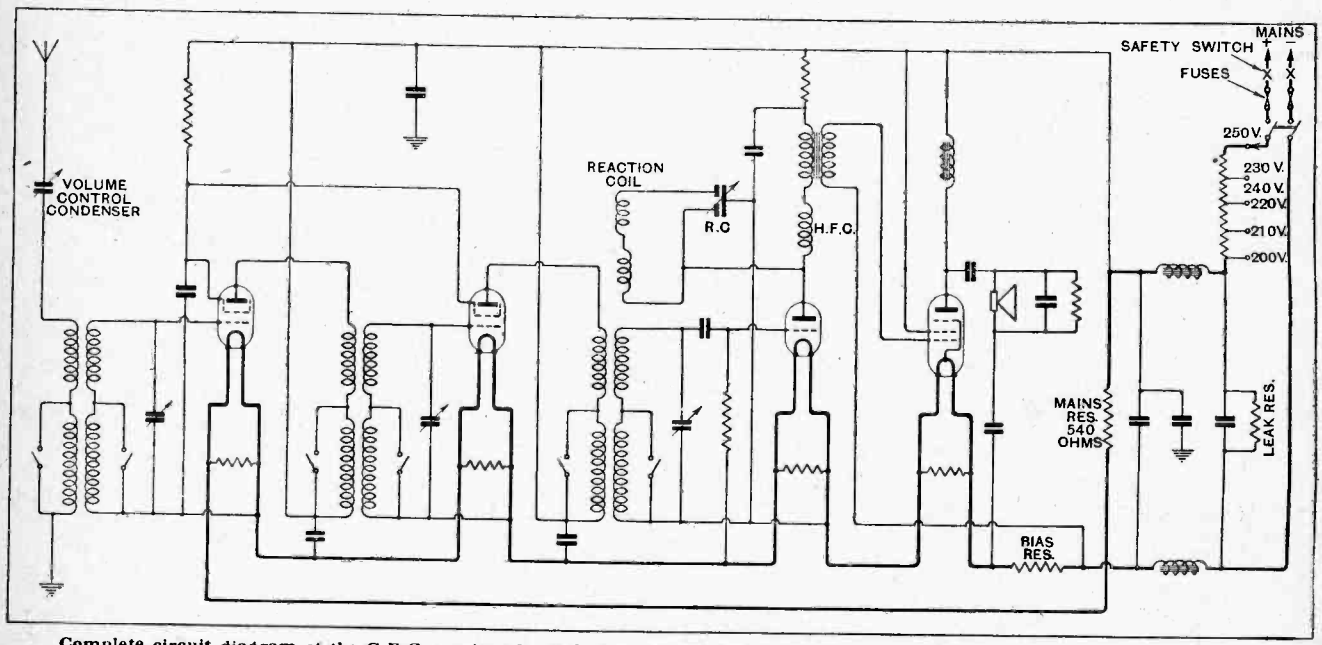
It is unnecessary to devote much space to the actual details of construction. With the exception of the tuning condenser, which is included in a separate three-unit ganged and screened assembly, the components associated with each H.F. stage are mounted under rectangular screened covers, which are secured to a metal base-plate. Under this plate is the smoothing equipment and wave-range switching mechanism, which are protected by a perforated sheet metal cover.

Medium-wave tuning coils are wound on threaded ebonite formers, while the long-wave windings are in evenly-wound sections. This method of construction would appear to make for exceptionally close and easy matching of inductance values.

The main voltage-reducing resistance is of unusually small size, its winding being supported on a porcelain tube and covered by a layer of vitreous enamel. It is mounted below and slightly to the rear of the fuse carrier, and is ventilated through a grille let into the side of the cabinet.

Especial care seems to have been taken to make the set as "safe" as possible, and to comply with all regulations and recommendations dealing with this matter. The metal chassis is "dead," being entirely isolated from the mains, except through condensers. As a further precaution it is observed that a leak resistance is fitted in such a position that all the reservoir condensers will be discharged when current is switched off.

As in other G.E.C. sets, the controls are particularly well arranged, being mounted at either side of the cabinet; the front panel is absolutely clear, except for the tuning scale—which, by the way, is calibrated directly in wavelengths. Reaction and turning knobs, which are naturally those most frequently used, are towards the front, and consequently in the most convenient position. All controls may be operated while resting the forearms on the table. No doubt after a little practice one becomes used to the direction of rotation of the reaction and volume-control condensers, but it seems rather a pity that they are not arranged both to turn in the same way to increase or to decrease the strength of signals.



Complete circuit diagram of the G.E.C. receiver for D.C. mains operation. The filament series circuit is drawn in heavy lines.

An extended test leads one to form the opinion that the receiver is singularly free of those unpleasant tricks and unaccountable inconsistencies which so often mar the performance of D.C. sets. Sensitivity is not exceptionally high for two H.F. stages, but it is more than adequate to fulfil all reasonable expectations; any sacrifices that may have been made in gain per stage are obviously compensated for by extra selectivity. Even with aerial coupling set at maximum, the set makes an exceptionally good showing in this respect when compared with others having similar single tuned circuits. On the rare occasions when abnormally high selectivity is needed it can readily be obtained, without any special skill, by reducing the aerial series capacity and tightening up the reaction coupling.

Perhaps the most attractive feature of the set is its freedom from background noises; an almost complete absence of mains hum is the best proof that the smoothing system is really effective.

Quality of reproduction is characterised by a full round tone, due to a well-marked lower middle register. There is some attenuation of the very low frequencies, but this is not objectionable. The higher frequencies are present at good, but not excessive, strength.

Next Week's Set Review:—
THE McMICHAEL RADIOGRAMOPHONE.

CURRENT TOPICS

News of the Week in Brief Review.

BRITISH PROGRAMMES ABROAD: GOVERNMENT PROTEST.

Our Washington correspondent reveals that Sir John Reith, during his recent visit to America, intimated that the British Government would shortly issue a formal protest to neighbouring foreign countries, notably France and Holland, against the use of their broadcasting stations for the sale of time to British advertisers seeking to reach the radio audience in the British Isles.

Sir John stated that a few firms in England, finding the British radio not open to them for the sponsorship of programmes, because the British broadcasting monopoly carries no commercial programmes, had gone to neighbouring countries where regulations against advertising do not exist. Their obvious intent, he said, was to attract the home audience to their programmes in order to advertise their products.

The British Director-General (writes our correspondent) was firmly convinced that the sponsorship idea was not for his country. He said he felt certain that the Governments of the few European countries that permit commercially sponsored programmes along the American plan would acquiesce in the proposal that British advertisers be barred from their stations. If foreign firms attempted to exploit their goods in America *via* the radio, he said, the American Government would probably enter the same protest.

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FRENCH SHORT-WAVE TESTS.

The short-wave tests of the French Meteorological Office have proved very popular in the past with British listeners, who will be interested to learn that the eighty-first group of the series will be held on Saturdays, July 11th, 18th, and 25th, the most important test being that on the 25th. The transmissions will be made at frequent intervals from Paris (Eiffel Tower) on 73.5, 36.7, and 32.5 metres, and from Lyons on 60 and 20.15, beginning at 9 a.m. (G.M.T.).

We understand that full schedules and report forms will be gladly supplied on application to the Office National Meteorologique, 196, Rue de l'Université, Paris, 7e.

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NEWCASTLE SOCIETY PROVIDES CHURCH CHIMES.

All Newcastle has been interested in the installation of a loud speaker in the belfry of Holy Trinity War Memorial Church at Jesmond for the purpose of providing chimes in the absence of a peal of bells. The demonstration, which recently astonished local residents who were aware that no bells had been fitted, was carried out by the Newcastle-upon-Tyne Radio Society. We are indebted to Mr. W. Pope, hon. secretary of the Society, for details of the amplifying equipment.

The amplifier consists of an M.H.4 coupled by a Ferranti A.F.5 to a D.A.60, which is run at 500 volts from two G.U.1 mercury rectifiers. Grid bias for this valve is obtained from a separate rectifier and transformer. The whole amplifier is supplied from 240-v. 40-cycle supply. Two B.T.H. pick-ups were used in conjunction with a Novotone, which fed through the amplifier on to three Brown P.2 public address speakers.

The demonstration proved a great success, but the Society feel that at least twice the existing power is required. At present the chimes, which are taken from a gramophone record of change-ringing at St. Paul's Cathedral, London, can be heard up to a distance of half a mile.

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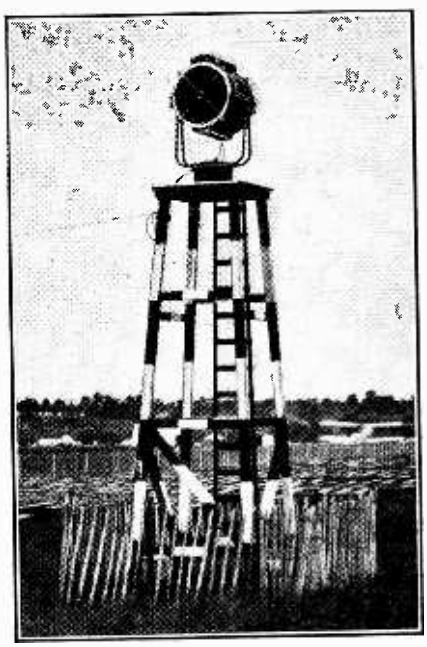
WAVE DODGING ON PARIS POLICE CARS.

To prevent jamming by the criminal fraternity, the Paris police have hit upon the ingenious expedient of using a pre-arranged order of wavelengths on their radio cars, of which there are seven roaming the French capital. Should interference be suspected, the car communicating with headquarters immediately changes over to another pre-arranged wavelength, and, if necessary, to a third and fourth. These lightning changes are effected at a pre-concerted signal sent by either station.

The police cars employ an aerial power of 50 watts with a waveband extending from 140 to 370 metres.



THE SEARCHLIGHT SPEAKER. One of the battery of new Marconiphone loud speakers which diffused information and music at the Hendon R.A.F. Pageant on June 27th.

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BRITAIN'S BOOTLEGGERS.

American newspapers are giving a false glamour to wireless pirates in this country by printing glowing stories of the Post Office chase after "bootleg radio sets." The art of "bootlegging," as practised in America, at least calls for a certain amount of pluck, which is a quite unnecessary qualification for installing an unlicensed radio set.

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CONGRESS TO FIGHT MAN-MADE STATIC.

That an "Anti-Static Congress" is to be held at the Paris Colonial Exhibition in September next by the leading French radio clubs is an indication of the gravity of the interference nuisance in France. The arrangements for the Congress are the outcome of an alliance between the National Federation of Radio Clubs and the Central Committee of Wireless Associations, both bodies being determined to stamp out the "parasites." Apparently the tramways are the great creators of disturbance in the big cities, due to the bad state of the rolling stock.

We wish the Congress every success, and shall hasten to add our congratulations if its members succeed in jostling the tramways into action.

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RADIO CIVILIAN BECOMES COLONEL.

M. Paul Brenot, who is virtually the permanent president of the French Radio Manufacturers' Association, served as a commandant in the army. Although he is now a civilian, the French military authorities have promoted him to Colonel in recognition of his services to military and civil radio.

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WHY THE SETS WERE SILENT.

The "hicks," or country cousins, in America, have been badly deceived by a radio manufacturer whose smart business methods might have spread to other firms but for the intervention of the Federal Radio Commission. Apparently innocent purchasers have been bewildered by sets which refused to work, and not until pathetic investigations have been made has the absence of "toobs" been discovered. In future, by order of the Commission, the manufacturers must display in type, as conspicuous as the price, the fact that valves are *not* included.

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REMOTE TUNING CONTROL.

Readers who have studied the article on "Remote Tuning Control Systems Adopted by American Manufacturers," which appeared in our issue of June 17th, will be interested to know that British manufacturers are also turning their attention to this subject, and an important patent covering certain methods of employing dialling systems for this purpose is owned by the Dubilier Company, so that we may hope to see some interesting developments in this direction in the future.

SILENCE TO ORDER.

Metal plates surrounded by asphalt are said to compose the walls of the "silence chamber" which has been invented in Copenhagen by Prof. Absalon Larsen with the object of providing a retreat from the noise of loud speakers.

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SHORT WAVES FOR RADIO TYPEWRITERS.

Five short waves have been added to the two long waves granted by the Federal Radio Commission to the American Radio News Corporation, a Hearst subsidiary, which is developing an automatic radio-typewriter system of news distribution to newspapers in various parts of the United States. The system is the invention of William H. G. Finch, a well-known radio engineer, who is supervising its installation.

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POST OFFICE RADIO EXPERT.

Mr. E. H. Shaughnessy, who retired from the Post Office Engineering Department last week after forty-four years' service, has been associated with official wireless activities for a long time and is a popular personality in the amateur radio world. It was Mr. Shaughnessy who undoubtedly hastened the raising of the ban on amateur wireless apparatus soon after

Mr. E. H. SHAUGHNESSY, assistant chief engineer at the General Post Office, who has retired after 44 years' service. He is a radio enthusiast and has always strongly supported the amateur.

the War, and he also made it his duty to smooth away many of the almost inevitable differences between the Post Office and amateurs when experimental facilities were still the subject of guarded discussion. Mr. Shaughnessy also figured prominently as a technical representative of the Post Office at the formation of the original British Broadcasting Company. He has been a familiar figure at amateur radio conferences and is a past vice-president of the Radio Society of Great Britain.

°°°°

RADIO CHAIN ON GERMAN RIVERS.

We learn that trials are taking place on the River Oder between Stettin and Frankfurt with a chain of small 2- to 5-watt transmitters which will link up with the tug boats and other small craft. A wavelength in the neighbourhood of 80 metres is used.

°°°°

POTTED TELEPHONE TALKS.

A device by means of which everything said by both parties concerned in a telephone conversation is recorded on a magnetic steel wire in such a manner that it can be reproduced at any subsequent time is the latest advance in communications technique announced by the International Telephone and Telegraph Corporation.

The record so obtained can be preserved as long as may be required, but it is also possible to obliterate the message so that the wire can be used over and over again.

By reason of the recent association with the International System of the Echophon Maschinen A.G., of Berlin, who have been furthering the development of this device, it is now possible to place this conversation recorder at the disposal of telephone users, and thus greatly increase the usefulness of the telephone in all countries in which the International System operates telephones or provides communication equipment.

One of the important applications of the conversation recorder is in connection with long-distance cable and radio telephone calls, but we can foresee many other possibilities. The telephone recorder will teach subscribers to weigh their words even if it does not give them "mike fright"!

°°°°

TRACKING A MOBILE TRANSMITTER.

A novel feature distinguished the annual direction-finding competition organised by Lt.-Col. Ashley Scarlett, of the Golders Green and Hendon Radio and Scientific Society and held recently in the neighbourhood of St. Albans. Whereas in previous field days the direction-finding groups have scoured the country in search of the concealed transmitter, on this occasion the groups took up stationary positions along an imaginary line drawn about three miles west of Rickmansworth-St. Albans, whilst the transmitting station was mobile and under the direction of Mr. Maurice Child, a vice-president of the Radio Society of Great Britain. In all there were five separate transmissions of ten minutes each, on a wavelength of 160 metres, from five different points at varying distances from the groups, the farthest distance being 11 miles. A Lanchester saloon car, belonging to the immediate past president, Mr. Arthur van Zwanenberg, was equipped as a transmitting station, the circuit was a loosely coupled Hartley circuit associated with an absorption keying circuit, the power being eight watts.

The high tension was supplied by an M-L converter, fed by the car's accumulator, and took up very little space and was most satisfactory. All the leading radio societies in and around London had been informed of the meeting, and the ever-increasing interest taken in these annual competitions was shown by the record number of entries. The judging was done by Mr. Barton Chapple, Mr. Leslie McMichael and Mr. L. Fogarty, and their task this year was made extremely difficult

A ROAMING TRANSMITTER. Mr. Maurice Child photographed with the eight-watt transmitter which was tracked by D.F. groups at the recent field day of the Golders Green Society. A loose-coupled Hartley circuit was used and high-tension was obtained from an M-L converter fed by the car accumulator.

owing to the very high standard of the work done.

However, after some deliberation the prizes were awarded as follows:

1. Messrs. Alexander Black, R. B. Jones, R. T. Stock.

2. Messrs. A. G. Griffiths, J. C. Emerson, B.Sc., E. F. Clarke.

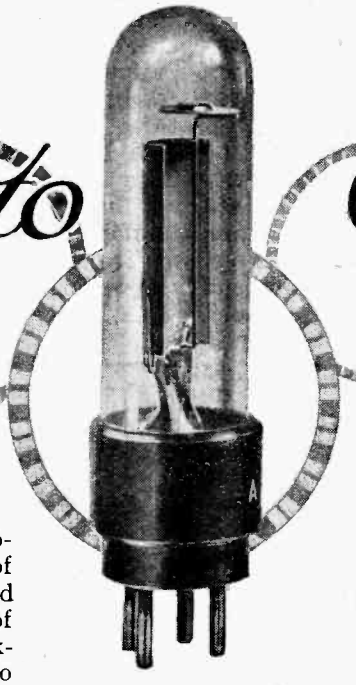
3. Messrs. A. J. Brenner, B.Sc., W. A. Hudson, M.P.S., E. Handsley.

4. Messrs. E. H. Laister, J. F. Swan, A. Tagent.

A very curious and interesting phenomenon was noted by one of the groups. During one of the transmissions they found themselves in the centre of a whirlwind; whilst all the surrounding trees and grass were being blown about, everything in their vicinity was quite calm and still. However, this fortunate position had a serious disadvantage, as they were unable to receive any of the transmission whilst adjoining groups, less fortunately placed, reported receiving extra strong signals.

Thus, whirlwinds must be added to the long list of enemies of radio.

The Photo Cell



By H. R. RUFF, B.Sc.
(Engineering Laboratory, The British Thomson-Houston Co., Ltd.)

(Concluded from page 4 of previous issue.)

The Manufacture of Photo-Electric Cells.

CELLS of all the metals giving photo-electric emission under the action of visible, ultra-violet and infra-red light are produced. The methods of manufacture are too numerous to be explained fully, but it is very interesting to note the change which the sound film and its attendant factory production of cells has wrought in manufacturing methods.

In general, the alkali metal can be deposited as cell cathodes by four methods:—

(1) Deposition from solutions. This method is not widely used.

(2) Deposition by distillation. This is one of the most general methods.

(3) Deposition by electrolysis. This is used for some sodium and potassium cells.

(4) Deposition by means of decomposing a compound of the metal.

The original method employed in the manufacture of alkali metal cells was distillation. The method of electrolysis through the glass bulb is convenient for factory methods, and some sodium cells on the market are made by producing the cells as though they were lamps. The sodium is then introduced by electrolysis, and recently a method has been devised for passing oxygen into the finished cell through the glass and making it more red sensitive. This type of cathode is, however, still much less red sensitive than that of the thin film caesium cell.

The fourth method of deposition from a compound is also suited to factory production. An outline drawing of a cell of this type is given in Fig. 8. To facilitate production, the light sensitive surface is formed on a separate silver-plated metallic cathode rather than on the cell bulb. The general construction of the cell is of a simple nature, consisting of the semi-cylindrical cathode at the axis of which is mounted the single wire anode. One of the difficulties of preparing cells of thick coatings of the alkali metals is, as has been mentioned previously, that the metals, particularly caesium and rubidium, and even, to some extent, potassium, possess a vapour pressure at normal temperatures, and tend to cause electrical leakage between the electrodes. The object in view in the manufacture of thin film alkali metal cells is, however, to retain only the very finest invisible film of the alkali metals on the cathode. This is retained by the stresses of atomic cohesion, and there is no tendency for it to distil on to the pinch between the electrodes. Hence, by choosing manufacturing methods to eliminate excess caesium, the insulation resistance of the thin film caesium cell can be made to be many thousands of megohms, even with the electrodes mounted close together on the same stem, and the use of a single stem construction makes for rapid production.

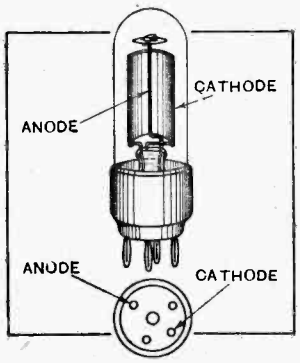


Fig. 8.—Details of construction of the B.T.H. photo-electric cell, in which the light sensitive surface is formed on a silver-plated metallic cathode.

The Characteristics of Photo-electric Cells.

Photo-electric cells are made of so many metals and in so many different shapes that it is difficult to classify them. The cathode may consist of any of the alkali metals or a combination of them. It may consist of a thin film of these metals, either on another alkali metal or on a metal base, and may have present an intermediate layer of some electronegative material such as oxygen. With reference to the geometrical construction of the cells, the cathode may be of any shape; it may be deposited upon the walls of the bulb, or on a separate metal plate, and the cathode may surround the anode, or the anode the cathode.

There is, however, one big division which should be recognised; a difference should be made between vacuum and gas-filled cells. In the former type of cell the vacuum is presumed to be so high that a pure electron discharge passes from the anode to the cathode. In the latter type a certain amount of inert gas is present, and the primary electron emission from the cathode surface is amplified by supplying an electric field to produce ionisation by collision.

The Photo Cell.—

With both types of cell it is usual to state the sensitivity of the cell in terms of micro-amperes per lumen of incident light. A lumen is the amount of light received by an area of 1 sq. ft. placed 1 foot away from a light source of one candle-power, and is hence measured by means of the human eye. The wavelength-sensitivity curve of the human eye is shown in Fig. 9, and it will be seen that the eye is most sensitive to yellow-green light. It will also be seen that this curve does not coincide with the wavelength-sensitivity curve of photo-electric cells, and hence the relative response of a photo-electric cell to light of different colours will not correspond to the number of lumens of that light present, as measured by the human eye. In addition, cells are influenced by radiation which has no effect upon the eye, so that two light sources which appear similar to the eye may excite an entirely different response from the photo-electric cell. Hence, one of the most important characteristics it is necessary to know of a photo-electric cell is its wavelength-sensitivity curve. Also, when a cell sensitivity is stated in micro-amperes per lumen, the light source from which the lumen is measured should be strictly defined. The wavelength-sensitivity curve of the Mazda thin film caesium cell is shown in Fig. 5 of the first part of this article.

With a vacuum cell the wavelength-sensitivity curve, and the statement of the cell sensitivity in microamperes per lumen of a definite light source, serve to convey almost all the data that is required for the calculation of the response of the cell for a given application. When light is shining on to the cell cathode electrons are emitted, whether they are collected by the application of a voltage to the anode or not, and, as has been explained previously, the number of electrons emitted is directly proportional to the intensity of the incident light. Fig. 10 shows the variation of photo current with applied anode voltage. It will be seen, then, with no voltage applied, an appreciable photo current flows. This is due to contact potential and to the fact that some of the emitted electrons strike the anode. As anode voltage is applied a rapid increase in photo current takes place until saturation occurs. With the cell illustrated this takes place at about 10 volts, and the curve above this value is practically horizontal; although it still rises slightly, due to the fact that the increased electric fields drag from the cathode electrons which would otherwise fail to emerge. The voltage at which this saturation occurs depends upon the relative size and shape of the electrodes, and the condition of the cathode surface.

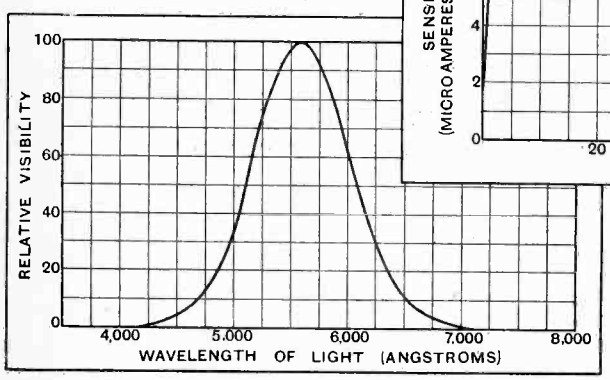


Fig. 9.—The wavelength sensitivity curve of the human eye, showing the band of wavelengths representing the visible spectrum.

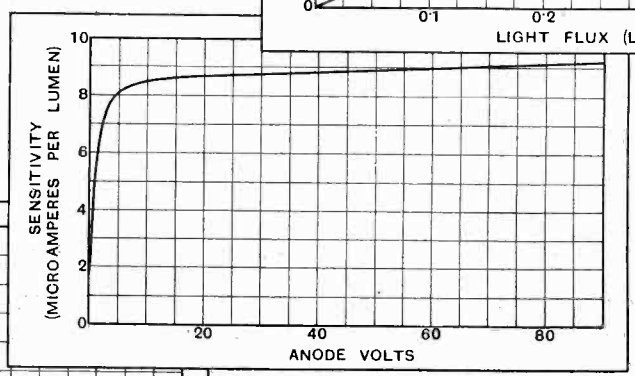


Fig. 10.—The variation in sensitivity of the photo cell with increase of anode voltage. The source of light in this instance is a 60-watt gasfilled lamp.

The variation of photo current with light flux is, as shown in Fig. 11, rectilinear in well-designed vacuum cells. This fact is very important, for most of the uses of the vacuum cell are for quantitative measurements such as photometry. The saturation of the photo current with voltage is also most advantageous, as, when an anode voltage is applied in excess of the saturation voltage, slight variations in the voltage do not affect the cell response. Also, when an external resistance is inserted in series with the cell the voltage drop across the resistance, when photo current passes, does not affect the cell response, and the dynamic curve corresponds very closely to the static curve shown.

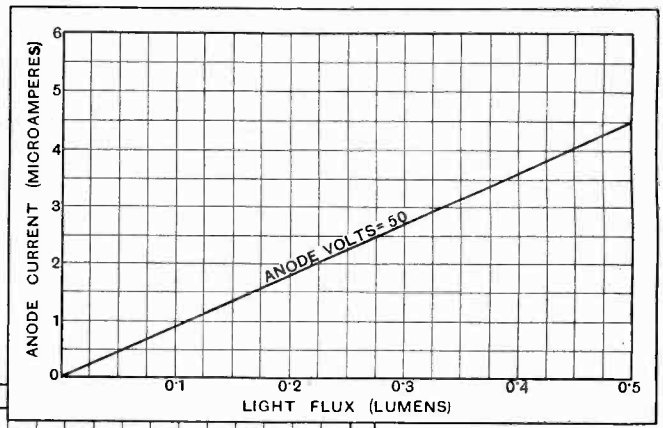


Fig. 11.—The straight line relationship between the anode current and the value of the light falling on the cell.

Another important fact about the vacuum cell is that since its emission is entirely electronic, and the mass of the electron is so small that it presents practically no inertia to any applied force, the response of the cell does not vary with the frequency of modulation of the incident light. It must be remembered, however, that the cell possesses some capacity, and that to amplify response at frequencies very much in excess of audio frequencies calls for very careful design of an amplifying circuit.

To understand fully the characteristics of a gasfilled photo-electric cell more data is required than for the

The Photo Cell.—

vacuum cell. The wavelength-sensitivity curve is still of the utmost importance, but, in addition, it is desirable to know:—

(a) The primary sensitivity of the cell cathode.

(b) The amount by which this primary emission is amplified by the gasfilling of the cell.

(c) The effect of modulation of the incident light upon the cell response.

(d) The life of the cell.

Glow Discharge.

Fig. 12 shows the variation of photo current with anode voltage for different values of light flux. Below 12 volts the curve is very similar to that of the vacuum cell shown in Fig. 10, and, in fact, the photo current with 12 volts applied is a pure electron current. No ionisation of the gas takes place at this voltage, and since saturation occurs, this current represents the primary sensitivity of the gasfilled cell, and expressed in microamperes per lumen, is known as its "primary emission." After 20 volts the curve starts to rise, the slope becoming more steep as the voltage is increased, until it finally becomes vertical, and a point is reached when the current flows whether light is shining on to the cell or not. This voltage is known as the "glow voltage" of the cell, and this glow discharge occurs due to the fact that the electrons liberated by collision possess sufficient energy to make more collisions and produce an electric current without the aid of the electrons ejected by light from the cathode. For normal operation the cell should work with its anode voltage safely below the glow voltage.

Fig. 13 shows the variation of photo current with light flux for various anode voltages. The response curve of the cell at low voltage is rectilinear but for higher voltages tends to bend slightly upwards. It should be noted, however, that since the cell output depends upon the anode voltage, the insertion of a resistance in series with the cell causes these curves to bend downwards, and the dynamic curves shown dotted are obtained. Due to the slight upward curve of the static characteristic, rectilinear dynamic response can be obtained for such applications as the sound film, where such a characteristic is most important, while for other applications, if a large resistance of 5 megohms is inserted, the drop of the dynamic characteristic serves to prevent overloading of the photo-electric cell. This type of characteristic is useful for such devices as the automatic switching of lights according to the value of daylight, where the cell must actuate a relay when light is low and yet must be exposed to the full brightness of the sky at mid-day.

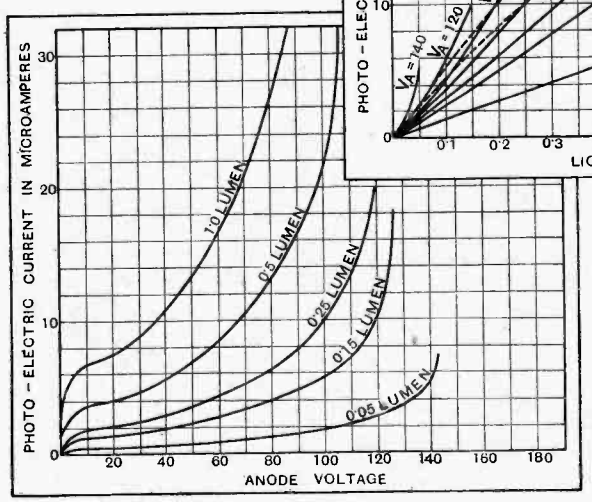


Fig. 12.—Curve showing the change of photo current, with variation of anode voltage and for different values of light falling on the cell.

Maximum sensitivity is obtained by working close to the glow voltage of the cell, and since for some gas-filled cells the glow voltage decreases with increased illumination, it is convenient to have a curve showing the variation of glow voltage with light flux.

If rectilinear response and long life under continuous running conditions are required, however, it is desirable to work farther from the glow voltage, and with Mazda cells for sound reproduction the photo current of the cell is not increased to more than ten times the cell primary emission by means of gas ionisation. Another factor of paramount importance in the application of gasfilled photo-electric cells to such things as sound film reproduction is the variation of their output when the light is modulated at audio frequencies. There is a slight falling off in response to higher frequencies, this fall being dependent upon the amount the primary emission

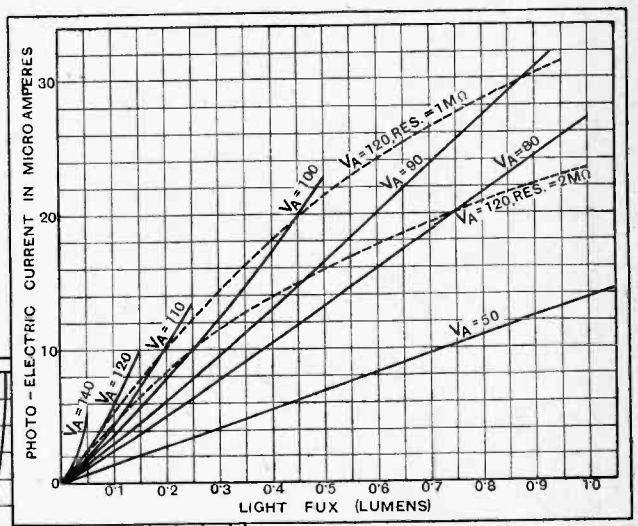


Fig. 13.—The variation of anode current with change in the value of light and given in respect of various anode voltages. The modification of the curves which results from the inclusion of resistance in the anode circuit is shown.

of the cell has been amplified by its gasfilling; i.e., the gas amplification factor. With suitable design the fall is, however, negligible, the difference of the response of the Mazda cell to light modulated at 100 cycles and at 5,000 cycles being of the order of 10 per cent.

The remaining factor is the life of the cell. When the gas is ionised positive ions return to the cathode and bombard it with a velocity depending upon the cell voltage. With correct working voltage, however, the cells will yield a good output with a good life, comparable with that of the vacuum radio valve of to-day.

It is difficult to state the life of the cell, since so much depends upon the conditions to which it is subjected, but with suitable conditions it is of the order of thousands of hours' continuous running.

The Photo Cell.—

Most applications of photo-electric cells can be divided into two sections: where the cells are used for quantitative measurement and where they are used for control.

The Application of Photo-electric Cells.

For such things as spectrophotometry and photometry, requiring a high standard of precision, the use of the vacuum cell is almost essential. For photometry it is necessary to select a cell giving a response corresponding to the human eye, or else to modify its wavelength-sensitivity curve by light filters or to insert some other compensating device. One very useful modification is to use two photo cells, one red sensitive and the other blue sensitive, and their relative response is a function of the temperature of such a light source as the tungsten filament.[1] Other very important quantitative measurements are those for ultra-violet radiation treatment, where a suitable cell with a quartz bulb can be used to control dosage.

The gasfilled photo-electric cell has some quantitative applications. It is sufficiently constant for the measurement of such fluctuating light as daylight, which its high sensitivity is most advantageous for recording. At the present day considerable work is being done in the investigation of the effect of light upon vegetation both on the land and under the sea. The temperature and humidity of most parts of the world are accurately recorded, but the amount and quality of daylight received by them, which has a great effect upon plant life, is almost unknown.

The gasfilled photo-electric cell is a robust instrument for industrial control, and by its aid the manufacture of products can be controlled according to the size, position, transmitting or reflecting powers of the article under consideration. Such control necessitates the amplification of the photo-cell currents by means of thermionic valves. Fig. 14 shows an elementary valve-amplifying circuit. The cell sensitivity being known as x micro-amperes per lumen, and the amount of light being known, the current through the cell circuit can be calculated. Hence the voltage drop across R, giving the grid swing on the thermionic valve, can be calculated, and from the normal valve curves the anode current of the valve can be calculated and the valve bias battery G can be set, so that the relay operates for a given quantity of light.

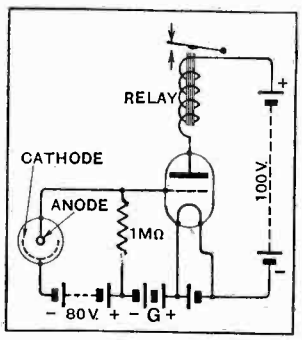


Fig. 14.—Circuit showing how to connect a photo-electric cell so that a relay is operated when the light falling on the photo cell fails.

This simple circuit enables the experimenter to study the characteristics of the modern photo-electric cell and to apply such cells to his own particular problems. In the title illustration accompanying the first part of this article is an apparatus which serves to demonstrate the potential applications of the photo cell to industrial control made possible by the rapid developments occurring in thermionic valve design. In this apparatus a photo cell is directly controlling the output of a new type of valve known as a "Thyratron," this output driving a D.C. motor. Thus, with one valve and a controlling unit all operating from an A.C. supply, variation of light on to the photo cell can be made to actuate sufficient power to fulfil many industrial uses.

With the example of the sound reproducer in view where the output of the photo-electric cell is amplified to some million times its value to operate loud speakers, it is unnecessary to explain that the response of the photo-electric cell can be amplified enormously with remarkable fidelity. With this in mind, together with the simplicity of the apparatus required to give moderate amplification, it will be realised that the application of photo-electric cells to automatic industrial control is still only in its infancy.

(This article is published by courtesy of the British Thomson-Houston Co., Ltd., to whom we are indebted for permission to give details of the experimental results described.)

[1] G. T. Winch, *Journal of Scientific Instruments*, Dec., 1929.

CLUB NEWS.

Business as Usual.

"No summer interval" is the order of the day with the Radio and Television Society, which is holding fortnightly meetings throughout the year at the temporary headquarters, London Lagonda Service Depot, 195, Hammersmith Road, W.6.

Since its formation a few months ago the Society has continued to enrol new members, and if the increase in numbers continues at the present rate new headquarters will have to be found. The subjects dealt with recently have covered a wide range from television and short-wave work to photo-electric cells and microphones. Visits have been paid to the Croydon Wireless Station and the Chelsea Power Station. Other outings are being arranged. It is proposed to start a Q.S.L. Service Bureau. All enquiries regarding the activities of the Society should be addressed to the Hon. Secretary, Mr. E. G. Nurse, at headquarters.

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Wireless at Wembley.

Loud speaker tests in a "padded room" was one of the fascinating events during the visit of the Wimbledon Radio Society to the Research Laboratories of the General Electric Co., Ltd., at Wembley on a recent Saturday afternoon. Members, who were accompanied by representatives of the Inland Revenue Radio Society, spent a considerable time in the Radio Section. In addition to the loud speaker tests the party witnessed development work in connection with the next season's radio requirements, and were able to inspect the new "Screened Building" for the Radio Section which is now in course of construction. The Valve-life Test Section aroused special interest.

Hon. Secretary: Mr. P. G. West, 11, Montana Road, Wimbledon, S.W.20.

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Summer Radio in Manchester.

In accordance with its usual practice the Radio Experimental Society of Manchester has decided to continue its activities into the summer months, and a series of more or less elementary lecture-demonstrations has been arranged. This evening (Wednesday) Mr. R. M. Kay will describe the design and construction of an A.C. receiver. On Friday, July 24th, Mr. J. H. A. Meadowcroft will give useful tips regarding radio cabinetmaking.

The Society, which owns the radio station G2FZ, is anxious to extend its membership of transmitting amateurs in the district.

Hon. Secretary: Mr. R. M. Kay, 8, Water Street, Manchester.

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Making Gramophone Records at Home.

The home recording of gramophone records provided excellent material for a lecture-demonstration given by Mr. J. Gilbert at a recent meeting of the Bec Radio Society. The apparatus consisted of a four-stage push-pull paraphase amplifier employing two L.S.6a valves arranged for push-pull amplification in the output stage and fed from an eliminator giving 500 volts at 250 m/A. Several successful records of the piano were played back to members, some of whom, during the course of the evening, made discs which included a violin duet and a speech in Italian. These recordings were then immediately played back by the pick-up, and the results closely approached those given by good commercial records.

Hon. Secretary: Mr. A. L. Odell, 9, Westway, Grand Drive, Raynes Park, S.W.20.

BROADCAST BREVITIES

By Our Special Correspondent.

Fresh Troubles in Scotland.

Scottish listeners' dissatisfaction with the present broadcasting service was mentioned in these columns last week, but from rumours which are now floating southwards I gather that there is a growing ferment in regard to another aspect of the B.B.C.'s activities north of the Tweed.

It is said that a lot of second-rate talent finds its way into the programmes, and this is alleged to be due to an obvious desire to pander to "high society" rather than to incorporate the best material.

oooo

Wanted: a Board of Enquiry.

The B.B.C. officials in Scotland cannot have it both ways. It may look impressive to have a titled artiste in the programmes, but listeners, I imagine, are prepared to forgo titled talent in order to obtain the best performance.

It would be a thousand pities if the forthcoming improvements in the technical side of Scottish broadcasting were stultified by a short-sighted programme policy, and I commend to Savoy Hill the idea of a thorough investigation of the disturbing rumours which are robbing broadcasting of its prestige in the North.

oooo

Prepare for the "Proms."

To begin the "Proms" season with gusto, Sir Henry Wood is including Ravel's "Bolero" in the programme on the first night, i.e., Saturday, August 8th. As a rule, Saturday nights will be devoted to miscellaneous and perhaps lighter music as compared with the more serious material to be given on other evenings of the week, but this year, I understand, "Saturday nighters" will have a dose of Wagner.

oooo

Soloists Galore.

The majority of the Promenade Concerts will be broadcast from one or more of the B.B.C. stations, so that lovers of orchestral music should find plenty to interest them during the season, which will last from August 8th to October 3rd.

The list of soloists is an impressive one. Among the pianists are Adela Verne, Ponishnoff, Solomon, and Moisewitch. The singers include Frank Titterton, Walter Widdop, and Muriel Brunskill, and the list of violinists includes Renee Chemet, Telmanigi, and Orrea Pernel.

oooo

Special Nights.

As usual, Mondays will be sacred to Wagner, and Friday to Beethoven. Tuesdays will strike a more catholic note with a mixture of Mozart, Haydn, Tchaïkovsky, and other composers. Bach and Brahms will be "featured" alternately on Wednesdays, as last year, while Thursdays will be devoted to British works.

Two Thursday concerts will contain Elgar's music exclusively, and two nights will be dedicated respectively to Delius and Vaughan Williams.

oooo

Dress Reform for Broadcast Players.

On these hot summer evenings the more humane among broadcast listeners always remember to shed a sympathetic tear for the musicians who provide us with music in the woods and pastures while they themselves sweat under a weary life in some dark and distant studio.

This year, so far as the "Proms" are concerned, we shall be able to repress these pangs, for I understand that the B.B.C., in conjunction with the Dress Reform League, are considering a lighter form of evening dress for the male members of the orchestra. (The ladies have already learnt how to dress!)

oooo

Soft Collars.

The suggested turn-out, I am told, omits the waistcoat and consists of a soft silk shirt, soft collar, and black tie, and a dinner jacket made of thin worsted material almost like alpaca.

Apparently uniformity is considered necessary, so the conductor will announce at morning rehearsals whether the prevailing temperature justifies this tropical outfit or whether "full marching order" is to be worn. Presumably, Sir Henry Wood will tune in each day to the Daventry weather forecast.

READY FOR LAUNCHING. Like a ship about to be run down the slips, "Broadcasting House" is now externally complete. The interior is still in the crude state, however, and doubts are expressed as to whether the B.B.C. staff can move in before November.

Climate to Order.

For studio performances, of course, orchestral players are not bound by hard-and-fast rules in the matter of dress. Anything within the bounds of decency is permissible, and I have seen artistes as well as conductors discarding first one garment and then another as the temperature of the studio increases.

It is hoped that in Broadcasting House this disrobing will be quite unnecessary owing to the efficiency of the ventilating system, which should be able to produce any climatic conditions necessary from Arctic winter to equatorial summer.

oooo

Demolishing Broadcasting House.

There seems to be no violent desire among the staff at Savoy Hill to transfer into the new quarters, and I understand that moving day is receding farther and farther into the misty future. Certain members of the staff have already carried out a critical inspection at Portland Place, and at least one forceful individual has arranged for the demolition of a party wall which threatened to curb his activities in the new surroundings.

oooo

New Edgar Wallace Mystery.

The mystery connected with Mr. Edgar Wallace's second appearance before the microphone, to take place on July 20th, is that he has not yet chosen a topic. As Mr. Wallace's scope covers every topic under the sun, I shall hazard no guesses!

oooo

A Daring Broadcast.

Despite all that is said in favour of broadcasting as a means of encouraging the "happy home" spirit, I believe that more domestic quarrels centre around the choice of programmes than around any other subject except the disposal of housekeeping money. This gives a touch of irony to the B.B.C.'s decision to broadcast the trial for the Dunmow Flitch on Bank Holiday. The Flitch is awarded to the couple who provide the best proof to the assembled court that they have not quarrelled once during the past year.

oooo

The Tyrannous Microphone.

Sir John Reith cannot escape from the atmosphere of the microphone even at his country retreat in Buckinghamshire. A few days ago when "hiking" past the impressive entrance gates to the "D.G.'s" dwelling, I was overtaken by a "talkie" van which whizzed by and disappeared down a leafy lane. Guessing that some fun was afoot I rushed on and found a moment later, within sight and a stone's throw of Sir John's windows, a mixed company of film operators, "supers," etc., preparing to "shoot" a rural love scene.

oooo

In the Alley.

The microphone was swinging gaily over the heads of Miss Gracie Fields and Mr. Ian Hunter, who were only waiting for a little sunshine to enable them to enact a moving episode in "Sally in Our Alley," the new British film appearing shortly.

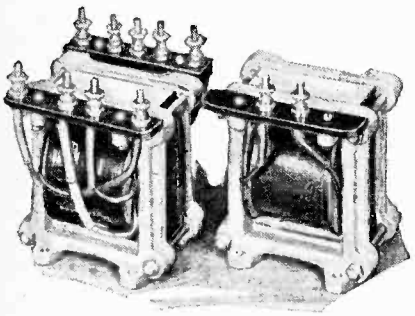
Fortunately, perhaps, Sir John had not returned from America!

Laboratory Tests on New Apparatus.

Review of New Radio Products.

TUNEWELL MAINS COMPONENTS.

The two components dealt with in this review comprise a mains transformer—type H.V/25—designed for use with the Philips 373 half-wave rectifying valve, and a constant inductance L.F. choke—type S.20/50—rated at 20 henrys.



Tunewell mains transformer, type H.V/25 and 20-henry L.F. choke, type S.20/50.

Although comparatively small in size—the overall dimensions are 3in. × 3in. × 3½in. in each case—they discharge their particular duties in a perfectly satisfactory manner.

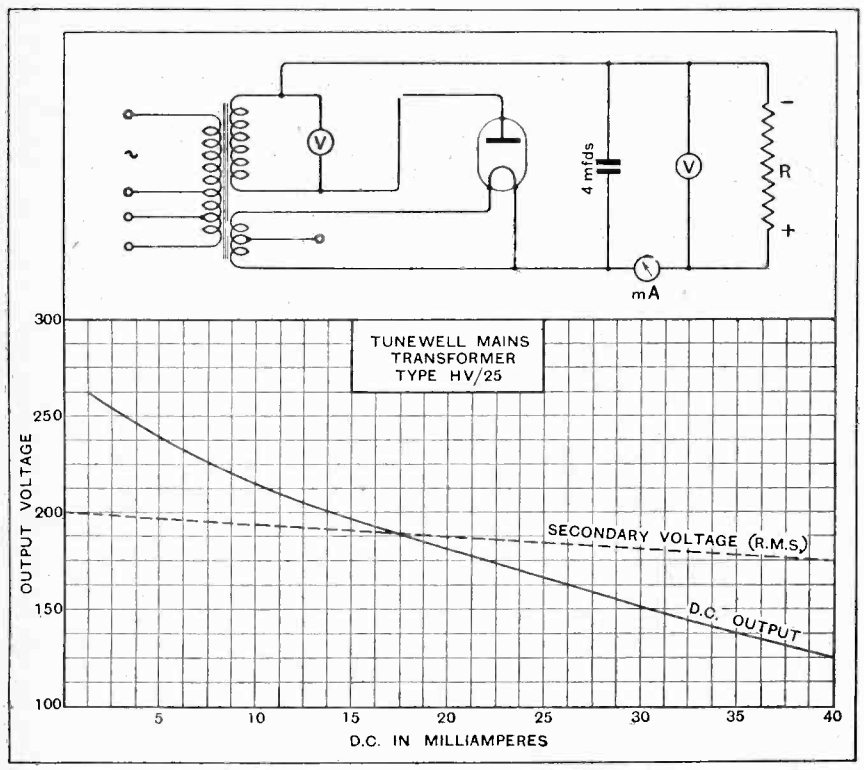
The output voltages of the mains transformer are well regulated, and on full load the filament of the rectifier is being operated at its correct voltage. Although the maximum output load is given as 25 mAs., the valve specified will handle up to 40 mAs. of current, but with this load the rectified voltage is 122 only. With 25 mA.—the makers' rated output—165 volts are available, which, after smoothing, will provide 150 volts or so of pure D.C. for the valves. The regulation of the combined valve and transformer with current loads up to 40 mAs is given in the graph.

The S.20/50 L.F. choke is rated to carry 50 mAs. of D.C. and to maintain an inductance of some 20 henrys. That the choke is well capable of discharging its allotted function is shown by the inductance measurements made at 50 cycles and with various amounts of D.C. flowing.

D.C. in mAs.	A.C. in mAs.	Inductance in Henrys.
0	1.07	23.8
10	1.07	23.8
20	1.09	23.3
30	1.12	22.8
40	1.18	22
50	1.18	21.5

For a choke of such small dimensions these inductance values are exceedingly good. Its D.C. resistance is 500 ohms.

The price of the H.V/25 transformer is 18s. 6d., and that of the choke 15s., and the makers are Turner & Co., 54, Station Road, New Southgate, London, N.11.



Regulation curve of the Tunewell mains transformer using Philips 373 half-wave rectifying valve.

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SIX-SIXTY VALVE SCREEN.

Made by Six-Sixty Radio Co., Ltd., 17-18, Rathbone Place, Oxford Street, London, W.1, this screen can be fitted to the S.G. valve without the need to disturb a single wire in the set. It fits on to the valve by means of a lug bent inwards at right angles. This lug has a hole drilled in it, and when placing the valve in the screen the earthed pin—i.e., the L.T. negative or cathode as the case may be—is passed through the hole so that when the valve is placed in its holder the screen is earthed. The screen is firmly attached to the valve by means of a screw which passes through the side of the screen and grips the base of the valve.

Six-Sixty valve screen coated with an insulating lacquer.

As a safeguard against damage to the valves in the event of a loose H.T. wire touching the screen, the latter is coated with a transparent insulating lacquer. This is easily damaged, however, and a scratch will break down the insulation; nevertheless, it does afford a measure of protection.

The price of these valve screens is 1s. 3d. each.

o o o o

HELSBY CONDENSERS.

Helsby condensers are made by British Insulated Cables, Ltd., Prescot, Lancs, in sizes ranging from 0.1 mfd. to 12 mfds., and suitable for operating voltages of from 250 to 2,000 volts D.C. In all cases

the pressure at which condensers are tested is double the marked working voltage. With the exception of one type, viz., 209B (500 volts D.C. test), which is supplied in moulded bakelite cases, all Helsby condensers are housed in metal cases.

Range of Helsby 500-volt test paper-dielectric-type condensers.

Prices vary according to size and the test voltage, thus a 1 mfd. in the 500-volt D.C. test type costs 2s. 7d., while the same size tested at 1,000 volts D.C. is listed at 4s. 9d. A 4 mfd. condenser tested at 800 volts—a satisfactory size and particularly suitable for use in eliminators and mains sets—costs 7s. 7d.

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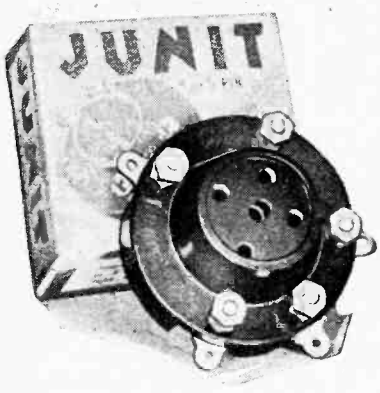
JUNIT "LOLOS" VALVE HOLDERS.

Mechanically and electrically the new style valve holders introduced recently by the Junit Manufacturing Co., Ltd., 2, Ravenscourt Square, London, W.6, exhibit many interesting features. Bakelite is employed for the shell, and the spring sockets are so arranged that the minimum area of contact between the sockets and the bakelite is present. Nevertheless, they are mechanically strong, and it is well nigh impossible to displace the contacts.

The socket, fixing lug, and soldering tag are made in one piece, and where terminals are fitted in addition the terminal shank is riveted to the spring contact. Every precaution is taken to guard against faulty connection throughout, and these valve holders should prove entirely satisfactory in use.



New Junit "Lolos" valve holders.

The H.F. losses introduced by shunting the valve holder across a coil of high efficiency are as low as possible having regard to the nature of the material adopted, and measurements show that, in this respect, they compare favourably with the best so far examined.

They are available in four- and five-pin types, and they can be supplied with or without terminals, the price being 10d. in each case.

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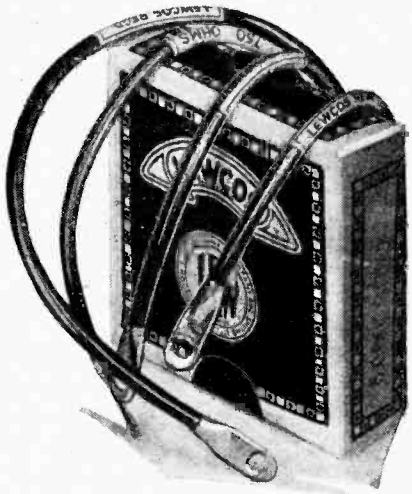
LEWCOS FRAME AERIAL AND SPAGHETTI RESISTANCES.

In general flat dwellers rarely have facilities for the erection of an outside aerial, so that wireless reception must, perforce, be undertaken using an indoor substitute. If the broadcast set is sufficiently sensitive exceedingly good results can be obtained with a frame aerial, and those who favour this arrangement will



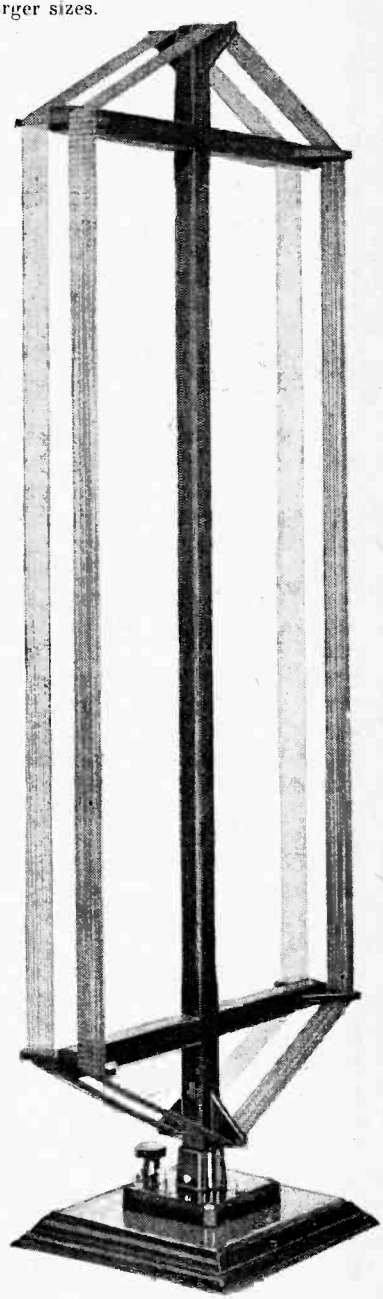
Lewcos spaghetti resistances.

be interested in the new style dual-range frame marketed recently by the London Electric Wire Co. and Smith's, Ltd., Church Road, Leyton, London, E.10.

The aerial occupies the minimum of space compatible with efficient operation, and will fit comfortably in a recess measuring about 12in. wide. The overall size of the frame is 10in. wide by 30in. high, and the wave range covered, when tuned by a 0.0005 mfd. condenser, is from 230 metres to 580 metres on the medium wave, and from 910 metres to 2,340 metres on the long waves. These measurements were made allowing for a minimum capacity of about 40 micro-mfds. The windings are tapped at the centre.

A switch built into the base changes from medium to long wave. On the medium waveband both windings are connected in parallel, while for the long wave reception one winding only is used. The price of the aerial is 32s. 6d.

The Lewcos Spaghetti type flexible resistances are now available in valnes ranging from 300 ohms to 100,000 ohms, the current-carrying capacity varying according to the size. Thus, a 300 ohm resistance will carry 50 mAs. of D.C., a 10,000 ohm size 10 mAs., and a 100,000 ohm resistance 5 mAs. They are described officially as type No. 42, and the prices range from 9d. for values up to 1,000 ohms, 1s. for values of from 1,000 to 10,000 ohms, and 1s. 6d. each for the larger sizes.



Lewcos dual range frame aerial with built-in switch.

On measuring a few samples we found the actual resistances agreed very well indeed with the marked values, and in no case did the difference exceed 4 per cent. In general a much closer agreement was noticed, especially with the higher values, where the difference rarely exceeded 1 per cent. in the samples tested.

Unbiased

by "FREE GRID"

A Political "Thorny Point."

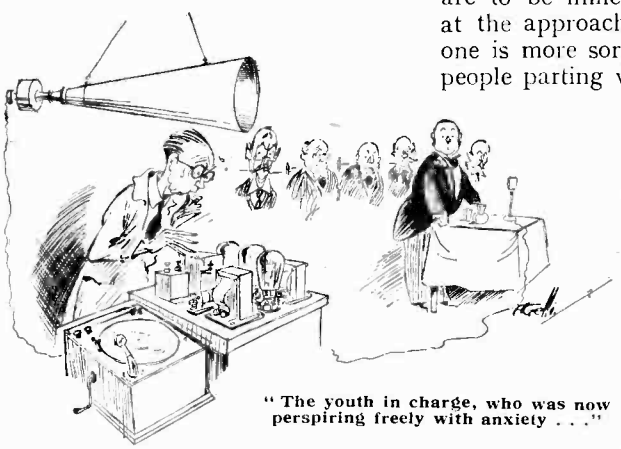
IT so happened that I was at a loose end the other evening in a certain provincial city and wandered into a political meeting in search of entertainment rather than enlightenment. I did not greatly bother myself as to which political party the meeting was intended to support. I always believe, on these occasions, in following the advice which Mr. Pickwick gave at Eatanswill, and so was quite prepared to sing the "Red Flag" or the "Black Shirt" with equal gusto as occasion demanded.

My attention was immediately arrested at the sight of a large number of loud speakers in the hall and at the sight of several formidable looking valves and other apparatus on the table in front of the chairman. I was rather puzzled, however, by the presence of a gramophone pick-up, and it was not until the chairman had jumped up at the conclusion of the first speech and announced that by the kindness of Mr. Blank a gramophone record of a speech by the leader of the Party would be put on, that my curiosity concerning its presence was satisfied.

At the chairman's words a bespectacled youth who had been sitting by his side rose with a record in his hand, and we all sat back, expectantly wondering what particular string of platitudes and banalities we were to hear this time. To everybody's surprise not a sound came from the loud speakers. The bespectacled youth immediately began a feverish examination of connections, and after a minute or two the switch was thrown over to the microphone again and the chairman announced that there would be a slight delay while the fault was remedied.

The youth in charge, who was now perspiring freely with anxiety, began a further examination, and so far lost his head that he commenced to look at parts of the circuit which were common to both microphone and gramophone, instead of doing the obvious thing and suspecting the connections to the pick-up. It was while watching his efforts that I suddenly recognised the make of pick-up, and the probable cause of the fault flashed across my mind.

I slapped my thigh in my excitement and immediately rose from my seat, only to be assailed with cries of "Sit down!" "Chuck him out!" and "He's the one that's bust the doings!" I raised my voice in protest, but nevertheless two of the stewards—ex-pugilists by the look of them — advanced menacingly towards me. It would probably have gone ill with me had I not managed to thrust one of my cards into the hands of one of them and bid him take it to the aforementioned perspiring youth. Immediately he received it he leaped to the chairman's side as though he had received an electric shock and breathed a few words into his ear. The chairman, with a look of consternation on his face, immediately left the platform in company with the youth, and after profuse apologies and mutual introductions I was escorted to the platform and the local dignitaries were presented to me. I managed to whisper a few hasty words of instruction to the now greatly relieved youth, and ten seconds later the long-awaited speech burst forth from the loud speakers.



"The youth in charge, who was now perspiring freely with anxiety . . ."

If people *will* use Burmese Colour needles in a pick-up *of the needle armature type*, how can they expect results? I naturally wondered why this fault had not been found out before, and on enquiry later the youth told me that he had tested everything with steel needles beforehand, but owing to the poor quality obtained from the record he had decided to try to improve it by substituting one of these synthetic thorns in place of a steel needle, but unfortunately he had had no time for a rehearsal before the meeting began.

Those 2 H.F. Portables.

I was talking the other day with a man well known in radio circles, and in the course of conversation he expressed the opinion that we had at length seen the last of the old inefficient type of portable receiver possessing two aperiodic H.F. stages. It is an old saying that the wish is father to the thought, and I am afraid that it was so in this case, and I was able immediately to disillusion him on this point as I know of several sets of this type which are to be inflicted upon the public at the approaching exhibition. No one is more sorry than I am to see people parting with good money for a two H.F. set which will do less in the way of station-getting than a single tuned stage using a modern S.G. valve.

One manufacturer who still intends to continue to market this type of set has informed me that his reason for so doing is that it is still the most popular type of portable, owing to the fact that, apart from reaction control, it has actually only one dial for tuning, and this has an immense appeal to the ordinary public.

Now, in my opinion, this attitude of the public is a perfectly praiseworthy one, but, instead of meeting the demand by two aperiodic H.F. stages, all manufacturers ought to turn their attention to the production of modern S.G. portables with only one tuning control. Of course, the more enlightened manufacturers have already produced excellent sets of this type, some of which have two S.G. H.F. stages, and it is to those who are still churning out the old-type instrument that I address my remarks.

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.

AVOIDABLE INTERFERENCE.

Sir,—You recently published an editorial note on "Policing the Ether," and a letter appeared from a correspondent, Mr. C. Hadfield Galloway, on "Avoidable Interference."

There is a point about this to which no reference is made, and that is whether it is really possible, and at reasonable cost, to silence existing generators and electrical apparatus so as to avoid producing interference. As I happen to be concerned with certain 220-volt D.C. generators, which, among other duties, supply my own house and others in the neighbourhood with lighting current, and which certainly produce a very great deal of noise in my own and other wireless receivers in the vicinity, I have, in my own interests, taken a considerable amount of trouble to try and silence such generators by special attention to the commutators and by means of condensers, etc. While a certain amount of success has attended the use of these devices, the machines are by no means properly silenced, and I should, therefore, be interested to know whether any of your readers can put forward practical methods of dealing with interference caused by such machines.

If users of electrical machinery are to be "compelled by law" to avoid causing interference, such users will naturally expect to be told in what way this can be achieved.

Cullybackey, Co. Antrim. J. W. HAUGHTON.

"TIME FROM THE MAINS."

Sir,—The article in your issue of May 27th provides an excellent survey of the present position, but is not quite correct historically. The Northmet Company adopted the Warren system of frequency control as long ago as 1922, and, since that time, the whole of their system has been run on standard frequency, synchronisation of time throughout their many undertakings being automatically accomplished by this means. The "Warren" domestic pattern clocks have been offered for sale to their consumers, but, owing to their high price, have not been very generally adopted.

I think I am right in saying that no other public supply authority in this country followed the lead of the Northmet in this matter for a period of five or six years. H. S. SELVES.

Southgate, N.14.

AMATEURS AND BROADCASTING.

Sir,—Replying to Mr. F. G. Kay, who writes *re* Sunday broadcasting in your issue of May 27th.

First, the amateur does not wish that there should be no Sunday broadcast *at all*. It would not benefit him, as under the terms of his licence he cannot transmit for more than two hours in any consecutive twenty-four.

My second point is that surely Mr. Kay (although I do not doubt but that he is a hard worker) does not work, say, from 8 a.m. until 9.30 p.m. as a general rule every day of the six in the week?

My chief reason, however, in writing this letter is to take up the cudgel on behalf of the "ham" as regards his last paragraph but one, wherein he states that the amateur has not helped radio research. Such a remark brings to mind many names, including G. Marcuse (2NM), the man who first showed that Empire broadcasting *was possible*. I wonder exactly how many amateur call signs there are amongst the staff of the B.B.C.? I could run off a few at random.

Surely Mr. Kay does not deny that it was the amateur who first showed that the waves below 200 metres were of practical use, and after they had done so, the commercial fraternity decided that it might be as well to look into the matter. To my knowledge no commercial firm had tried the old amateur 110-metre wave when F8AB found he could work W1MO at Hartford, Conn., easily, and later G2OD worked New Zealand.

No, Mr. Kay, give credit where credit is due, and live and let live. Also, don't forget the "hams'" work in New Zealand in connection with the recent earthquake disaster.

Heswall, Cheshire. IAN D. AUCHTERLONIE (G6OM).

Sir,—In one of the letters published in your Correspondence columns of your issue of May 27, Mr. Kay asks the question, "Which should come first, amateurs or listeners?" May I answer quite definitely that in my opinion it is the amateurs who should take precedence? I am afraid Mr. Kay belongs to that ever increasing and, if I may say so, lamentably narrow-minded body of the public who regard broadcasting, like drainage systems and the police force, as one of their rights. They imagine that, because they pay a licence for their receiving set, they are definitely entitled to be provided with programmes by the B.B.C. But in this point they are wrong, for, as has often been pointed out in your journal, they would have to pay the licence just the same if there were no such organisation as the B.B.C.

The point they overlook is that radio is essentially a science, and that broadcasting is merely a quite unimportant branch of the practical application of the science. The real object, in my opinion, of radio, is that it should be as technically perfect as possible, not for the sake of any purely pleasure-giving purposes such as broadcasting, but for its application to its really important practical side, namely, transoceanic telephony and telegraphy, distress signals, etc.; and, even more important to my mind, for the purpose of scientific progress and knowledge for its own sake. Now actual broadcasting of concerts, etc., does nothing towards this end; indeed, it would be much more useful if standard frequencies, transients and the like were transmitted.

Now this is where the amateurs come in, for, in spite of Mr. Kay's withering remarks in his penultimate paragraph, the amateurs really are doing immense work towards a greater knowledge of radio; if he wishes to verify this for himself, I should advise Mr. Kay to glance through a few numbers of the "Tok Bulletin" (the official organ of the R.S.G.B.); in them he will find articles on "Lunar Effects on the Short Waves," "Fading," etc.; all these articles are written by amateurs and show the result of the independent and combined

research of thousands of amateurs all over the world; it is their research that will eventually lead towards the goal to which we should be heading.

I would end by saying this: Mr. Kay, and with him every other "listener," owes a debt to radio, not radio to him. Far be it from me to advocate the abolishment of programmes, for I am myself a regular listener from 5.15-6.15 on weekdays (London Regional), but I definitely think that when it is a question of programmes or serious work, the serious work should come first, even if those engaged in it are far fewer than the pleasure seekers—remember, majorities are seldom right.

N. L. SPOTTISWOODE.

EMPIRE BROADCASTING.

Sir,—As one who is in a position to give first-hand information on the subject of "G5SW's" transmissions to listeners overseas, I should like to make the following observations and comments.

In this longitude we are two hours in front of B.S.T., so that the home programme is available from 1430-1530 and 2100-0200; these times are fairly reasonable. The 1430-1530 programme has been consistently weak, fading from readable signals to inaudibility during the past month with everything "turned full on."

The evening programme from 2100-2400 is generally fairly well received, but a tendency for the transmission to deteriorate until its programme value is negligible is usually noticeable from 2400-0200.

The announcements *re* the *following* night's programme at 2055 are too brief. Why can we not have an announcement at that time for the current performance?

At 2300 there is the usual interval of fifteen to twenty minutes while the news is being read—but not to us. This is referred to by the humorist at the microphone as a brief pause.

Since the current news, which is, incidentally, available from several sources by W.T., is considered to be unfit for overseas consumption, why can the listener not be told in detail the programme for the following night, and would it strain the resources of the B.B.C. to give a selection of gramophone records in this interval?

Owing to the conditions of S.W. reception overseas it is considered that the items transmitted are in many cases totally unsuitable. The experience of listening to a Queen's Hall concert through a background of incipient atmospherics accompanied by fading is not conducive to appreciation of the undoubted excellence of these concerts, and a sustained soprano note subject to drifting or fading is rather a bar to appreciative listening.

The experiment should be tried on a local station quality receiver of frequently adjusting the volume control, while a generator with a slightly sparking commutator is operated at irregular intervals to obtain some idea of the conditions obtaining in this country.

Let me hasten to add that I do not blame the B.B.C. for the atmospherics.

As criticism should be constructive to be of any value, may I suggest that the programme for overseas consumption should consist of extracts from the lighter forms of entertainment, such as interesting talks, light music, dance music and variety.

Personally, I appreciate talks, and find considerably less exasperation is occasioned when a speaker's voice fades out slightly than from a similar occurrence in a musical production.

This brings forward another aspect of overseas listening. It will be found that the most trying items to listen to are those in which the volume of transmitted sound varies considerably; for instance, from a solo violin to a full orchestra in a concert performance, in conjunction with the usual fading. This explains why talks, in which the volume transmitted maintains approximately a constant value, are generally easy to follow. Such items as popular light music, dance music and variety also fall into this category, with the advantage that the ear is more able to fill in the portion of the transmission which happens to be subject to interference, except in the case of variety which, from a listener's point of view, is subject to the same disadvantages as a talk in which words are unavoidably missed.

Lest it might be thought that my apparatus is not capable of the demands made on it, I might state that Rome, Berlin and PCJ frequently come in at such strength that the volume control has to be fairly liberally used if telephone reception is to be comfortable. These stations, and in particular Rome, are particularly free from fading, and as reaction has not to be pressed to the limit, some relief is found from atmospherics, fan motor interference, etc.

In conclusion, it is not easy for the short-wave listener at home to realise how dependent one is on 5SW for an English programme. When he gets tired of his American stations, etc., he switches on to the local and receives the programme as it should be received with no fading, and usually no background of X's, but if the local-station listener could get no better reception than that provided by 5SW in a distant country, it is likely that the outcry would be considerable.

All times in this letter are local times.

Hinaidi, Iraq. C. R. MASON, Flight Lieutenant, Royal Air Force.

Sir,—May I support Mr. Chapman in his appeal in your issue of June 3rd for an Empire short-wave transmitter to cover all the countries of the British Commonwealth?

I am a Canadian by adoption, but English by birth and education, and I think that the influence of radio broadcasts is so great that we should utilise it to the full in order to strengthen the bonds of sentiment that already exist.

I have written to the B.B.C. several times on these lines, and can say that, whereas Rome was very much stronger in Halifax prior to March 1st last, since that time G5SW has held her own, and we have heard her every night practically up to the day we left Halifax, when we were delighted to get the broadcast of the nightingales.

Many of my friends are short-wave enthusiasts, and naturally London is our Mecca.

All big international features are, of course, re-broadcast by CHNS, our local station, but it is a much better arrangement for us to be able to tune in at will on London, thus keeping close contact with the heart of the British Commonwealth of Nations.

W. E. TIBBS.

Worcester.

TRANSFORMER VERSUS *R.C. COUPLING.*

Sir,—In view of the changed conditions, new valves, etc., I should be glad if you would allow me to reopen this old controversy.

As far as the characteristics of a good transformer and good R.C. couplings are concerned, I do not think there is much to choose between them, but where the R.C. coupling scores heavily is in its better production of transients, such as cymbals, drums, and pistol shots.

As the rectified output curve from detector valve will (I presume) be a falling curve, what is wanted is a rising curve for the L.F. amplifier. This can be got with R.C. or good transformer coupling, though the R.C. will, I think, give the better curve.

What I fail to understand is the present tendency amongst amateur constructors to build a single-stage transformer stage instead of two stages of R.C.C. This, I think, is often done through mistaken economical reasons, as I contend it is to-day just as cheap (if not cheaper) to build two good low-gain R.C. stages as one *good* transformer stage.

It means:—2 Spaghetti resistances .....
2 0.01 mica condensers .....
2 grid leaks .....
1 extra valve and valve-holder
} say £1,

as compared with:—

One *good* transformer, say, 25s. or £1.

I do not consider cheap transformers, as they cannot give first-class quality.

As far as volume is concerned, the two R.C. stages will give considerably more volume than one transformer stage, and, in my opinion, far better quality.

If quality is the consideration, I fail to see any reason for the transformer set as compared with R.C., and still less reason for the transformer pentode set, now so popular.

I do not intend my remarks to apply to manufacturers, who may have good reasons, but only to amateur constructors who want real good quality.

R. W. TALLIS.

Newport, Mon.

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.

"Avoiding Detector Distortion."

I should like to try the new method of grid detection advocated in an article under the above heading in your issue of May 20th. Will you give me an idea as to the right value for the grid leak?

It is advantageous to use, in conjunction with a tuned acceptor grid circuit, a leak of comparatively high value—say two or three megohms.

o o o o

Not for a Frame Aerial.

Will you please show me how to modify the "Super-Selective Six" so that it may be used with a frame aerial?

This receiver is essentially designed for operation with an open aerial system, and we think it would be a mistake to attempt to alter it so that a frame could be substituted. In any case, if results approximating to those obtainable from the set as described are aimed at, we are afraid that the alterations necessary would be so extensive that the whole matter would be rather beyond the scope of the Information Department.

o o o o

Decoupling H.F. Circuits.

In place of the usual resistance of 600 to 1,000 ohms, would it be practicable to use an H.F. choke for decoupling the anode and screening grid circuit of an H.F. amplifier?

High-frequency chokes can be used in certain circumstances for this purpose, but in practice are generally less satisfactory than non-inductive resistances.

o o o o

New Wine—

I am still using a three-valve receiver built on the lines suggested in your journal nearly four years ago, in which a neutralised H.F. stage is followed by an anode bend detector. Do you think it would be worth while to change over to the power grid rectification principle?

High-efficiency neutralised H.F. amplifiers of the type which we presume you are using do not work at their best with the new method of detection, which is essentially intended to be used either in reacting detector sets or after an H.F. amplifier in which screen grid valves are employed. Litz-wound neutralised transformers were generally designed on the assumption that they would be followed by a detector arranged to impose comparatively little damping. If you wish to use power-grid rectification, all we can suggest is that you should "tap down" the grid connection on the transformer secondary. Alternatively, or in addition to this alteration, reaction might be added.

o o o o

"Square Peak" Coils.

Will you please show me how to connect one of the new Varley "Square Peak" intput filter coils to an indirectly heated S.G. high-frequency amplifying valve? It is proposed to use a ganged tuning condenser with earthed rotors, and my difficulty is to see how bias can be applied.

Would there be any objection to including an input volume control of the resistance potentiometer type, as in the "Super-Selective Six"?

A suitable method of connection for this coil is given in Fig. 1. As tuning condensers with earthed rotors are to be used, it will be most convenient to bias the H.F. valve by inserting a resistance of the necessary value in series with its cathode; at the same time it will be necessary to shunt the coupling condenser with a resistance. The actual value of this resistance, to which we have given a value of 10,000 ohms, is by no means critical, provided it exceeds 1,000 ohms or so. An H.F. potentiometer input control should be quite satisfactory, and is shown in the diagram.

The four terminals of the coil assembly have been lettered to correspond with the manufacturers' markings.

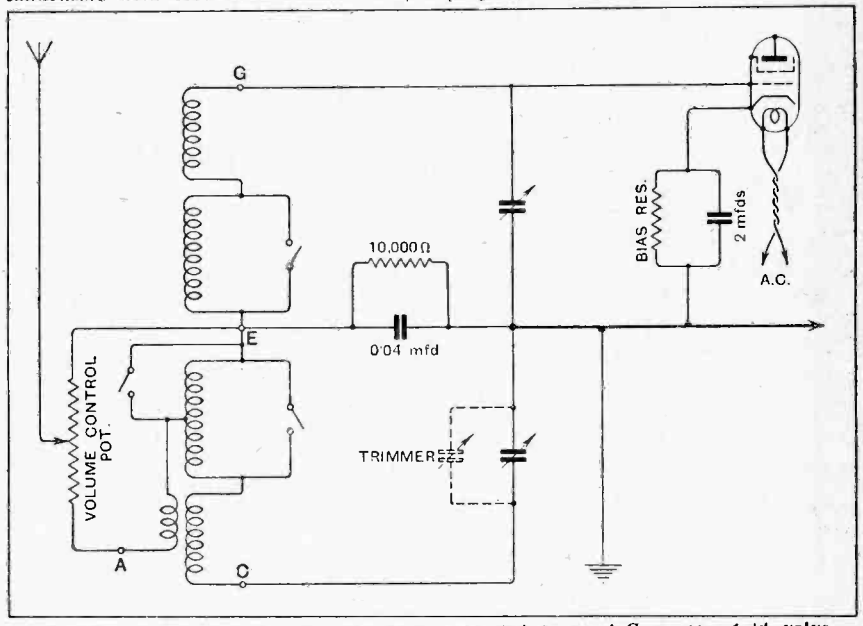


Fig. 1.—A commercial filter coil unit connected to an A.C. screen grid valve.

o o o o

Out of Place.

Would it be worth while to use a "mixed" filter, of the type described in your issue of February 18th, in the intermediate-frequency amplifier of a superheterodyne? If so, I should appreciate some suggestions as to suitable windings for the coils, and the capacity of the necessary coupling condenser.

The advantage of a constant-width band-pass filter of the type to which you refer is that it gives sensibly the same broadness of tuning over a fairly wide range of wavelengths. In a superheterodyne intermediate-frequency amplifier this property is quite valueless, as this amplifier is required to tune only to a single wavelength, and consequently it would be useless and extravagant to employ a type of filter giving constant peak separation.

Grid Detection without High-note Loss.

I was interested in an article published in your issue of May 20th, in which the possibilities of using a tuned acceptor circuit in place of the usual grid detector condenser were discussed. If possible, I should like to include this device in my own receiver, a circuit diagram of which is enclosed.

Will you please show me how to arrange the acceptor circuit inductances so that waveband switching may be included? Also, as this seems to be a case where the principle of "tapping down" the detector grid connection would be of advantage, will you please indicate how this refinement may be included.

The system of rectification to which you refer is applicable to a grid detector which is coupled to a preceding H.F.

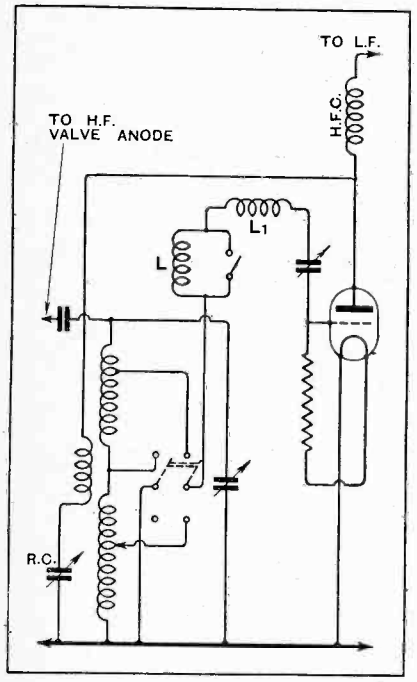


Fig. 2.—Detector grid circuit with tuned acceptor and waverange switching.

stage by means of a "tuned grid" coupling, and the appropriate connections are shown in Fig. 2. The long- and medium-wave acceptor circuit inductances are marked respectively L and L_1. Care should be taken in the wiring of these components and of the associated short-circuiting switch and tuning condenser in order that undesirable couplings may not be introduced.

oooo

Wire Gauge and Coil Inductance.

If wire of a gauge heavier than that specified is used in winding a certain inductance coil, will it be necessary to put on a greater or lesser number of turns?

All other things being equal, the use of a heavier gauge of wire will result in a coil of greater winding length for a given number of turns, and so its inductance will be reduced. To attain the designed inductance value, it will be necessary to wind on more than the specified number of turns: we should perhaps add that by doing this the shape of the coil will be altered, and it is likely that its efficiency will be impaired to a certain extent.

oooo

Anode Current Measurement Problem.

I have been attempting to check the anode currents of the various valves included in my receiver (a commercial product), but have been unsuccessful so far as the H.F. valve is concerned.

The various components are not easily accessible, and the only point at which the meter can conveniently be inserted is between the anode terminal of the valve and its flexible lead. When the instrument is connected, self-oscillation is produced, and I presume that the reading of anode current shown cannot be the same as that passed under normal operating conditions.

Can you suggest a way of making an accurate measurement without dismantling the set?

As it is apparently impossible to insert a milliammeter in the correct position (at the low-potential end of the anode circuit), we suggest that before making a measurement you should short-circuit the grid coil associated with the H.F. valve. If this is inaccessible, then it should be possible to prevent self-oscillation—which is evidently brought about by stray couplings due to the meter and its leads—by connecting a large condenser between the H.F. valve anode and earth.

We may add that if your set its mains-operated, and if the H.F. valve is negatively biased by the insertion of a resistance in its cathode lead, the same effect may be produced by introducing a short-circuit between the valve grid and the metal chassis or earth line. This will not alter operating conditions so far as grid voltage is concerned, and the points or connection will certainly be get-at-able.

oooo

Excessively Cautious.

After completing the construction of a single-valve set on the lines of the "Radio Reading Lamp" described in your issue of March 11th, I took the precaution of measuring the voltage across the valve filament terminals before inserting a valve. I am glad that I did so; with the help of a two-range voltmeter it was found that a voltage of nearly 200 existed across the filament terminals.

I cannot see that the slight modifications that have been introduced can do any harm. Will you please examine the enclosed circuit diagram and say where I have gone wrong?

The circuit given by you is correct; the substitution of an output transformer for the resistance-capacity telephone feed included in the original set cannot affect filament voltage. Provided that the instructions given with regard to the choice of a resistance lamp have been followed, there is no fear of applying an excessive voltage to the valve. In your case you have overlooked the fact that when the valve is not in position in its holder the current consumed by the measuring instrument is comparatively so low that a greatly decreased loss of voltage takes place in the resistance lamp, and you are getting a totally erroneous reading.

Further, there is the question of change of lamp resistance with temperature. Current consumed by the meter will be insufficient to heat its filament to incandescence, and consequently its resistance may amount to something like 100 ohms instead of about 2,000 ohms, which is roughly the normal value.

The only way of making a proper test without a valve in position is to connect across the filament terminals of the holder a resistance of the same value as the valve itself.

oooo

H.T. Supply in the Tropics.

I am shortly making a trip to the tropical part of Africa, and propose to take with me a short-wave receiver. Low-tension current will be obtainable from a car accumulator, but I understand that the problem of H.T. supply is rather difficult in these climates, as the ordinary type of dry battery deteriorates rapidly. Do you know of any suitable source of supply? A high voltage is not needed, as headphones will be used for reception.

Inert dry cells will be satisfactory. These are produced by most of the bigger firms of battery makers, and they do not begin to deteriorate until they have been put into use by the addition of water.

A battery consisting of a couple of dozen cells or so should be quite adequate for headphone reception.

FOREIGN BROADCAST GUIDE.

RADIO LYON

(France).

Geographical position: 45° 41′ N., 4° 47′ E

Approximate air line from London: 460 miles.

Wavelength: 286 m. Frequency: 1,049 kc. Power: 0.8 kW.

Standard Time: Greenwich Mean Time (France adopts B.S.T.)

Standard Daily Transmissions.

10.30 B.S.T., concert; 12.00, concert, news (Sun.); 15.30, transmission of photographs; 19.45, news, concert; 20.30, relay of "talkie" films (Sun.); 21.30, dance music, concert, news; 22.00, relay of foreign stations (Sat.); transmission of photographs (Belin process).

Man announcer.

Opening signal: Counting in French from 300 to 320.

Call: *Hallo! Hallo! Ici Radio Lyon.*

Closes down with usual French formula, followed by *La Marseillaise.*

The Wireless World AND RADIO REVIEW

(19th Year of Publication)

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Battery Sets Can Be As Good.

LOOKING back over a few years, it comes as rather a surprise to discover how really recent in date is the efficient receiver operated entirely from the electric light mains. For some years after broadcasting started, whether you had electric light supply or not, at least your wireless set was run from batteries, and it was a considerable while before the first mains-driven sets began to make their appearance. They started with sets operating from direct current using battery valves, and later the production of the very low-consumption filament (60 mA. filaments, as they were called) paved the way for the introduction of the first all-A.C. sets using a valve rectifier. Mains-driven sets did not really become popular and a satisfactory practical proposition until the introduction of indirectly heated valves.

The interest attaching to these new valves has, we think, tended to distract the attention of set designers from proper consideration of the requirements of that still very large percentage of the community which is, as yet, without electric light supply. Certainly in the direction of the bigger and more selective sets this neglect is particularly noticeable, so that we are not surprised to find that our announcement that in this issue we would be describing a battery superheterodyne of outstanding performance should have been met with a spontaneous and an enthusiastic welcome.

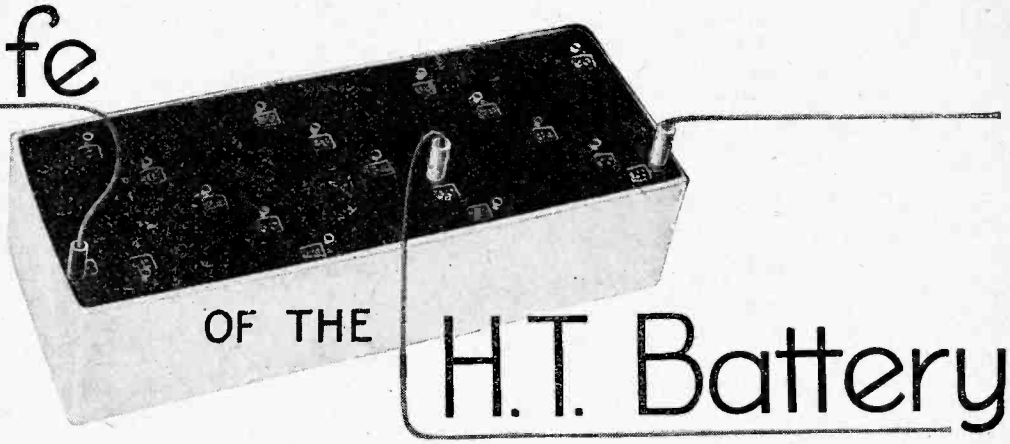
Indirectly heated valves are, admittedly, more efficient than the battery-heated type, but when it comes to the design of a set giving extreme amplification it is rather questionable whether the mains valves retain this superiority, for the reason that when operated at maximum efficiency as regards amplification they tend to produce a certain amount of valve noise of a type which is absent with battery valves, so that it may be possible for a battery-type superheterodyne to make use of the last ounce of amplification, whereas with the indirectly heated type of valve a certain amount of background noise would be present when amplification reached its highest degree.

This statement may comfort those who have regarded themselves as severely handicapped by not having electric supply mains available, and one can go, perhaps, a little further and say that the production of the present set has really brought within their reach a receiver giving a degree of amplification and selectivity largely in excess of that obtainable from any battery-operated receiver hitherto available.

When we consider, too, the difference in the initial cost, due to the elimination of rectifying and other mains equipment and the lower prices of battery valves as compared with indirectly heated types, the battery-set user will find that he is still well in hand financially to offset the cost of accumulator and dry battery maintenance. If the user is able to arrange for the upkeep of accumulator H.T. his running costs may be kept lower still.

In This Issue

The Life of the H.T. Battery



Hints on the Choice and Maintenance of Dry-cell H.T. Batteries.

IN spite of the increasing attention which is being given to all-mains receivers and battery eliminators, the dry-cell H.T. battery is still the most important source of H.T. current. During 1930 the number of battery-operated sets sold to the public was more than twice the number of mains sets, while the total number of dry H.T. batteries sold exceeded 7,000,000. It is somewhat surprising to find, therefore, that the average user takes so little interest in this most important accessory. He gives much careful thought to the care of valves and the choice of a loud speaker, but when it comes to buying a battery he is content to see the voltage checked by the dealer, and then to connect it up and hope for the best. In view of the fact that the renewal of H.T. batteries constitutes the greater part of his running costs the matter should repay a closer study.

Essentially, the Leclanché cell unit is a simple organism. It is shown diagrammatically in section in Fig. 1. The negative electrode is a cylindrical zinc container, and the positive electrode a carbon rod to which contact is generally made by a metal cap surmounting the top. Surrounding the carbon rod is a small muslin bag containing manganese dioxide. This substance is known as the depolarising agent. Its function is to absorb chemically the hydrogen which is evolved at the carbon rod as a result of the action of the cell. The effect of an accumulation of hydrogen at the positive electrode is to generate an E.M.F. in opposition to that of the cell as a whole, which causes the voltage to fall on discharge. The space between the depolariser sack and the zinc container is filled by the active electrolyte—a mixture of ammonium chloride (sal ammoniac) solution and a suitable absorbent material such as sawdust.

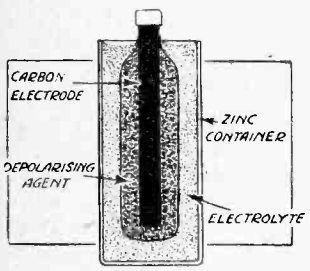


Fig. 1.—Section of a typical Leclanché dry-cell unit.

Years of patient research on the part of physical chemists are concealed by the apparent simplicity of the modern H.T. cell. Apart from the more obvious improvements, such as the use of seamless cold-drawn zinc containers in place of the older built-up pattern with soldered joints, and the admixture of carbon granules of a specially prepared type with the depolarising agent as a means of lowering the internal resistance, recent research has provided data which enables the battery maker to control not only the shelf life of the battery, but also the form of the discharge curve. The last-named quality is perhaps the most important factor governing the choice of an H.T. battery, and

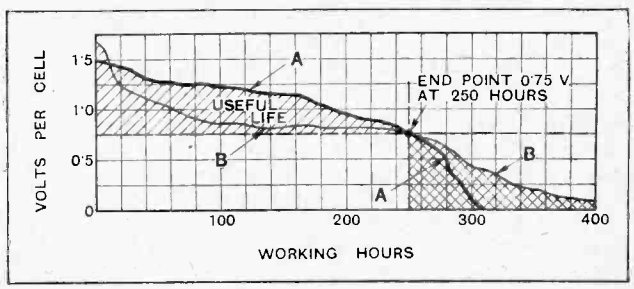


Fig. 2.—Typical discharge curves through a constant external resistance. Battery A, having maintained a high average voltage during its useful life, falls away rapidly after the end point, whereas battery B gives a large percentage of its output at a voltage too low to work the set satisfactorily.

should be the first consideration when comparing the merits of different makes.

The Discharge Curve.

The ideal type of discharge curve for a dry H.T. battery in the present stage of the art is that marked A in Fig. 2. This battery gives the greater part of its output at a voltage level well above the generally accepted end-point, viz., 0.75 volt per cell, and then falls away rapidly. Battery B, on the other hand, although showing a higher initial voltage, gives its useful output at a voltage which barely justifies the continuance of the battery in service. When the end point is reached a considerable proportion of the total watt-hour capacity remains in the cell, but it cannot be usefully employed as the voltage available is not high enough to operate the receiver satisfactorily. For the sake of argument we have assumed that the useful life in hours is the same in both cases, but in practice batteries of the type B frequently drag out their existence for 400 to 450 hours, and even when discarded still contain an appreciable percentage of their total capacity. But for two-thirds of the time they are in service the volume and quality

The Life of the H.T. Battery.—

of reproduction from the set is barely tolerable, and crackling may develop towards the end even before the 0.75 volt per cell limit is reached. Obviously, the battery A, which works hard during its useful life, and then runs down quickly and definitely is to be preferred.

Internal Resistance.

The next qualities in order of importance to receive consideration should be the internal resistance and the activity of the depolarising agent. These factors determine the maximum economical current which can be drawn from the battery, the rate at which the terminal voltage of the battery falls during each working period and the time required for recuperation during rest. In the last respect the performance of most modern batteries is satisfactory, and great strides have also been made in reducing internal resistance. Whereas in the past it was customary to assign a maximum discharge rate to batteries of different sizes, the catalogues of the leading battery makers to-day contain no such stipulation. Even the smallest sizes are capable of standing up to currents for which only "triple"- or "super"-capacity batteries were formerly prescribed. Naturally, the periods during which the higher currents are sustained are proportionately lower, but it is significant that the ampere-hour capacity of the modern battery is practically independent of the discharge rate. This point, which is frequently overlooked, is amply borne out by the actual curves shown in Fig. 3. Even the small-capacity battery shows a decrease in capacity of not more than 20 per cent. as a result of increasing the discharge rate from 5 to 20 milliamperes, while in the case of the triple-capacity battery the difference is less than 10 per cent. The average ampere-hour capacities of the three most popular sizes are approximately as follows: "Small-" capacity, 1 ampere-hour; "Intermediate-" capacity, 3 ampere-hours; "Super-" capacity, 7 ampere-hours.

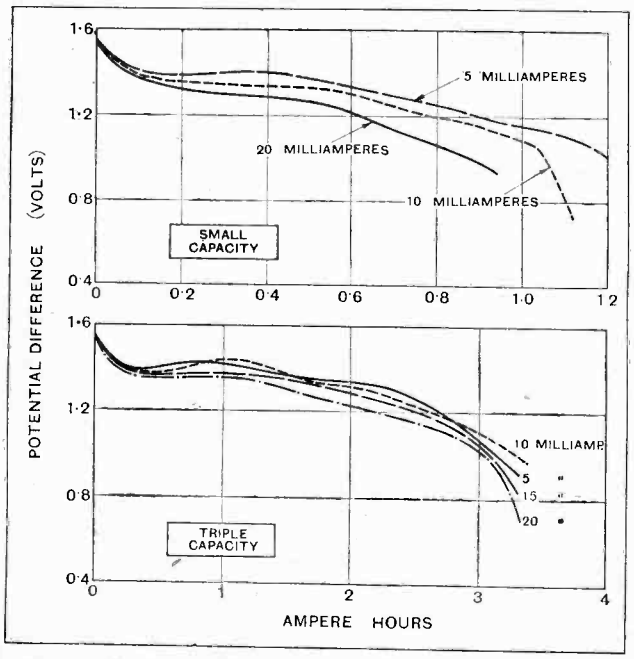


Fig. 3.—The ampere-hour capacity of the modern H.T. battery is practically independent of the discharge rate.

Although the small-capacity battery can be relied upon to give a good account of itself at heavy discharge rates, it is preferable to use a larger capacity for discharge currents in excess of 10 mA. In fact, there is an optimum size of battery for any given range of discharge currents. If the capacity of the battery is too small frequent replacements will be necessary and less than the full ampere-hour capacity will be obtained. There is also the question of value for money, for a battery having three times the capacity of the smallest size can be obtained for considerably less than twice the cost of the latter size. On the other hand, it is false economy to use the largest type of battery for a discharge of, say, 5 or 6 mA., since the service life may then exceed the shelf life and crackling noises may develop before the full capacity of the battery has been used up. Further, one stands to lose more in the event of an accidental short-circuit or an unsuspected insulation breakdown in the set. Speaking generally, the optimum discharge rates for the three principal sizes of battery may be assigned as follows: (1) "Small-" or "single-" capacity, 5 to 10 mA. (2) "Intermediate-" or "Triple-" capacity, 10 to 20 mA. (3) "Super-" capacity, over 20 mA.

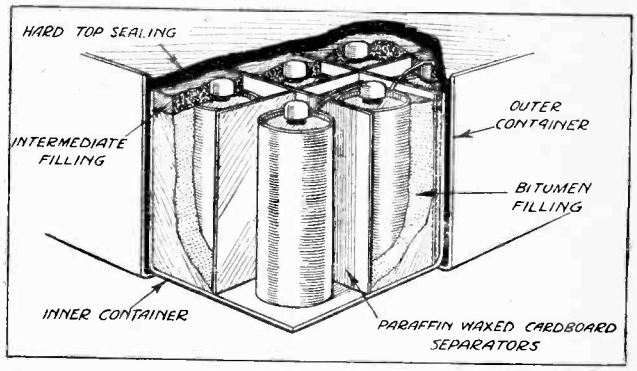


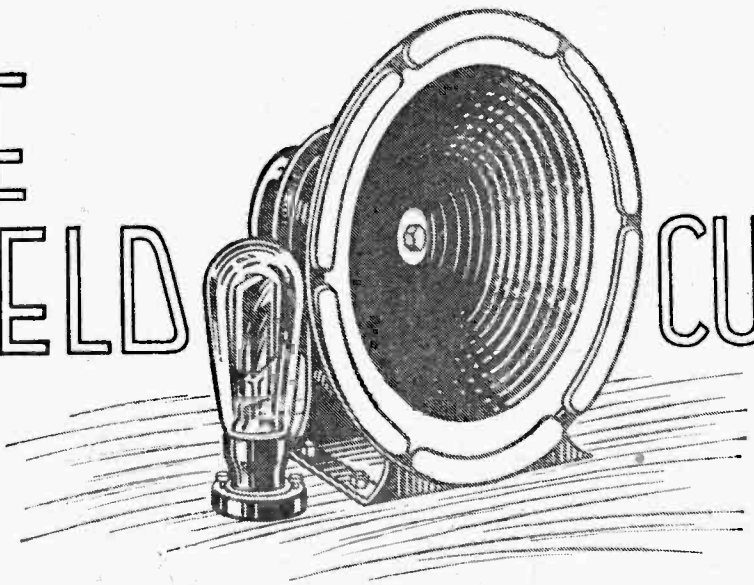
Fig. 4.—Constructional details of a high-grade H.T. battery, showing inter-cell insulation.

Elementary Precautions.

With intelligent use the modern dry-cell battery is a reliable and economical source of H.T. current, but it should not be overlooked that it is essentially a delicate organism which is easily open to abuse. Having paid good money for a battery, it behoves the amateur to make sure that he obtains a full return for his outlay. The battery should be installed in a cool place away from radiators or hot-water pipes, and short-circuits of however short a duration must be avoided at all costs. From time to time the set should be tested for leakages by inserting a sensitive milliammeter in the H.T. lead with the L.T. current switched off; in any case, it is a good plan to remove the plug connections from the battery if it is to be left standing for any considerable time.

Finally, good inter-cell insulation is always worth paying for, and a few more shillings on the initial cost of a battery so constructed is invariably justified by the performance of the battery towards the end of its life.

FREE FIELD CURRENT



Moving-coil Loud Speaker Field Excitation in Smoothing and Grid-biasing Circuits.

By F. H. HAYNES.

ONE of the most inappropriate of terms is "free grid bias." In battery sets the grid cells deliver no current, and, but for their own internal deterioration, would give indefinite service. In mains sets grid-biasing potentials are best produced by passing the anode current through a resistance, a process which robs the anode voltage of an amount equal to the grid bias by dissipating anode watts in the biasing resistance. In this way the biasing resistance becomes slightly heated and many watts may be consumed. However, with mains sets the watts consumed are of little consequence and the failings of the grid-biasing battery are avoided. It is possible, of course, to make a smoothing choke serve the dual purpose of both biasing and smoothing, an economy which was effected in *The Wireless World* Four. This brought down the load on the rectifier to within safe limits.

A more real attempt at obtaining something for nothing is that of field excitation for a moving-coil loud speaker and in which the field winding takes the place of a smoothing choke, biasing resistance or output choke.

A LESS expensive alternative to the use of the permanent magnet for the loud speaker field is a small electro-magnet with a winding forming part of the smoothing or grid-biasing circuits. A voltage loss is inevitable in a smoothing choke and deliberate in the biasing circuit of an all-mains set. As a loud speaker field winding possesses both resistance and considerable inductance it can replace either biasing resistance, smoothing choke, or both, and the watts that would thus be normally thrown away may be used to energise the magnet. In addition to giving circuit arrangements for free field excitation, this article gives valuable reference data for the automatic grid biasing of output valves.

New Moving-coil Speakers.

It is true that field current can be dispensed with by the use of a permanent magnet, but in the case of an A.C. mains set not only is field-excitation current available, but choke coils with similar properties to the field winding must necessarily be used. This article summarises the conditions under which "free field current" can be obtained, and describes the special moving-coil speakers recently introduced for the purpose by Amplion, Ferranti and Magnavox.

The amount of energy required to produce the necessary ampere turns and an adequate flux density in the gap is determined in watts being a product of the current passed and the volts required to force that current through the resistance of the winding. When the first moving-coil loud speakers were designed it was quite common for their field windings to consume as much as 20 watts, this amount of energy being necessary partly owing to the large area of the gap, but essentially because of the generous gap width which was adopted to give freedom of movement to the moving coil. By careful centring much narrower gaps are now used, and bearing in mind that to halve the width of the gap will quarter the watts required, a considerable saving may be effected in the number of ampere turns required to produce adequate flux. Further saving may be effected by a reduction in the diameter of the moving coil, so that a given flux density is now produced in a smaller gap area. Thus, by using the smallest possible gap and reducing the pole face area the excitation watts may be brought down to a minimum of about 4 in respect of the Amplion and Ferranti models and 5 for the Magnavox.

The essential detail when using these loud speakers in mains receivers is the resistance of the field winding. This has been fixed at 2,500 ohms for the Amplion and Magnavox and 1,150 ohms for the Ferranti, although the winding adopted in the latter may be changed for special requirements. From these resistance values we can convert the watts rating to values of current required, and volts dropped as shown in the accompanying Table A. When the field winding is

Free Field Current.—

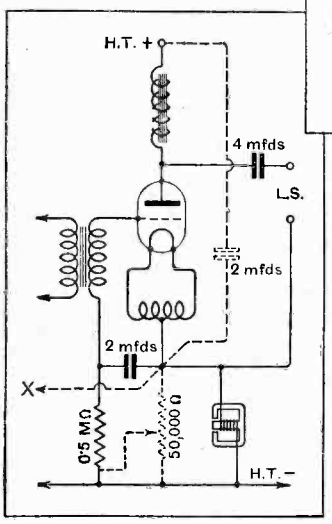
interposed in the circuit of a receiver it is unlikely that the exact value of current required will be available and

TABLE A.

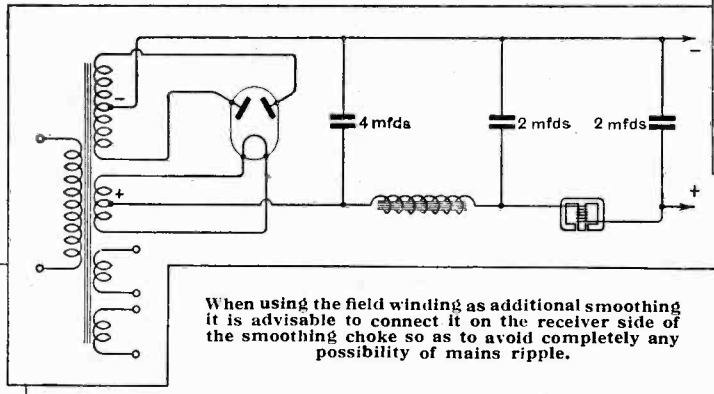
Type.	Resistance.	Minimum Watts Required.	Current mA.	Volts Dropped.
Amplion .	2,500	4	40	100
Ferranti .	1,150	4	60	70
Magnavox	2,500	5	44	110

Current and voltage requirements of the field coils. Total voltage available must create a stated current in the field winding and the potential dropped will then be additional to the voltage requirements of the receiver circuit in which the field coil is interposed in the leads from the rectifier.

the number of milliamperes given should be taken as the minimum. It should not be exceeded by more than about 50 per cent., bearing in mind, for example, that to double the current through the winding will increase the watts dissipation by four times and, as the heat developed is proportional to the watts, excessive temperature rise may result.



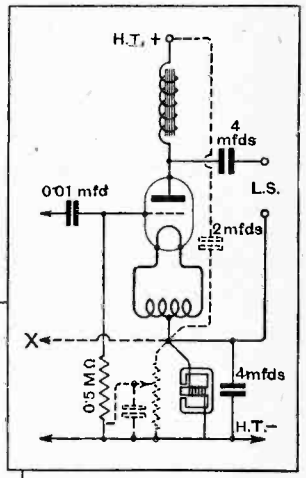
Connections showing the use of the resistance of the field magnet winding for producing free grid bias. When the biasing voltage produced is excessive, the magnet winding is shunted with 50,000 ohms and the earth side of the 0.5 megohm grid leak connected to a tapping point.



When using the field winding as additional smoothing it is advisable to connect it on the receiver side of the smoothing choke so as to avoid completely any possibility of mains ripple.

Test reveals that it is not entirely safe to use the field winding as a single smoothing choke and that it is better to use a double smoothing circuit as shown in the diagram with the field as one of the chokes, though the volts and the watts dissipated in a good smoothing choke will, of course, be much lower than that occurring in the loud speaker field winding. Measurement of the inductance of the field winding of the Amplion loud speaker revealed a value of 71 henrys with no D.C. passing and 67 henrys when passing 50 mA. The mean value can be taken as about 70 henrys, the gap having the effect of producing an almost constant inductance irrespective of current values. In the case of the Magnavox the inductance with no D.C. flowing was 55 henrys, falling to 53 at 40 mA. and then dropping to 37 at 35 mA. This decline in inductance value is due to the use of a smaller gap in the Magnavox and a greater area due to the larger moving coil.

From the number of valves in a receiver and the total current taken by the anodes, screens and probably associated potential dividers, the total current consumed can be found. Table B shows the additional voltage that will be dropped across the loud speaker field winding when used as a smoothing choke, together with the watts that will be developed in the winding. It will be seen that where the 2,500-ohm field is correctly excited with 40 mA., that 100 volts must be added to the initial output of the rectifier, but with the 1,150-ohm field, excitation is produced when 60 mA. is passed, and some additional 70 volts must be rendered available from the rectifier.



Circuit connections of an output stage following resistance coupling. When only part of the available biasing voltage is used and the grid leak is connected to a tapping point on a shunt biasing resistance across the loud speaker winding, a 2 mfd. by-pass condenser must be connected between the tapping point and H.T.–. By connecting a 2 mfd. condenser between the H.T. + and the centre of the filament heating transformer, additional smoothing will be provided when the H.T. negative lead is taken off as shown at X.

It is not considered worth while to produce field excitation by connecting the field winding directly across the rectifier. Not only is the advantage of additional smoothing lost, but the increase in current requirements does not coincide with the customary outputs of rectifying valves. On the other hand, it is quite common for rectifying valves to be arranged to deliver a much lower voltage than their maximum rating and as much as 100 volts can usually be added.

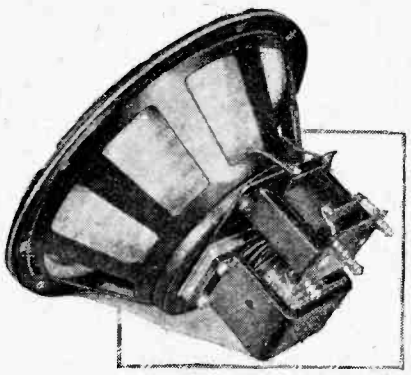
TABLE B.

mA.	2,500 ohm Field. *Amplion and Magnavox.*		1,150 ohm Field. *Ferranti.*	
	Volts Dropped.	Watts Produced.	Volts Dropped.	Watts Produced.
20	50	1	23	½
30	75	2¼	35	1
40	100	4	46	1¾
50	125	6¼	57	2¾
60	150	9	69	4
70	175	12¼	80	5½

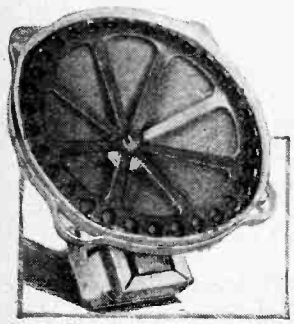
When the loud speaker field winding is interposed in the H.T. supply as additional smoothing, the rectifier voltage must be increased by the amount shown for the value of the current passed. This table shows the watts developed for various values of H.T. current.

Free Field Current.—

The circuit diagram shows the smoothing chokes connected in the positive lead, although they may both equally well be connected in the negative. By so doing the junction point between the loud speaker field and the smoothing choke becomes one from which negative bias can be taken through a decoupling resistance to control the grid of the output valve. Another way of showing the same arrangement is given in the circuit diagrams of output stages with transformer- or resistance-coupled inputs. To assist in considering the possibility of using the resistance of the loud speaker field winding for producing free grid bias it is helpful to tabulate the bias and anode current conditions of the commonly used output valves. Only those valves passing more than 20 mA. are included in the accompanying table. It will be seen that except in the case of the LS5*a* and LS6*a* that there is insufficient energy available for field excitation.



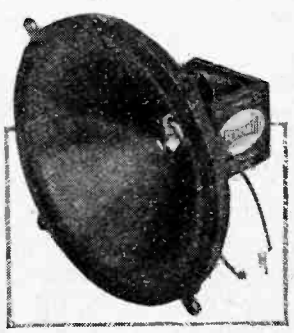
The small Amplion moving-coil loud speaker for use in the construction of all-mains operated sets.



The Magnavox model.

This, however, does not prevent the use of the field winding for bias, as the biasing voltage produced across the loud speaker field is in excess of requirements. The table gives the total potential available and that which must be added to the rectifier output voltage together with the watts consumed in the speaker field winding. In addition, the position of a tapping point has been determined on a 50,000-ohm resistance which bridges the winding. In this way the required reduced voltage is tapped off along this resistance, and an economy has been effected not only by using the field coil for smoothing the anode circuit of the output valve, but, in addition, the grid bias is not obtained at the expense of throwing away any more of the anode voltage than that which is required to energise the loud speaker.

Practice reveals that humless field excitation results from the circuit arrangements shown. It must not be overlooked that hum in mains-driven receivers usually arises when a loud speaker field is fed direct from a rectifier arranged as a separate unit and in which smoothing is not provided. In localising this form of mains hum it is necessary to disconnect the moving-coil winding from the set, but it is essential that this winding should be short-circuited. If a slight hum can then be detected it means that a ripple potential will be fed back on to the anode of the output valve, which is in turn transferred to the grid across the valve capacity, being returned into the anode circuit after amplification. By using the field winding in the smoothing or biasing circuits not only is the total smoothing augmented, but the loud speaker field takes its supply from a circuit already fitted with smoothing components.



The Ferranti model.

Type of Valve.	Grid Bias.	Anode Current.	Biasing Resistance for Free Grid Bias.	Energy Consumed by Bias Resistance.	Across 2,500 ohms (*Amplion and Magnavox*).			Across 1,150 ohms. (*Ferranti*).		
					Energy Consumed.	Potential Dropped.	Tapping Point from Filament end on 50,000 ohms shunt Resistance for Correct Bias.	Energy Consumed.	Potential Dropped.	Tapping Point from Filament end on 50,000 ohms Shunt Resistance for Correct Bias.
	Volts.	mA	Ohms.	Watts.	Watts.	Volts.	Ohms.	Watts.	Volts.	Ohms.
P.625	26	24	1,100	0.6	1.4	60	—	0.6	27	—
2/P.625 ...	26	48	550	1.2	5.8	120	11,000	2.6	54	—
LS5a	112	33	3,400	3.6	2.7	83	—	1.2	37	—
2/LS5a ...	112	66	1,700	7.2	11	165	34,000	4.9	74	add 580 in series with field winding
LS6a	91	63	1,450	5.6	10	158	29,000	4.5	72	add 300 in series with field winding
2/LS6a ...	91	126	725	11.2	40	316	—	18	144	—
PX4	33	50	660	1.6	6.3	125	13,000	2.8	57	—
2 PX4	33	100	330	3.3	25	250	—	11.4	114	15,000
PP5/400 ..	32	63	500	2	10	158	10,000	4.5	72	22,000
2/PP5/400.	32	126	250	4	40	316	—	18	144	—
PM256 ...	26	20	1,300	0.5	1	50	—	0.5	23	—
2/PM256 ..	26	40	650	1	4	100	13,000	1.8	45	—
PM24a ...	21	21	1,000	0.4	1.1	53	—	0.5	24	—
AC/PEN...	10	30	330	0.3	2.3	75	—	1	34	—

Using the field winding for biasing an output valve. In the first place, this table shows the value of bias resistance normally required and the watts that will be thrown away across it. When the biasing resistance is substituted by the field winding this table shows the watts rendered available for field energising. The number of watts required must not be less than 4 and should not exceed 12. As the value of bias produced will in most cases be excessive, the field winding is bridged with a 50,000-ohm resistance of the tapped type and the values given show the resistance to be included between the filament end and the lead to the grid circuit.

Free Field Current.—

Loud speakers of this type will find their way into the majority of mains-operated sets, for they are both convenient to use and low in cost. It might be mentioned that they can be used with D.C. supply by connecting in series with the field winding a voltage-dropping resistance. Any of the three types referred to can be connected directly to a 100-volt supply. With a supply of 150 volts a series resistance of 1,000 ohms should be used, and a 2,500-ohm resistance will suit 200/240-volt supplies.

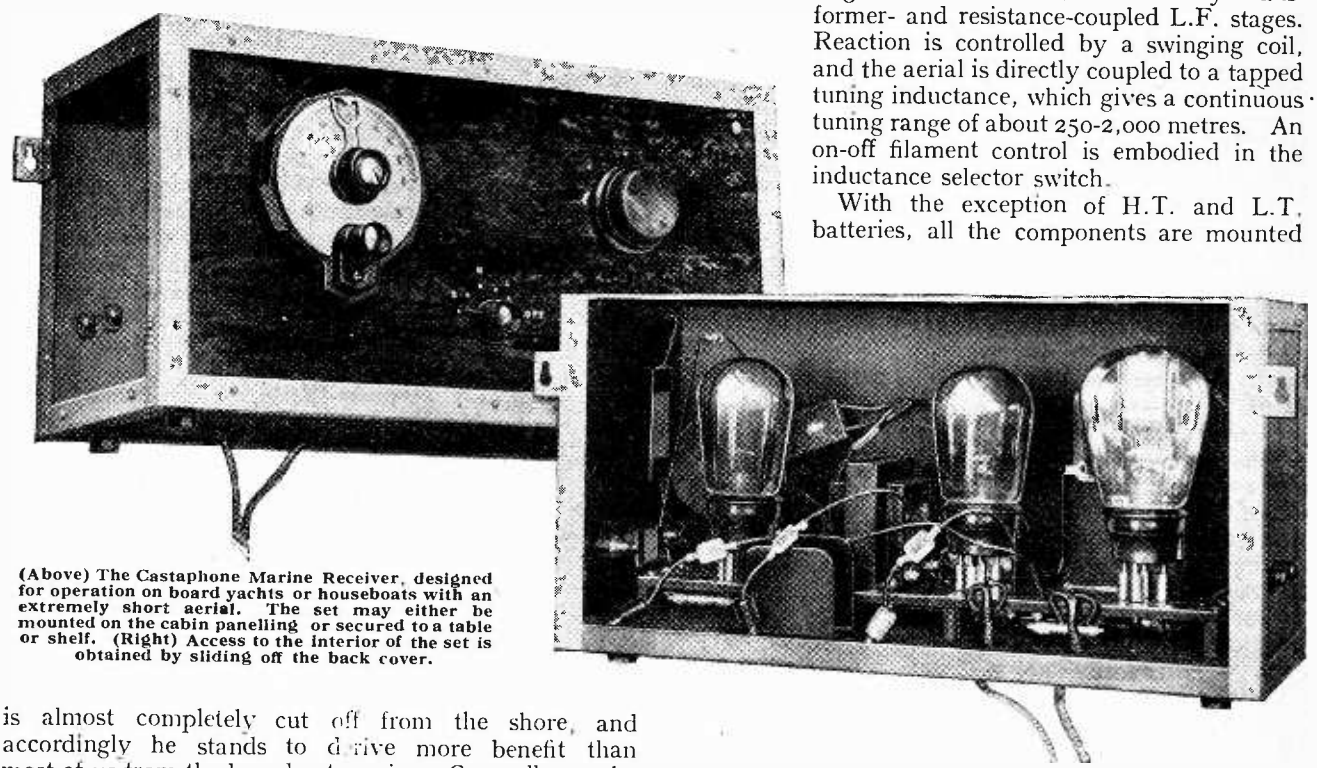
An input transformer fitted to the Amplion model gives three input ratios. The speech coil has a D.C. resistance of 1.5 ohms and an impedance at 400 cycles of 2.2 ohms; its transformer gives ratios of 25 to 1 (terminals 1 and 2), 50 to 1 (terminals 1 and 3) and 75 to 1 (terminals 1 and 4); while, for push-pull, terminals 1 and 3 are used, with 2 as a centre tap. A push-pull output transformer is fitted to the Magnavox model giving a ratio of 35 to 1. Its moving-coil winding has a D.C. resistance of 3.4 ohms and an impedance at 400 cycles of 4.4 ohms, suiting the loud speaker to a pair of push-pull valves with an average impedance of 2,000 ohms. If the valves are parallel connected so that the combined impedance is a quarter of that of the push-pull arrangement, then the correct ratio that is obtained is produced by using half the transformer primary in filter-fed output circuit.

A MARINE RECEIVER.

A Simple and Compact Broadcast Set for Small Yachts.

WHILE his boat is at sea, or even sometimes when it is lying in harbour, the yachtsman is almost completely cut off from the shore, and accordingly he stands to derive more benefit than most of us from the broadcast service. Generally speaking, the ordinary domestic receiver is not entirely suitable for use afloat in a restricted space, and contributors to this journal have recently expressed surprise that special yacht sets were not available commercially.

One of the first receivers specifically designed to meet this need has now been submitted for examination by its manufacturers, The Castaphone Radio Service, of Culver Street, Colchester. A good idea of its suitability can be gathered from the accompanying illustrations; compactness is a leading feature, as overall dimensions are only 12¼in. × 5in. × 5in.



(Above) The Castaphone Marine Receiver, designed for operation on board yachts or houseboats with an extremely short aerial. The set may either be mounted on the cabin panelling or secured to a table or shelf. (Right) Access to the interior of the set is obtained by sliding off the back cover.

The receiver is, of course, for battery operation, and embodies a regenerative detector, followed by transformer- and resistance-coupled L.F. stages. Reaction is controlled by a swinging coil, and the aerial is directly coupled to a tapped tuning inductance, which gives a continuous tuning range of about 250-2,000 metres. An on-off filament control is embodied in the inductance selector switch.

With the exception of H.T. and L.T. batteries, all the components are mounted in a metal case, strengthened by strong brass angle pieces. Internal and external metal work is treated to resist the action of sea air.

Long connecting leads are fitted, so that the batteries may be neatly stowed away in a locker or any other convenient place. Sockets for the connection of aerial and earth leads, and also for the loud speaker, are mounted on the sides of the case.

At the low price of £4 17s. 6d. (or £6 5s. with Mullard valves) this set should appeal strongly not only to yachtsmen but to the owners of houseboats and caravans.

UNBIASED

BY FREE GRID

Nightingales and Needle Scratch.

I SUPPOSE that many people have already noticed the great success which has attended the B.B.C. nightingale broadcasts during the past two or three years; this year's performances, in my opinion, surpass all previous efforts. This is in great contrast to the results obtainable about half a dozen years ago, when all the birds seemed to be sulky and it was a rarity rather than a commonplace to have a successful night.

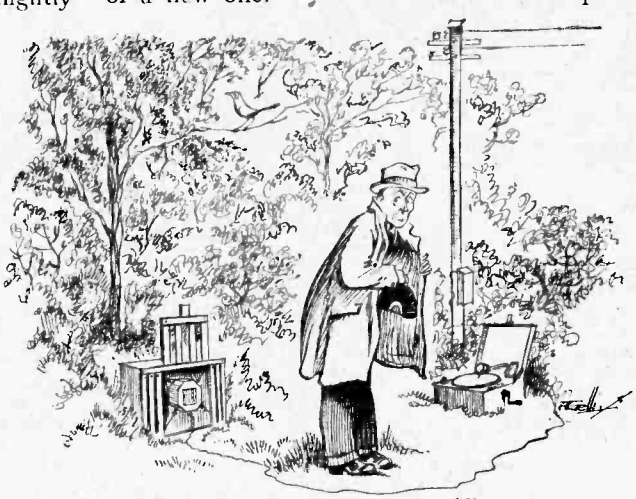
Now, I had always supposed that the lack of results in the early days was due to the fact that the B.B.C. foolishly disclosed the exact whereabouts of the microphone, with the inevitable result that hordes of honking motorists turned up and scared every bird for miles around; whereas, in later days, the nightly venue was kept a profound secret, and the seal of the confessional placed upon the lips of every one of the privileged few who have from time to time been invited to accompany the engineers.

I see, however, that the B.B.C. have publicly stated where they are working, and although the exact locality is in private grounds some few hundred yards away from the road, the distance is not far enough to prevent the songsters from being scared into silence by noisy curiosity-mongers who are bound to turn up sooner or later to gape at nothing.

In spite of this lack of foresight on the part of the B.B.C., I must confess that I was considerably startled the other evening at the conclusion of a highly successful nightingale broadcast, when a friend, well known in scientific and naturalist circles, after remarking upon the increasing skill of the B.B.C. in handling this sort of thing, concluded by saying, "Why! you could scarcely hear the needle-scratch at all." I immediately expostulated at this insinuation that the B.B.C. made use of gramophone records.

A Public Denial?

My friend expressed his astonishment at my ignorance of the fact that the B.B.C. officials always took down to Pangbourne with them a portable gramophone and a pick-up for use when the birds were silent. "Why!" he went on, "you must be getting rusty, as I thought everyone knew that the actual records were made by one of our most famous recording companies by a microphone suspended in the woods; furthermore, the actual 'pressings' used by the B.B.C. are specially treated to reduce needle scratch to a minimum, each being used once only and then discarded in favour of a new one."



Not to disappoint the listening public.

I must say that although I could scarcely credit my friend's statement I could not dismiss his allegations lightly, as he spends a good deal of his time at Savoy Hill and his voice is often heard "over the air." Enquiry in other quarters has confirmed his statement, and it has been pointed out to me that, since the record is barely distinguishable from the actual nightingale, the B.B.C. are justified in resorting to this subterfuge when it is absolutely necessary, in order not to disappoint the great listening public.

I cannot say that I agree with this argument, however, and am beginning to wonder whether certain American and Continental broadcasts do not actually originate in the studios at Savoy Hill, the atmospherics and other noises being artificially produced, and I look to the B.B.C. for a public denial of this story, which I can still scarcely credit. If no such denial of this is forthcoming, of course, the conclusion to be drawn is rather obvious, and I shall in future visualise the Vienna Symphony Orchestra as being safely ensconced under Waterloo Bridge, Jack Payne, in a Tyrolean hat, doing the necessary conducting in order to put over the correct "atmosphere" by creating the usual "land line" noises.

Rex v. *Free Grid.*

The Income Tax authorities are probably the most "live" department of the Civil Service, and in this respect other departments would do well to follow their example. I mention this because I have just received an income tax assessment form addressed to F. Grid, Esq., c/o the Editor, *The Wireless World*.

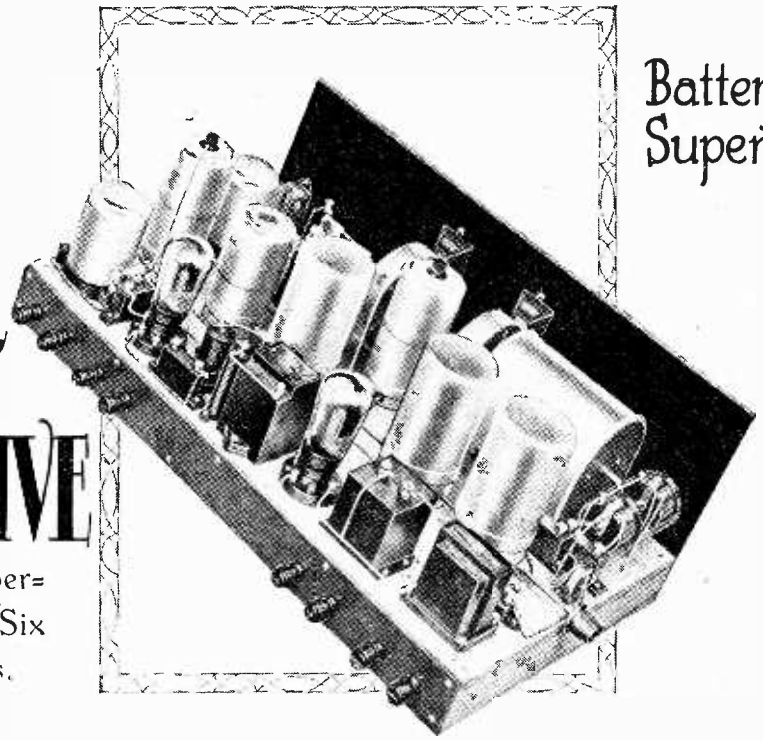
If I do not pay or make an explanation I suppose they will demand my private address from the Editor. If he refuses to give it he will, I believe, be liable to be hauled up and fined, and if he still refuses he will go to gaol. If, on the other hand, he discloses it to a third party without my permission, it will constitute a breach of my agreement with him, and I can pot him easily in a High Court action.

His best way out, from the financial point of view, is to let me occupy the Editorial Chair while he takes a holiday at His Majesty's expense. Both of us would, I feel sure, greatly benefit in health from the enforced change of occupation, while I should have the opportunity of making or wrecking the journal by extending my own section of it.

Wireless World

Battery Model Superheterodyne

SUPER-SELECTIVE FIVE



A Five-valve Super-heterodyne with Six Tuned Circuits.

By W. T. COCKING.

THERE is no doubt that where alternating current lighting mains are available they are far preferable to batteries for the power supply of a receiver. The running costs of even a large A.C. set are usually smaller than those of quite a modest battery receiver, while the unfailing regularity of the supply is itself no mean advantage. Although it is recommended that anyone possessing A.C. mains should make use of them, there are, unfortunately, many houses still without electric light, and there is consequently a real demand for a sensitive and selective receiver which will run economically from batteries and at the same time give good quality reproduction.

Surprising as it may seem, the superheterodyne fulfils these requirements, and so it was decided to modify the Super-Selective Six[1] in order to render it available for battery operation. Now modifying an A.C. set for battery operation does not mean merely removing the mains transformer, rectifier, and smoothing apparatus and changing over the valves to battery types; it involves the complete redesign of the whole apparatus, and is not a problem, therefore, to be tackled lightly. This redesign has been carried out in the present case, and although the basic circuit and much of the component layout are the same as in the A.C. model, a host of minor alterations have been found necessary.

Two limitations are imposed by battery operation; the valves themselves are less efficient than the mains types, and the power supply is strictly limited by considerations of economy. Five valves are employed, and the filament current from a 2-volt accumulator is 0.8 ampere; the load upon the H.T. battery is 28 mA. when this has a potential of 160 volts. At a sacrifice of quality, it is possible to reduce both the H.T. and L.T. current consumption somewhat, and the necessary modifications for this are indicated later in this article.

SPECIFICATION.

Five-valve superheterodyne receiver for operation with 2-volt battery valves and an H.T. voltage of about 160.

1. *Band-pass tuning with six tuned circuits.*
2. *Two tuning controls.*
3. *Ganged waveband switching.*
4. *Dual ganged volume control.*
5. *New non-radiating frequency changer.*
6. *Special circuit for cutting out long-wave interference.*
7. *Grid detection.*
8. *Triode power output of 350 milliwatts.*
9. *18 kc. selectivity on powerful local stations.*
10. *Economical battery operation; L.T. 2 volts at 0·8 ampere; H.T. 28 mA., at 160 volts.*

The Frequency Changer.

As already explained, the basic circuit of the original model is adhered to, and so the simplified frequency changer[2] is still used. A screen-grid valve, negatively biased by 1.5 volts to act as an anode bend rectifier, serves as the first detector; and in its anode circuit are included both the primary of the first intermediate frequency transformer and the tuned anode circuit of the oscillator. This makes the circuit non-radiating, prevents interaction between the tuning control, and greatly simplifies the

[1] *The Wireless World*, June 3rd and 10th, 1931.

[2] See "Frequency Changers," May 6th, 1931.

LIST OF PARTS REQUIRED.

1 L.F. auto transformer, 7 : 1 .. (Varley Nicore)
1 L.F. choke, 20/30 henrys .... (R. I. Hypercore)
1 Two-gang condenser, 0.0005 mfd. and drum dial ..... (Polar Tub)
1 Variable condenser, 0.0005 mfd. and drum dial ..... (Polar Universal)
1 Grid leak, 0.1 megohm ..... (Ediswan)
1 Grid leak, 0.25 megohm ..... (Ediswan)
1 Porcelain grid leak holder ..... (Bulgin)
3 Fixed condensers, 0.0001 mfd. .. (Dubilier 620)
2 Fixed condensers, 0.001 mfd. .... (Dubilier 620)
4 Fixed condensers, 0.1 mfd., 400v. D.C. test ..... (Dubilier, Type BB)
3 Fixed condensers, 1 mfd., 400v. D.C. test ..... (Dubilier, Type BB)
2 Fixed condensers, 2 mfd., 400v. D.C. test ..... (Dubilier, Type BB)
1 Fixed condenser, 4 mfds., 400v. D.C. test ..... (Dubilier, Type BT)
1 Pre-set condenser, 0.0005 mfd. max... (Polar)
1 Resistance, 600 ohms ..... (Watmel)
3 Resistances, 10,000 ohms ..... (Watmel)
1 Resistance, 20,000 ohms ..... (Watmel)
2 Resistances, 30,000 ohms ..... (Watmel)
1 Resistance, 50,000 ohms ..... (Watmel)
1 S.G. cell, 0.9v. ..... (Siemens)
1 G.B. battery, 16½ volts ..... (Siemens, G8)
1 D.P. 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)
8 Ebonite-shrouded terminals .... (Belling Lee)
1 Bakelised panel, 21in. × 8in. × ¼in.
1 Bakelised terminal strip, 21in. × 2in. × ⅛ in.
1 Baseboard, 21in. × 12in.
4 Wander plugs ..... (Lisenin)
Sleeving, copper foil, wire, screws, wood, etc.

This list gives the actual components used in the construction of the set. There are certain instances where alternatives of other manufacture may be introduced, but readers must take into account the quality and suitability as regards dimensions when adopting a substitute. In addition to the sources of supply mentioned, other manufacturers are specialising in the production of components of similar type which are suitable for use in the building of this receiver.

waveband switching. A Marconi L2/B valve is used as an oscillator with its anode circuit tuned and the reaction coil in the grid circuit to keep the harmonic generation at a minimum.[3] The grid is negatively biased by 3 volts in order to prevent the anode current from running to an excessively high value.

The system by which the various voltages are obtained will repay a little attention; it will be seen from the full circuit diagram of Fig. 1 that only two terminals are provided for the H.T. battery connections, and that the different working voltages are obtained, as in a mains set, by voltage dropping resistances. In this way, full de-coupling can be readily obtained and the whole battery is discharged at a uniform rate, the net result being that a somewhat longer battery life is to be anticipated than would be the case if the voltages were obtained by tapping directly on to the battery.

The screen voltage of the first detector is obtained from the potentiometer comprising the two resistances R_3 and R_4 of 50,000 and 30,000 ohms respectively, while the screen is earthed to high-frequency voltages by the 1 mfd. condenser C_7. The screen-grid potentiometer, and the anodes of both the first detector and the oscillator are fed through the 10,000 ohms resistance R_5, while a 1 mfd. by-pass condenser C_9 is connected between the lower end of this resistance and earth. Grid bias for these two valves is obtained from tappings on the main output valve bias battery; the first detector grid return lead is de-coupled by the 0.1 meg. resistance R_2 and the 0.1 mfd. condenser C_6. No de-coupling resistance is fitted in the oscillator circuit, but the requisite section of the bias battery is shunted by a 0.1 mfd. condenser C_8. A word of warning should be given against any attempt to use a de-coupling resistance in this circuit, for it has been found that it is likely to upset the operation of the oscillator, and to lead to howling.

The Pre-selector and Volume Control.

In order to avoid second channel interference,[4] a two-stage loosely coupled band-pass filter is used to precede the first detector; completely screened coils are

[3] "The Frequency Changer of the Super-Het," A. L. M. Sowerby, October 29th, 1930.

[4] "The Selectivity of the Super-Heterodyne," May 13th and 20th, 1931.

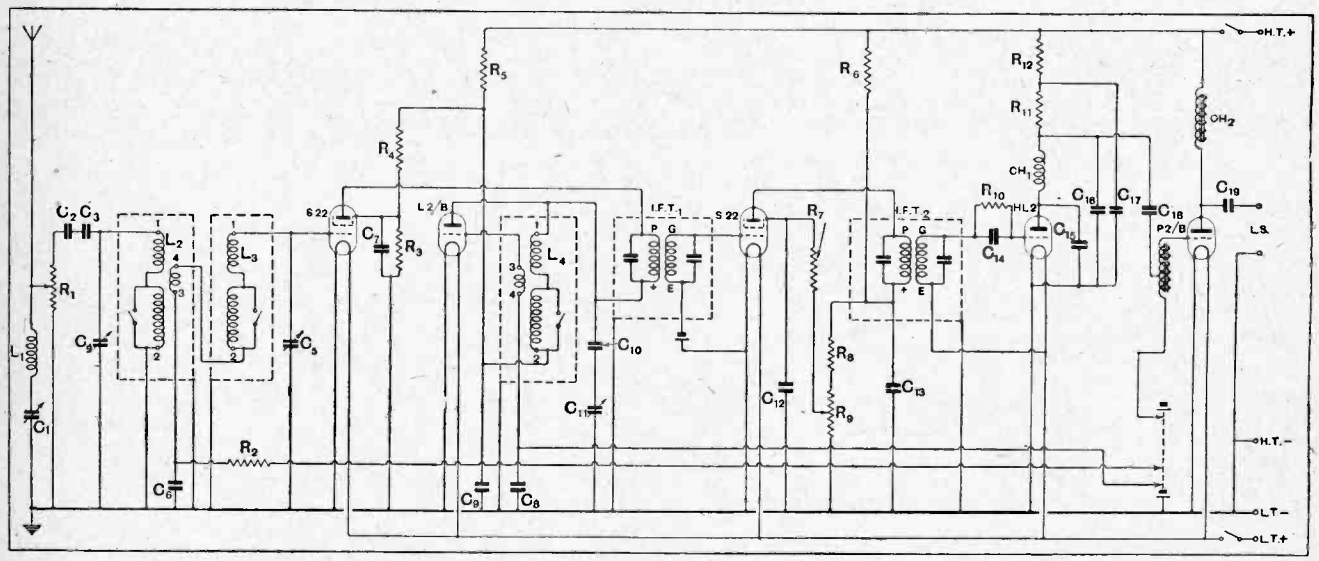


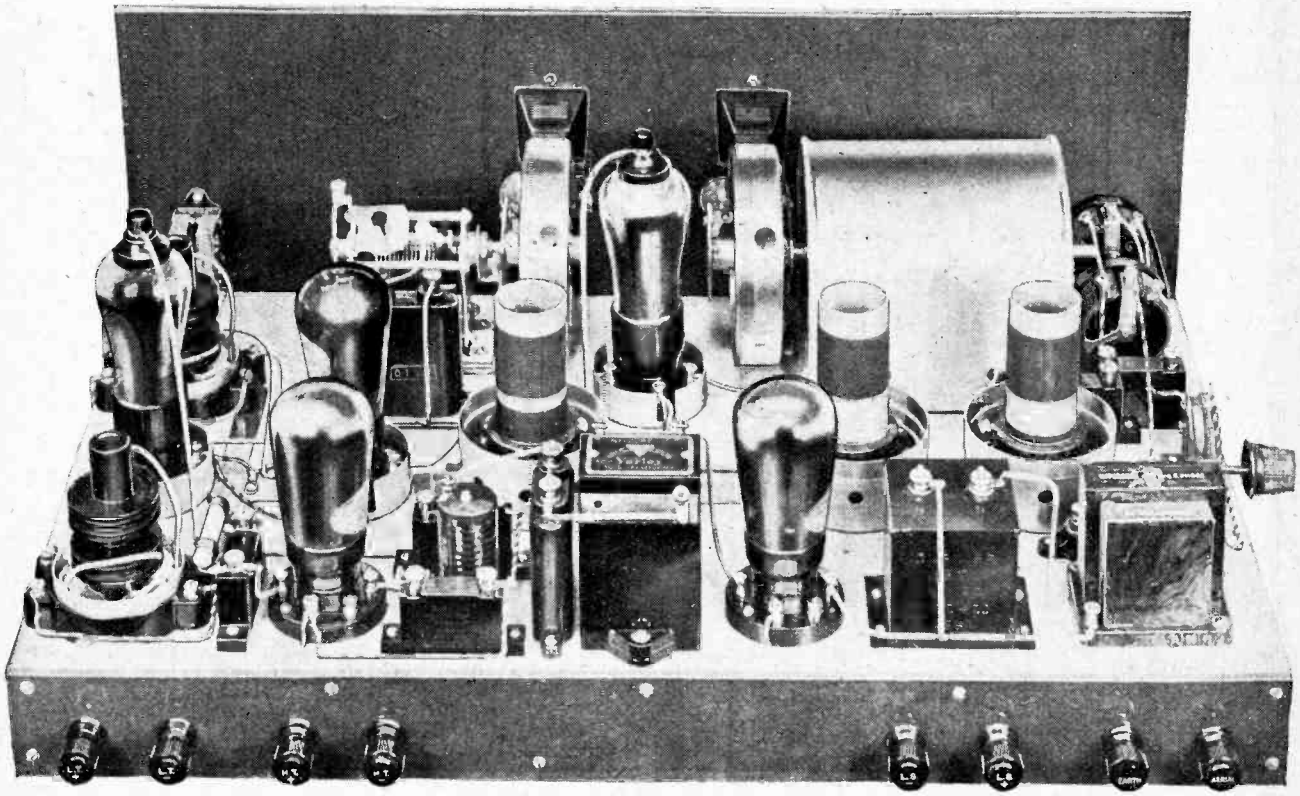
Fig. 1.—The values of the principal components are as follows: C_1, 0.0005 mfd. pre-set condenser; C_2, C_3, C_{14}, 0.0001 mfd.; C_4, C_5, 0.0005 mfd. twin-gang; C_8, C_8, C_{10}, C_{18}, 0.1 mfd.; C_7, C_9, C_{12}, 1 mfd.; C_{11}, 0.0005 mfd.; C_{13}, C_{17}, 2 mfd.; C_{15}, C_{16}, 0.001 mfd.; C_{19}, 4 mfds. R_1, R_9, 25,000-ohm dual potentiometer; R_2, 0.1 megohm; R_3, 50,000 ohms; R_4, R_8, 30,000 ohms; R_5, R_6, R_{12}, 10,000 ohms; R_7, 600 ohms; R_{10}, 0.25 megohm; R_{11}, 20,000 ohms; CH_1, H.F. choke; L_1, slab coil; L_2, L_3, input filter; L_4, oscillator coil.

Super-Selective Five.—

used both in the filter and the oscillator, and as the switches for waveband changing are built into the bases they may readily be ganged. The two circuits of the filter are tuned by a completely screened two-gang variable condenser fitted with trimmers, and it should be emphasised that the use of a screened condenser is essential at short distances from a high-power station if the full advantage of the filter in reducing second channel interference is to be retained.

The aerial is connected to the first filter circuit through a combination consisting of the intermediate frequency acceptor circuit L_1C_1, the volume-control potentiometer R_1, and the two series connected 0.0001 mfd. condensers

by means of two identical transformers. Each transformer is really a band-pass filter and contains two coils, each tuned to 110 kc. by small adjustable trimmers. As the coupling between each pair of coils is readily adjustable, the optimum operating conditions and the best compromise between selectivity and quality are readily attainable. Grid bias for the screen-grid valve is obtained from a 0.9-volt battery, fitted beneath the baseboard. The screen and anode voltages, however, come from a number of series-connected resistances, R_6 of 10,000 ohms, R_8 of 30,000 ohms, and R_9, the screen volume-control potentiometer, of 25,000 ohms. The by-pass condensers have values of 1 mfd. and 2 mfd. for the screen C_{12} and the anode circuit C_{13} respectively.



The complete receiver. The valve and coil screens have been omitted.

C_2, C_3. The acceptor circuit prevents any trouble on the long waveband from stations working with a frequency similar to the intermediate frequency, while the same trouble is prevented on the medium waveband by the adoption of inductive coupling in the filter. The volume-control potentiometer, which has a value of 25,000 ohms, serves to reduce the aerial input; it is ganged to another control operating upon the screen voltage of the intermediate frequency amplifier valve, and the two ganged controls afford a smooth and distortionless control of volume which has a range sufficient to reduce a strong local station to a whisper.

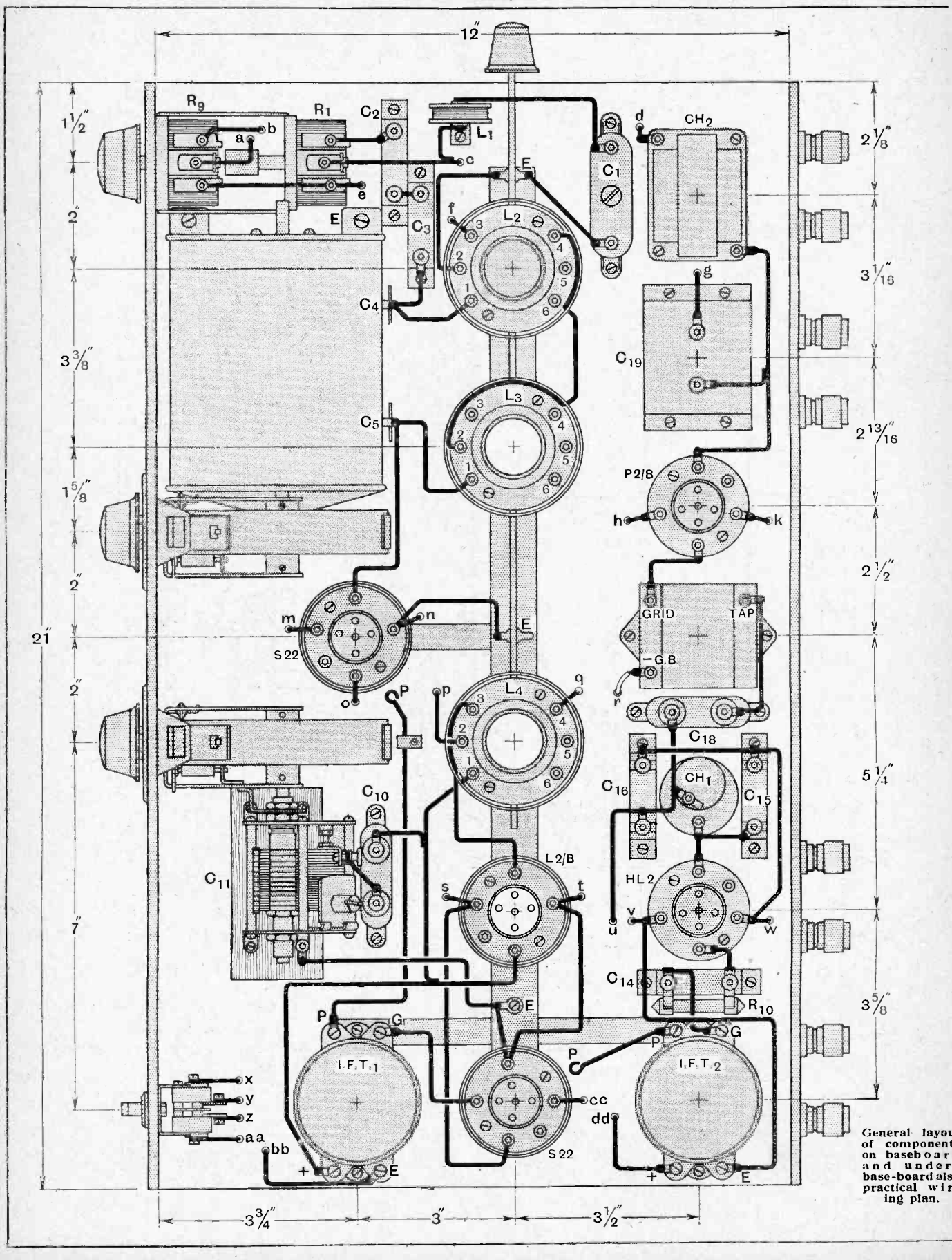
The Intermediate Frequency Circuits.

A single screen-grid valve serves for the intermediate frequency amplifier, and its grid and anode circuits are coupled to the first and second detectors respectively

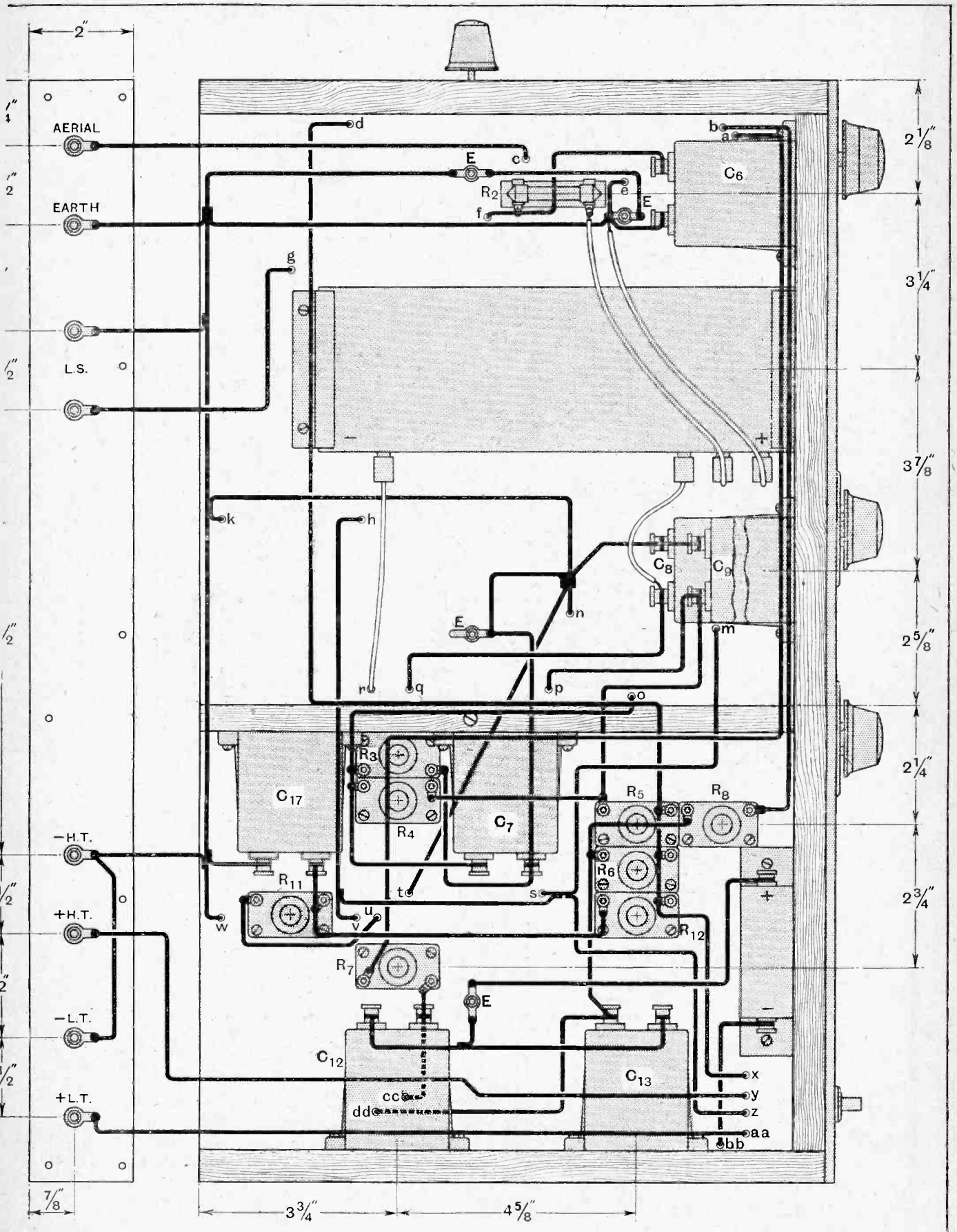
As the lead from the screen to the potentiometer is rather long, a 600-ohms resistance R_7 is inserted close to the valve.

The Second Detector and Output Stage.

A medium-resistance valve has been chosen for the second detector in view of the high sensitivity with economy of anode current which can be so obtained. The internal A.C. resistance of 18,000 ohms possessed by the HL2 is not sufficiently high to lead to a falling off in either the bass or the high-note reproduction, and it can be considered quite satisfactory from the point of view of quality. The grid leak and condenser have values suited to power-grid detection, that is, 0.25 meg. and 0.0001 mfd., although, on account of its low anode current of 2.6 mA., it can hardly be said to fall within this class of rectifiers.



General layout of components on baseboard and under-base-board also practical wiring plan.



Super-Selective Five.—

A low-pass filter, comprising a high-inductance H.F. choke and the two 0.001 mfd. condensers C_{15} and C_{16}, is fitted to keep the anode-load impedance to I.F. low and to prevent I.F. currents from reaching the L.F. circuits. Detector de-coupling is provided by the resistance R_{12} of 10,000 ohms, together with the 2 mfd. condenser C_{17}. Resistance coupling is adopted to feed the L.F. transformer, and for this resistance R_{11}, a value of 20,000 ohms, is used.

Owing to the low detector-anode current and to the characteristics of battery valves, only a small L.F. output can be obtained; it is necessary, therefore, to use a transformer with a high step-up ratio in order fully to load the output valve. An auto-transformer with a ratio of 7-1 has been chosen therefore, and this is fed through the 0.1-mfd. condenser C_{18}; this resonates with the primary section of the auto-transformer and leads to increased amplification of the lowest notes.

A triode has been chosen in preference to a pentode for the output valve; the latest triodes have mutual conductances very little inferior to the small battery pentodes, their undistorted output is of the same order, and they are somewhat more economical in their demands upon the H.T. battery. In addition to this, the necessity for critical matching of the loud speaker and valve is avoided; and this is of particular importance with the reed-drive type speaker usually used with a battery receiver. The Marconi P2/B valve used takes a grid bias of 13.5 volts and will give an undistorted output of about 350 milliwatts. The anode current is about 16 mA., which cannot be considered excessive for good-quality reproduction. A 30-henry choke is used in the anode circuit, and the speaker is fed through the 4 mfd. condenser C_{19}.

In a receiver in which the various H.T. voltages are obtained by means of potentiometers, it is insufficient merely to fit a switch in the L.T. circuit; it is necessary to disconnect both batteries. A double-pole switch of the quick make-and-break type is fitted, therefore, and is connected to break the positive leads of both the H.T. and L.T. batteries. It is fitted in an accessible position on the front panel, and the necessity for a good-quality component should be emphasised, as unless the contacts are quite perfect a sensitive receiver of this type will give noisy reception.

In next week's issue full constructional details will be given. (*To be concluded.*)

POLISH-AMERICAN PROGRAMME PLANS.

America's keenness to exchange programmes with Europe is again indicated by the news that Poland is to pick up the transatlantic relays and will reciprocate by transmitting national music for the benefit of Polish emigrants in America.

o o o o

GREAT STUFF—THIS RADIO!

On July 1st members of the Derby Wireless Club paid a visit to Messrs. Bass's brewery premises at Burton.

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EMPIRE BROADCASTING FROM AUSTRALIA.

The first regular world-wide broadcasting service from the southern hemisphere has been inaugurated by Amalgamated Wireless (Australasia), Ltd., and elsewhere on this page we print the schedule of the transmissions which are being carried out daily (Sundays included) from Sydney 2ME and Melbourne 3ME on a wavelength of 31.28 metres.

This splendid effort deserves the support of all amateurs, and we hope that as many readers as possible will encourage our Australian friends by sending in reports to Amalgamated Wireless at Australia House, Strand, London, W.C.2.

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THE DAYS OF GRACE.

In Britain there is no middle course between the high road of legalised listening and the low road of piracy, but in Italy it is now possible to test a new set without a licence for a period of ten days. And to prevent abuse of the arrangement the Italian Government decrees that all retailers issuing receivers under this rule must keep a careful check on the dates of issue and return, as customers may suffer from short memories!

Although there are no official "days of grace" in this country in regard to wireless licences, the Post Office authorities generally provide ample warning before prosecuting offenders.

NEWS OF THE WEEK.

HECKLING BY RADIO.

"Holland is verily the home of radio surprises," writes a correspondent. "During the recent municipal elections agitation occurred in political circles owing to the sudden arrival on the scene of a secret broadcast transmitter operated by a small reactionary party."

Just when election fever was at its height (continues our correspondent) thousands of listeners were amazed to hear on the official 298-metre wavelength of Hilversum the announcement: "Hallo! Vote for Vohydbond, list No. 3. Down with the Reds!" Later on, during the Hilversum musical programme, the same voice was heard attacking Socialists, Protestants and Catholics, while inviting listeners to vote for the aforementioned candidate.

TIME SCHEDULE OF AUSTRALIAN SHORT-WAVE BROADCASTING.

Transmissions from Sydney 2ME.

(Wavelength 31.28 metres.)

05.00 to 07.00 G.M.T. for American countries bordering the Pacific.

09.30 to 11.30 G.M.T. for New Zealand, Fiji, New Caledonia, New Guinea, Islands of the Pacific and Eastern Australia.

11.30 to 13.30 G.M.T. for West Australia, Java, Japan, China, Straits Settlements, Burma, Ceylon and India.

19.00 to 21.00 G.M.T. for Great Britain, Western Europe, South Africa, British East African possessions, Egypt and other African countries.

All programmes will have included in them the laugh of the Kookaburra.

Melbourne 3ME will transmit on the same wavelength from 10.00 to 11.30 G.M.T. every Wednesday and Saturday.

The authorities are still diligently hunting for the offending transmitter, but all they can be certain about is that its hiding-place is somewhere in the northern part of Rotterdam. The power employed is 6.5 kW.

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SAY IT WITH SHORT WAVES.

As a first step towards the establishment of America's international relay broadcasting service, the Federal Radio Commission has just authorised the formation of the Short Wave Broadcasting Corporation with four channels with which to commence operations. Our Washington correspondent states that the Corporation's first object is to furnish programmes to the Latin-American countries during 1931, but arrangements are already in hand for supplying a service to Japan, China, and the Far East, as well as certain countries in Europe.

The nucleus of the system will be a new 15 kW. station located on the eastern seaboard. The wavelengths to be used will be 49.67, 25.42, 19.67, and 13.97 metres.

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LANCHESTER LOUD SPEAKERS.

In order that the user may ensure that his loud speaker is working under the best possible conditions, Messrs. Lanchester Laboratories, Ltd., Spring Road, Tyseley, Birmingham, have prepared a series of informative leaflets dealing with operating conditions in the output stage. Copies are available free of charge from the above address, and the subjects dealt with in the first three so far available are as follows: (1) The Pentode, (2) The Push-pull Circuit, (3) The Power Valve.

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SMALL ADVERTISEMENTS.

The approach of the August Bank Holiday necessitates slight alterations in our printing arrangements. The latest date on which small advertisements can be accepted for *The Wireless World* of August 5th is Wednesday, July 29th.

VALVES WE HAVE TESTED

MARCONI and OSRAM HL2.

A Non-microphonic 2-volt Valve for Use as Detector or First L.F. Amplifier.

AN important feature of a detector valve is that it should be as little responsive as possible to acoustic reaction; or, put in more popular terms, it should be non-microphonic. Recent research has shown that to achieve this end the electrodes must be exceedingly rigid, and this applies as much to the filament as to the grid and the anode. In addition to some surprisingly good electrical characteristics the new HL2, which has been added recently to the Marconi and Osram range in the 2-volt class, embodies these mechanical features.

Non-microphonic detector valve: the Marconi and Osram HL2 for 2-volt accumulator.

The characteristics of the valve are:—

* A.C. resistance, 18,000 ohms.
* Amplification factor, 27.
* Mutual conductance, 1.5 mA./volt.

Maximum anode voltage, 150.

* Measured at Ea 100, Eg=0.

This valve shows a definite advance on preceding technique, since it has been possible to attain the satisfactory mutual conductance of 1.5 mA. per volt with a valve having an amplification factor greater than 20. Hitherto the best "slope" exhibited by valves in this category has been of the order of 1 mA. per volt.

In addition to these outstanding electrical characteristics the HL2 is, as mentioned earlier, virtually non-microphonic, this feature being achieved by rigidly interlocking the whole of the electrode assembly, and further by supporting the hairpin filament at its centre as well as at its extremities.

Uniform Characteristics.

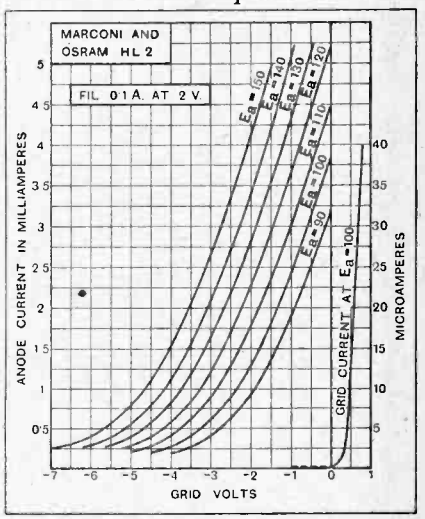
The two samples sent in for test exhibited sensibly the same characteristics, the mutual conductances being of the correct order when measured at zero grid bias and with 100 volts on the anode. The other values found are given below.

MARCONI-OSRAM HL2.

HL2.	A.C. Resistance. Ohms.	Amplification Factor.	Mutual Conductance. mA./Volts.
Maker's Rating	18,000	27	1.5
Specimen 1 ..	16,000	24	1.6
Specimen 2 ..	15,000	24	1.6

It will be observed that the A.C. resistance and amplification of both samples are lower than the maker's figures, but these are down proportionally, resulting in the same mutual conductance in one case, and a slightly better value in the other.

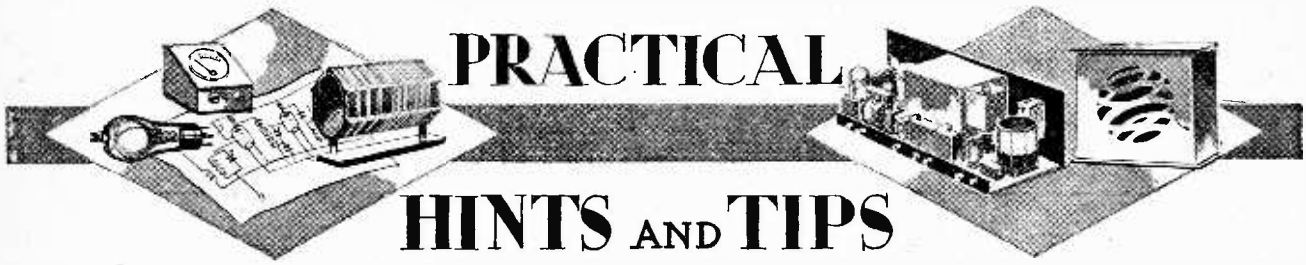
As a grid detector the valve will require about 60 volts on the anode, and, with the grid returned to the positive leg of the filament, an anode current of between 2.5 and 3 mA. will flow. This is well within the capacity of most L.F. transformer windings, and at the same time a high primary inductance should be maintained which is an essential feature to assure the correct balance in amplification between the high and the low musical frequencies.



Anode current-grid voltage curves of the new HL2 valve. Average values under amplifying conditions are: A.C. resistance, 16,000 ohms; amplification factor, 22; and mutual conductance, 1.4 mA/volt.

Used as a low-frequency amplifier, the valve might well be given the maximum anode voltage and a grid bias of −3 volts will be required. The anode current will be of the order of 2.6 mA., a value sufficiently low not to introduce any difficulties where either transformer or resistance-capacity methods of coupling are adopted, furthermore adequate decoupling can be embodied without the need for an unduly high H.T. voltage.

This valve should make a worthy companion to the three other recent additions, namely, the H2, the LP2, and the P2, made to the 2-volt class of valves in both the Marconi and the Osram range.



PRACTICAL HINTS AND TIPS

Aids to Better Reception.

WHEN reference is made to the "earthed end" of a circuit or component, this statement must not always be taken in its literal sense. More often than not, by directly connecting any point commonly referred to in this way to earth, a short-circuit would be introduced across the source of grid bias voltage, or even the H.T. supply system.

"OF THE EARTH,—"

Used in this connection, the expression "earthed" is synonymous with "low-potential," it being inferred that we are dealing with signal-frequency potentials; a given point in a circuit may be 200 volts or more above true earth potential so far as D.C. is concerned, and still be described as "earthed."

In order to avoid ambiguity, it would perhaps be a good plan to get into the habit of applying the adjective "earthy" in such cases. In spite of the rather unpleasant associations of this word, it seems to convey precisely the right shade of meaning, and already has currency among some technicians.

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Modern dual-range coil assemblies include, as often as not, built-in switches for wave-range changing. This is a welcome development, as it offers considerable advantages, permitting a neater layout, easier wiring, and, most important of all, conferring freedom from undesirable interaction, which is so often introduced by long leads between a coil and its associated switch.

TESTING WAVE-RANGE SWITCHES.

On the debit side there is the undoubted disadvantage that, if these switches ever develop a fault, they are inaccessible, and before the trouble can be remedied, it will be necessary to disconnect all the leads and to remove the coil bodily from its mounting. To reduce the risk of having to do this, it is an excellent plan to devote a little time to testing—and, if necessary, to adjusting—the switches before assembly.

A satisfactory test can be made with quite simple apparatus; indeed, a flashlamp and dry battery are almost as good as the most elaborate equipment. As most coil assemblies of the type used nowadays have a long-wave winding of relatively fine wire with a much greater D.C. resistance than that of the medium-wave section, it is generally found that continuity through this winding is indicated by the fact that the test lamp glows at greatly reduced brilliancy.

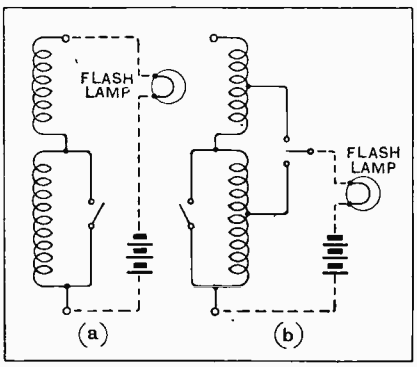

Fig. 1.—Testing built-in dual range coil switches with a flashlamp and battery. External connections in dotted lines.

In Fig. 1 (a) is shown the best method of testing the most widely used type of coil assembly, in which medium- and long-wave sections are connected in series, with a short-circuiting switch across the latter. It can generally be assumed that everything is in order if the lamp glows more brightly when the switch is closed. A further test for intermittency, which will be indicated by flickering, should be made by shaking or tapping the coil.

Inductance assemblies with change-over switches may be tested in the manner suggested in Fig. 1 (b). In this case, relative brilliancy of the lamp is not always a useful indication—everything depends on the positions of the coil tappings—but at the worst it is possible to make sure that there is continuity through the switch in either position.

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In order to avoid complications, it is usual to provide a fixed aperiodic coupling between the aerial-earth system and the tuned input circuit of a receiver. The extent of this coupling is determined on a compromise basis.

HOW TO INCREASE RANGE.

and, like most compromises in receiver design, it introduces a certain amount of loss, which may be avoided by those who do not object to an extra control. In practice, it is found almost impossible to devise a fixed coupling which will not introduce extremely poor selectivity at the lower end of the tuning scale, and which at the same time will give anything like sufficient transference of energy at wavelengths around 500 metres.

The performance of a "2 H.F." set is seldom improved to any noticeable extent by the provision of means for variable aerial coupling, but when maximum range is desired from a less ambitious receiver with not more than one high-frequency stage, this addition is to be recommended. A semi-variable coupling, with two or three adjustments, is quite satisfactory, but it should be get-at-able.

Now that the inclusion of band-pass filters has enabled us to operate our sets without sacrificing aerial input in order to get reasonable selectivity, there would appear to be an opening for a practical device whereby aerial coupling might be maintained automatically at sensibly the optimum value while passing over the tuning scale. Without going deeply into the matter, it seems possible that such a device might include compensation for changes in transferred aerial capacity, so that the operation of a ganged tuning system would not be upset.

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In every sphere of activity there is a right and a wrong way of doing even the simplest thing; the radio art is no exception, but it is perhaps rather a pity in some ways that often the penalty for doing the academically wrong thing is not heavier than it is. A set will sometimes work—after a fashion—when its design and construction are wrong at almost every point.

A SMALL POINT, BUT—

For this state of affairs, the valve, a truly wonderful device that we all take for granted, is largely responsible. Without any great amount of exaggeration, it may be said that it is a difficult matter to connect up a valve receiver so that signals—of a sort—are not obtainable, provided always that the filaments are hot and the plates are positive!

It is not the purpose of this note to enter a plea for slipshod design and construction; rather is it intended to emphasise the old axiom that, although the apparent effect of "rightness" in one detail may possibly not be evident, the cumulative effect of several moves in the right direction will be clearly perceptible.

A case in point is the connection of short-circuiting switches, particularly in H.F. circuits. In perhaps nine cases out of ten it is quite immaterial which terminal is connected to the high-potential end of the circuit, but now and again the constructor who is careless in these matters finds himself up against a particularly puzzling form of trouble.

Put in the simplest way, the rule is that, if there is any choice, the terminal which is in electrical connection with the greatest mass of metal should be joined to the earthed or low-potential end of the circuit. Almost invariably, this terminal will be in contact with the moving blade, arm, or plunger when the switch is in the "off" position.

Take the most common application of an H.F. switch, shown in Fig. 2 (a), where it is used to short-circuit a long-wave loading coil. In the medium-wave position (switch closed) it is clearly quite immaterial how the switch is connected. But, on changing over for long-wave reception, where the short-circuiting contacts are open, it will be appreciated that if the switch be wrongly connected there will be an unnecessarily large mass of metal "hanging on" to the point X, which is at relatively high oscillating potential. If the switch be mounted on a metal panel, it is quite likely that the extra capacity so introduced may be responsible for difficulties in "ganging" the tuning condensers, to say nothing of the possibilities of introducing dielectric losses.

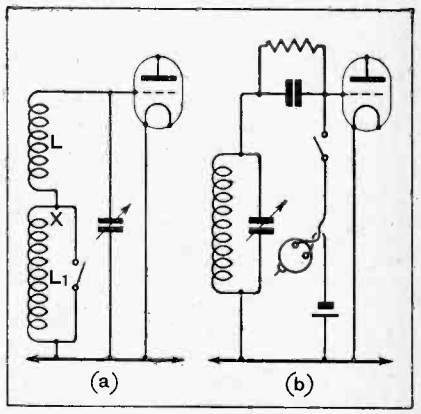
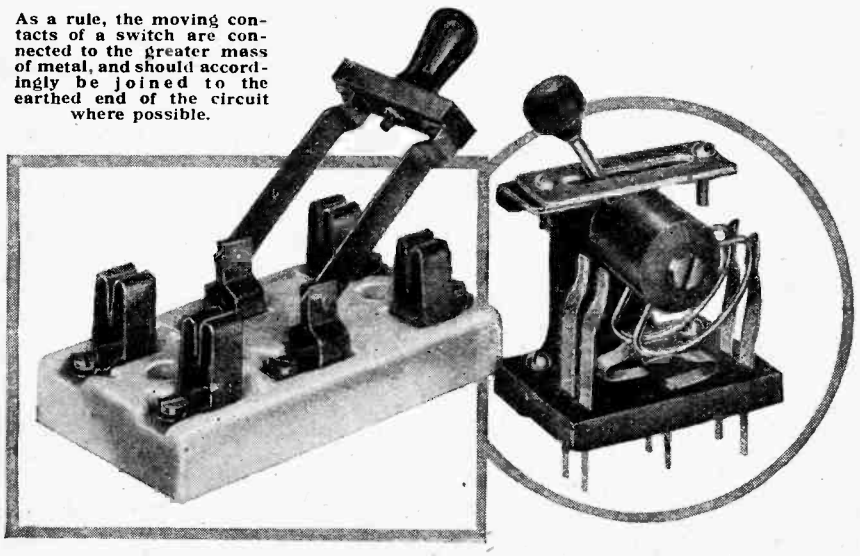


Fig. 2.—Illustrating the correct method of connecting switches in H.F. circuits. Note that the moving arms are "earthed" in both cases, so far as H.F. potentials are concerned.

The same generally applies when the switch is used for changing over from radio to gramophone reproduction (Fig. 2 (b)). Indeed, the inspiration for this note was provided by a certain case which came to the writer's notice; an unduly restricted tuning range was finally traced to the fact that more than 30 micro-microfarads of unwanted capacity had been inadvertently introduced by wrongly connecting the radio-gramophone switch.

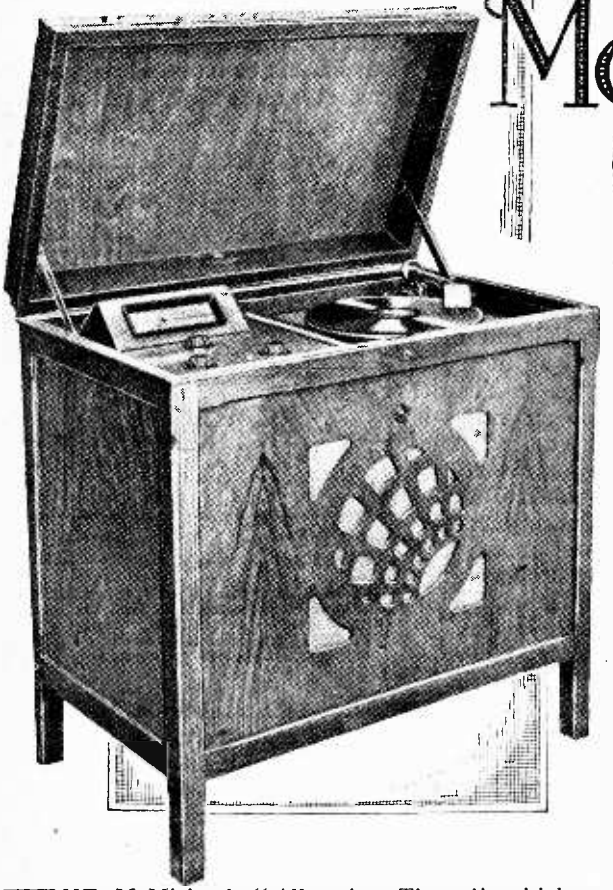
In some circuits where a high-potential connection must be changed over by the switch, we cannot help ourselves, and must perforce join this point to the moving contact. In such cases more than usual care must be paid to the choice of a suitable component. Probably this is the reason why wave-changing is now almost always carried out by open-circuiting or short-circuiting a long-wave loading coil. As we have seen, this method is not entirely free from pitfalls, but it is certainly safer than any other scheme.



As a rule, the moving contacts of a switch are connected to the greater mass of metal, and should accordingly be joined to the earthed end of the circuit where possible.

The McMichael Radiogram

A Dual-purpose Instrument Incorporating the "All-mains Three" Radio Chassis.



THE McMichael "All-mains Three," which was reviewed in our issue of December 31st last, is now available in radio-gramophone form. It is housed in a figured walnut cabinet, and in general finish and workmanship still further enhances the reputation which this firm has established in the past.

The components chosen for the gramophone are of first-rate quality and include a Marconiphone pick-up and Garrard induction-type A.C. gramophone motor. The latter incorporates a "throw-off" automatic stop which is actuated by the eccentric needle groove at the centre of the record. Separate volume and tone controls are provided for the gramophone pick-up, the latter taking the form of a condenser and variable resistance in parallel with the output, for the purpose of controlling the proportion of high frequencies relative to the bass. The gramophone accessories also include a used-needle well communicating with a detachable chamois-leather bag inside the cabinet.

The sketches on the opposite page show the layout of the various components. The radio chassis is mounted under the left-hand side of the motor board, and the illuminated horizontal dial has been arranged to project through the board at an angle. This is a particularly effective arrangement, and the dial, which is calibrated in wavelengths, can be read at a glance while standing normally in front of the cabinet to operate the controls. The radio controls are mounted immediately in front of the tuning scale, and the gramophone controls are situated at the right-hand side of the cabinet.

The back of the cabinet is provided with a removable panel and a hinged inspection door. The mains connecting plug passes through a slot in this door, and lugs are formed on the plug so that the door cannot be opened without first disconnecting the mains supply. Inside the cabinet the eliminator unit is screwed to the bottom immediately behind the inspection door. The latter also gives easy access to the radio chassis, and no difficulty was experienced in inserting the valves in their respective holders.

Insertion of the screen-grid valve is facilitated by a detachable screening box. The loud speaker is one of the new McMichael R.K. moving coils, with permanent magnet field, and is supported behind the front grille on a massive wood cradle.

The illuminated wavelength scale gives visual indication that the mains current is switched on. In the event of the lid of the cabinet being closed, however, a red pilot light is visible immediately above the loud speaker grille.

The performance of the radio side has already been described in this journal. Upwards of fourteen foreign stations

SPECIFICATION.

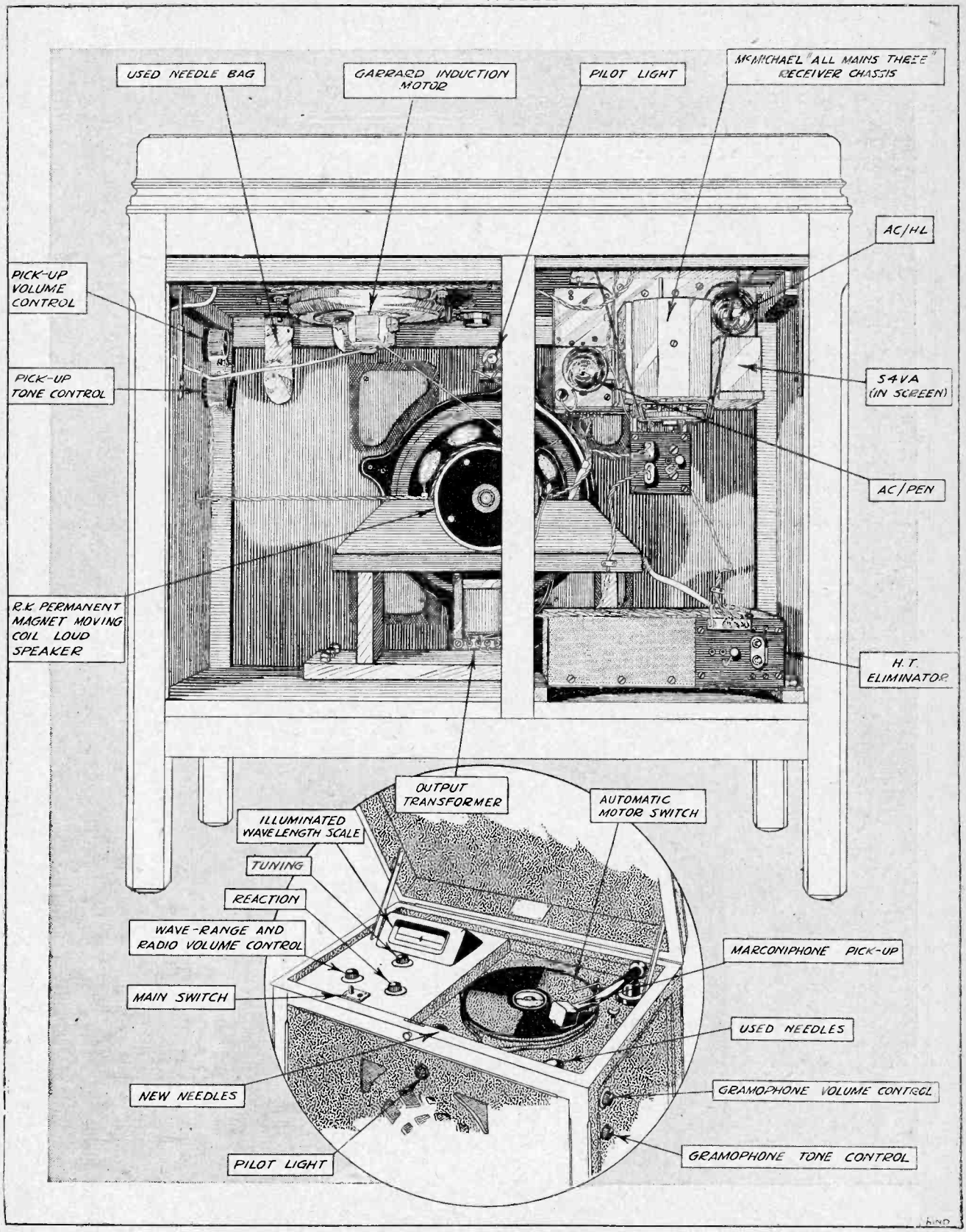
CIRCUIT: Three indirectly heated valves. Screen grid H.F., grid detector (with reaction), power pentode. Full-wave metal oxide rectifier.

CONTROLS: (1) Tuning (linear illuminated dial). (2) Combined wave-range, radio volume control and pick-up switch. (3) Reaction. (4) Pick-up volume control. (5) Pick-up tone control. (6) Automatic motor switch. (7) Mains "on-off" switch.

GENERAL: McMichael "All-mains Three" radio chassis. R.K. permanent magnet loud speaker. Marconiphone pick-up. Garrard induction motor.

MAKERS: Messrs. L. McMichael, Ltd., Slough, Bucks.

PRICE: 48 Guineas (25 cycle model 50 Guineas).

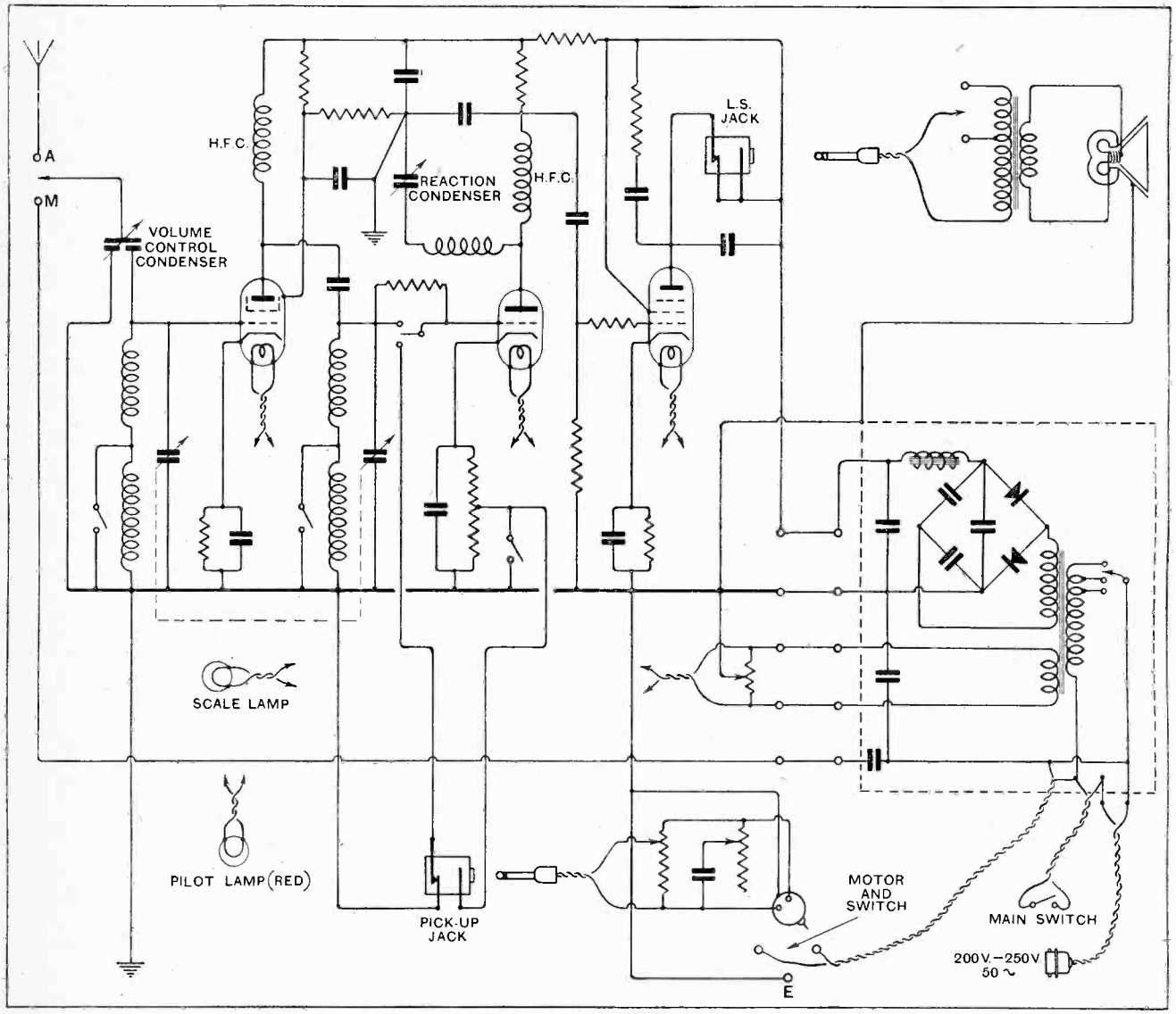


Interior layout of the McMichael Radiogram and plan view showing principal controls.

McMichael Radiogram.—

are within the scope of the medium-wave range, while the long waves should provide nine or ten reliable programmes. In the present model, anode bend has been substituted for leaky grid detection with a noticeable improvement in selectivity. The 2-megohm leak in the grid circuit of the detector eliminates noises due to a momentary free grid in switching over from radio to gramophone. A further modification of the original circuit is the use of parallel-fed tuned grid coupling.

The gramophone side provides an ample reserve of volume, and the reproduction is of a full, round quality. The high-frequency response, above 3,000 cycles, while adequate, was by no means excessive, and the slightest movement of the tone control was sufficient to suppress it entirely. With the tone control in full use the quality was definitely low-pitched, and we are of opinion that the majority of listeners will prefer to work with the tone control out of action. In view of the fact that a tone control is provided, it might be an advantage to allow the pentode to pass a greater proportion of high frequencies, since there is plenty of latitude in the range of the tone control. The writer's personal preference would be for the present balance between high and low frequencies in the minimum position of the control to be found about half-way across the scale. The circuit diagram shows that there is already a compensating circuit across the output from the pentode, and a readjustment of the condenser and resistance values should have the desired effect. No doubt the designers will give consideration to this matter in future models.

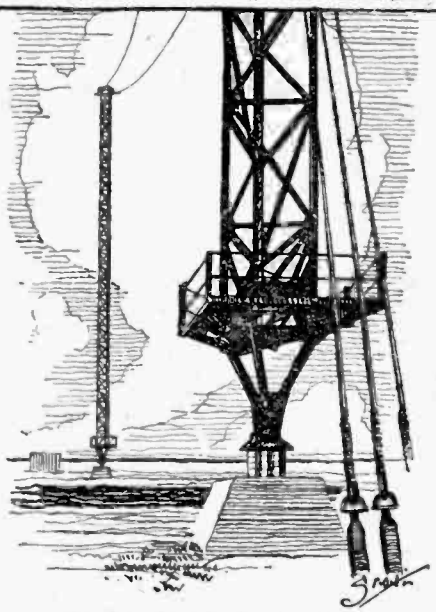


Complete circuit diagram of the McMichael Radiogram.

At present the McMichael Radiogram is available for A.C. mains only, and can be obtained in two voltage ranges (200-250 and 100-115) for either 50 or 25 cycles.

Next Week's Set Review:
EDDYSTONE SCIENTIFIC TWO.

BROADCAST BREVITIES



By Our Special Correspondent.

The Deceptive Season.

That deceptively pleasant period of the year is now here when neighbour remarks unto neighbour upon the delightful diminution in interference between European broadcasting stations.

A similarly fallacious sense of security seems to flavour the latest reports concerning the meeting of the International Broadcasting Union, recently held at Ouchy-Lausanne.

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Stormy Period at Lausanne.

I understand, however, that not half has been told us concerning the true nature of these international conversations, which turned for the most part upon the ticklish question of wavelength allocation.

Listeners are fully aware that mutual interference between European broadcasting stations is actually on the increase; the International Union is also alive to the fact, nor is it a betrayal of secrets to say that the Ouchy-Lausanne discussions revealed more than a suspicion of rancour among certain of the delegates.

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Don't Quarrel!

It is distressing to think that broadcasting, which has done so much to establish friendly relationships between the nations, should at any time form the basis of quarrels, but, in the opinion of more than one observer, trouble is bound to develop sooner or later unless the International Union can carry more authority than it does at present.

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Why the Prague Conference Succeeded.

That most successful of radio conferences—the conference at Prague in 1929—owed most of its success to the fact that it received official recognition by the Governments of the countries concerned. Postal and telegraphic representatives attended, with the result that definite rulings were arrived at concerning the distribution of wavelengths.

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Sacrificing Wavelengths.

At the present time the broadcasting officials can merely talk and wrangle among themselves, each trying to prevail upon the generosity and good nature of the others. For example, if Great Britain were even to suggest that the general situation would be eased by the sacrifice of exclusive wavelengths—were, in fact, to offer, say, two of its own wavelengths—it would depend entirely upon the caprice of the other broadcasting authorities whether they made similar sacrifices or not.

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Jealousy?

One important country on the Continent, it is said, is jealous of alleged British predominance in the European broadcasting field. Possibly some of our Continental friends may forget that it was Britain who convened the first international broadcasting meeting which was held at Savoy Hill in March, 1925.

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Wanted: Government Representatives.

In matters of broadcasting, however, it would surely be better for European countries to meet on terms of equality, and the best way to bring this about would be to avoid any suggestion of the "bar parlour" by investing the International Union with Governmental authority.

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With the "Mike" on the Dirt Track.

A running commentary on the dirt-track racing at Wembley on August 14th will be relayed in the National programme.

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A Talk on Faraday.

All wireless amateurs should tune in to one of the National transmitters on July 21st for Sir James Crichton-Browne's talk entitled "Faraday Once More," to be given in connection with the Faraday Centenary Celebrations and Exhibition at the Royal Institution.

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More Listeners.

No sort of depression—atmospheric or trade—seems to affect the steady growth in the number of receiving licences. The latest figures show an increase of 38,056 during May, making 10,914 in excess of the corresponding increase last year, and bringing the total up to 3,710,942.

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Is Savoy Hill "Hard Up"?

A little while ago the B.B.C. was complaining of being "hard-up," but I notice that Savoy Hill has now become more reticent on this point, as well it might.

No doubt the Moorside Edge station is costing a good deal of money, but many of the new licence holders are undoubtedly drawn from the Northern area and are thus paying for their own station; also, we have to remember that the opening of Northern Regional has rendered possible the closing down of several other stations, making for economy on the transmission side as well as through the reduction of staff.

No, we need not lie awake o' nights worrying over the finances of the B.B.C.

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No Complaints in the North.

On Sunday last the Moorside Edge transmitters were permanently assimilated into the British broadcasting machine. The trials have been very cautious and rather prolonged, but they have enabled every listener in the area to adapt himself to the new conditions, and I have not heard of any serious complaints.

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Speeding Up the Scottish and Western Regionals.

The development of the Scottish and Western Regional stations should now offer few difficulties to the B.B.C., and with the experience they have gained with Brookmans Park and Moorside Edge it is reasonable to hope that the completion of the Regional Scheme will be handled more expeditiously.

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The Four Cherry Stones.

"This year, next year, some time, never," became the pet gag among Northern listeners a few months ago when they waited in vain for the first signals from Moorside Edge. When they like, Scotsmen can express their impatience just as forcefully, while Welshmen—but enough said!

FUTURE FEATURES.

National (261 and 1,554 metres).

JULY 23RD.—"The Rumour," a play by C. K. Munro.

JULY 24TH.—"The Stage Revolves," Second Edition, by Henrik Ege and Peter Wyse.

JULY 25TH.—Running Commentary on The King's Cup Air Race.

London Regional.

JULY 21ST.—Concert Version of "Maritana" (W. Vincent Wallace).

JULY 22ND.—"The Stage Revolves."

JULY 24TH.—"The Rumour."

Midland Regional.

JULY 23RD.—"That Reminds Me . . ." a Reminiscence Extravaganza.

North Regional.

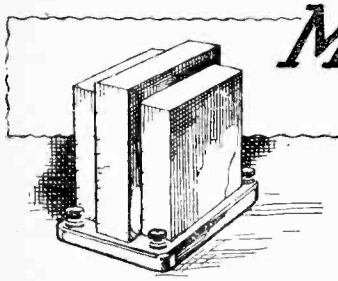
JULY 23RD.—Excerpts from Francis Laidler's revue, "Say it With Laughter," from the Empire Theatre, Liverpool.

West Regional (Cardiff).

JULY 22ND.—H.R.H. The Prince of Wales speaking at the luncheon of the Royal Welsh Agricultural Society Show, 1931.

Glasgow.

JULY 25TH.—Harry Gordon (The Man Frae Inversnecky) and his Company, relayed from Aberdeen.



Making the Most of the L.F. Transformer

A Useful Alignment Chart.

By W. A. BARCLAY, M.A.

(*Concluded from page 33 of previous issue.*)

SO far we have considered the low-frequency transformer simply as a device for obtaining a magnified voltage across the secondary for a given impressed voltage across the primary. The conditions of working, however, under which its performance was studied were so far removed from actualities as to merit the term "ideal." The most important of the assumptions made hitherto, and the one which chiefly calls for removal if our theory is to have more than a passing resemblance to "practical politics," is that which concerns the reactive element in the transformer. We must remember that the windings of the instrument are necessarily inductive, and that in addition they possess self-capacity. The result of this is to modify the purely resistive load on the transformer by introducing reactance, the amount of which will vary with different frequencies. If we continue to look at the transformer from the standpoint of the primary circuit we may illustrate this effect, as in Fig. 4, by including a reactance X_0 in parallel with the apparent primary resistance $\frac{R_{g2}}{n^2}$ due to the secondary load. X_0 may be called the "primary reactance at no-load," being, in fact, for any frequency the reactance of the primary when the secondary is open-circuited. At low frequencies X_0 is purely inductive; if the primary inductance be L henrys the frequency being f cycles per second, X_0 will be $2\pi fL$ apparent ohms. Herein lies the chief source of low-note losses inevitable with this form of amplification. With low values of frequency the value of X_0 is likewise small. The effect is thus to short-circuit the voltage across the primary winding which, in the absence of X_0, would possess the comparatively high resistance $\frac{R_{g2}}{n^2}$.

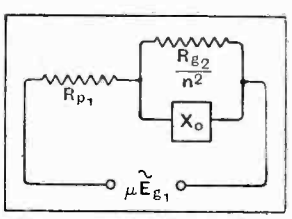


Fig. 4.—Equivalent circuit of L.F. transformer, in which the transformer reactance X_0 is shown in parallel with the load resistance in the primary.

When the frequency is relatively high, say, over 2,000 cycles per second, the inductive reactance of the windings will likewise be high, and will not, therefore, exercise this shunting effect. On the other hand, the self-capacity of the coils now begins to make itself felt. The higher the frequency the smaller is the reactance associated with this capacity, which, operating in parallel with the load resistance, tends again to "short" the highest notes in the same manner.

Alignment Chart (including Effect of Primary No-load Reactance).

The mathematical analysis of the circuit of Fig. 4 is rather beyond the scope of *The Wireless World*, but it is possible to illustrate very compactly the resulting conclusions by the alignment chart reproduced in Fig. 5. This chart differs from that given in the previous part in that it does not yield the value of $\frac{E_{g2}}{E_{g1}}$ or "stage magnification" directly. If this ratio $\frac{E_{g2}}{E_{g1}}$ be considered as the product of the valve magnification μ and a factor F, thus, $\frac{E_{g2}}{E_{g1}} = \mu \times F$, then the chart of Fig. 5 establishes an alignment relation between the quantities R_{p1}, R_{g2}, X_0, n, and this factor F. This is accomplished in the following manner. The two upright scales at either side carry respectively values of the ratio $\frac{X_0}{R_{p1}}$ and F. In the centre is a numbered network of shorter upright lines and curves, the lines representing values of turns ratio, n, and the curves values of the ratio $\frac{R_{g2}}{R_{p1}}$. Then, for any frequency at which X_0 is determined, *a straight line joining* $\frac{X_0}{R_{p1}}$ *to the intersection of the given n-line and* $\frac{R_{g2}}{R_{p1}}$ *curve will meet the scale of* F *in the required value.* To obtain the stage gain it is then simply necessary to multiply F by μ.

An Example.

We shall take as a practical example of the use of this chart the case of a transformer whose primary inductance at no-load is 7.5 henrys, and whose turns ratio is 4.5 to 1. We shall place this between two valves V_1 and V_2, the anode A.C. resistance of V_1 being 34,000 ohms and $\mu = 10$; the input impedance of V_2 being taken as 1 megohm. Let us find the stage magnification for this coupling at a frequency of 1,000 cycles per second.

The primary no-load reactance at 1,000 cycles is $2\pi fL = 47{,}100$ ohms, so that we have $\frac{X_0}{R_{p1}} = \frac{47{,}100}{34{,}000} = 1.4$. Further, $\frac{R_{g2}}{R_{p1}} = \frac{1{,}000{,}000}{34{,}000} = 30$. Armed with these values we proceed to find that point on the network corresponding to $n = 4.5$ and $\frac{R_{g2}}{R_{p1}} = 30$, and, joining it to the point $\frac{X_0}{R_{p1}} = 1.4$ on the left-hand scale, we find imme-

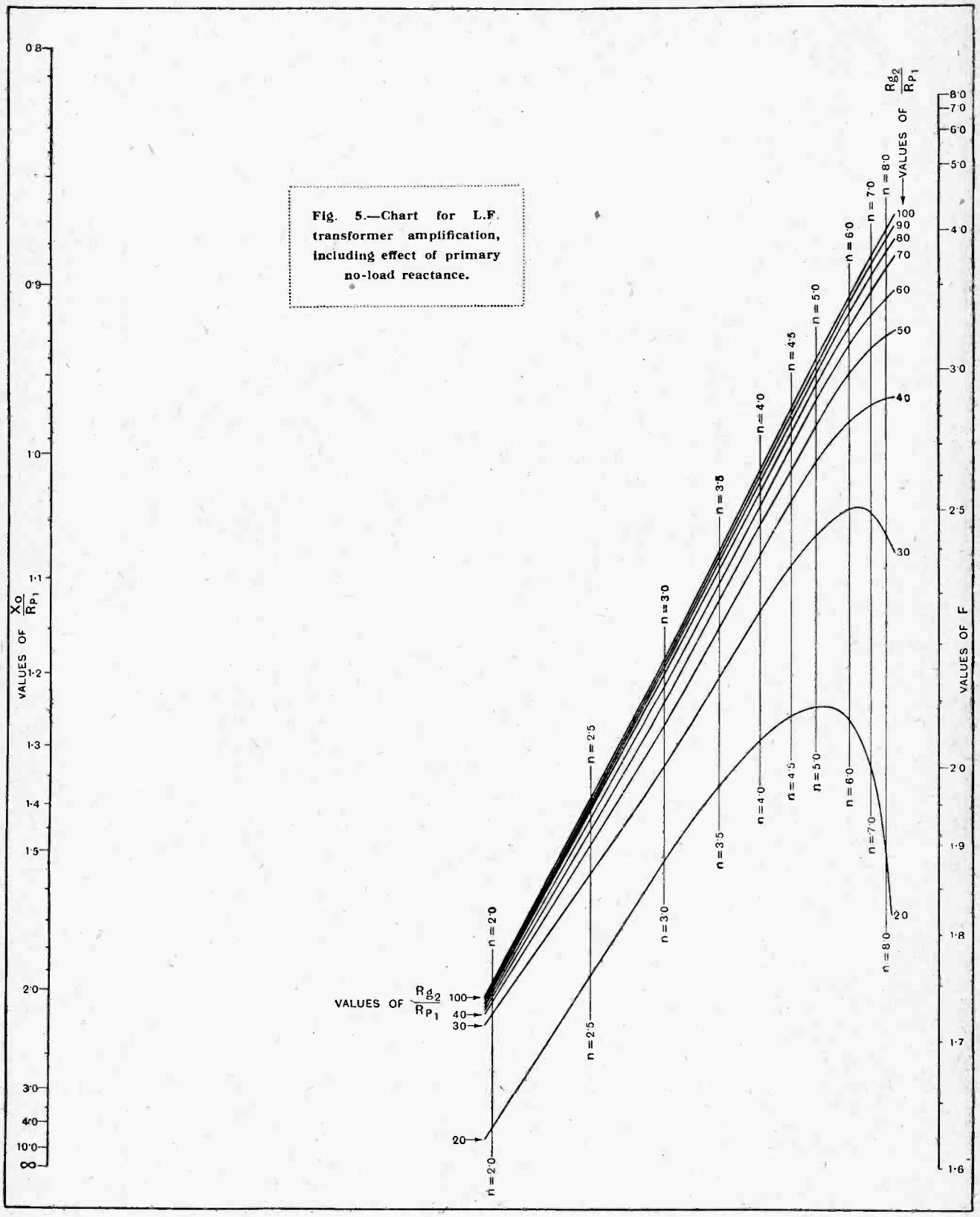


Fig. 5.—Chart for L.F. transformer amplification, including effect of primary no-load reactance.

Making the Most of the L.F. Transformer.—

diately that F = 2.5. Hence the stage magnification is approximately 25.

As in the case of the previous chart, the present diagram enables us to trace the effects of varying any of the quantities concerned upon the resulting stage gain. If, in the above example, the turns ratio were increased from 4.5 : 1 to 6 : 1, it will be seen that the result is only to cause F to increase to 2.6—a quite disproportionate gain—and that for still higher turns ratios the value of F will actually diminish. Clearly, 4.5 : 1 is an upper limit to the useful turns ratio for satisfactory amplification at this frequency.

It must be remembered, however, that the variation of magnification with frequency is the most important information which it is desired to have about a transformer, and this is very easily obtained by an inspection of Fig. 5. To take the same example, if the turns ratio is fixed at 4.5 : 1, we can easily trace the changes in F as X_0 varies. For instance, at 600 cycles the ratio $\frac{X_0}{R_{p_1}}$ will be 0.6 of its former value, i.e, it will be 0.84, so that F falls to 2.2. On the other hand, however much X_0 be increased, there is an upper limit to the value of F. It will be seen that the point at which the ratio $\frac{X_0}{R_{p_1}}$ becomes infinitely great is situated near the bottom left-hand corner of the diagram. When, therefore, X_0 is very large, the index line will pass through this point, and in the present case where the point on the network is fixed, F will be seen to have a maximum value of 2.7. This indicates that *with this coupling a stage magnification of 27 cannot be exceeded whatever the frequency to be amplified.* This figure 27 represents the theoretical amplification to be expected from an "ideal" transformer possessing the above constants. It may be interesting to confirm this by referring to the chart of Fig. 3 in the previous part. Entering this chart for the given values $\frac{R_{g_2}}{R_{p_1}} = 30$, $n = 4.5$, and $\mu = 10$, it will be found that the stage gain in the ideal case is 27.

Readers who have followed this account so far will not need further guidance in utilising Fig. 5 inversely as an aid to the design of L.F. transformer coupling. One or two points, however, may be noted.

The Best Value of Turns Ratio.

We have seen that beyond a certain value of X_0 a further increase of X_0 does not lead to any useful increase of stage magnification. It is inadvisable, therefore, from this point of view, to increase the windings beyond a certain amount, especially as this would lead to other sources of loss. On the other hand, too small a turns ratio will lead to small values of F, with resulting inefficiency. In any practical case, a compromise must be arrived at, and the resulting values of F for different windings and frequencies may be rapidly estimated and compared from the chart. Generally speaking—though where so much is variable it is almost impossible to lay down any rules—it is well where possible to keep n below 4 or 5.

Limitations of L.F. Transformer Coupling.

A study of Fig. 5 will bring out clearly the essential features of L.F. transformer amplification. The whole subject is one of exceptional difficulty, for it is far from easy to assign precise numerical values for the various quantities involved. Especially is this true regarding the input impedance R_{g_2} of the following valve, which, as we have seen, depends largely upon the grid bias which is applied to that valve. With a proper negative bias on the grid of V_2 the input impedance may be considerable, and the higher it is the higher, of course, is the ratio $\frac{R_{g_2}}{R_{p_1}}$. An examination of the manner in which the $\frac{R_{g_2}}{R_{p_1}}$ curves are distributed on Fig. 5 reveals that—other things being equal—a lower value of R_{g_2} (or higher R_{p_1}) will always result in decreased amplification. The moral is, keep the grid bias at a proper potential.

The object of the above notes is, as above stated, to supply the experimenter with a convenient means of dealing quantitatively with L.F. transformer coupling. It will be realised, of course, that owing to the existence in the transformer of iron-core and resistance losses, and in the valve of capacity feed-back effects, the charts now given cannot provide results of absolute accuracy, though sufficiently correct for most design purposes.

It is hoped that the rapidity and ease with which the numerical values concerned may be correlated will justify their inclusion in *The Wireless World*.

Catalogues Received.

Lissen, Ltd., Lissenium Works, Worple Road, Isleworth, Middlesex.—Descriptive folder dealing with heavy-duty flexible resistances, giving values, current-carrying capacity and prices. Also 15-page booklet giving curves and other useful data relating to Lissen New Process Valves.

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The Central Manufacturing Co., Crown Works, Walsall.—Illustrated folders describing their range of moving-coil and moving-iron type meters for D.C. measurements.

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The Crypto Electrical Co., Ltd., Acton Lane, Willesden, London, N.W.10.—Leaflet describing and illustrating Crypto D.C. to A.C. converter equipment in portable soundproof cabinet.

Triotron Radio Co., Ltd., 91, Great Russell Street, London, W.C.1.—Descriptive literature relating to the full range of Triotron valves and loud speakers.

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Louis Holzman, Ltd., 37, Newman Street, London, W.1.—Illustrated folder dealing with the elimination of electrical interference.

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Philipson and Co., Ltd., Holland Street, Astley Bridge, Bolton.—Illustrated booklet dealing with the Philipson "Safety" All-Electric Three receiver, mains transportable receiver and battery eliminator.

Ferranti, Ltd., Hollinwood, Lancashire.—Constructors' broadsheet for the A.C. Mains Screened-Grid-Four receiver, also illustrated leaflets dealing with two- and three-valve mains console-type receivers.

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Claude Lyons, Ltd., 40, Buckingham Gate, Westminster, London, S.W.1.—12-page booklet describing the range of B.A.T. switches for use in mains circuits.

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Philips Lamps, Ltd., 145, Charing Cross Road, London, W.C.2.—Illustrated folder dealing with the type 2701 25-watt power-amplifier.

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Varley (Oliver Pell Control, Ltd.), 103, Kingsway London, W.C.2.—Coloured folder illustrating and describing the Varley Constant Square Peak Coil.

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.

THE AMATEUR.

Sir,—I have noted with great interest the various letters following the leading article in your journal regarding the amateur experimenter and his efforts in the past towards assisting the progress of telegraphy and telephony on the shorter wavelengths, and should like to take this opportunity of stating a few facts.

During the years 1918 to 1923 a considerable amount of real experimental work was carried out by a very enthusiastic band of amateurs who expended much time as well as much money with the object of ascertaining the possibilities of long-distance communication by the use of wavelengths below 200 metres.

Commercial concerns were also interested, but not to any great extent, as at that period short waves were considered more or less "useless," and I think I have the support of many well-known experimenters in making this statement. The reply one obtained from most of the experts in the early days when enquiring as to the utility of short waves was to the tune of "well, we did try them some time ago, but they are not of much use excepting for short-distance work."

Following the failure of the first well-organised 200-metre experiments between the amateurs of the U.S.A. and this country, it was obvious there was a certain amount of truth in this assumption, but very few people at that time thought of "going lower" into the unexplored regions.

The subsequent success of a few in establishing two-way contact with the U.S.A. on wavelengths of the order of 110 metres made the commercial experts sit up and take notice, and within a few months one could hear their efforts, which, I may add, were at first much more feeble than the amateur with his 100 watts or so, as they fished around and asked "CQ" for reports.

It is true that many of the one-time "amateurs" are now following the calling as "professionals," but I consider that it is rather unfair that the few who worked hard and spent several years of listening and lost many a good night's rest in an earnest endeavour to achieve their object, which they eventually did, should be belittled by the concerns now benefiting therefrom.

There remains very little more to be said, and one has only to spend a few minutes amongst the higher frequencies to be assured of the complete success of short-wave communication over long distances, which I still contend is mainly due to the efforts of the amateurs who had the courage to tackle a problem which had been turned down by the "big noises" of radio at that time.

Merton, S.W.19. J. A. PARTRIDGE, G2KF.

Sir,—Unless amateur radio has lost any of its lure for the one who is interested in it from an experimental standpoint, I have a feeling that the communication by Mr. F. G. Kay, which appeared in the May 27th issue of *The Wireless World* will bring forth an unusual number of protests.

No harm will come of it. Quite the reverse probably will be true, because once again the amateur fraternity undoubtedly will take advantage of the opportunity to defend its rights for existence. One can only generally assume from the communication that Mr. Kay is not too well informed on amateur radio and and its activities. Perhaps it wouldn't be amiss to generalise these activities, not only for the enlightenment of Mr. Kay, but for the benefit of others who may in some measure agree with his attitude.

It would be no affair of mine, except for the fact that amateur radio is a world-wide institution in which I am interested and have been interested for a good many years. Does it seem quite reasonable that there is any cause for a complaint which in all likelihood may not belong to the amateur or experimenter?

Does Mr. Kay know that many of the things which we enjoy in radio to-day are directly traceable to the activities of the amateur and experimenter? Does he realise, too, that it is due to the persistent efforts of the amateur that radio broadcasting has been made possible? Of course, it is generally conceded that broadcasting would have come in any event, but at the same time, due credit must be given to the amateur for his efforts in hastening that coming.

It would take far more than a reasonable amount of space in your publication to set down the numerous radio activities by which all humanity has benefited through the efforts of the radio amateur. The communication facilities with various exploration and expeditionary parties alone have been contributions in the interest of science in all its branches. This is a class of communication in which the amateur alone has done far more than any commercial organisation, or group of commercial organisations. The amateur has participated freely and willingly in this sort of work, and the past history is full of records in which amateur radio has been the sole means of communication in scientific work of this nature. A great majority of the engineering talent now in the commercial field has grown up from the ranks of the amateur, and I doubt if there is any large progressive organisation in radio in which these amateurs will not be found.

Every once in a while the amateur fraternity will be called upon to defend itself, as it is being called upon now, and such defence as heretofore should be in the way of enlightenment and education, if all of us are to profit equally by it.

Chicago. F. H. SCHNELL, W9UZ.

[Mr. F. H. Schnell, one of the best-known of American amateurs, is a past-president of the A.R.R.L.—ED.]

Sir,—That such a fuss should be made over my innocent request that Sunday broadcast hours should not be extended is indeed an honour to me. Hair-splitting has been freely indulged in by your correspondents—yes, even by myself—but the origin of all this to-do was in my innocent request that Sunday broadcast hours should not be extended, out of consideration to the amateurs. Whatever people may say, the fact cannot be avoided that amateurs *have* contributed largely to the betterment of the science of radio. Dr. Eccles has said so, and he is in a far better position to judge than are any of your correspondents. Thus Mr. Kay *is not* informed, despite his protests to the contrary. Each of his letters drives home this fact, especially where he attacks QSL cards and "radiese." These are no longer in use, except among a few Continental transmitters, who are not engaged on experimental work. All British amateurs hold their licences for experimental work, and soon lose them if abused.

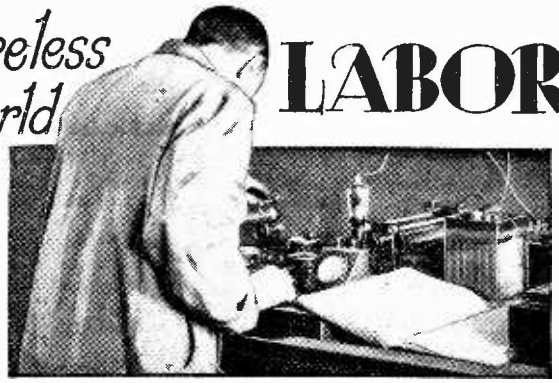
In my previous letter to you I said I would not enter into a discussion with all and sundry on this matter. It is quite unnecessary to do so as all my original remarks are true. The stir they have caused is indeed flattering to such a humble (pardon the pun) member of the community as I.

Can we not all strive to attain that ideal when the Mr. Kays and the Mr. Hums will "give and take," as Mr. J. Eric Johnson has said? After all, *chacun à son goût!*

Perhaps, however, the B.B.C. hours will not be extended on Sundays, in which case we end up "all square," as if this correspondence had never been started. J. H. HUM.

London, N.10.

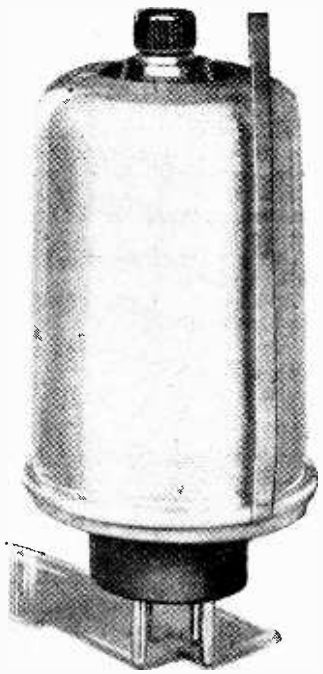
Wireless World LABORATORY TESTS



Review of New Radio Products.

"THIMBLE" VALVE SCREEN.

Made by Regional Radio, Ltd., 9, Southampton Street, High Holborn, London, W.C.1, this valve screen is intended to serve a dual purpose. Used in conjunction with screen grid valves, it serves to augment the internal screening, but only in small measure does it assist in isolating the external anode and grid connecting leads.



"Thimble" aluminium screen for S.G. valves.

Its other uses include an anti-microphone device when employed as a cover on detector valves or L.F. amplifiers, which show a tendency to react to mechanical vibration due to the impinging of sound waves on the outside of the valve.

The screen is positioned by means of a rubber ring, which fits on to the base of the valve. A copper strip for earthing the screen is provided, and the price complete is 2s. 6d.

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RIPAULTS EBONITE.

A special high-grade ebonite ideally suited for panels in wireless sets is now obtainable from Ripaults, Ltd., King's Road, St. Pancras, London, N.W.1. It is particularly strong, and it can be drilled and machined without chipping or flaking. The choice of three styles of finish is available, viz., mahogany, silver grey, or green, while in each case the reverse side is black. All surfaces are highly polished, and the standard thicknesses are $\frac{3}{32}$in., $\frac{3}{16}$in., and $\frac{1}{4}$in.

Panels can be supplied cut to any desired size, and the price is $\frac{1}{2}$d. per square inch in each case.

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WATES RESISTANCES AND FIXED CONDENSERS.

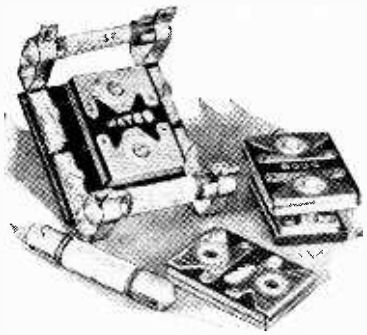
Although taking the general form and size of a grid leak, Wates resistances are of the wire wound variety, being available in values ranging from 10,000 ohms to 2 megohms. Each resistance contains about 10in. of special spiral-wound resistance wire, which, after adjustment for value, is inserted in an insulated sleeving and then wound on a paxolin former measuring $1\frac{1}{2}$in. long. This is fitted with end caps of the familiar grid-leak type.

These resistances are rated to dissipate 2 watts, and the price is 10d. each, irrespective of resistance value. The actual resistance of a few samples taken at random were found to be within 10 per cent. of the marked value. Some of the smaller resistances, notably of the order of 20,000 ohms, showed a much better agreement and in some cases the deviation did not exceed 2 per cent.

The range of fixed condensers includes all standard sizes from 0.0001 mfd. to 0.005 mfd., and the prices are as follows: Up to and including 0.0009 mfd., 5d. each; 0.001 mfd. to 0.002 mfd., 6d. each, and 0.003 mfd. to 0.005 mfd., 8d. each. Copper foil, mica and bakelite are the materials employed, and the finished condenser is tested at 3,000 volts. A special insulated holder is available for baseboard mounting; this carries two plugs on to which the condenser fits, the eyelet holes in the metal end caps serving as sockets. These holders can be obtained in a variety of forms; one to support a condenser only, another to accommodate a condenser and a resistance, and a third style which has provision for one condenser and two resistances. They are priced at 6d., 9d. and 1s. 6d. respectively.

Measurements showed that the actual capacities closely approximated the marked values. For example, a 0.0005 mfd. size showed a measured capacity of 0.000503 mfd., while one of 0.001 mfd. was found to be 0.001034 mfd. actual.

The makers are Standard Battery Co., 184-8, Shaftesbury Avenue, London, W.C.



Samples of Wates 2-watt resistances, fixed condensers, baseboard mounts and combined resistance and condenser holder.

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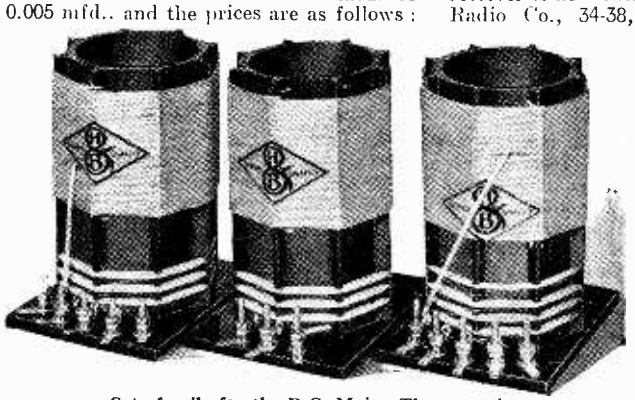
H. AND B. COILS FOR D.C. MAINS THREE RECEIVER.

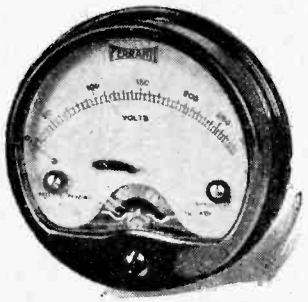
A set of coils made especially for this receiver is now obtainable from H. and B. Radio Co., 34-38, Beak Street, Regent Street, London, W.1, and the price is 25s. The specification has been strictly adhered to in every respect, and the coils will be supplied carefully matched. The terminals are placed in exactly the same positions as they appear in the drawings already published, so that there should be no difficulty whatsoever in making the correct connections.



Set of coils for the D.C. Mains Three receiver made by H. and B. Radio Co.

NEW RANGE OF FERRANTI A.C. METERS.

With the wider use of A.C. for operating radio receivers, there naturally arises a demand for some inexpensive but reliable instruments for measuring A.C. voltage and A.C. current. To meet this demand, Ferranti, Ltd., Hollinwood, Lancs, have developed a range of moving iron type meters for use on frequencies of from 25 to 100 cycles per second.



Ferranti moving iron type A.C. measuring instruments.

These instruments are fitted with engraved scales 2½in. long and the familiar Ferranti knife-edged pointers. Errors due to difficulty in reading the scale, therefore, are reduced to a minimum. At present these meters are made in single range types only, but multi-range instruments will be available shortly. In the voltmeter class there are some fourteen different types, starting with a full-scale deflection of 7.5 volts to one reading up to 500 volts. The prices range from £1 8s. 6d. to £2 15s., and relate to the projecting type as illustrated, and the flush fitting type, both with back connections.

Measurements made with a 0-120-volt meter at various parts of the scale showed that the average error was exceedingly small, and over a large part of the scale was of the order of the thickness of the pointer only.

For the measurement of current meters are available reading from 0-100 mAs. to 0-30 amps. for a full-scale deflection, and in all there are eight different ranges. These instruments cost £1 8s. 6d. in each case. The order of accuracy revealed by measurements made with a few selected instruments was such that the readings obtained give an exceedingly good indication of the actual conditions obtaining, and for all practical work they are entirely satisfactory.

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SAVAGE TRANSFORMER FOR SUPER-SELECTIVE SIX.

Further tests carried out on the sample type S86 transformer by W. B. Savage, 292, Bishopsgate, London, E.C.2, reveal that with all windings correctly loaded the output from the 4-amp. and 1-amp. L.T. windings is, as near as no matter, 4 volts in each case. At 1.6 amps., the voltage across the filament of the rectifying valve is 5 volts. Thus the transformer is entirely satisfactory in every respect.

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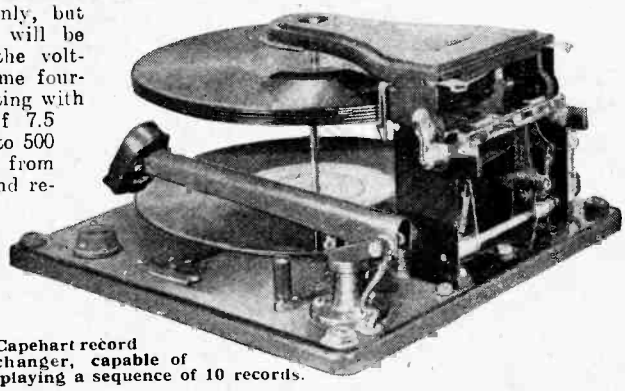
CAPEHART RECORD CHANGER.

Manufactured by the Capehart Corporation of America, this combined electrical gramophone motor and record changer is capable of playing a continuous sequence of 10 records (one side only). The records are placed in a hinged carrier immediately above the turntable and are released one at a time in the proper sequence by an ingenious system of cams working in conjunction with the tone-arm movement. The tone-arm is automatically reset and gently lowered on to the fresh record with absolute precision. It is possible to repeat any given record an indefinite number of times, and a press-button is provided which enables the record being played to be rejected in favour of the next one in the magazine.

The mechanism will only function with modern records in which a spiral or eccentric groove is provided at the end of the record, but provision is made for playing either 10in. or 12in. records provided that all the records in the magazine are of the same size.

Supplies are available in this country from the Sun Electrical Co., Ltd., 118, Charing Cross Road, London, W.C.2, and the price is 28 guineas.



Capehart record changer, capable of playing a sequence of 10 records.

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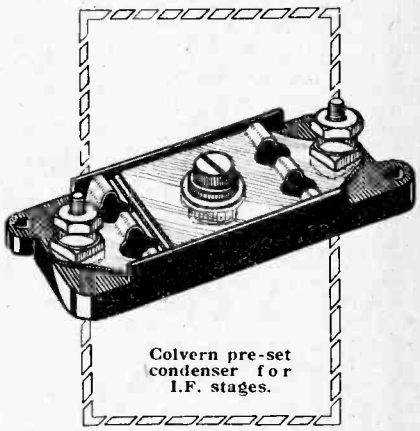
NEW TYPE PRE-SET CONDENSER.

Intended primarily for tuning the intermediate stages of a superheterodyne receiver, the new type pre-set condenser produced by Colvern, Ltd., Mawneys Road, Romford, Essex, will find many applications in set construction.

The manufacturers state that their aim has been to produce a "variable fixed" condenser that can be accurately adjusted and will hold its precise capacity value when once set. This is achieved by the use of German silver plates with spring end folds so that the plates remain in any position they may be set. A small bakelite moulding carries the plates, which are separated by mica insulation and a central adjusting screw is fitted which is entirely insulated from the condenser. Two types are available, having measured capacity values between 20 to 100 micromicrofarads (0.0001 mfd.) and 50 to 250 micromicrofarads (0.00025 mfd.). These little condensers are just the thing for trimming superheterodyne intermediates, and can, of course, be used for circuit trimming generally. In addition, they will find use as series aerial condensers as well as for anode bypass in the plate circuit of a detector valve in order to produce smooth control of reaction. The price is 1s. 9d.



Colvern pre-set condenser for I.F. stages.

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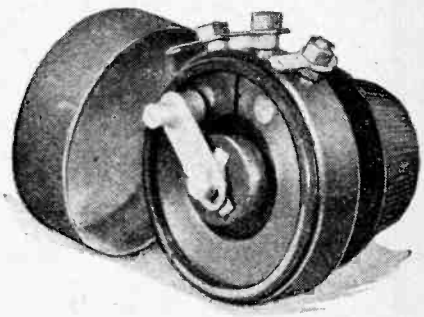
GAMBRELL VOLUVERNIA.

Having a nominal resistance of 500,000 ohms, the Voluvernia can be used either in wireless receivers or in gramophone amplifiers as a volume control. It is fitted with a graded resistance track, so arranged that the attenuation is approximately proportioned to the angular movement of the knob. To achieve this it is essential that the connections to the three terminals should be made in a certain order, and in the leaflet accompanying each component the correct connections for various circuits are given.

The resistance element consists of a special compound and contact between the slider and the track is made through the medium of a spring-loaded graphite plunger mounted in a cup-shaped housing on the end of the moving arm. This assures a good electrical contact and results in a perfectly smooth movement.



Gambrell Voluvernia with graded resistance track.

The makers are Gambrell Radio, Ltd., Buckingham House, Buckingham Street Strand, London, W.C.2, and the price is 6s. 9d.

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.

Magnification and Smoothing.

My mains-operated receiver originally included a two-stage resistance-coupled L.F. amplifier. Recently I replaced the second resistance by a transformer; after a certain amount of trouble in getting rid of L.F. interaction, it was found possible to obtain very fair results, but there is an annoying background of mains hum which was not present before.

The L.F. transformer is at present directly connected in the anode circuit. Do you think that hum would be reduced if I were to adopt the resistance-feed parallel arrangement?

It is unlikely that this alteration would make much difference. Your trouble is due to the fact that you have greatly increased the overall L.F. magnification of the set by fitting a transformer, and it is only natural that hum should become more evident. The remedy is to fit more effective smoothing devices.

o o o o

Loud Speaker Testing.

With the help of some "constant frequency" gramophone records and a three-valve resistance-coupled amplifier (circuit diagram enclosed) I am trying to test several experimental loud speakers for frequency response.

As you will know, the voltage output of a pick-up, used with these records, is by no means of constant value over the wide range of audible frequencies that are covered.

In order that the apparent acoustic output of a loud speaker at various frequencies may be judged aurally, it is obviously necessary to have a constant power output, irrespective of frequencies. Can you suggest how this can be obtained in any simple way, bearing in mind that I have not access to laboratory equipment?

We think that the simplest way of assuring a constant input to the loud speaker under test is to fit a "voltmeter" valve (which need not be calibrated) to your amplifier as a monitoring device. By careful manipulation of the volume control (in your case an anode potentiometer) while watching the anode meter, it should be possible to "follow up" variations of pick-up output from the amplifier. It would be particularly easy to do this when using, say, a "falling tone" record.

If you adopt the method of connection shown in Fig. 1 it should be remembered that the monitoring valve will have a considerably higher A.C. resistance than the L.F. amplifier with which its grid is in parallel; the first-mentioned valve must be operating as an anode bend rectifier under conditions where the second is acting as an amplifier.

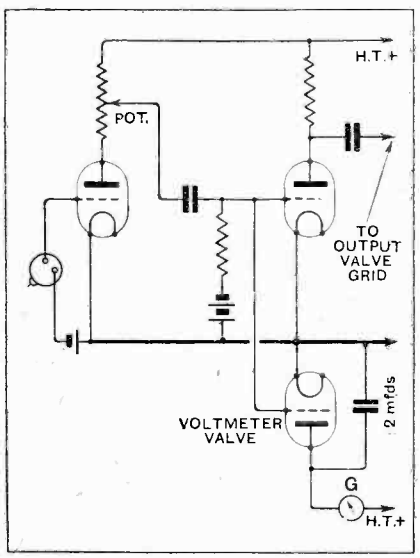


Fig. 1.—A monitor valve connected in parallel with the second valve of a gramophone amplifier. Assuming a "straight-line" amplifier, output from test records can be kept at a constant level by operating the volume control so that a steady galvanometer reading is maintained.

High or Low Impedance?

Can you give me a word of advice as to the best choice of an H.F. valve for a 1-v-1 set? I am undecided as to whether to use a high- or low-impedance type.

This is a matter that can hardly be discussed adequately in the course of a letter, but, briefly, it is usual nowadays to select an H.F. valve of medium or low impedance if it is to be used in a set without an input band-pass filter. When preselection is employed, the high-impedance valve can generally be substituted with some advantage, as troubles connected with cross-modulation and H.F. valve rectification will then be less pronounced.

o o o o

". . . Nr. Slaithwaite, Yorks."

For reception of the Northern Regional station, which is only a few miles away, I use a power grid detector, followed by a pentode output valve. The selectivity of this arrangement seems to be rather inadequate, and I am wondering whether it would be worth while to replace my existing outside aerial by a frame.

So far as the reception of twin transmissions operating on the same site is concerned, it should be made quite clear that the use of a frame aerial does not confer the slightest advantage in the matter of selectivity. True, it may bring about an apparent improvement, but exactly the same effect could be obtained by reducing the dimensions of your open aerial (or reducing its coupling, which comes to the same thing) until signal strength is reduced to the same level as that obtainable with the frame aerial.

An input filter seems to be indicated in your case, although it should be possible to obtain very fair results by making provision for suitable reduction in aerial coupling—provided that no other stations beyond the local ones are required.

o o o o

Free Bias Polarity.

I have just been reading your recent description of the Dubilier three-valve A.C. set, but cannot understand how negative bias is provided for the anode-bend detector. As the cathode is joined to a positive point on the H.T. potentiometer, it appears to me that positive bias (instead of negative) is applied.

As you say, the cathode of the detector valve is positive with respect to the earth line, to which the grid is connected through the H.F. transformer secondary. But as the cathode is positive with respect to the earth line and grid, it follows automatically that the grid must be negative with respect to the cathode. This is the proper operating condition.

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Territorial Ether.

THROUGHOUT the history of the civilised world, international legislation has concerned itself, amongst other things, with the question of territorial waters, and has had to decide how far each nation's rights extend beyond its shores. It may well be that the time will come when the question of broadcasting will have to be similarly treated and international agreements arrived at on the question of how many milli-volts per metre of, say, French or German broadcasting will be permitted to cross the shores of this country or the frontiers of any other adjacent countries.

It does not seem unreasonable to suppose that the day must eventually come when some sort of control of this kind will have to be agreed to by those countries who are close enough neighbours to cause interference with one another's local broadcasting transmissions.

So long as there are enough wavelengths to go round without mutual interference sufficient to render the reception of local transmissions difficult, nothing of the kind will perhaps be thought necessary, but, to judge from the present trend, we may suppose that it will not be very long before stations are really far too numerous for serious overlapping to be avoided, and it would then seem that some definite attempts will have to be made to limit the power of stations or to devise a means of effectively "localising" their range. This might come about with a development of special types of aerials, as proposed by the British Broadcasting Corporation some time ago.

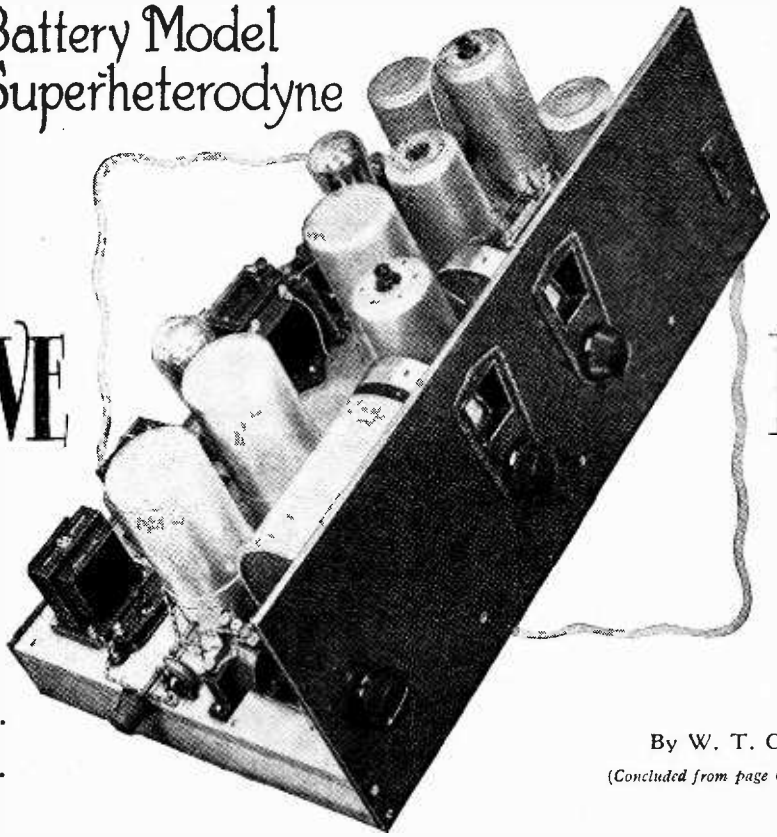
In the meantime, countries which are neighbours should see to it that they do not abuse what may be regarded as the temporary concession to encroach into the territorial ether beyond their own frontiers, by permitting the broadcasting of any matter which might offend against the national feelings, customs or internal policy of adjoining nations.

In this connection we might mention a report which we recently published emanating from our Washington correspondent in which he stated that Sir John Reith, during his recent visit to the States, had indicated that it was the intention of the British Government shortly to make a formal protest to the Governments of neighbouring countries against the practice of their broadcasting stations of putting out advertising programmes paid for by sponsors in this country, when advertising through the medium of broadcasting is expressly prohibited here under the terms of the Government licence to the B.B.C. Although we have since learned that Sir John Reith was not responsible for such a statement, for, obviously, he would not presume to anticipate any possible action on the part of the Government, yet if some protest were made in official quarters it could hardly be said to be an unreasonable request, but would merely be in keeping with the traditions of fair play and mutual consideration between friendly powers.

In This Issue

Wireless World Battery Model Superheterodyne

SUPER-SELECTIVE FIVE



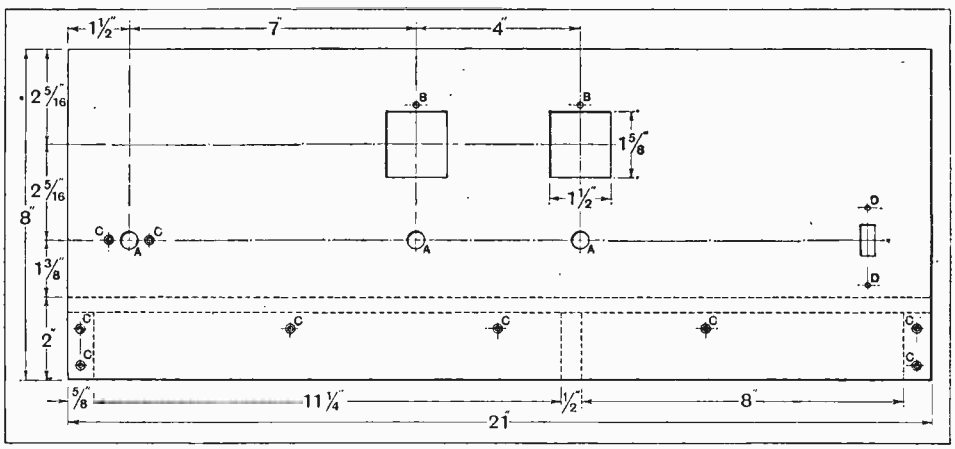
Constructional Details. Initial Adjustments. Operating Voltages.

By W. T. COCKING.

(*Concluded from page 64 of previous issue.*)

THE constructional work involved is simple and straightforward, and consists in the assembly of factory-built components. A composition panel is used, and holes must be cut in it for the two drum dials and the switch. The wave-range switch spindle, however, comes out through the side of the cabinet, but as it consists of a length of square-section steel rod it can be pushed through the whole coil assembly after the receiver is fitted to its cabinet.

The coil screens, valve screens, and I.F. transformer screens are earthed by placing strips of copper foil beneath them when screwing them down to the baseboard, and this foil is used as a common earth return for a number of leads. The wiring is carried out principally beneath the baseboard, where the by-pass condensers and the voltage-dropping resistances are located, and the leads are run in the shortest and most direct route. The only special point to note in the wiring is that large loops should not be formed in the wiring to the low-pass filter in the second detector-anode circuit, and that the low-potential end of the secondary of the second I.F. transformer is returned to positive L.T., *not negative L.T.*



Panel dimensions and drilling data. Extra support is given tn the panel by the addition of battens to the baseboard. A = 7/16in. diameter. B = 5/32in. diameter. C = 1/8in. diameter, countersunk. D = 1/8in. diameter.

The 0.9-volt grid battery for the I.F. valve is screwed to the under side of the baseboard by the cardboard flaps provided, but in view of the greater weight of the 16½-volts battery some form of clips should be provided for this. Wherever possible, the specified components should be adhered to, but many changes are permissible without any great effect upon the results. A lower-ratio L.F. transformer must not be used, since it would then prove impossible fully to load the output

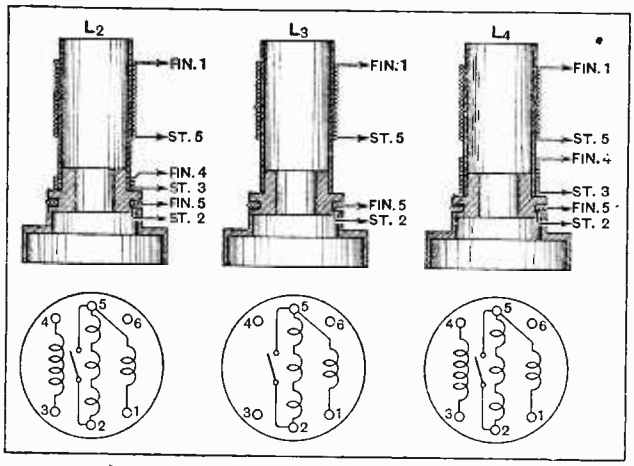
Super-Selective Five.—

valve without running into detector distortion. If the set is to be used within 15 miles of a strong local station, a completely screened two-gang condenser must be regarded as essential, but there is no objection to the use of a partially screened component when there is no local station. Similarly, no change should be made in the I.F. transformers, or it may prove troublesome to obtain the correct balance between sensitivity, selectivity, and quality.

Although the valves for a battery set are not as critical as those for an A.C. mains receiver, it is recommended that the following types, which were used in testing the set, be adhered to. The first detector and the I.F. amplifier should both be Marconi-Osram type S22, while for the second detector an HL2 will give the best results. The Marconi P2/B and L2/B were used for the output stage and the oscillator respectively, and can be recommended.

Battery Supply and Current Consumption.

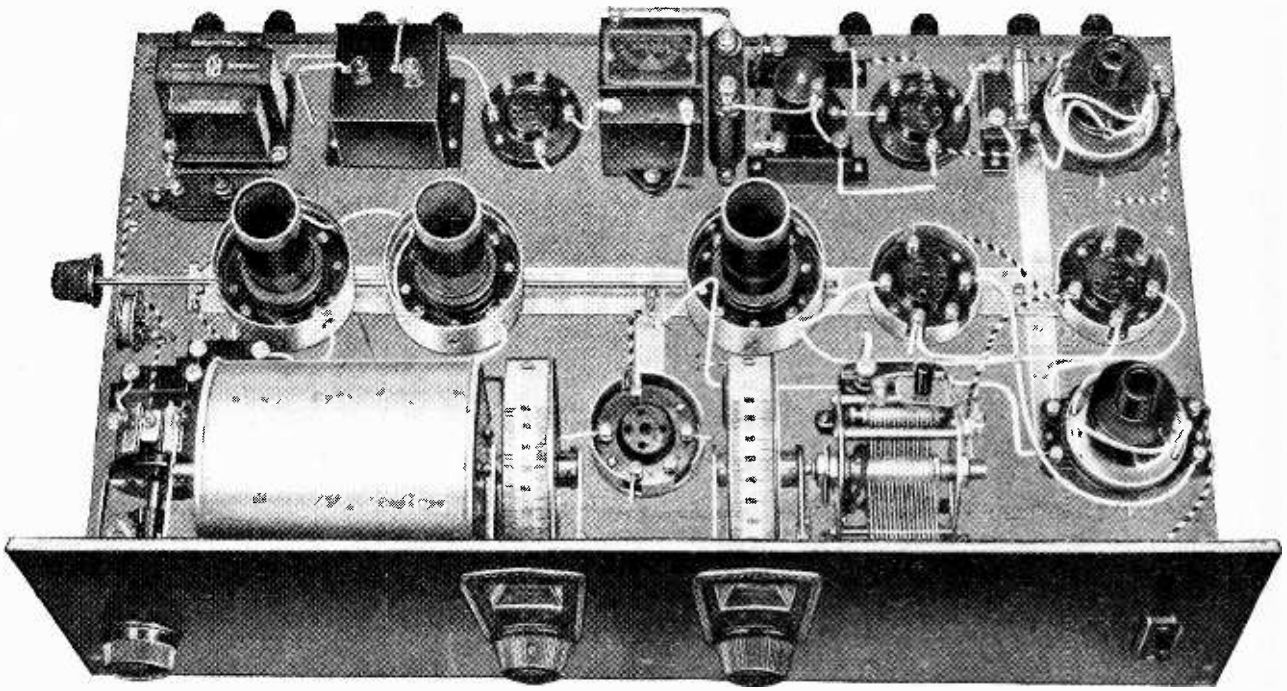
A two-volt accumulator is needed for the L.T. supply, and as the current consumption is 0.8 ampere its capacity should not be less than 20 a.h. (actual capacity), and preferably 30 a.h. Fairly heavy-gauge flex leads should be used for connecting it to the set, in order to prevent a voltage drop along them. A 160-volts H.T. battery is required for the best results, and the current consumption is 28 mA., so that large-capacity cells should be used in order to obtain the most economical running. Quite a fair life will be obtained with medium-capacity cells, however, although large-capacity are recommended, but no attempt should be made to use small batteries.



Coil winding data and terminal markings of the band-pass coils and (right) the oscillator coil. To avoid any mistake when constructing or ordering coils, it should be noted that their lettering in this receiver differs slightly from that of similar coils in the Super-Selective Six.

In view of the inevitable voltage drop in dry batteries, it is convenient to commence with 180 volts (two 90-volts batteries in series). The excess voltage will do no harm, and a longer period will elapse before the voltage is too low for good results. By commencing with a battery voltage slightly in excess of the normal good operation is secured over the full battery life.

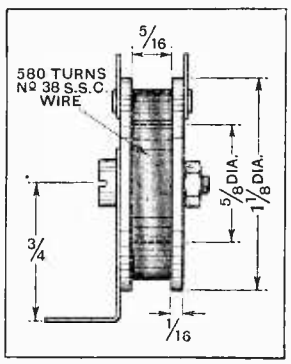
The receiver was tested with a measured battery potential of 162.5 volts at 28 mA., and, under these conditions, the voltages and currents given in the table were obtained at various points throughout the set. It will be seen that the receiver is quite economical in anode current; apart from the output valve, the total



General view of the receiver with coil and valve screens removed.

Super-Selective Five.—

current taken by the two detectors, the oscillator, the I.F. amplifier, and the two screen potentiometers is only 11.6 mA. The output valve, with its nominal 13.5 volts (measured 14 volts) grid bias, takes 16.4 mA.



Details of the aerial acceptor coil.

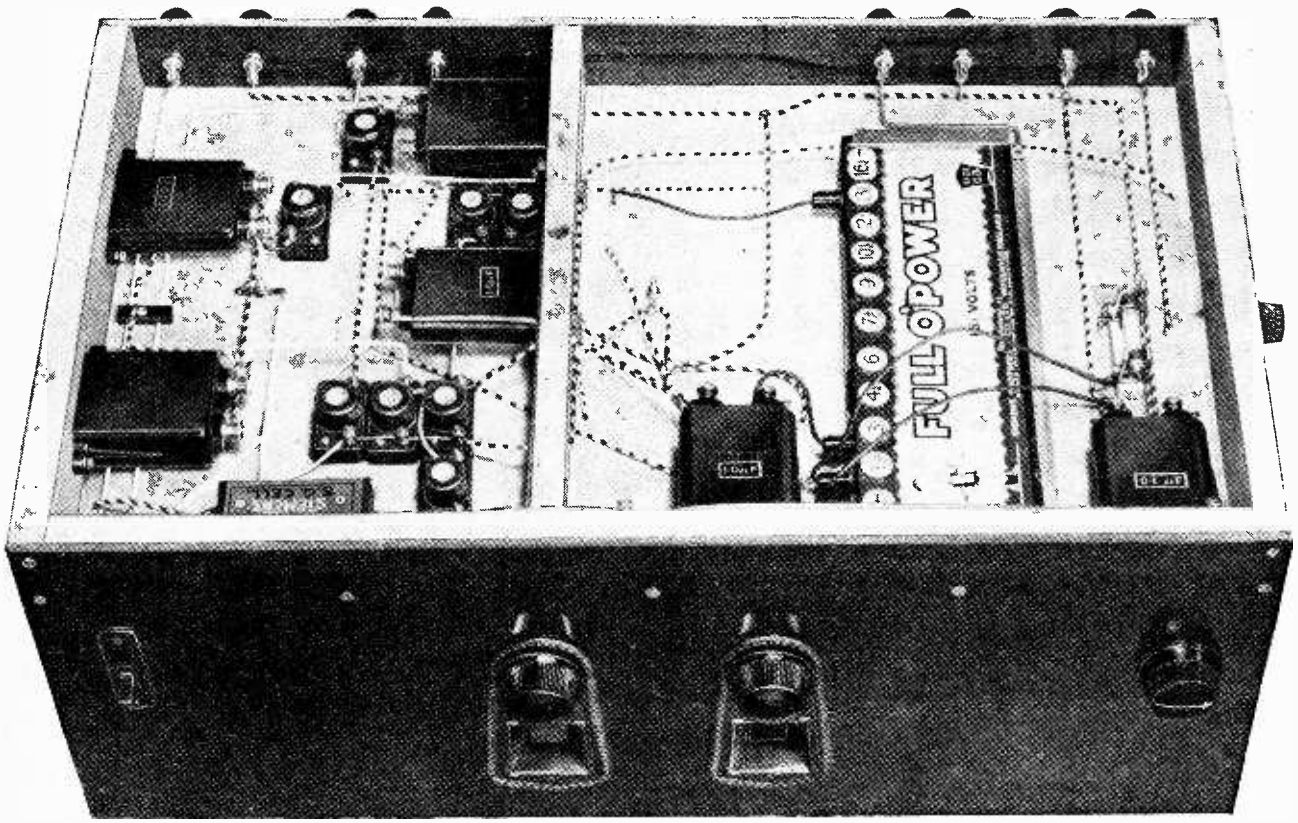
In cases where greater economy is considered essential, this may be obtained at the expense of quality by the use of a smaller output valve. If a P215 valve be substituted for the P2/B and the grid bias changed to 12 volts, the total current for the set will be only 20.1 mA. The sensitivity and selectivity of the set will hardly be changed, but the quality will suffer, since the undistorted output will be reduced to 150 milliwatts. A compromise between the two conditions may, of course, be obtained by retaining the specified valve and working it with a somewhat higher grid bias than the normal; the exact balance between quality and anode current can then be readily obtained.

The Initial Adjustments.

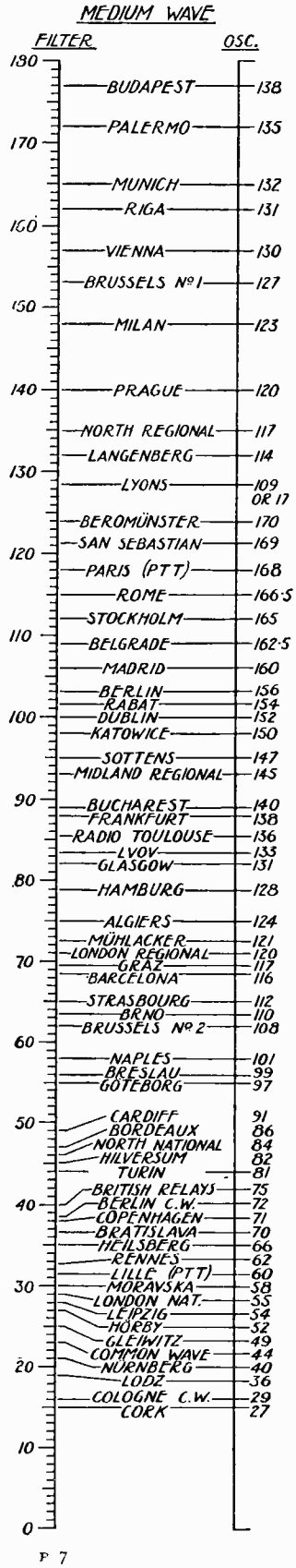
A number of adjustments is required before the receiver will give of its best, but no difficulty should be experienced in carrying them out, provided that the correct order is adhered to. The compression-type condenser C_1 must be fully screwed down, and the wave-range switch set for the medium waveband; the trimmers on the gang condenser should be fully unscrewed, while the coils in each I.F. transformer should be set so that their centres are about one inch apart. The local station should be tuned in accurately on both dials, keeping the volume control at a low setting so that it is only just audible. The coils in the intermediate-frequency transformers must now be adjusted to exact resonance by means of the built-in trimming condensers. These are controlled by the small levers projecting from the bases, and each lever should be moved with a piece of wood or ebonite to the position

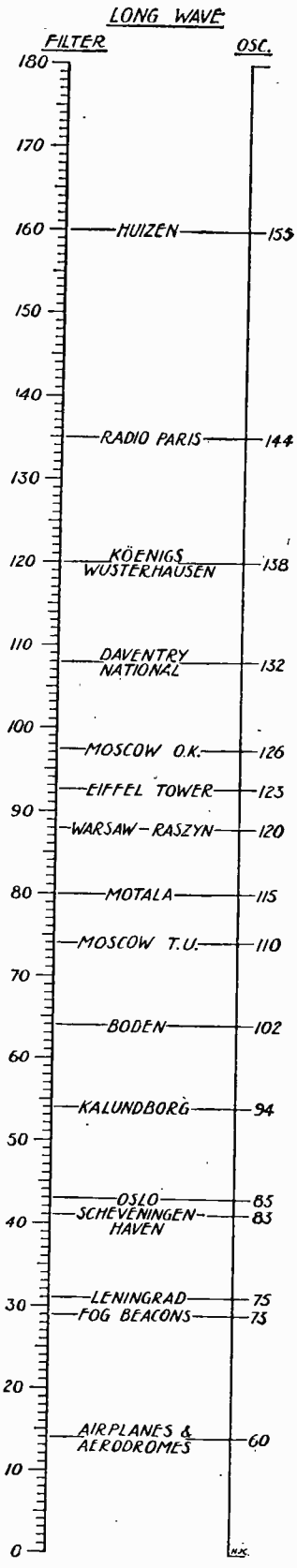
TABLE.

Valve.	Anode Volts.	Anode Current.	Screen Volts.	Screen Current.	Grid Volts.
1st detector. S.22	110	3.5	60		−1.6
Oscillator. L2/B	110		—	—	−3.2
I.F. amplifier. S.22	125	0.8	50	0.6	−0.9
2nd detector. HL2	130	2.6	—	—	+2
Output P2/B	162.5	16.4	—	—	−14



The decoupling condensers and resistances, also the grid bias batteries arranged on the under-baseboard.





Supcr-Selective Five.—

at which optimum signal strength is obtained. A start should be made with the grid circuit of the second detector, and each circuit adjusted in turn, working backwards to the anode circuit of the first detector.

The correct coupling of the coils must be found experimentally to give the best compromise between selectivity and quality. The best results will usually be obtained when the coils in the first transformer are set at about one inch apart, and those in the second transformer at about three-quarters of an inch apart. It should now prove possible to tune in a number of stations, and a weak station on a wavelength below 300 metres should be selected and accurately tuned on the oscillator dial. Its strength should preferably be such that it is only just audible with the volume control at maximum.

The two trimmers on the gang condenser are then adjusted for the maximum strength. A clockwise rotation of the star-shaped wheels increases the trimmer capacity, and only just sufficient capacity in each circuit to bring them into exact resonance is desirable. Once the ganging is adjusted at a low wavelength, it will be found to hold quite accurately over the entire wave-range.

The only other adjustment is that of the acceptor circuit L_1C_1, and for this the wave-range switch must be set for the long waveband. If now it be found that there is CW. telegraphy interference on stations on the 1,000-2,000 metres waveband, *and that the note of the C.W. changes as the oscillator condenser setting is altered,* then the condenser C_1 should be adjusted until the interference just vanishes. If the note of the C.W. station does not change, however, then the interference is due to a station working on a wavelength very close to that of the desired station, and the acceptor circuit will not eliminate it.

When tuning the receiver, it should be remembered that on the 1,000-2,000 metres waveband every station will be receivable at only one setting of the oscillator dial; but that on the 200-550 metres waveband most stations can be heard at two entirely different settings. In order to simplify the initial tuning, therefore, the station settings of the original receiver are reproduced here, and if care be taken in the receiver construction the dial settings should not be greatly different from these.

Results.

The large number of stations shown were all received on the loud speaker during a single test of only 3 hours duration. Most of the long-wave stations, of course, can be relied upon to give consistent loud speaker reception in daylight, but on the medium wave-band only a few distant stations will be audible before dark; even during the summer months, however, Brussels No. 1 can be received well at 5 p.m., while Langenberg can be heard at any time during the day.

The selectivity is not quite so high as in the A.C. model, owing to the closer coupling which must be used in the band-pass filters in order to avoid a loss of high notes. Partly because of the somewhat lower sensitivity, this decreased selectivity is barely detectable in

Super-Selective Five.—an ordinary listening test, and no difficulty has been experienced in receiving Algiers within nine miles of Brookmans Park without a trace of the London Regional. On the long waveband there is entertainment value from many stations, including Kœnigswusterhausen which can be received with only the merest trace of Daventry National and Radio Paris.

The sensitivity, although lower than that of the A.C. model, is sufficiently great to give loud speaker reception of all but the weakest of the Continental stations, provided that a reasonably good aerial be used. The selectivity is such that any station separated from its neighbours by 9 kc. can be received without interference, except those immediately adjacent to a strong local transmitter, where a separation of 18 kc. is needed to obtain freedom from interference. The quality with a good moving-coil speaker is excellent, although the undistorted volume is naturally not large, since only 350 milliwatts output is available. This is ample, however, for the small rooms of the average modern house, and, under such conditions, quite respectable volume can be obtained with a reasonably sensitive speaker.

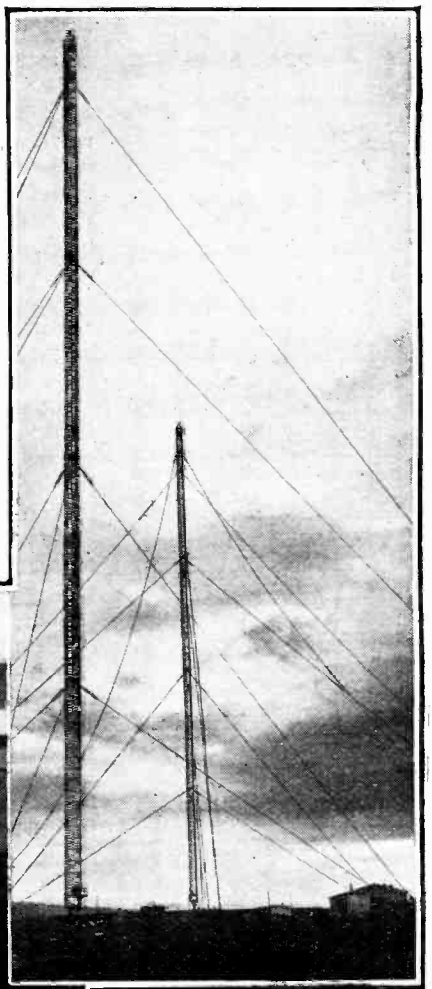
ICELAND'S NEW BROADCASTING STATION.

THE erection of the Reykjavik station was begun in the spring of 1930, the masts being constructed by the Telefunken Company, of Berlin, while the transmitter was installed by Marconi's Wireless Telegraph Company. The station completed its final tests in May, and was formally opened for broadcasting service on June 1st.

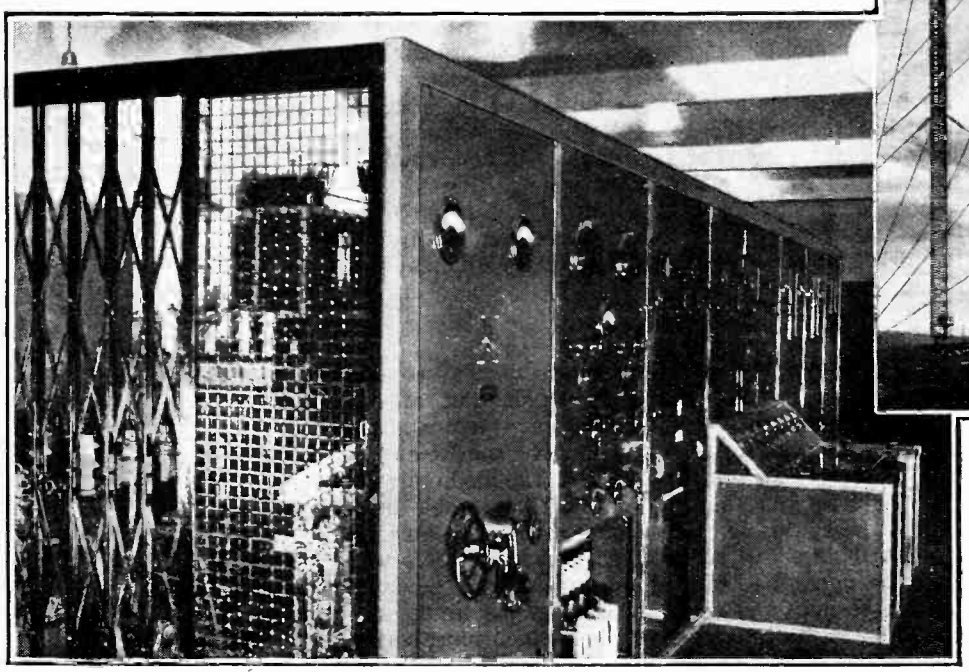
The Broadcasting Committee consists of five members, with Mr. Helgi Hjorvar as chairman, and the station is owned and operated by the State. The transmitter and 150-metre masts are situated on a hill about 9 kilometres south-east of Reykjavik. The wavelength selected is 1,200 metres, and the power to the aerial 16 kW. The Committee supervises the instructional activities of the broadcasting services and arranges the programmes in co-operation with the director of the broadcasting service. The Icelandic State holds a monopoly on the sale of receiving sets, and it is stated that the prices are slightly less than those in neighbouring countries. The licence fee is 30 kronur (about 33s.), and there are already about 3,500 licences.

The broadcasting station began its first active transmissions in December, 1930, and the call has hitherto been "Utvarpsstöd Islands i Reykjavik" (the Icelandic broadcasting station in Reykjavik), but this will now be shortened to "Utvarp Reykjavik"—Utvarp being compounded from the words "ut" (out) and "varp" (to throw). At present its transmissions are experimental, but by the beginning of October the new studio will be completed, when a regular broadcasting service will be established and programmes sent to neighbouring countries for publication.

The need for an efficient broadcasting service was keenly felt by the Icelanders, as the country is large and the inhabited parts widely scattered and cut off from each other by mountain ranges.

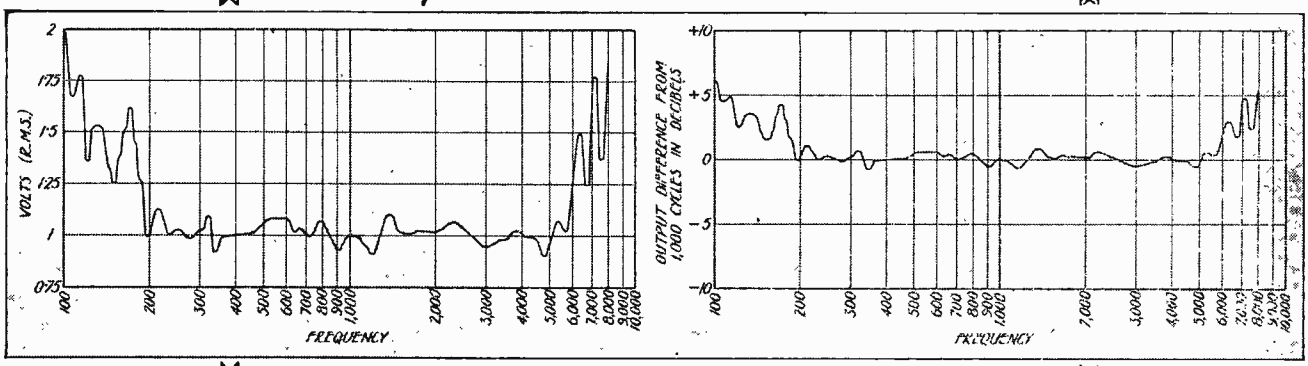


The Telefunken masts occupy a dominating position overlooking Reykjavik.



A corner of the Marconi 16-kW. transmitter, showing the control desk.

Why the Decibel?



The Equal Ratio Scale Simply Explained.

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

MANY searchers after knowledge concerning amplifiers and sound reproduction apparatus in general are intensely irritated when in their reading they encounter references to "T.U." or "decibels," which they regard as devices to obscure simplicity. Irritation at the use of T.U. is perhaps pardonable, seeing that they have more or less officially been pronounced obsolete, but those people who are used to them are not obliged to learn a new system; the decibel is just a new name for the same thing. But those who think it is quite good enough to express amplification as the number of times louder the sound, or stronger the current, or higher the voltage—as the case may be—when the amplification is operative, may question the necessity for introducing a less obvious system. Though less obvious, a decibel scale is much more informative and satisfactory, more simple even, when a very little trouble has been devoted to grasping its principle.

Whether we are considering the audio voltage at the grid of an amplifier, the air pressure produced by a loud speaker, or the amplitude of the groove on a gramophone record, the ultimate effect in mind is that on the ear of a listener, which these other quantities represent at various stages in the chain of sound reproduction processes. It will be granted that in drawing curves or any sort of diagram representing the performance, as to relative intensity, of any of the pieces of apparatus involved, it is most desirable that the diagram should convey to the eye as nearly as possible the same impression as the effect it is intended to represent conveys to the ear. So, if the scale of intensity conveys to the eye a very noticeable drop at a certain part of the diagram, whereas the ear does not detect any falling off in loudness at that point due to the behaviour of the apparatus itself (after allowing for defects due to other causes) then that scale is a bad one.

TO many the term decibel is surrounded in mystery. They can clearly grasp the significance of voltage amplification, yet the proportional scale of decibels conveys but little. In explaining the decibel and its advantages numerical values are given of a potential divider advancing by even amounts on an equal ratio scale.

The working of the ear is by no means simple, and an ideal scale has not been invented, but there is a very simple scale for comparing intensity which does correspond fairly closely with the ear's estimate, and when used in the construction of a diagram enables one to judge from it the capabilities of the apparatus to which it refers.

Naming the Unit.

Suppose something can be switched into the circuit of an amplifier so that it doubles the amplification. The ear is conscious of a certain increase in loudness. Now if the listener moves farther away so that the sound appears to be the same strength as originally, and another doubler is switched in, the ear is conscious of the same increase as on the first occasion, and the same process can be carried on any number of times within the limits of the power-handling capacity of the amplifier and loud speaker. So it seems the most reasonable idea to arrange our scale of loudness so that a twofold increase (or any-fold increase, in fact) is always represented by the same distance on the scale.

The first thing that is obvious is that we cannot start the scale at o like a linear or "straight" scale, for by however much we multiply o it always remains the same. The best commencement, or origin, is 1, because an amplification of 1 is no amplification at all, it is "as you were." Of course, 1 is not always shown on the scale, just as o is not always shown on a linear scale;

Why the Decibel?—

the lower part may be cut away to save paper, but 1 is the true origin all the same.

So if we start laying out the scale, making a two-fold increase occupy the same length all along, we get Fig. 1 (a), and if we try to fill in the other numbers, 3, 5, 6, 7, etc., it is rather difficult, and they get terribly crowded towards the top. We could get over the difficulty by making the scale unit a twofold increase and calling it a "Scrog" or any name we fancy. Actually, ten is considered to be a more important number, and a tenfold increase has been called a "bel," after A. Graham Bell, the inventor of the telephone, who is considered to be a more important person than M. Graham Scroggie. In spite of that, a tenfold increase is rather a coarse sort of unit, and represents a big jerk upwards in strength, so it has been subdivided into ten decibels.

Voltage and Power.

A decibel (abbreviated db) is an amplification ratio of 1.259 . . . , that is to say, about 26 per cent. increase (or decrease), and if you multiply that number by itself ten times, the result is ten, or one bel, which is as it should be.

But what is it an amplification of? One might have decided to call it voltage, for one can easily measure voltage at various stages of an amplifier, but an amplifier may do a great deal of business without raising the voltage at all—in fact, it may lower it; so, to get over the difficulty, it is the amplification of *power*, or voltage multiplied by current, which is taken into account. Now this is one way in which the decibel scale is an advantage, apart from that already mentioned. It is difficult to measure the power in a circuit of the type used in telephone and radio work, and one nearly always takes readings in volts. Now to convert a voltage scale into a power scale means squaring all the readings (for power is proportional to voltage squared), and if the voltage scale is linear, that means altering it into a non-uniform power scale, or else altering the shape of the curve entirely. Whereas, if the scale is in *ratios* of voltage, it is converted into a ratio-of-power or decibel scale by the delightfully easy process of doubling it. The same is true if it is the current that is measured. So that, although a tenfold *voltage* increase is not 10 db, it is a hundredfold power increase, which is two tenfold increases, or 20 db. In the same way, a voltage ratio of 1.122 . . . is 1 db, because $(1.122 \ldots)^2$ is 1.259 . . . A power ratio of 1.122 . . is half a db.

The full simplicity of this is not realised until one considers how to convert decibels into actual ratios or vice versa. It is easy for 10, 100, 1,000, etc., which are 10, 20, 30 db respectively, but it is quite a difficult calculation to arrive at the ratio corresponding even to the simple example of 1 db, so it might appear more bother than it is worth. Fortunately, tables for converting one to the other are the commonest form of table published, namely, logarithms, and even if log. tables are not available a slide-rule generally is. The whole principle of a slide-rule is that the scales are such that equal ratios occupy equal distances along the scale, so that numbers may be multiplied by adding the distances. Most slide-rules are provided with a uniformly divided scale, so that 0 can be made to register with one end of the main slide-rule scale, which, of course, starts at 1, and 1 on the uniform scale corresponds to 10 on the main scale. That uniform scale, therefore, can be marked "bels," and if multiplied by 10, decibels, corresponding to power ratios on the main scale, or if multiplied by 20 corresponds to voltage or current ratios on the main scale. Thus, if the voltage at the grid of a valve is raised from 6 to 12, that is a ratio of 2, and 2 on the slide-rule scale comes approximately against 0.3 on the uniform scale, so the increase is 6 db. A log. table gives the same thing, for the number of decibels is 10 times the log. of the power ratio, or 20 times the log. of the voltage ratio.

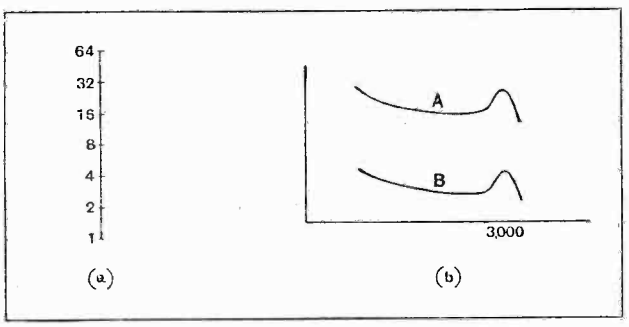


Fig. 1.—(a) A proportional scale in which a two-fold increase is represented by equal intervals. (b) Voltage output curve of two gramophone pick-ups. The resonance at 3,000 cycles in respect of A is of small importance yet that shown by curve B is by no means negligible.

At first, when one sees curves with decibel scales, it may be a little difficult to visualise what they mean. A convenient thing to remember is that 2 db is about the smallest increase appreciable to the ear. Using a step-by-step potentiometer which raises the audio voltage at some part of the apparatus in steps of 26 per cent., or 2 db, giving a power increase of 58.5 per cent., it is barely possible to notice that it is not continuously variable, unless it is a single constant note that is being controlled.

Choosing the Most Convenient Scale.

A convenient form of diagram, therefore, for characteristic curves is one which has a vertical or amplification scale of 2 db per division, preferably per centimetre. Raising a curve bodily up or down on such a diagram, without altering the shape, makes no difference so far as the relative amplitudes judged by the ear are concerned, whereas with a "straight" amplification scale the shape of the curve depends on whether it is high up or low down. A rise of 1 cm. on a straight scale means a great deal more if it is near the bottom than if it is in the upper reaches, whereas on a decibel scale it means a just perceptible aural effect no matter whereabouts on the curve it is. To express very big changes in level, it may be necessary to allow more than 2 db per cm.; that figure is given only because it is known to be standardised by some people and is a convenient scale for most purposes, also by adhering to a standard scale it is easy to see at a glance what a curve means. Even a 2 db per cm. scale, however,

Why the Decibel?—

though clearly showing small variations, covers a power ratio of 1 : 100,000 in 20 cms. A linear scale of the same length would not cover anything like the same range of ratios and would be far less convenient.

In Fig. 1 (b) are imaginary curves for two gramophone pick-ups. If the scale is linear, one has to estimate the resonance at 3,000 cycles of A as a ratio, and see that it is about 1.2 as compared with the general level, and therefore practically negligible, whereas that of B, which appears the same in shape, is actually 100 per cent., and therefore by no means negligible. The trouble is that most people do not make these mental calculations, and are consequently misled into supposing that the two pick-ups are very similar in constancy of output.

The importance of working to a db or logarithmic scale is recognised practically in the construction of volume controls of the potentiometer type. If the resistance element is uniform, the first quarter of the movement gives an increase in volume of something to nothing, which is indeterminate, the second quarter an increase of 4 : 1, the third 2.25 : 1, and the fourth 1.77 : 1. So the rate of increase differs according to the part of the scale, and reception of a powerful station is not controllable in the same way as that of a weaker transmission, for which the more advanced part of the scale is used. The correct type of potentiometer is one in which the resistance is graded or tapered so as to give equal ratios for equal movements. This can be done roughly in cheap volume controls with composition elements, but the full benefit is obtained in an accurately constructed step-by-step control such as that shown in Fig. 2. If the input impedance of the valve is very large compared with that of the potentiometer, then the audio voltage transferred to the grid is proportional to the resistance between the moving arm and −GB. The correct values for the resistors R_1, R_2, R_3, etc., are given in Table I for a 100,000-ohm potentiometer to give 2 db per step, with a total voltage ratio of 100 : 1, or power ratio of 10,000 : 1 between stud 2 (the first which gives anything at all) and stud 22. A volume control such as this, besides giving delightfully uniform variation, can also be used to obtain actual measurements of the increase or decrease produced by certain changes, by moving the control at the same moment as the change is made and noting the number of db required to preserve the level constant. This roughly is the basis of the usual method of measuring the gain of an amplifier; an attenuator is used, which is an elaborate type of volume control in the form of a network which maintains the impedance relations of the circuit constant, and which is calibrated in db; it is adjusted until the combined result of the attenuator and amplifier is to leave the level constant. The gain of the amplifier is, then, obviously equal to the loss of the attenuator.

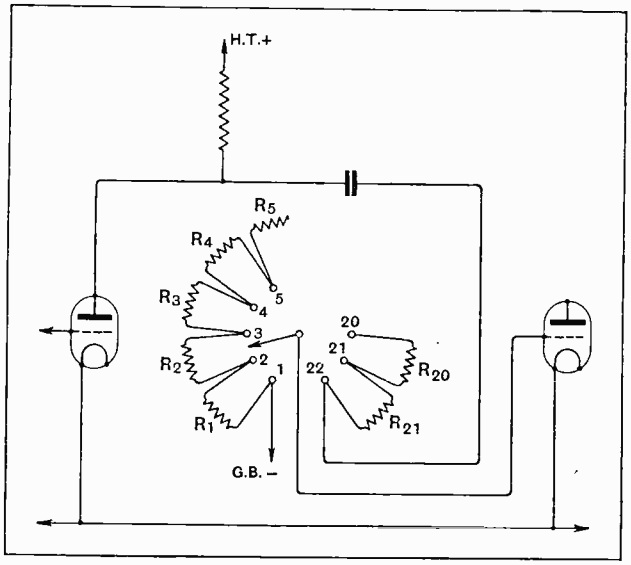


Fig. 2.—Circuit arrangement of a potential divider embodying the resistance values given in Table I and representing a step-by-step increase of two decibels.

It is interesting to note that the db scale is similar to the scale used for frequency or pitch, which musicians divide into octaves (frequency ratios of 2 : 1) and subdivide into 6 tones or 12 semitones, on the equal temperament system. The frequency ratio of one tone is the same as the voltage ratio of 1 db. In the matter of frequency, the ear still more definitely recognises the equal ratio system, for it can estimate the interval of an octave of sound with the greatest ease and accuracy, whereas very few people can estimate a single frequency really accurately.

It is perhaps desirable to emphasise again that the number of db gain or loss can only be derived in the manner described from the ratio of the voltage or current if the impedance is constant, for it must never be lost

TABLE I.

No. of Resistor.	Ohms.
1	1,000
2	259
3	326
4	410
5	517
6	649
7	819
8	1,090
9	1,240
10	1,611
11	2,079
12	2,590
13	3,260
14	4,100
15	5,170
16	6,490
17	8,190
18	10,900
19	12,400
20	16,110
21	20,790
	100,000

TABLE II.

db.	Power ratio.	Voltage or current ratio.
1	1.259	1.122
2	1.585	1.259
3	1.996	1.413
4	2.512	1.585
5	3.162	1.778
6	3.981	1.996
7	5.012	2.239
8	6.310	2.512
9	7.943	2.818
10	10.000	3.162
20	100.000	10.000
30	1,000.000	31.623
100	10^{10}	100,000.000

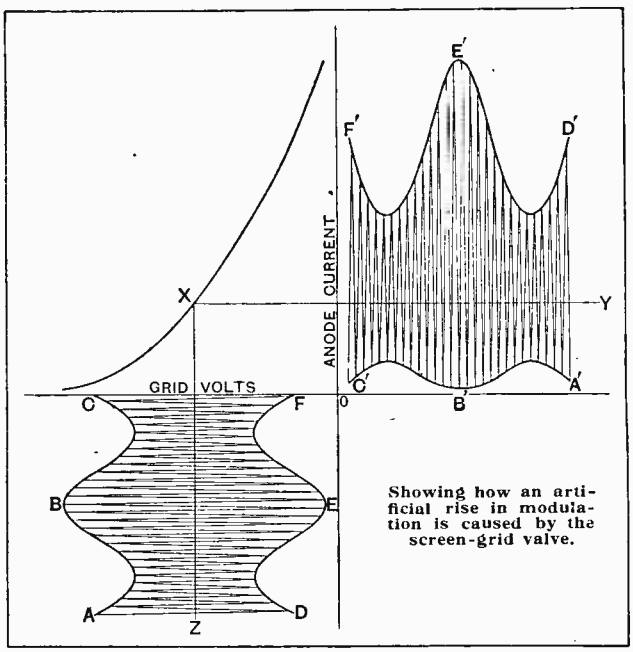
Why the Decibel?—

sight of that it is a *power* ratio that we are concerned with (Table II). A L.F. transformer by itself may raise the voltage, but there is no gain, for the impedance goes up with the square of the voltage in the ideal case, and the power remains constant. In an actual transformer there is, of course, a slight loss of power.

This stipulation usually causes no difficulty in the case of changes of volume or "sound level" at a single point in a system, but it requires some thought when, for example, one wishes to state the gain of an amplifier. Except for the last stage, a valve amplifier is regarded as a voltage-operated device, and one is not concerned with the *power* absorbed at the grids of the valves. That is an important and complicated matter when one comes to the design of the amplifier, but it would be very misleading to raise that issue in such a simple matter as stating the amplification. Therefore it will be assumed that the coupling devices have been adjusted to give the maximum possible power, which condition is met by making the impedance of the coupling equal to the impedance it works into. A valve anode circuit may have an impedance of 10,000 ohms, and the input impedance of the next valve 1,000,000 ohms, and as the impedance of a perfect transformer winding is proportional to the square of the number of turns, the ideal transformer ratio in this example is 1 : 10. But the impedance varies with frequency, and in practice it would be impossible to maintain the secondary impedance of a 1 : 10 transformer at 1 megohm over the whole band of audio frequencies, so the loss due to the inevitable departure from perfection is charged against the amplifier. So it is allowable to take the voltage ratio between two points, such as the grids of two valves in the amplifier, where the impedance may be assumed to be infinitely great, i.e., true voltage-operation conditions. If the voltage amplification is largely thrown away in the interests of quality, such as by using resistance coupling which gives no step-up, it is not legitimate to point to the increase in *current* and claim compensation on that account, for the current is not used to an appreciable extent.

A NOTE ON MODULATION DISTORTION.

CONSIDERABLE attention has lately been directed to hitherto unsuspected effects due to rectification in a screen-grid amplifying stage. Disappointing selectivity caused by what is called cross-modulation, when quite ambitious tuning coils are used, A.C. hum when tuning in a station, and audible distortion may all be experienced in a modern H.F. receiver, unless care is exercised in the design of the aerial input circuit. Many articles have appeared in *The Wireless World* advocating the principles of pre-selection and pre-H.F. volume control, which together go a long way towards mitigating the cross-modulation nuisance, but little information has appeared concerning the distortion of the modulated carrier waveform which may result from applying a large signal to an S.G. valve, especially to one of high impedance.



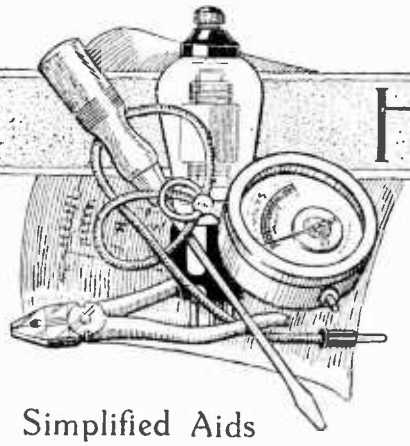
Showing how an artificial rise in modulation is caused by the screen-grid valve.

The accompanying diagram shows how the waveform of a modulated carrier of large amplitude can be affected when amplified by a typical S.G. stage. Assuming the bias point to be X, it will be seen that the left-hand modulated fringe ABC will be amplified at a region of the characteristic curve where the mutual conductance is low, and the resulting fringe $C^1B^1A^1$ will be slightly straightened out. On the other hand, the fringe DEF on the right will be *considerably* accentuated by amplification at higher mutual conductance (or steeper slope), as shown by the envelope $F^1E^1D^1$. The output waveform for subsequent amplification or detection is anything but a replica of the input wave, and the net effect is an artificial increase in the percentage modulation, and, incidentally, the addition of alien modulation frequencies. Furthermore, the whole output wave is not symmetrical about XY, although the areas of the input wave on either side of XZ are, of course, equal.

It is now generally accepted in America, where considerable research has been carried out in connection with H.F. distortion with the new variable-mu tetrode, that artificial rises in modulation up to 20 per cent., due to curvature of characteristic, cause unobjectionable distortion, but more than this cannot be tolerated.

Although a large input is shown in the diagram to make the change in modulation clearer, it should be pointed out that a 20 per cent. rise in modulation can occur when the input is of the order of 0.3 volts with modern screened valves. Fortunately, pre-H.F. volume controls are to be found in most screen-grid receivers, and their proper application when the field strength is large helps considerably to reduce the input below the critical value. Another method of minimising H.F. distortion of waveform is in the hands of the valve manufacturers, and consists in the production of H.F. valves of lower impedance, so that larger signals can be accepted without rectification. W. I. G. P.

Practical Hints & Tips



Simplified Aids to Better Reception.

THE DETECTOR L.F. PROBLEM.

Although a good deal of attention is now devoted to the design of detector-L.F. sets (without H.F. amplification) for high-quality local-station reception, those adherents to this type of circuit who expect to be able on occasion to indulge in long-distance reception may conceivably feel that they are being neglected.

When we come to face the facts, it must be admitted that this state of affairs is inevitable, although a detector-L.F. combination, with the aid of reaction, is sensitive enough to provide good signals at long distances in these days of high-power transmitters. It is, in its usual form, entirely lacking in selectivity, and, if we try to improve it in this respect, it becomes almost unduly complicated and expensive, and its operation calls for a considerable amount of skill. Worse still, it is likely to disturb other listeners by re-radiation.

In spite of these handicaps, a number of amateurs remain faithful to this class of receiver, and may be interested in the circuit arrangement shown in Fig. 1. Although one must not exaggerate its possibilities, it can be fairly stated that it has definite and clearly demonstrable advantages over the more conventional type of detector-L.F. set with a two-circuit aerial tuner. Due to the fact that regenerative reaction control is more than usually constant, it is easier to search for transmissions without allowing self-oscillation to take place as soon as aerial loading is lightened by detuning.

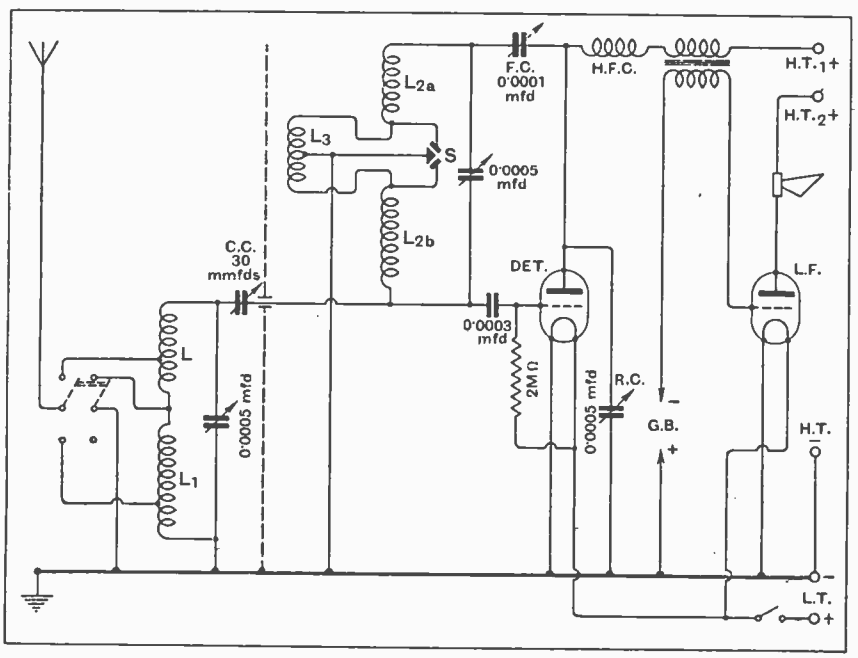


Fig. 1.—A selective detector-L.F. set with two-circuit aerial tuner and throttle-controlled reaction.

It will be observed that capacity coupling by means of a small condenser (CC) is provided; this condenser should be carefully chosen for its low minimum value (preferably not more than 3 micro-mfds.). The tuned detector-grid circuit is of the type familiar to many readers, in which the medium-wave inductance is wound in two adjacent sections (L_2a and L_2b), with a break at the centre point, in which the long-wave loading coil, L_3, is inserted. Wave changing is effected by a three-point switch (S).

Almost any type of coil can be used in the tuned aerial circuit (L, L_1), but effective screening between this and the detector grid circuit should be provided. In an experimental receiver built to the circuit under discussion, this coil was actually of the "potted" variety. For the feed condenser (FC), a semi-variable condenser will do admirably.

As for the rest of the set from the detector anode circuit onwards, any conventional arrangement may be employed, and it is suggested that the tuning and aerial coupling circuits shown might with advantage be taken as a basis when remodelling an existing set found to be unsatisfactory for modern needs.

c c c o

ADDING AN INPUT FILTER.

Those who are attempting to modernise an old receiver embodying a triode H.F. valve with a neutralised coupling by fitting an input band-pass filter would be well advised to install a ganged double condenser for tuning the component circuits of the filter.

But with regard to the tuning of the H.F. coupling in a set of this type, it is generally best that it should be done independently; if an attempt be made to tune all three circuits together, difficulties will generally arise.

The general adoption of ganged tuning is responsible for a minor difficulty which is not present when all circuits are separately controlled; due to the fact that there is of necessity a relatively high minimum capacity across these circuits, a good deal of "juggling" with inductance values may be needed in order to cover the normal medium broadcast waveband.

RESTRICTED WAVE RANGE.

However, it is quite possible to embrace the necessary band of frequencies when using standard tuning condensers of 0.0005 mfd., provided that reasonable care is taken to keep stray capacities within bounds. It has been observed that in some cases unnecessary difficulties of the kind under consideration have been introduced artificially by setting all trimming condensers at too high a value. In cases where it seems possible that failure to cover the wavelength range is due to this cause, the remedy, of course, is progressively to reduce the capacity of each trimmer until one of them is at its minimum setting.

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The use of what is generally known as a compensated output circuit for pentode valves has been consistently advocated by contributors to this journal, and a number of the sets that have been described are fitted with a simple form of tone control, consisting of a resistance and condenser shunted across the output choke.

RADIO-GRAMOPHONE TONE CONTROL.

It may be pointed out that the adjustment of this tone-lowering device which is found to give the most pleasing results when the set is functioning as a radio receiver will not of necessity be best when gramophone records are being reproduced. When the receiver is acting as a gramophone amplifier, it will be obvious that there is no possibility of high-note loss in the tuned circuits, and it is logical to assume that the natural tendency of a pentode to over-accentuate the higher frequencies should be checked to a greater extent than formerly. This alteration may be effected by reducing the value of the tone-control resistance. The actual amount of correction necessary will depend on the characteristics of the pick-up—and of the records.

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Hardly anything is more annoying than the effect of hand capacity in a receiver; little pleasure is to be derived from its operation if, after laboriously tuning-in a weak and elusive transmission, signals suffer a serious diminution in strength when the operator's hand is withdrawn from the condenser knob.

ALLOWING FOR HAND CAPACITY EFFECTS.

As receiver technique improves, this trouble becomes less and less common, and nowadays there is little excuse for its presence, except, perhaps, in short-wave sets or in detector-L.F. receivers with critically controlled reaction, and in the design of which sacrifices have been made for the sake of simplicity, compactness and cheapness.

It does not appear to be always realised that the effect of the operator's body capacity is always to add to the capacity existing across the tuned circuit. Although it is perhaps wrong to suggest a palliative when a real cure can generally be effected by alterations in design, it will be appreciated, if this is borne in mind, that compensation for the effect of removing the hand can be made by setting the tuning capacity at a slightly higher value than that giving loudest signals. With a little skill and practice, it is possible to carry out the operation of tuning in such a way that the circuit adjustment becomes exactly right when the hand is withdrawn.

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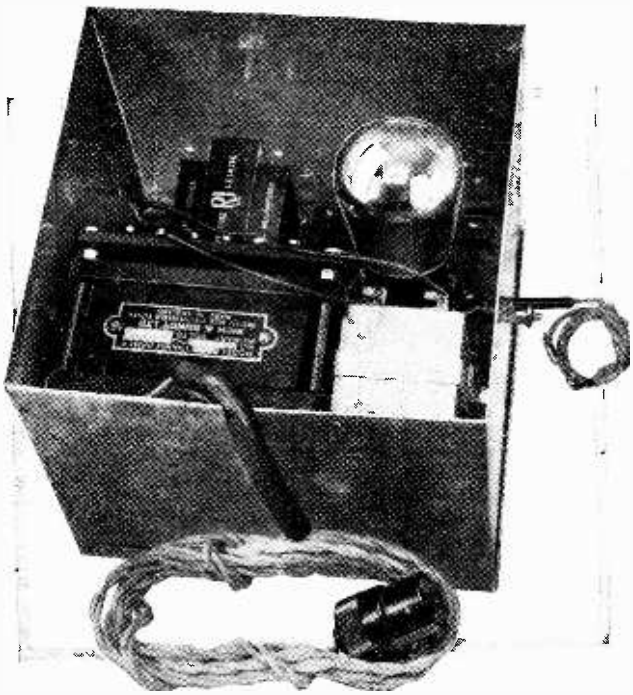
Now that smoothing chokes with high-permeability cores are readily obtainable, it is possible to make a battery eliminator of extremely small overall dimensions. The unit described in the issue of *The Wireless World* for August 13th, 1930, although designed for a somewhat specialised set, might well be taken as a basis by the prospective constructor of an eliminator. This piece of apparatus was assembled in a standard screening box, measuring not much more than 6in. cube, and even so, ample space remained for the fitting of a second smoothing choke, or, if necessary, for anode feed resistances and condensers. These latter, however, are usually more conveniently mounted in the receiver itself, as by doing so the number of inter-connected leads is reduced.

A COMPACT ELIMINATOR.



A neat and effective eliminator unit built into a standard aluminium screening box.

VALVES WE HAVE TESTED

Tungsram Power Valve

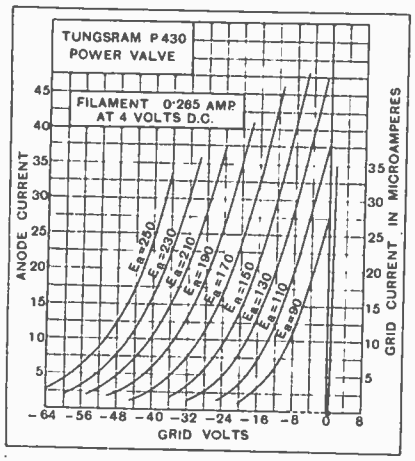
Type P430.

THIS is a comparatively recent addition to the Barium range of valves distributed by the Tungsram Electric Lamp Works (Great Britain), Ltd., and has been introduced to provide a valve of comparatively generous output operating with a modest anode voltage. It is rated to give approximately 1,000 milliwatts of undistorted A.C. power with a maximum anode potential of 250 volts.

The rated characteristics of the valve are:—

* A.C. resistance, 2,000 ohms.
* Amplification factor, 5.
* Mutual conductance, 2.5 mA/volt.

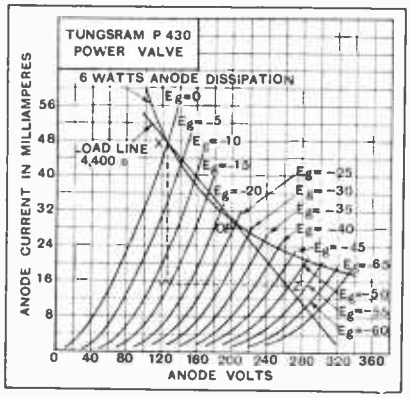
An "M"-shaped filament is fitted consuming 0.3 amp. at 4 volts, a characteristic which permits the use of either A.C. or D.C. for heating,



Anode current-grid voltage curves of the Tungsram P430 valve. The average values under working conditions, i.e., Ea, 200 volts, Eg, −24 volts, are A.C. resistance, 2,200 ohms, amplification factor, 3·5, and mutual conductance 1·6 mA/volt.

according to whichever happens to be the more convenient. The electrodes are constructed on the "box" pattern and inclined at an angle within the bulb. They appear to be rather on the small size having regard to the maximum anode dissipation the valve is rated to stand.

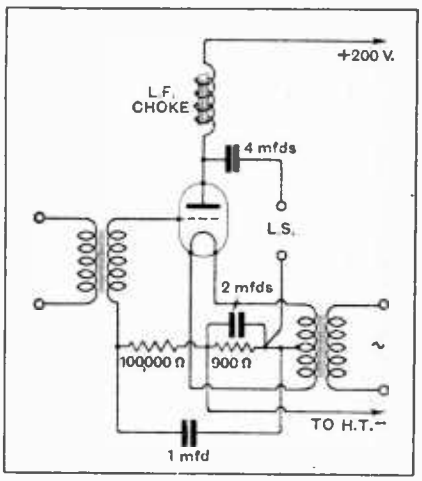
This is given as 6 watts. Our tests showed that, although the anode will dissipate this wattage satisfactorily, there is a tendency towards curvature of the characteristic with anode potentials much in excess of 200 volts. This feature was found to be exhibited by all the specimens tested. As a consequence we feel that the most suitable operating potential is of the order of 200 volts.



Anode current-anode voltage curves of the Tungsram P430 power valve. The best operating conditions are:—Anode volts, 200, grid bias, −24 volts.

With this value of anode voltage the optimum grid bias is −24 volts and the average anode current 30 mA. The best load line (loud speaker impedance) that could be obtained from the curves under the operating condition already cited was one of 4,400 ohms, and we found that the maximum undistorted A.C. output, allowing 5 per cent. of second harmonic, was 625 milliwatts.

Increasing the anode voltage to 250 and applying a grid bias of −38 volts introduced a slight complication, since it was found necessary to assume a load impedance of 9,000 ohms to limit the amount of second harmonic to 5 per cent. Under these conditions the available A.C. power output was a shade over 900 milliwatts.



Suggested arrangement of the output stage when the Tungsram P430 valve is operated from the A.C. supply mains.

The measured characteristics of the valve when an anode potential of 200 volts is employed and a grid bias of −24 volts used are:—

A.C. resistance, 2,200 ohms.

Amplification factor, 3.5.

Mutual conductance, 1.6 mA/volt.

A second specimen showed sensibly the same values when measured under identical conditions.

* Measured at Ea = 100; Eg = 0.

The grid bias values mentioned so far apply to cases where a 4-volt accumulator is employed for the filament supply, but if A.C. is used these amounts must be increased by 2 volts. Since the average anode current amounts to 30 mA, with 200 volts H.T., it is more than probable that the P430 valve will find most favour where an electric supply is available, and if this is of the alternating variety it would offer an opportunity to dispense with batteries—so far as the output stage is concerned at least—and take all its voltages from the mains. This can be achieved in a very simple manner by arranging the output stage on the lines depicted in the diagram. The 4-volt winding supplying the filament current should be separate from the transformer winding supplying the other valves in the set, otherwise the biasing arrangement will be complicated. Unless a spare winding is available on the main transformer, it would be advisable to fit a separate filament transformer for this valve.

An inductance of some 20 henrys will be ample for the anode feed choke, but one of lower value could be used without impairing the efficiency of the output stage, so that if one of any value over 15 henrys is available it could be employed.

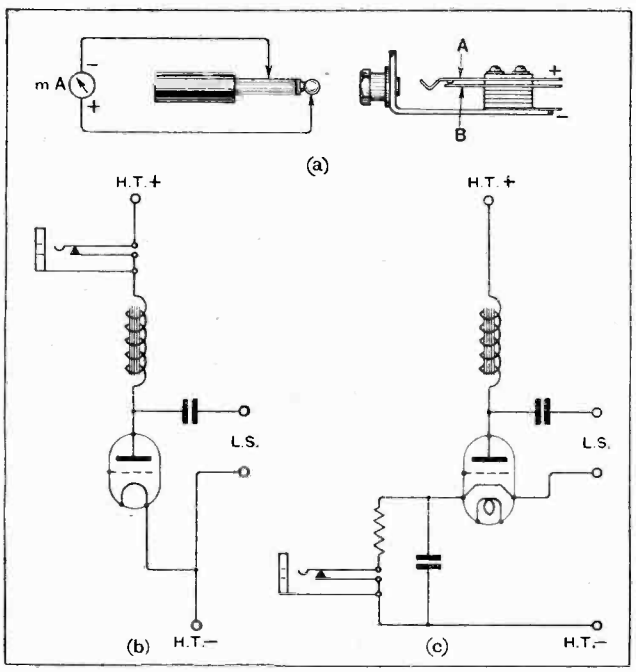
With 200 volts on the anode, the power output will be sufficient to operate all types of reed-driven loud speaker and many of the more sensitive kind in the moving-coil class. For a room of average size an output of 600 milliwatts is generally accepted as adequate even for a moving-coil instrument.

CHECKING ANODE CURRENT.

The Use of Permanently Wired Jacks.

IT has often been recommended in the pages of this journal that a milliammeter be connected periodically in the anode circuits of the various valves in order to keep a check on their operating conditions. If a list be kept of the currents flowing when the valves and batteries are in good condition, any alteration in their characteristics will be at once shown up by an alteration in their currents. In this way it becomes readily possible to keep a check upon the condition of a receiver, and to ensure that it is always operating at its maximum efficiency.

It is usually quite a troublesome process, however, to connect the meter in circuit, involving at the best the disconnection and reconnection of numerous battery leads; and at the worst, the unsoldering and resoldering of wires within the receiver itself. It is often advantageous, therefore, to make provision for the use of a milliammeter when building the set, for its connection can then become a matter of seconds only.



(a) The type of plug and jack required. (b) The anode circuit when using a battery set. (c) Cathode lead connection in a mains set.

A telephone jack should be wired into each anode circuit and the meter connected to a plug, for it can then be plugged into circuit at any time without affecting the operating conditions in the least. A suitable type of jack is shown at (a) in the illustration, and it is desirable that the springs be so arranged that the contact between "A" and "B" is not broken until the plug is making contact with its own springs. In many cases, where the jack does not fulfil these requirements, it can be made to do so by bending the springs.

The illustration shows also at (b) how the jack should be wired in circuit in a battery receiver, and at (c) the most suitable connections for a mains set. In this latter case it is usually more convenient to connect the jacks in the cathode leads, as shown, than in the positive of the H.T. supply, for they are then earthed and any risk of a short-circuit is reduced. Care should be taken, of course, to wire all the jacks the same way round, otherwise it will be necessary to reverse the connections to the meter when changing from one valve to another. Care should also be exercised not to plug the meter into the power valve jack when its range is set for a low current, or it may be damaged.

If suitable jacks be chosen, and their springs are properly arranged, this method of meter connection will be found delightfully simple and satisfactory. The plug can be inserted while the set is in operation without upsetting the working conditions, and in many cases without causing even a click in the loud speaker.

W. T. C.

CURRENT TOPICS

News of the Week in Brief Review.

ARE THE PIRATES WINNING?

During the hearing of a "pirate" case at Lewes last week, Mr. C. I. Carr, representing the Post Office, said that the Postmaster-General found that the fines imposed throughout the country were not arresting the practice of using wireless sets without a licence, and that it was very difficult to prove the whereabouts of portable sets.

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H.M.V. AND OLYMPIA SHOW.

We hear that the Gramophone Company, Ltd., have taken a large hall opposite Olympia for a display of new H.M.V. instruments from September 18th to 26th, during the run of the Radio Show. The company will not exhibit at Olympia.

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RADIO, ETC.

Television and "talkie" displays will be included in the German Radio Show at Berlin from August 21st to 30th. Gramophones will also be in evidence.

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SAD STORY.

Just as "Radio Paris" was about to give a running commentary on a Montlhéry motor race the Post Office authorities, without warning, took possession of the Arpajon telephone line, which had been hired for the occasion, with the result that the commentator poured his lurid story into a "dead" microphone

No reporter was present when he learned the truth

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BUILDING THE "PRISON PORTABLE."

A German ex-convict is becoming famous through the exhibition of a complete radio receiver which he constructed in gaol, without the knowledge of the authorities, by means of components smuggled in by his visiting friends.

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RADIO TO SPEED UP PRESS PHOTOS.

"Running water, two armchairs, two small beds, and a radio transmitter and receiver" are reported to form the main equipment of a new telephotographic car which has been put in service by the French Government for providing the Press with a quick photo service dealing with current events.

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SECRET PICTURE TRANSMISSION.

A "cryptographic" picture transmitter has been evolved by the French inventor, M. Edouard Belin, who claims that he is now able to send messages, drawings and photographs in a manner which makes them unintelligible except to a listener aware of the "key." The cylinders of the transmitter and receiver are rotated at varying speeds.

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BRAVO, GLASGOW!

We take off our hats to the Glasgow Municipal Transport Committee for adopting a scheme which, by the end of this year, should cut out all tramway interference with broadcast reception. The scheme involves the scrapping of nearly 1,000 trolley wheels at present used for picking up current, and replacing them with Fischer Bow collectors—a type which has passed rigorous tests in Budapest, Vienna, Leipzig, and other Continental cities and was the subject of a favourable report by the British Post Office two or three years ago.

We hear that Glasgow's example is to be followed by Sunderland, and probably by Aberdeen and Birmingham; and we hope to hear that other municipalities will soon follow suit.

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ECHO OF R34 FLIGHT.

Capt. R. F. Durrant, A.F.C., who was the wireless officer on the airship R34 when it crossed the Atlantic in August, 1919, presided over a reunion dinner in London on Saturday, July 11th, to celebrate the twelfth anniversary of the historic flight. Only two other members of the original crew of thirty-three, Mr. E. E. Turner (engineer) and Mr. Lindsay, were present, the remaining eleven or twelve survivors being scattered in various parts of the world or prevented from attending by their duties at Cardington.

In an account of the flight which he contributed to *The Wireless World* of September, 1919, Capt. Durrant related how from England to New York not a ship was sighted until he got into wireless touch with an Australia-bound liner. The worst experience of the trip was in the Bay of Fundy. Electrical disturbances abounded; the air was hot, and sparks leaped from the aerial as it was quickly hauled in. "We use," wrote Capt. Durrant, "the now well-known system of undamped waves produced by the vacuum valve—to which is also attached a wireless telephone unit capable of efficient speech up to 80 miles. . . . For communication with merchant ships I used a small aircraft 100-watt transmitter. . . . We worked St. Johns from a distance of 1,800 miles. . . . Surely the day is now coming when spark will make way for the silent continuous waves!"

We are glad to think that Capt. Durrant's heartfelt wish is being realised.

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ORGAN-MADE STATIC.

The electrical blowing apparatus used for church and cinema organs is not infrequently the cause of interference with reception. We hear that the ecclesiastical authorities in Carlsruhe have requested the clergy and church administrators to equip all such installations with "anti-parasite" devices. We commend this move to church and cinema authorities in Britain.

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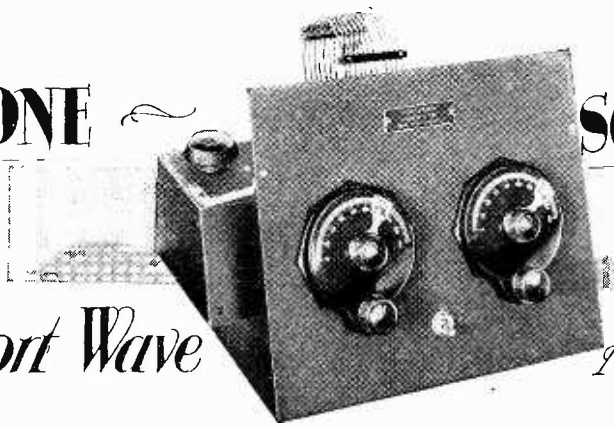
SMALL ADVERTISEMENTS.

Slight alterations in our printing arrangements will be necessary on account of the August Bank Holiday. The latest date on which small advertisements can be accepted for *The Wireless World* of August 5th is Wednesday, July 29th.

TWELVE YEARS AGO. This photograph, which appeared in *The Wireless World* of August, 1919, shows the officers of the airship R34, which had just completed the flight of the Atlantic. Capt. R. F. Durrant (back row, third from left) who was the wireless operator, presided over a reunion dinner a few days ago, when only three of the original crew of thirty-three attended. Major Scott, who lost his life while commanding the ill-fated R101, is seen on the right in the front row.

EDDYSTONE SCIENTIFIC TWO



Short Wave Assembly

IT is rather surprising that short-wave work is more neglected than any other branch of wireless reception; without suggesting for a moment that it provides a thoroughly reliable and entirely consistent supply of long-distance signals, it is certain that nothing else offers so much in this respect at so little cost. Though perhaps rather less attractive to the amateur in this country than to the temporary exile abroad, a short-wave receiver may be regarded as a most useful addition to his equipment, and can be depended upon for a great deal of entertainment.

A two-valve detector-L.F. circuit, as embodied in the Eddystone Scientific Two, is still the most popular arrangement for short-wave reception. In this particular case the design is straightforward and simple, with a minimum of complications. Aerial coupling is direct to the high-potential end of the tuned grid coil, through a very small variable condenser, by means of which the effect of aerial loading may be controlled as required. The detector valve functions, as usual in a set of this class, on the grid principle, and reaction between its grid and anode circuits is regulated by a condenser in the conventional manner.

A pentode output valve is specified, and is coupled by a Ferranti A.F.8 transformer. Output to the loud speaker—or head phones—is direct. A triode may be substituted, but the pentode, which gives more magnification, is generally to be preferred, and will afford sufficient signal strength for loud speaker reproduction when conditions are fairly good.

It would have been better if the on-off L.T. switch had been arranged in some other way; as things are, the valve filaments may be burnt out if an accidental short-circuit takes place between H.T. positive and any part of the metal chassis when this switch is "off."

A well-devised pressed-metal chassis is supplied as a foundation for the receiver, and is ready drilled, so that nothing more than assembly and wiring is required from the constructor. The tuning and reaction condensers are operated by slow-motion dials fitted to spindle extensions which are "broken" electrically by insulating sleeves. These components, as well as the tuning coil, are mounted so that they may be remote from the operator's hand, in order to avoid capacity effects. The metal base plate is folded in such a way that, as an additional precaution, the condensers are screened.

Apart from the advantage of screening, this method of construction provides a protective cover for the tuning condensers, and, in consequence, there is no need for a cabinet except, perhaps, on the grounds of appearance. Actually, it is very convenient to operate the set in a "stripped" condition, as the aerial coupling condenser, which must occasionally be manipulated when receiving the shortest wavelengths (say 15-25 metres) is then quite accessible.

A regenerative short-wave set stands or falls on the behaviour of the reaction control; in the Eddystone receiver this works unusually well, especially on the middle range, where the detector valve may be maintained on the verge of self-oscillation over the whole tuning scale with the reaction condenser dial at settings intermediate between 39 and 42 degrees—a variation of 3 degrees only, which is as near constancy as one is likely to get. On the higher wave-range control is nearly as good; it tends to become slightly "patchy" below about 25 metres.

Actual "threshold" L.F. oscillation, often a serious handicap to short-wave reception, does not occur at any frequency, and is barely perceptible in its incipient form at the lowest wavelength of the set.

In spite of its simplicity, the set, when directly compared with a standard of similar but more complicated design, proved to have a high degree of sensitivity. Hand-capacity effects, even when using phones, are only troublesome when receiving the shortest waves.

An Easily Assembled Set of Parts for Building an Effective Short-wave Receiver.

SPECIFICATION.

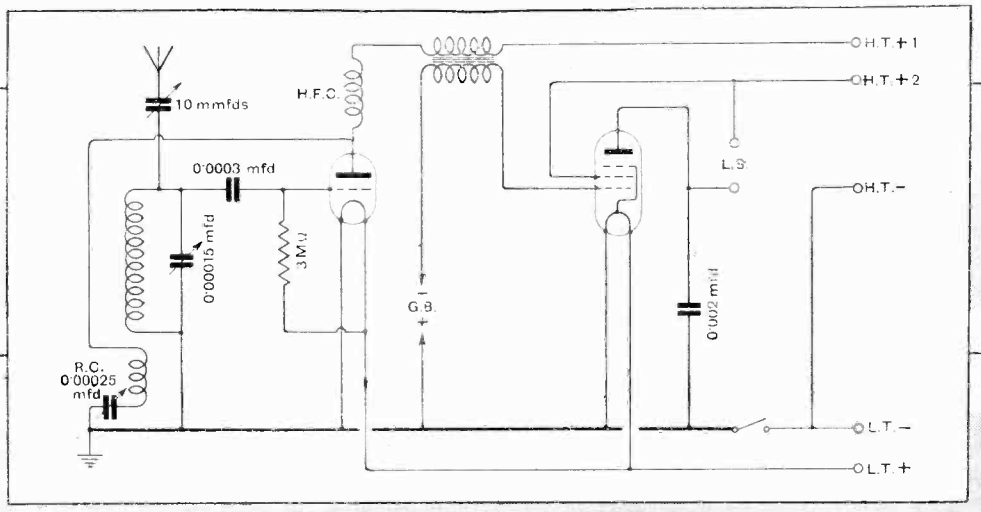
GENERAL: Battery-operated receiver, for use with open aerial and for reception of wavelengths between 15 and 93 metres. Three tuning ranges covered by plug-in coils:—15-36 metres; 27-55 metres; 46-93 metres.

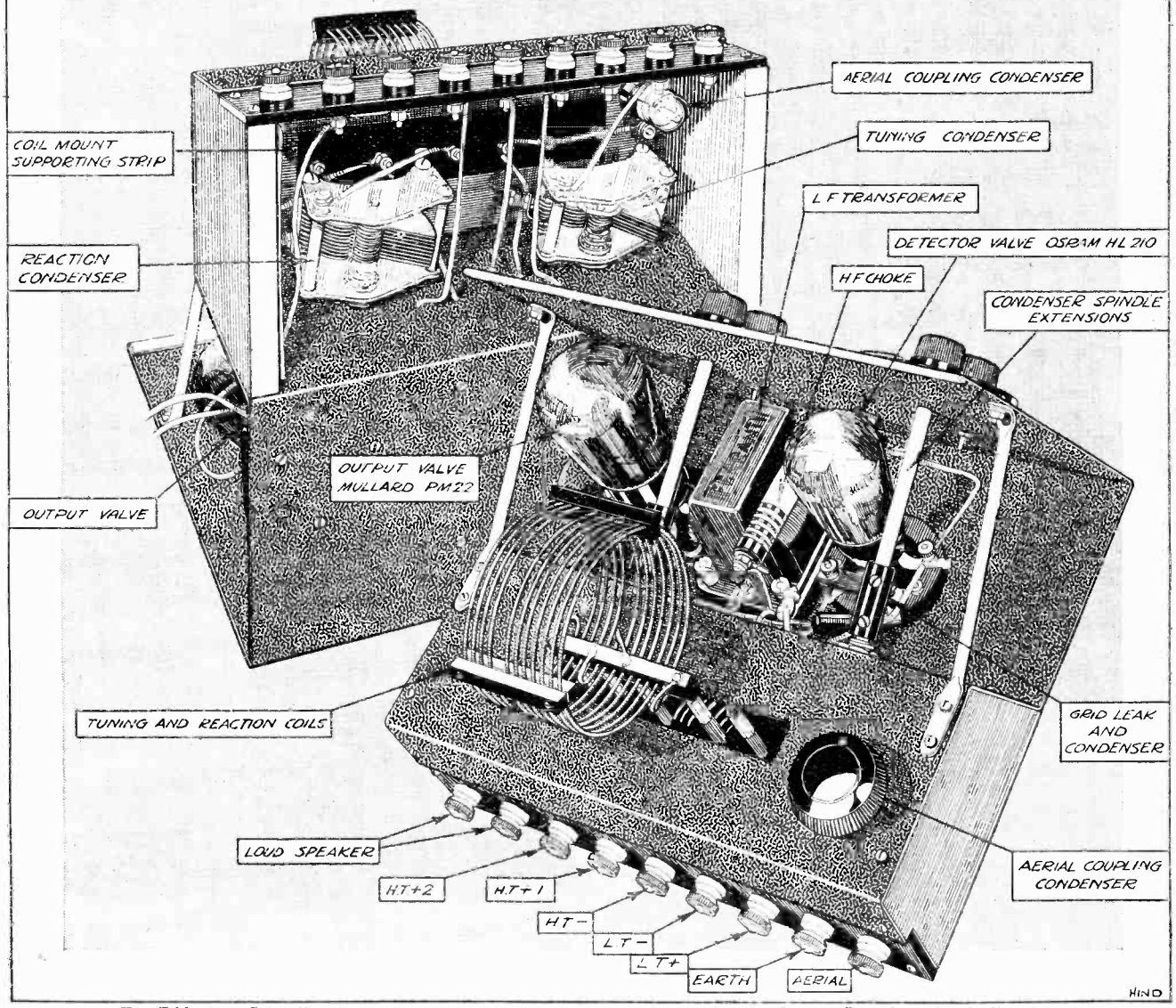
CIRCUIT: Regenerative detector followed by transformer-coupled pentode valve. Directly connected loud speaker.

CONTROLS: Tuning and reaction condensers; aerial coupling condenser; on-off switch.

PRICE: £4 5s. for the complete set of parts.

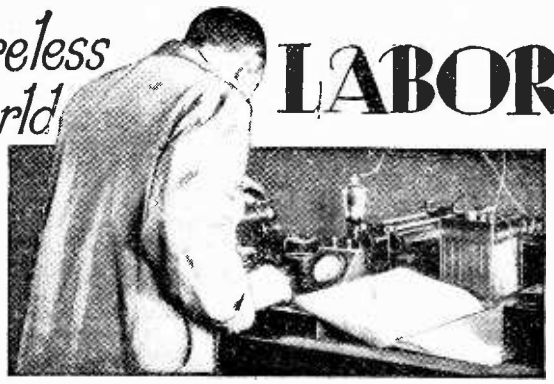
MAKERS: Stratton & Co., Ltd., Bromsgrove Street, Birmingham.





The Eddystone Scientific Two chassis, as seen from the rear and from below. Inset: Complete circuit diagram.

Wireless World LABORATORY TESTS



Review of New Radio Products.

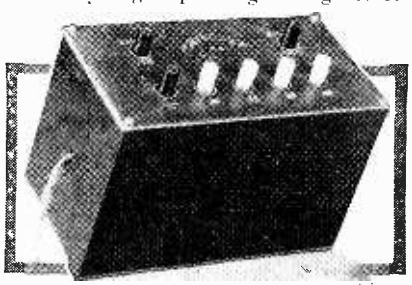
"SUPREMUS" D.C. ELIMINATOR. Model D 120 A.

This model has been designed for heavy duty work and is rated to give up to 120 mA. Four output voltage tappings are provided marked 60 volts, S.G., 120 volts and 200 volts respectively. In addition, two sockets are included for the purpose of interposing a condenser between the wireless earth and the earth terminal on the set the condenser being included in the unit.

Measurement of the output voltage at various current loads from the "power" tapping gave the following figures. The mains voltage was 210 at the time of test.

Output current in mA.	Output Volts.	Output current mA.	Output Volts.
10	192	70	139
20	183	80	130
30	174	90	122
40	165	100	112
50	157	110	104
60	148	120	95

The maximum useful output current would appear to be about 50 mA. if a reasonably high operating voltage is required. This amount of current will be more than sufficient to operate most multi-valve sets. The marked voltages were given when 3.8 mA. were taken from the 60-volt tap, 3.4 mA. from the 120-volt tap, and 38 mA. from the 200-volt tap. At the S.G. tap 65 volts were given with a current of approximately 0.5 mA.



"Supremus" D.C. eliminator with four output tappings giving 60, 120 and 200 volts in addition to screen volts for S.G. valves.

A practical test showed the smoothing to be adequate for all normal requirements, but for satisfactory operation careful decoupling of the anode circuits in the set is advisable.

The eliminator is housed in a neat bakelite case, the overall size being 6¼in × 3⅛in. × 3¾in., and the price is £2 2s. 6d.

This is but one of a very complete range of A.C. and D.C. models made by the Supremus Specialities, Ltd., 118, High Street, Erdington, Birmingham.

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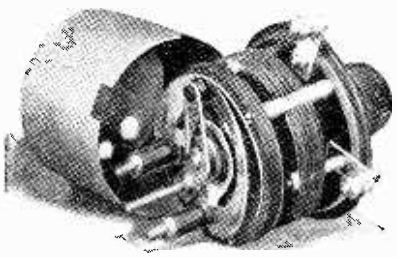
MAGNUM TWIN CONTROL UNIT.

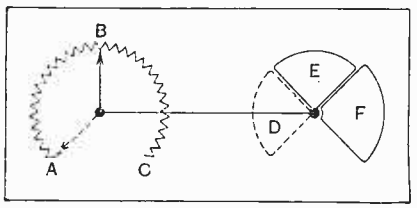
This new Magnum product combines a reaction condenser and a high-resistance potentiometer, both mounted on a common spindle but independent so far as their electrical connections are concerned. The plates of the condenser are so shaped that during one half rotation of the control knob only the potentiometer is affected, while during the following half rotation the condenser vanes mesh and at the same time the potentiometer slider continues to travel round the resistance track. How this is achieved is shown clearly in the sketch, from which it can be seen that as the potentiometer slider moves from A to B, the moving vanes of the condenser travel from the dotted position D to the position E, and do not start to mesh with the fixed vanes F until the potentiometer slider is travelling from B to C.



Magnum twin volume control consisting of a potentiometer and combined reaction condenser.

Thus it is possible to arrange the volume control so that the normal position of operation is with the potentiometer slider mid-way round the track and movement of the control knob in an anti-clockwise direction decreases volume—by virtue of a reduction in screen grid potential—while movement in the opposite direction raises the volume, since it increases the screen voltage and also applies reaction to the circuit.

The measured resistance of the potentiometer is 900,000 ohms and the capacity of the condenser 0.000226 mfds. The makers are Burne-Jones and Co., Ltd., Magnum House, 296, Borough High Street, London, S.E.1, and the price is 12s. 6d.



Schematic arrangement of the potentiometer and condenser in the Magnum twin volume control.

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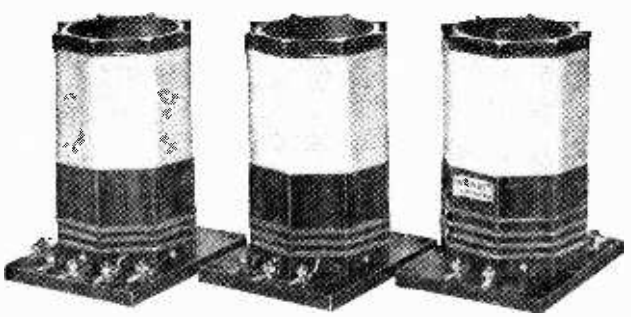
WEARITE COILS FOR THE D.C. MAINS III.

A set of coils made exactly to specification is now obtainable from Wright and Weaire, Ltd., 740, High Road, Tottenham, London, N.17, for use in the D.C. Mains III receiver. Each coil is mounted on an ebonite base, and the various terminals are disposed in the correct order. Identification of the coils is further assisted by the distinguishing letter adjacent to each terminal, as appears on the circuit diagram.

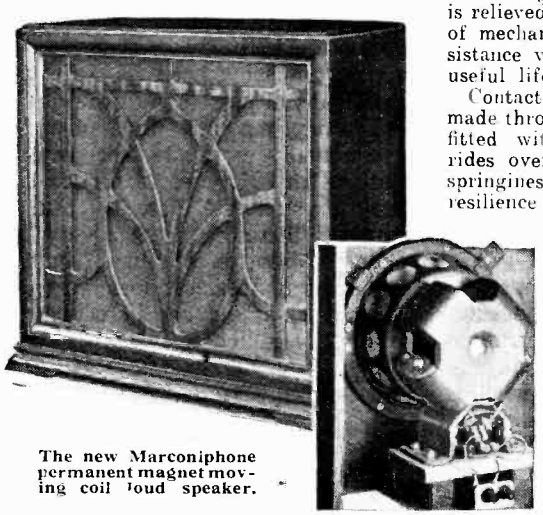
The medium wave portion on each coil is wound in shallow grooves cut in the ribs; these definitely position the winding, thus preventing any possibility of the end turns loosening, which would most certainly upset the matching. Furthermore, we understand that the long-wave coils will be carefully matched before despatch so that we can confidently recommend these coils. The price is 50s. the set of three.



Set of Wearite coils for the D.C. Mains III receiver.

MARCONIPHONE PERMANENT MAGNET LOUD SPEAKER

The latest addition to the range of Marconiphone products is a permanent magnet model of the moving coil loud speaker. As in the mains-energised model, the diaphragm is pressed in a single piece from metal-sprayed buckram and centred to the pole piece by a single screw. The moving coil is of the low-impedance type, and an output transformer is incorporated in the base of the instrument. This is provided with two primaries, one for output valves up to 1,500 ohms A.C. resistance and the other for valves over 1,500 ohms, including pentodes. The latter winding is also suitable for push-pull output valves. By a simple arrangement of plugs and sockets it is also possible to connect the moving coil directly to the output terminals of the set in the event of a suitable output transformer being already installed. Incidentally, the average impedance of the moving coil is of the order of 20 ohms.



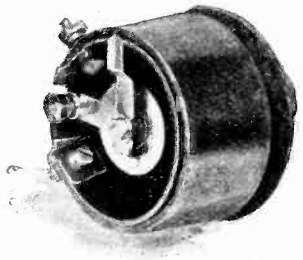
The new Marconiphone permanent magnet moving coil loud speaker.

The permanent field magnet is of exceptionally massive design, and with the small air-gap should hold its magnetism indefinitely. The small air-gap also gives a high degree of sensitivity and the instrument functions satisfactorily with small power valves. Its best qualities are only appreciated, however, when the input is in the region of 750 milliwatts or more. Under these conditions the response from 50 to 1,500 cycles is aurally uniform. From 1,500 cycles there is a rise to 2,000 cycles, the output being maintained at the new level to 3,500 cycles. Above this frequency it falls gradually to 4,500 cycles, and then rapidly to 6,000 cycles. The net result is good reproduction of the upper register, without undue shrillness or extraneous noises such as needle scratch, balanced by a uniform output in the bass and middle register. There is no audible trace of bass resonance, and both speech and music are free from hollowness.

Two types are available as follows: Type 91 (chassis only) at 6 guineas, and Type 131 (in mahogany cabinet as illustrated), 10 guineas. The makers are The Marconiphone Co., Ltd., 210-212, Tottenham Court Road, London, W.1.

WATMEL WIRE-WOUND POTENTIOMETER.

This is a new component recently added to the Watmel range, and embodies a number of rather interesting features. The resistance wire is wound on a bakelite former which possesses non-shrinkable qualities, thus ensuring that the wire will always remain taut. The thin wire is relieved, therefore, of a certain amount of mechanical strain, and a constant resistance value is assured throughout the useful life of the component.



Watmel wire-wound potentiometer protected by a bakelite shell.

Contact with the moving arm is not made through the bearing, the slider being fitted with an extension spring which rides over a circular disc. A certain springiness in this disc, together with the resilience of the back contact, ensures a good electrical connection. Furthermore, the arrangement is self-cleaning, owing to its wiping motion.

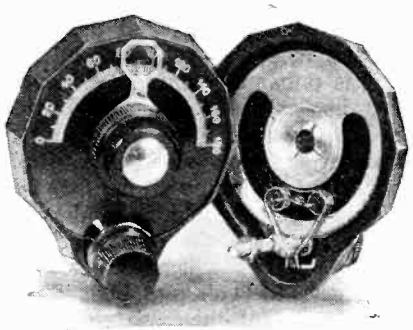
The single-hole fixing attachment is supported in a stepped insulated bush moulded on to the bakelite shell; this serves to insulate the spindle when the component is mounted on a metal panel. These new potentiometers are made in all standard values up to 50,000 ohms, and the price is 5s. 6d. each. The makers are Watmel Wireless Co., Ltd., Imperial Works, High Street, Edgware, Middlesex.

"ASTRA" MIDGET DIALS.

When panel space is somewhat limited, as in the case of most portable sets, the "Astra" Midget dial might prove a welcome component. Its overall diameter is 2¼in., and the dials are available finished in black or brown bakelite. These dials are foreign-made and manufactured under licence, since they incorporate the Ormond patents.

A geared reduction drive is fitted, but there is negligible backlash, as the driving pinion is kept fully meshed with the toothed rack by spring tension.

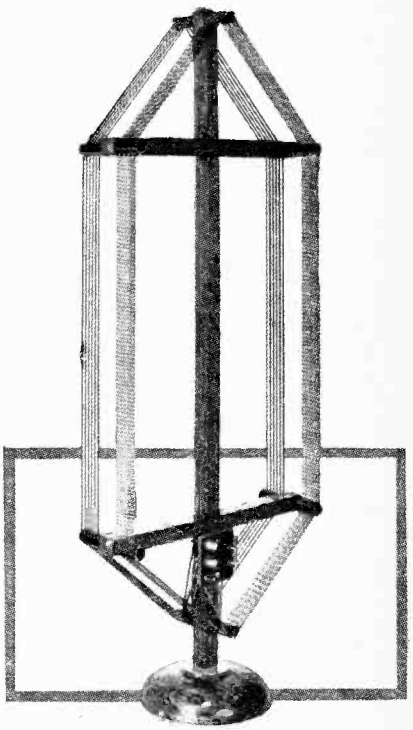
Supplies are obtainable from Emkabe Radio, Ltd., 47, Farringdon Road, London, E.C.1, and the price is 2s. 6d.



Astra midget dial with slow-motion geared drive.

"EELEX" FRAME AERIAL.

Made by J. J. Eastick and Sons, 118, Bunhill Row, London, E.C.1, the "Eelex" frame aerial will tune from 230 metres to 2,320 metres without a break when used in conjunction with a 0.0005 mfd. condenser, and in a circuit where the minimum capacity is approximately 20 micro-mfds.



"Eelex" dual-range frame aerial.

The simplest of switching is embodied, a single pole make-and-break switch serving to change from medium to long waves. This is made possible by connecting both windings in parallel for medium-wave reception, but employing one winding only for a higher wave band. The windings are centre tapped.

The convenient shape of the frame enables it to be accommodated in a recess, or stood on top of the wireless cabinet, without occupying too much space. The price is £1.

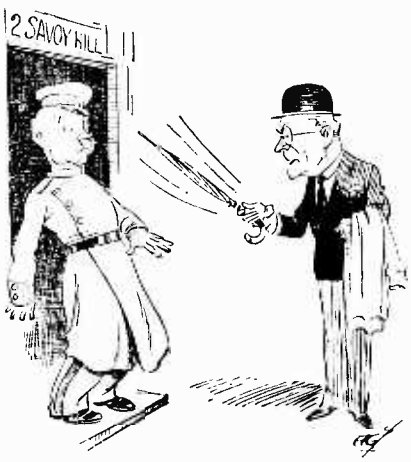
Next Week's Set Review:—
MURPHY A3 ALL-MAINS RECEIVER.

Unbiased

By FREE GRID.

"Hams" Want More Tongues.

During the few years that the B.B.C. has been in existence most of us have imbibed large quantities of French, Italian, German and Spanish from the various B.B.C. professors at whose feet we have sat. Personally speaking, I have absorbed enough of these particular four languages for my immediate needs and think it about time the B.B.C. ceased to ring the changes on them and gave us a fresh one. Personally, I vote for Portuguese, as I have seen it stated in one of our most expensive morning journals that once you have mastered this language all the remaining Latin tongues, including, I presume, Roumanian, are as easy as falling off a log.



Working knowledge of some half-dozen languages.

It is obvious, therefore, that if one can get a working knowledge of some half-dozen languages by this process Portuguese should come next on the B.B.C. syllabus. There are others, I am told, who have written to the B.B.C. in favour of Russian, Sanskrit and even the Semitic Babylonian of Hammurabbi, but their demands are, I think, merely frivolous.

While on this subject I may mention that it has often struck me as curious that the B.B.C. have never employed a native of the country to teach Spanish as they have done in the case of other languages. The excellence of Wiganites and Scots as linguists is proverbial, but I think that there is room for a Spaniard, if only to prevent us getting too grammatical and too exact in our pronunciation. Thus the excellence of Monsieur Stephan as a teacher of French cannot be denied, and yet I am told, on reliable authority, that certain English pedagogues listen with academic horror to his forceful handling of his native tongue. My opinion is, however, that it is better to learn the French which they use in France than the mysterious lingo which they still hand out to the children in some of our educational establishments. Fain would I have the ability to hold my own in an argument with a Parisian Jehu than to be able to conjugate accurately a list of highly irregular verbs.

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Intelligible Messages from Mrs. Dash.

A reader has written to me propounding a rather unusual question. He asks me whether he is infringing the law by the fact that he possesses and uses a wavemeter, and whether he ought not to confess his sins and make application to the P.M.G. for a transmitting licence. Now, although I do not set myself up as an expert on law, it is my opinion that he, and all others who are using wavemeters—except, of course, those of the absorption type—ought to be hauled before the local court and put in the dock, together with the man who installs a set without a receiving licence.

It is true that practically all types of electrical machinery radiate ether waves which are picked up by receivers in the neighbourhood, and this is only too painfully evident in my district where, from the various noises which I hear in my loud speaker, I know when Mrs. Blank next door is making up her face with a violet-ray machine, and when Mrs. Dash, on the other side, is taking off her silk stockings preparatory to going to bed (for an explanation of this, see elementary textbook on "Electricity and Magnetism") and the P.M.G. cannot get at this form of radiation, however, because it does not convey any message or any intelligible information *via* the ether, thus infringing his monopoly.

On second thoughts, however, I suppose that if the P.M.G. were a conscientious fellow he ought to sue Mrs. Dash for wearing silk stockings, as when she removes them his monopoly is infringed by the fact that an intelligible message *is* conveyed to me, namely, that she is going to bed or going to have a bath.

In the case of a wavemeter, of course, there can be no doubt that owing to the fact that it obviously radiates ether waves it does convey an intelligible message, namely, the information whether or no the set is fully tuned to the wavelength to which the wavemeter is adjusted. Personally, I possess various types of oscillators for experimental work, and actually modulate the emanations of my H.F. oscillator for certain experimental work, and I suppose, therefore, I am a very bad offender, because although I have a transmitting licence it does not cover the particular *ménage* in which my laboratory is housed.

Radiation.

I am quite prepared to go to gaol, however, but if I do receive a summons I shall not hesitate to turn King's Evidence and give information not only against all the owners of wavemeters whom I know, but also against Mrs. Dash and her legs, or, rather, her silk stockings.

B 22

Broadcast Brevities

By Our Special Correspondent.

The Technical North.—And What of Falkirk?—The Procession.

All Quiet on the Northern Front.

If proof were needed that the British public has made great technical strides in the past three or four years it would be found in the remarkable smoothness with which the Moorside Edge transmitters have slid into dual operation. To the newsgetter and seeker after unconsidered trifles there is something almost disconcerting in the stolid and sensible manner in which northern listeners have accepted the new arrangements.

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That Blessed Word.

The correspondence received by the B.B.C. has all along revealed that listeners have a remarkable grip of technicalities; consequently, the letters have lacked those specimens of unconscious humour that used to compensate the Technical Correspondence Department for their toil. Only one little point has arisen to bring smiles to the faces of these dour individuals, viz., the different renderings of the word "selectivity."

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"Selectivity."

Here are some attempts in letters to wrestle with this baffling noun :—

Celektivety.	Sinevlivetry.
Cilactivity.	Silvitity.
Ciliberty.	Seractiverty.
Elactivity.	Telectivity.
Inactivity.	Seelectiffity.
Lacktivey.	Captivity.
Civicactivity.	Selecativiy.

But the prize, I think, should go to the listener who referred to "Select Tiverty."

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Impatience in Scotland.

If no news be good news, then great things must be happening at Falkirk, for the dearth of intelligence concerning the next station in the Regional Scheme almost suggests a conspiracy. Workmen are still excavating the site, and discussions are raging as to whether the masts shall be 300 or 500 feet in height. It would be more to the point, however, if attention were concentrated on the work which lies between excavation and mast-raising. Scottish listeners do not wish to see a repetition of the long delays which occurred during the construction of Northern Regional.

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A Procession.

It is quite possible that the move from Savoy Hill to Portland Place will be in the form of a long procession. This remark must not be taken literally, for I do not wish to suggest that an actual procession will be formed in the Strand, with the Governors and Sir John Reith at its head, and that the column will wander impressively through the West End carrying banners to represent the various departments.

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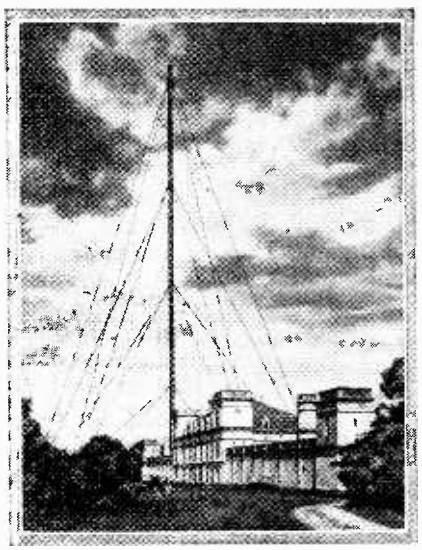
The Move.

This would, of course, be the happiest way of effecting the move, but there are arguments against it, including the new traffic signals in Oxford Street.

Actually, the departments will find their way to Portland Place one by one, with the cashiers in the vanguard. The accountant's office at Broadcasting House is already nearing completion, and we can take this as an indication that the B.B.C. wish to begin their career in the new premises on a business footing.



NEW CONTINENTAL GIANT. **A picturesque view of the Château de Saint-Agnan, housing the new "Radio Toulouse," which is about to begin transmissions with a power of 85 kilowatts. The two masts are each nearly 400ft. high.**

o o o o

Steps in the Studio.

Among the various "improvements" suggested at the new headquarters was the combination of two adjoining studios to form a small hall. This has been done, with the rather discomfiting discovery that one is eighteen inches higher than the other! Thus half-way across the enlarged studio there must be at least two steps, and one is left wondering who will be the first artist to break his or her neck.

o o o o

Comfort for the Critics.

A spacious sitting-room, measuring about 20ft. × 16ft., is to be provided at Broadcasting House for the use of critics. This apartment will be comfortably furnished and equipped with writing facilities so that musical and literary critics after listening as long as they please may do their writing on the spot while the memory of what they have heard is still fresh in their minds.

o o o o

Round-Britain Air Race.

In the air race for the King's Cup on July 25th, there are five control points at which competitors have to land and wait for forty-five minutes. The running commentary by Squadron-Leader Helmore, which is to be broadcast on the National wavelength, will take place from Heston Air Port, the fourth control point. Forty-two machines have been entered by private owners, including Mrs. Victor-Bruce, Miss Jean Forbes-Robertson, and Miss Diana Guest.

o o o o

A Grossmith Talk.

"Talkie" production has certain affinities with broadcasting, and no doubt Mr. George Grossmith will exploit this similarity in the talk which he is to broadcast on August 26th entitled, "My Apprenticeship at Hollywood."

During the early days of the B.B.C. Mr. Grossmith rendered valuable help in the presentation of vaudeville.

o o o o

In Honour of Faraday.

For the first time, I believe, in the history of the Promenade Concerts, there will be a break in the middle of the series. This will occur on Monday, September 21st, when the Queen's Hall will be required for the Faraday Commemorative Meeting.

o o o o

Orchestra Thankful for Small Mercies.

Not even the fanatics among musicians will grudge an evening in honour of one who at least helped to make broadcasting possible: and I should not be surprised if the hard-worked orchestra were to bless the shade of Faraday for quite another reason!

o o o o

The Week's Great Thought.

"Broadcasting is in its infancy."—The Rev. H. L. Johnston, of St. Martin-in-the-Fields.

New All-Electric Pipeless Organ.

Musical Oscillator with 150 Valves and 50,000 Circuits.

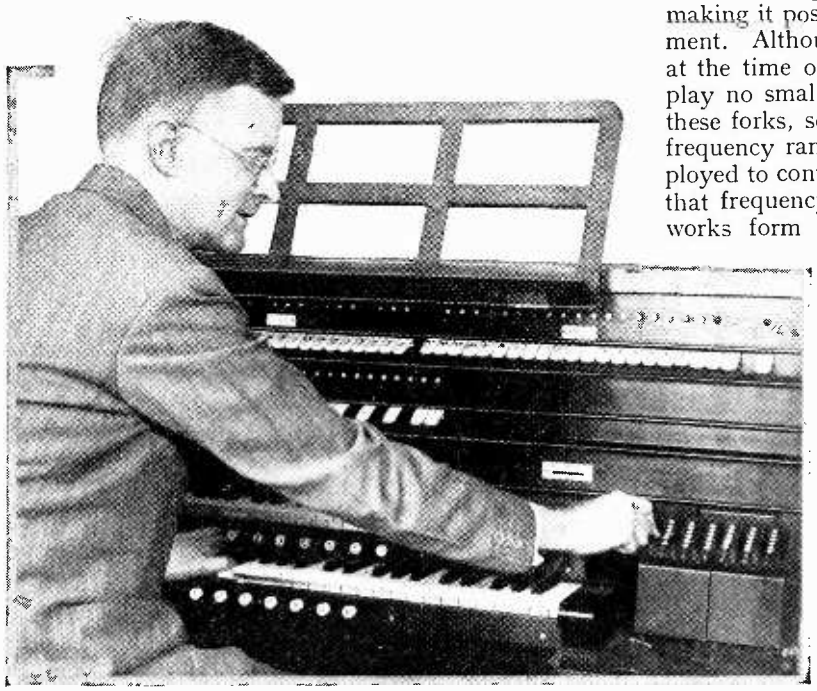
A field which the valve has been slowly but surely invading is that of musical instruments, examples of which have appeared from time to time in the pages of this journal. It is reasonable to predict that the new form of organ here described may replace not only the standard pipe organs, but compete with the complete symphony orchestra as well.

While it was not possible to obtain photographs of the interior of this new apparatus, this illustration reveals that fundamentally the equipment consists of tuning forks used in conjunction with tuned circuits. Actually twelve forks are employed.

THE latest development in the application of the oscillating valve to the production of an all-electric pipeless organ comes from America, and has been designed by Capt. R. H. Ranger, of Newark, N.J. It was Capt. Ranger who, in 1924, after years of research in the laboratories of the Radio Corporation of America, produced apparatus which enabled the R.C.A. to inaugurate a successful trans-Atlantic photo-telegraphy service.

The new organ employs a standard two-manual console, somewhat adapted by Capt. Ranger to suit his purposes, and is installed in the living room of his home. Thirteen dynamic speakers, which take the place of pipes in an ordinary organ, are mounted on two adjoining doors in the hallway. The diaphragms of these speakers are of different diameters to accommodate a wide-frequency band. In a garage behind the house are thirteen amplifiers (one for each speaker), generators, switches, and relays.

The organ has a range of nine octaves, from 16 cycles (the lowest pedal note, C) to 8,000 cycles, which is two octaves above the range of a standard pipe organ. The instrument has 150 valves, 50,000 circuits, and 900 relays assembled in somewhat similar style to a telephone system. When played at full volume the organ shakes the entire house. The keyboard controls the frequency of the current, producing the fundamental tones, while a series of stops control the overtones, or harmonics, thus making it possible to duplicate the timbre of any instrument. Although no technical details have been released at the time of writing, it is apparent that tuning forks play no small part in the system. There are twelve of these forks, so graduated that each one covers a certain frequency range. One assumes that these forks are employed to control the frequencies of valve oscillators, and that frequency changers and complicated electrical networks form the most important part of the system.



A reconstructed two-manual organ console produced by Captain R. H. Ranger. The numerous switches on the right take the place of the conventional organ stops.

It is claimed that the new organ opens up new vistas for composers and musicians by making available to them hitherto impossible combinations of sound. The effect of an entire symphony orchestra can be produced, and Leopold Stokowski, conductor of the Philadelphia Symphony Orchestra, who recently heard the instrument, predicts that some day a device like Capt. Ranger's will replace not only standard pipe organs, but complete symphony orchestras as well.

Recently a half-hour performance on the new instrument was broadcast through WEAF and WOR, two of New York's largest stations. Incidentally, one feature of the organ is that for broadcasting purposes no microphone is

New All-Electric Pipeless Organ.—

necessary; the electrical output is connected directly to the line to the transmitter. A Belgian organist, Charles M. Courboin, handled the instrument during the broadcast, and the programme was chosen so as to cover as wide a range of instrumental music as possible. Although imperfections in the music, as heard over the radio by the writer, indicated that the best methods of playing and broadcasting the organ have still to be worked out, there did seem to be justification for the claims of musical versatility made by the inventor. This adaptability of tone was apparent during the broadcast, when the tone at times seemed to depart from the familiar organ timbre and to simulate the piano, woodwinds, and even stringed instruments. In one passage an interesting effect was noticed—there was an approximation to chimes.

Defects which showed up in the broadcast included an absence of the characteristic bass quality of the deeper organ notes. This would appear to have been due to conditions associated with broadcasting, for independent observers who have heard the organ at Capt. Ranger's house report that the bass was well marked. Another noticeable defect was a lack of sharpness of "attack" at the commencement of some notes. In other words, when a key was pressed, the resultant sound took a short but noticeable period of time to reach full amplitude. There was also a tendency for sustained notes to wobble uncertainly, though only slightly, both in frequency and in volume. The writer has occasionally observed a somewhat similar effect in an under-powered pipe organ, or one with defective bellows. Again, the timbre of the notes was not an entirely true reproduction of the particular stop or instrument which was being played or simulated; there was a tendency to "thinness" or reediness, indicating that the full complement of overtones was missing. Sufficient has been demonstrated to show that this new application of the valve oscillator is well on the road to establishing itself as a new and important form of musical instrument.

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.

ALTERNATIVE PROGRAMMES?

Sir,—When is an alternative programme alternative?

I ask as one puzzled, not as one who wishes to pull the editorial leg.

You see Huizen and Hilversum swopped horses this morning, and that 1,875m. one is a sorry nag compared with the 298m. one.

Thus it comes about that I am searching for a British programme at about the hour of 17.30 B.S.T., risking it being a Payne-ful one.

It is! I mean "they are"—three of them—I didn't try any more. All on Wimbledon—5XX, Regional, National.

Have they three *alternative* commentators? Or—I come back to my opening question. WM. B. WEST.

Deal, Kent.

THE AMATEUR.

Sir,—Might I beg the favour of your columns in reply to Mr. Kay's second letter, in your issue of July 1st?

Mr. Kay rightly admits that amateurs pioneered the way. Whilst I agree with him regarding the maxim "the greatest good for the greatest number," I would point out that surely the pioneer work done by the amateur is of sufficient importance to justify the very limited facilities enjoyed by amateurs, in particular the comparatively small power allowed, the very restricted time permitted, and the range of frequencies allotted.

Any well-informed person is aware that the way the British amateur operates his station is a matter for congratulation. He is known throughout the world for his efficiency and has done more towards "cleaning the air" by crystal control than any other country's amateurs.

If Mr. Kay suffers from interference, why not call on the transmitter responsible, and my experience moves me to assert that he will almost certainly be pleased to co-operate in its elimination. Surely this is the rational course. There's another maxim, Mr. Kay—"Live, and let live."

Still quoting maxims "To save time is to lengthen life," and to class recognised abbreviations and international code as "prostitute English" is to place shorthand and Esperanto in the same category.

Perhaps Mr. Kay has also missed the fact that amateur radio is doing very great work in bringing the peoples of all nations closer together. He also must be unaware of the valuable work done by amateurs in the recent New Zealand earthquake, when all other means of communication had failed.

Surely Mr. Kay is not serious when he suggests that millions have to forego their entertainment for the sake of a few transmitters.

In closing, might I suggest that after admiring the restraint and sensible letters of Mr. Marcuse, etc., he might have emulated their example? G.5NI.

AN URGENT OBLIGATION OF THE B.B.C.

Sir,—Your leading article under the above title is very timely—in fact, overdue.

It is a thousand pities the B.B.C. had to accept the 300/500-metre waveband at all. This band is quite unsuited for broadcasting beyond, say, fifty to sixty miles. Here at Salisbury reception is continually varying from any station within this band after nightfall, and cannot usually be trusted for more than a few minutes.

Salisbury is not by any means badly situated for reception. The distance from both Daventry and Brookmans Park is just about the same, viz., eighty-five miles. Daventry 5XX is the station practically every listener prefers to use if the programme allows. It is extremely reliable and can be depended on at all times.

If the 300/500 waveband is unsatisfactory in Salisbury what must it be like in localities farther away? Just imagine 5XX closing down for good. Wireless would be given up by hundreds of thousands. E. W. COLLETT.

Salisbury.

GOOD REPRODUCTION.

Sir,—The subject of recent correspondence in your columns, "Good Reproduction" has been very interesting, and it is quite clear that all of the gentlemen contributing to it are quite decided in their views. Mr. H. A. Hartley in particular is very emphatic on the subject, and has decided that his method of obtaining good reproduction is the last word; he concludes his letter in your issue dated July 1st by informing Mr. Pratt that "until he does (whatever Mr. Hartley regards

as necessary) he won't have it (good reproduction) *and that is all there is to it.*"

Well now, Mr. Hartley, I don't know you or your receiver, and I am perfectly satisfied to accept your assurance that the reproduction you obtain is as good as is possible; but surely it is like running your head into a brick wall to attempt to define what constitutes the best reproduction. The whole matter depends upon the taste of the listener. Would it be reasonable to start an argument as to which is the prettiest colour? Each person has his individual taste, and it is quite impossible for one to impose his taste upon the others.

If Mr. Hartley will take for a moment the simple analogy of a photograph, it will help to make my contention clearer. The harsh black-and-white amateur snapshot (supposing that it is sharp) is a plain statement of fact; it represents a more-or-less true picture, but it is not by any means as artistic as a carefully posed and skilfully retouched studio portrait by a camera artist. The portrait has had the slight blemishes covered, it has had the background toned down, a little high-light emphasised here and there; it is a beautiful picture. But it is not the truth. Now Mr. Hartley, each listener must decide whether he likes the harsh, truthful snapshot, the retouched studio portrait, or a composition of the two. It is not for me to publicly state that a retouched portrait is better than an amateur snapshot, "and that is all there is to it," and equally it is not for me or for Mr. Hartley to try to bully anybody into accepting that loud speaker reproduction which consists for the most part of thick, treacly bass, is the last word in reproduction. Neither is it necessarily the fact that only moving-coil loud speakers are capable of giving satisfactory reproduction, although my own personal opinion is that they are, so far, at the top. Always remembering, of course, that the speaker will only give out what is put into it—which is by no means an original statement, but I use it to convey to some of my less advanced customers that it is not absolutely certain that they will get better reproduction when they replace the old speaker with a moving-coil; often they are better off with the old one—the defects in reproduction don't show up so much.

And, as a concluding point, may I point out that the truth is not always pleasant; and I wonder whether any of the contributors to this discussion have ever listened to an orchestra at close range, and conceived the thought that "if that were my loud speaker I would tone it down a little." A little too much first violin; rather too heavy on the kettle drums; and withal too loud altogether to be pleasant. If it were being reproduced through "the wireless" you would not like it. But you are listening to the real thing—and it must be right.

It all boils down to this—that what we like is nice. I don't suppose Mr. Hartley would like the reproduction I like, but then why should he? R. H. COSKY.

London, E.15.

INEXPENSIVE QUALITY.

Sir,—I was much amused to read in the issue of *The Wireless World* for July 1st Mr. Hartley's reply to my letter under the *nom de plume* of "Veritas." I hesitate to give him a further excuse to annihilate me, but I cannot find myself even now in agreement with him.

Surely to state that "quality never was and never can be inexpensive" is very sweeping. Are there not degrees of quality? Surely good quality can often be obtained comparatively cheaply.

I cannot agree, therefore, that "inexpensive quality" is an "absurd tag." I must state in defence of the writer of that article that I think he was definitely catering for a certain demand, i.e., to get the best quality available for a moderate outlay, not everybody in this world being blessed with abundant cash. It is surely very narrow-minded for the Rolls-Royce man to condemn outright everything which does not come up to that standard.

I do admit that one should strive for the best quality one can obtain for the price, and I claim that such results are not as inferior as you would have us believe.

I myself have no mains and am therefore limited as to volume, but my set is the Band Pass Three, with 4-volt battery valves, supplied both for high and low tension by accumulators. The output valve is a Mazda 4-volt Pentode and matched Epoch moving coil (permanent magnet). Now, I am no conductor or otherwise qualified musician, but I fancy I have a good ear musically, and I claim that the result I get for a comparatively moderate outlay is not so very inferior to Mr. Hartley's.

When considering the best quality procurable then one is obviously on different ground. It seems to me that until we achieve "stereoscopic" output, i.e., until the sound output is no longer emitted directionally from one small aperture, we cannot hope to have comparatively *true* reproduction. For example, no speaker to-day gives any indication of movement, although what can be achieved in this direction can be realised if two speakers situated a few feet apart are coupled by a change-over switch to the amplifier, and during a play where two characters are speaking by means of switching over by hand, each speaker is allotted its own character. This method is admittedly crude, but the effect of position is certainly interesting.

I claim no originality for this, and Mr. Hartley is probably already aware of it, in which case I apologise for taking up your time. C. L. YELLAND.

London, S.E.15.

AVOIDING DETECTOR DISTORTION.

Sir,—With reference to the diagram of Lieut. Featherstone's receiver and his letter in your isue of July 1st, headed, "Avoiding Detector Distortion," Lieut. Featherstone shows an H.F. choke between the anode resistance and the paralleled anodes of the push-pull detector valves, and he states that a shunting condenser, shown in dotted lines, between the anodes and L.T.—, has been omitted from the circuit.

I would like to point out to Lieut. Featherstone that neither the choke nor the condenser is required. Since the grid tuning inductance is virtually centre-tapped to earth, the voltages impressed on the grids are 180° out of phase, and therefore any H.F. appearing on either anode is neutralised by H.F. 180° out of phase on the other anode, and so there will be no H.F. to bypass to earth. H.F. feedback to the grid circuit, as far as the broadcast signal frequency is concerned, is nil, but Lieut. Featherstone states he has been troubled by oscillation or a supersonic frequency. The probability is that oscillation is occurring at a frequency much higher than the broadcast frequency, and, it is most likely, a short-wave oscillation of the connecting leads to grids and anodes. P. JOHNSON.

Dulwich, S.E.21.

EMPIRE BROADCASTING.

Sir,—We have of late been able to listen in the mornings here to rebroadcasts from the local stations of the London National programme received *via* G5SW, and very pleasing it is to hear old friends again—even the B.B.C. nightingale vying with Jack Payne and Big Ben. For some purposes the present reception is almost good enough—at times—but when it comes to such broadcasts as "Lohengrin" from Covent Garden, it is just good enough to make one wish it very much better. That, of course, raises the question of the long-delayed improvements to 5SW, and who is to pay for them. Even your excellent journal seems to have given up hope in that direction, so I venture to suggest a scheme, which I have not, as yet, seen mentioned, though it seems to be a feasible one. Certainly, it is the overseas listeners who should pay for the service, but to collect the money from them is quite impossible. But surely there are many listeners in Britain who would willingly pay a small sum to be able to share their excellent programmes with friends overseas. Would it not be possible to attach a coupon to the Broadcasting Licence, allowing those taking out licences to pay, if they wish, say an extra shilling to be devoted to a fund for Empire Broadcasting? The extra work entailed for the Post Office would be small, and if only one-tenth of the licence-holders paid up, there would be £15,000 a year to begin with. It would be a gesture to the Empire from British listeners. No doubt, too, if such a fund were started, many donations would be received from interested bodies and people, both at home and abroad. There may be difficulties greater than I foresee, but I would be interested to have some opinions on the scheme.

Wishing your journal every success. G. H. MUNRO.

Melbourne.

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.

Less Effective Decoupling.

In an attempt to improve quality, I have just fitted a centre-tapped output choke in the anode circuit of my pentode valve. This replaces a conventional output filter circuit. The set was originally quite stable, but now motor-boating takes place in spite of the fact that the detector anode circuit is decoupled. What do you recommend me to do?

It is natural enough that the alteration you have made should have decreased the efficiency of the existing decoupling arrangements; this is because a greater proportion of the output valve anode current (at signal frequency) is now passing through the common resistance or impedance of the source of H.T. supply.

We recommend that you should increase the value of the detector anode L.F. by-pass condenser, and also that of the associated resistance, if possible. Alternatively, or in addition to this modification, you might find it advantageous to reduce the overall magnification of the L.F. stage.

o o o o

Power Transformer: Idle Windings.

I have just obtained a power transformer with H.T., L.T., and filament heating windings. As my set is to be converted gradually for mains operation (I am making a start by providing H.T. current), I should like to know if any harm will be done by operating this transformer temporarily with nothing connected to the two sets of 4-volt L.T. secondary terminals.

By reducing the total load on the transformer below the figure intended by its designer, there will be a small rise in H.T. voltage. But this should be quite inappreciable; you need have no fears that any harm will be done, provided the instrument has been designed on reasonably generous lines.

o o o o

An Alternative to Tapping.

I should like to try the effect of "tapping down" the detector grid connection on the secondary of my H.F. transformer, but unfortunately the windings are somewhat inaccessible, and to do this would be a difficult matter. Is there any way whereby the effect of detector loading can be reduced?

An electrically similar effect can be obtained by using more capacity and less inductance in the tuned circuit. Probably, however, this would be no more convenient in your case than the other arrangement, because it would be necessary to remove turns from the tuned windings.

A Desensitising Switch.

I have been trying to fit a "local-distance" switch in the aerial input circuit of my receiver, which was originally arranged as shown on the enclosed sketch. The set has ganged tuning control, and I have so far been unable to devise a method that does not introduce a serious alteration of tuning when changing over.

Can you suggest a satisfactory scheme?

The arrangement shown in Fig. 1 should prove satisfactory. You will see that we suggest the insertion of an extra series condenser in the aerial circuit: by operation of the switch, this condenser

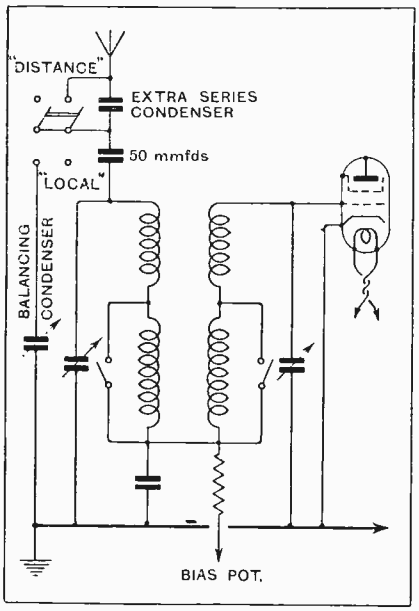


Fig. 1.—Adding a local-distance switch to a receiver in which the aerial is normally coupled through a small condenser.

may be short-circuited for long-distance work. For local reception, the condenser is placed in circuit, and at the same time a balancing condenser is thrown across the tuned circuit in order to compensate for a reduction in transferred aerial capacity.

The balancing condenser can be of the semi-variable type, and, when once adjusted, will not need any subsequent alteration.

As your set has two H.F. stages, and you live at a distance of about thirty miles from the local station, it is probable that an extremely small capacity will be required for the extra condenser; this must be determined by trial.

o o o o

Too Easy.

As the behaviour of a non-inductive resistance is not dependent on frequency, would it not be possible to use one as a coupling between the elements of a band-pass filter?

By doing this, it would appear that the much-coveted "constant band width" effect could be obtained with a minimum of trouble.

In order to obtain true band pass effects, inter-circuit couplings must be of a reactive nature, and in consequence must be inductive, capacitative, or possess a combination of these properties.

o o o o

Unattractive Complication.

In converting my receiver for A.C. mains operation, I have had a good deal of trouble through L.F. oscillation. As it appears that the rectifier valve which I already have is in any case inadequate, I have come to the conclusion that all possibility of inter-action between detector and output valves could be avoided by using the present eliminator circuits for feeding the H.F. and detector valves and providing a second rectifier for the output valve only. The makers of my power transformer tell me that its H.T. secondary is quite capable of supplying the necessary current for the two rectifiers; one of the L.T. windings, which is at present idle, would serve for heating the extra rectifier filament.

Do you think that this arrangement would be satisfactory?

You are mistaken in thinking that any possibility of inter-action would disappear if a separate rectifier were used for feeding the output stage. Actually, the resistance of the H.T. secondary would be common to all circuits, and to be entirely logical, it would be necessary to fit a separate power transformer—a rather extravagant procedure.

We feel sure that the right course in your case is to provide a rectified H.T. output sufficiently large to enable adequate decoupling resistances to be inserted.

Spurious Oscillations.

Although the reaction control of my "Pre-Selection A.C. Three" works quite normally on the medium band it is anything but satisfactory when long waves are being received. Signal strength is actually diminished as the reaction condenser is moved from "minimum," and becomes gradually less until an increase takes place suddenly, just before the detector valve goes into self-oscillation.

A milliammeter connected in the detector anode circuit shows a somewhat reduced reading on switching over to the long waves.

From this information, can you say what is likely to be wrong?

It is clear that self-oscillation is taking place at some frequency other than that to which the receiver circuits are tuned. Although no heterodyne note will be heard, the detector valve cannot operate efficiently under these conditions.

This form of trouble is by no means uncommon when efficient modern valves are used. Fortunately the remedy is simple; all that is necessary is to insert a non-inductive resistance of from 600 to 1,000 ohms in series with the reaction circuit, as shown in Fig. 2. This arrangement is included in the "D.C. Mains Three."

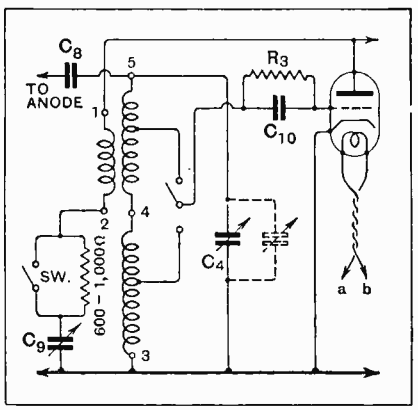


Fig. 2.—For preventing spurious oscillations: a reaction circuit resistance added to the "Pre-Selection A.C. Three." This arrangement will often improve the long-wave performance of any receiver with a tapped-down grid connection.

If it is found that the presence of this resistance has a detrimental effect on the medium-wave performance, a short-circuiting switch should be fitted, as indicated in our diagram.

c c c c

Good for Valve Makers.

I have just been unfortunate enough to burn out all the valves of my H.F.-det.-L.F. receiver, through making an accidental short-circuit between the positive H.T. lead and a metal screen. If it is possible, I should be glad if you would tell me how to prevent a recurrence of this trouble.

If the filament circuits and the H.T.-L.T. inter-connection are properly arranged in the manner always advocated in this journal, there is not the slightest reason why accidents of this sort should take place.

There are several incorrect methods of arranging these matters, and it is possible that your set is wired on the lines shown in Fig. 3, with H.T.— connected to

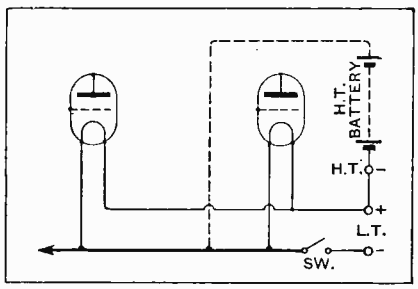


Fig. 3.—Showing how valve filaments may be burnt out if battery interconnections are incorrect. An H.T. battery short-circuit to earth is indicated by dotted lines.

L.T.+ and the on-off switch in the L.T. negative lead. A consideration of the diagram will show that if the positive side of the H.T. battery is brought into contact with the base line—to which screens are normally connected—the full voltage will be applied across the valve filaments when the switch is "off."

By adopting the plan of joining H.T.— to L.T.— and inserting the on-off switch in the L.T. positive lead, the valves cannot be harmed in this way, although, of course, the battery itself may suffer if the accidental short circuit is of long duration.

c c c c

Consistency of Valve Characteristics.

Not being quite satisfied with the sensitivity of my receiver, I have checked the anode current consumption of the H.F. valve, and find that it is about 15 per cent. greater than that shown on The Wireless World *Valve Data Sheet and the makers' pamphlet. Do you think that this can be taken as an indication that the valve is an abnormal specimen?*

No; a difference of 15 per cent. over or below the current consumed by an average specimen cannot be taken as suggesting that the valve is in any way defective. Divergencies of this order are quite usual, particularly with screen-grid valves.

c c c c

Field Winding Conversation.

As our electrical supply is shortly to be changed from D.C. to A.C., I should be glad if you would give me a word of advice as to the cheapest method of supplying field current for a moving-coil loud speaker.

On the assumption that the instrument is at present wound to suit the D.C. supply voltage, it seems certain that the cheapest way of making the necessary alterations is to obtain a high voltage rectifier and smoothing unit capable of giving the necessary current output.

If the rectified output is at the same voltage as that of your original supply, there will be no need to touch the existing field winding.

Unsuitable for All-wave Work.

Would it be advisable to adopt the circuit arrangement of the second detector and output valve of the "Super-Selective Six," as the basis for a short-range "quality" set?

As a general rule it may be taken that the filtering arrangements included in the second detector of a superheterodyne receiver are designed to be effective at a single predetermined frequency, and not to cover a comparatively wide band of wavelengths, as in a "straight" set. Consequently, this part of the circuit of a superheterodyne should seldom be used for any purpose other than that for which it is intended. In this particular case, however, the arrangement you propose should be satisfactory enough.

c c c c

Estimating Bias Resistance.

In determining the value of automatic bias resistance to use in conjunction with a power pentode, is it necessary to take into account the screening grid current as well as that flowing in the anode circuit?

Yes; if anode current must be taken into consideration, it will invariably be necessary to add to it the current passed in the screening grid circuit. The only "return" path for current in these two circuits is through the cathode of the valve.

c c c c

Back Numbers.

On applying to your publishers for a back number of The Wireless World *containing an article that I particularly want to read, I am informed that it is out of print. Can you suggest any way of getting it?*

Readers are often able to obtain "out-of-print" back numbers by making their wants known through our Small Advertisement columns. If this plan is unsuccessful, we would point out that you are quite at liberty to consult our files at the Editorial Offices (116-117, Fleet Street).

FOREIGN BROADCAST GUIDE.

MONTPELLIER

(France).

Geographical position: 43° 37′ N., 3° 53′ E.

Approximate air line from London: 560 miles.

Wavelength: 285.2 m. Frequency: 1,052 kc. Power: 1.2 kW.

Time*: Greenwich Mean Time.
(*France adopts B.S.T.)

Standard Daily Transmissions.

12.45 B.S.T., gramophone records, news; 15.00, own concert; 17.00, news and concert; 20.30, concert or relay of broadcast from Marseilles, Lyons or Paris (PTT).

Call: *Allo! Allo! Ici poste de radiodiffusion des PTT de Montpellier-Languedoc.*

Closes down with usual French formula, followed by *La Marseillaise.*

The Wireless World AND RADIO REVIEW

(19th Year of Publication)

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Straight Set or Superhet?

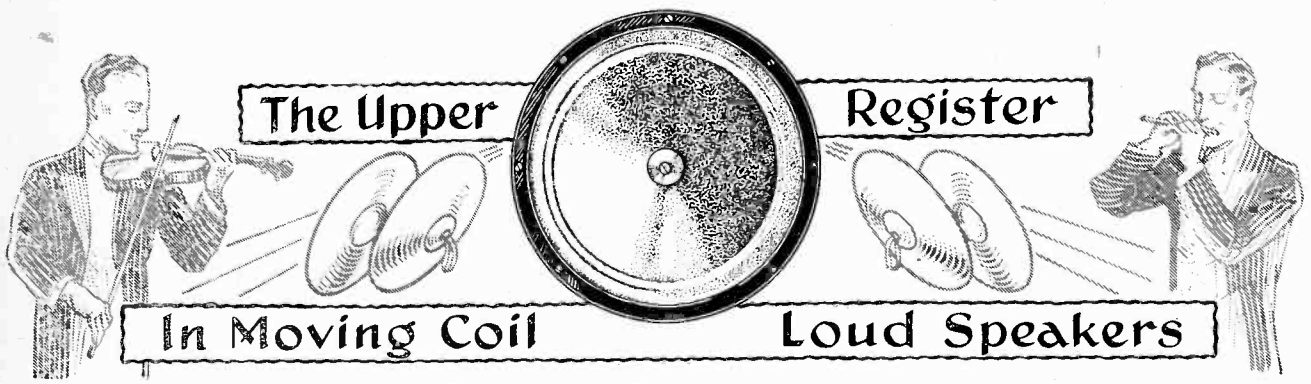
NEXT season's sets are already taking shape, and the time limit has been reached after which changes in design are no longer possible. Activity in the development of superheterodynes both here and abroad forced upon the manufacturer the difficult problem of deciding between a continuance of the straight set, with its two or more tuned H.F. stages, or diverting his energies to an investigation of the superheterodyne. As to quality and range of reception, the straight set and superheterodyne are equally effective, but in a brief comparison of their relative merits the superheterodyne possesses the outstanding feature of high selectivity, a requirement which present-day dual transmissions in areas of dense population has made vitally necessary. Cost of production is in favour of the superheterodyne, as it has fewer variably tuned circuits, but its principal drawback is the need for two tuning dials.

On this point the merits of single-dial tuning cannot be over-stressed, for with the one control the novice is at no disadvantage over the expert in his ability to tune in a large number of transmissions. Superheterodynes with single-dial control are common enough, and the method by which the necessary constant frequency displacement of the oscillator is produced has been explained in these pages, but the single-dial sets that are available invariably tune over a single wavelength range. Owing to the difficulties in producing a two-range single-dial superheterodyne it is probable that the straight set will remain long in favour. If the selective properties of the superheterodyne enforce its adoption, then the problem of single-dial control, combined with reception on the two wavebands, must be solved without unduly increasing cost or complication. It was expected that the all-round increase in the power of foreign stations would have brought about an added interest in the reception of distant programmes. The reverse has been the case, however, owing to inadequate selectivity, heterodyning, and mush. These difficulties are much more readily remedied by the superheterodyne, and as its popularity grows so will the dominant position of the local station decline.

In weighing up the many considerations, it must not be overlooked that changes in the properties of screen-grid valves, combined with the more general use of the band-pass filter, may result in a considerable improvement in the selectivity of the straight set. We think that when the new season's designs are disclosed that the majority of the manufacturers will have standardised a straight H.F. set with all modern refinements, though a few superheterodynes will make their first appearance.

Another development due to the superheterodyne revival is a more general interest in short-wave broadcasting. A short-wave superheterodyne, or in fact an autodyne attachment in front of a broadcast receiver, will in this country give reliable loud speaker reception of the short-wave broadcasts from several continents.

In This Issue



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

The Influence of Diaphragm Resonance.

WE have seen in a previous article in this journal (May 6th and 13th, 1931) that the lower register in the M.C. speaker depends upon either resonance of the surround itself acting as an auxiliary diaphragm, or of the diaphragm as a whole on the surround. The output in either case far exceeds that which would be obtained if the diaphragm were a freely suspended rigid disc, or a cone with a reinforced edge and no annular support. This increase in output at low frequencies is necessary to balance the powerful upper register caused by resonances due to symmetrical modes of vibration. In this respect the experimenter will find it of interest and use to test a diaphragm of normal dimensions, with the outer edge bent over and glued to a thin ring of cardboard (say ¼in. wide and 30 mils thick). This should be suspended by elastic cords from four points, as shown in Fig. 1. If the elastic stretches too much the ends can be replaced by cotton threads so that the middle portion will give sufficient resiliency. Where the air gap is too small to permit of this arrangement, the coil can be retained in position by aid of a centring device in the usual way, whilst its periphery is supported as shown in Fig. 1. The reproduction of radio broadcasting will be characterised by a relative lack of bass and a preponderance of upper register. The object of this article is to explain the reason for the enhanced output at the upper frequencies. In attacking this problem, we first proceed to measure the apparent radiation or output resistance of the diaphragm, with the coil free and with it fixed. As we showed in the last article, although this is only an approximate test, owing to the inclusion of diaphragm and other losses, it serves the purpose of exhibiting powerful resonances.

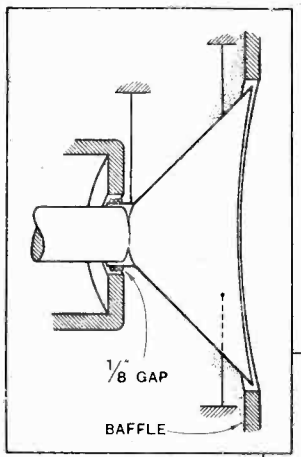


Fig. 1.—Diagram showing method of suspending cone for experimental work on apparent radiation resistance (Ra).

Speech Coil Data.

Taking a diaphragm with the dimensions shown in Fig. 2, and using a light coil (small mass) attached in the usual way, we should probably find a number of resonances, starting at about 800 to 1,000 cycles and progressing at intervals to 3,000 or 4,000 cycles. This gives a curve which is too complicated for the purpose of ascertaining exactly what the diaphragm is doing. If, however, we use a coil of 28 d.s.c. wound on a paper tube about 2in. in diameter, as shown in Fig. 2, the performance curve of the diaphragm has only one prominent resonance above 1,000 cycles. The coil is varnished with fluid bakelite and baked in an oven for several hours at 110 deg. Centigrade—just above the boiling point of water. The neck of the coil is mounted on the cone by serrating it and bending it over to the conical surface where it is held securely with seccotine. From experience, coupled with a knowledge of elementary mechanical principles, we are aware that every structure—whatever its geometrical form—when tapped by hand or with a suitable striker, emits a sound. With a metal gong this sound is musical—especially prior to a good meal—and the music corresponds to the natural frequencies of the gong which enervate the inherent tendencies of the inner man!

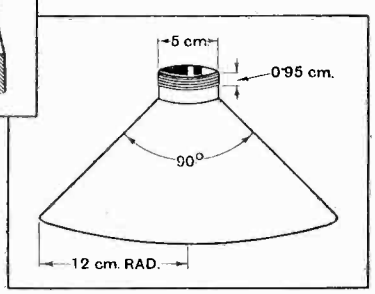


Fig. 2.—Diagram giving dimensions of cone used in experiments on apparent radiation resistance.

Again, we have excellent examples in the bass drum or the tympani (copper cauldron type), but, of course, the sound in these instruments is derived from a vibrating stretched membrane and is of low frequency. No one seems to have had the audacity to introduce high-frequency drums into a modern orchestra. In fact, there is a conspicuous lack of research and innovation

The Upper Register in Moving Coil Loud Speakers.—

(excepting for some of the discordant cacophonies of the ultra-modern music) in the combination of orchestral instruments, barring, of course, that ear-splitting thing called the muted cornet! This is apparently somewhat of a contradiction of terms, because the device is certainly not mute. It would be more musical were this true. Doubtless the word mute in this case is derived from the Latin *muto*—I change—namely, a plug is placed in the acoustic orifice, or a bowler hat hung on the flare.

Returning to our cone, there is now no difficulty in understanding that, in company with the other appliances we have quoted, it will have a series of natural frequencies. In fact, if we tap on its apex there is a complex sound which corresponds to the natural oscillations of the cone. If we take a round bar, it is possible to predict its natural frequencies by oscillation without recourse to experiment. A bar can vibrate in various ways. (1) It can vibrate from end to end, this being a longitudinal vibration, as shown in Fig. 3*a*. In so doing it extends and contracts. (2) It can vibrate laterally, in which case it bends, as shown in Fig. 3*b*. (3) It can twist about its axis, as shown in Fig. 3*c*. This is a torsional oscillation, and can easily be demonstrated by fixing a radial member on the end of the bar. There are other forms of oscillation, but these examples will serve our present purpose. In general, when the bar is long compared with its diameter (say 12in. long and ¼in. diameter), the lateral, or bending, oscillation has a lower frequency than the longitudinal or end-to-end oscillation. When we come to the case of a coil-driven cone, we no longer have a simple structure like a round bar. Here we have a cone and cylinder (the neck of the coil) driven by a circular coil.

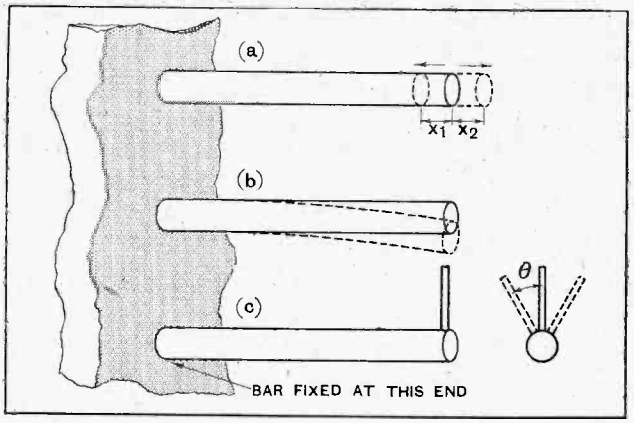


Fig. 3.—Diagram illustrating various modes of oscillation of a circular bar held firmly at one end—in a vice. (a) Longitudinal oscillation where x_1=contraction and x_2=extension (x_1=x_2). (b) Flexural or bending oscillation. (c) Twisting or torsional oscillation.

At the moment no formula exists by means of which the natural frequencies of a cone (conical sheet as opposed to a solid cone) can be calculated. In fact, the various modes of oscillation of a cone have not been examined mathematically, and the same is true of our coil-driven cone of Fig. 2. Without the guidance of mathematical analysis it is difficult to predict the ultimate behaviour of a complex structure of the type illustrated in Fig. 2. With a simple bar there is no difficulty in realising what happens when it is pulled over at one end and let go. If there is, we can always have recourse to an experiment with a table knife. It is this lack of theoretical guidance which rather leaves us in the dark, and, moreover, in the meantime we must have recourse to experiment—an essential expedient even if a formula were available, since one cannot leave anything to chance where accurate data is desired.

There is one experimental point regarding which some uncertainty exists. When a stiff, heavy coil is used to drive the diaphragm there is only one *major* resonance, which, with our standard diaphragm of Fig. 2, occurs about 2,000 cycles. When the turns on the outer layer of the coil are removed it is more flexible, but its mass is reduced to one half. In this case the upper register is more powerful, since above a frequency of 2,000 cycles per second the output is maintained at a higher level than it is with the whole coil, i.e., a wider frequency band is covered. The difficulty which arises, therefore, is to determine whether the extension of the upper register is due entirely to the reduction in mass of the coil, or in part to its flexural modes of vibration.[1]

The Mass of the Coil.

Experiments have been conducted using coils wound with 42 s.w.g. double-silk-covered wire, the number of turns being 40 in each case. One was a standard single-layer coil, whilst the other was one third the length and had *three* layers. The masses were almost identical, but the single-layer coil was more flexible. Tested on broadcast signals, the upper register was fairly powerful in each case, and the quality of reproduction—judged by ear—was much the same on speech or music. This is only a rough practical test, but it tends to indicate that the mass of the coil is a controlling factor. However, quantitative observation is the only way to arrive at a definite answer. Especially is this true when the insensitivity of the human ear is taken into consideration.

AS a natural corollary to his earlier investigation of the behaviour of moving coil loud speakers in the bass register, an examination of the peculiar properties of diaphragms at the higher frequencies is here undertaken by Dr. N. W. McLachlan, one of the leading authorities in loud speaker design and the author of numerous works on the subject.

In this article, and in others on topics of a similar nature, we have made use of the expression *nodal circle* quite freely. Doubtless the reader visualises a circle on a disc or on a cone, which said circle remains at rest in space whilst the remainder of the structure vibrates oppositely on either side. This concept, which has been handed down to us from a less practical age, is purely hypothetical. It is only true when the disc or cone is quite thin, has no internal transmission loss and vibrates *in vacuo* to eliminate radiation loss.

[1] See *Philosophical Magazine*, page 1, January, 1931.

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Moreover, the diagram of Fig. 5 must be interpreted with this in mind. When the amplitude of vibration and the loss is small, Fig 5 gives a picture which is substantially accurate. With a reed-driven circular disc vibrating at the first centre moving symmetrical mode, a good nodal circle can be obtained with sand, provided the amplitude is small. When the amplitude is augmented by increasing the input to the reed movement, the sand no longer lies peacefully on the disc, but spends most of its time in mid-air, doubtless in an attempt to emulate aeronautical acrobatics. Using lycopodium powder, and a button microphone as described below, the same effect occurs with paper cones. A complete explanation of this phenomenon is beyond the scope of *The Wireless World*, but will be dealt with in a letter appearing in *Experimental Wireless*. The following will serve our present purpose: When a lossless disc is driven *in vacuo*, the energy transmitted from the centre is *all* reflected back from the periphery. One nodal circle occurs at a certain frequency, the outgoing and incoming energies being equal and opposite both in magnitude and time of arrival (phase). Consequently there can be no motion at the nodal circle—in the absence of energy. But, when loss occurs, the outgoing energy not only exceeds that reflected from the periphery, but there is a phase displacement between the maximum values, i.e., they do not occur simultaneously as in the hypothetical case. Thus the transmitted and reflected energies do not cancel out and the disc is not absolutely at rest at the so-called nodal circle. Moreover, the nodal circle is actually a position of minimum amplitude—and therefore minimum kinetic energy. The same argument is applicable to cones and other vibrating structures.

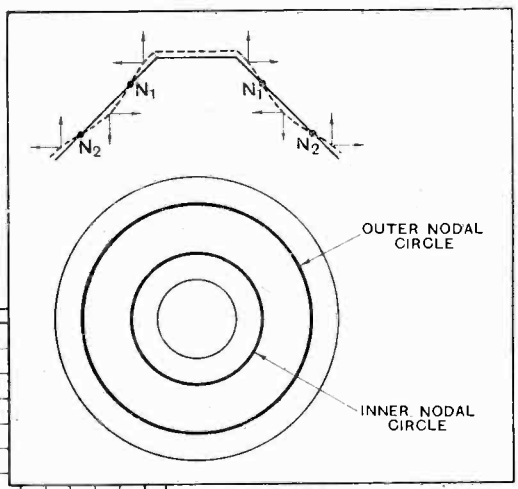

Fig. 5.—(Above) Diagram (exaggerated) showing shape of cone when executing main or second symmetrical mode with two nodal circles N_1, N_2. These circles are so-called radial nodes.

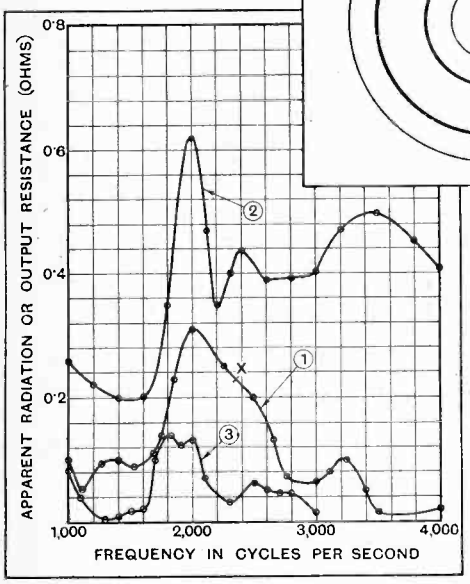

Fig. 4.—(Left) Curves illustrating effect of different coils on the output from the diaphragm of Fig. 2. Curve 1=Coil having 40 turns (2 layers) 28 d.s.c. on paper former 8 mils. thick. Curve 2=Coil having 40 turns (1 layer) 42 d.s.c. Curve 3 =Coil of 40 turns 42 d.s.c. wound on paxolin tube.

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Detecting the Nodal Lines.

Coming now to the actual experiments, measured values of the apparent radiation or output resistance for the arrangement of Fig. 2 are exhibited in Fig. 4, curve 1. The main or most powerful resonance occurs at 2,000 cycles per second. This resonance is due to a symmetrical mode of the diaphragm, in which case the middle section moves in an opposite direction from the coil and the peripheral part of the cone—what one might describe as concertina action of the diaphragm. There is reason—based on experiments too lengthy to describe here—to believe that it is the second major symmetrical[2] mode, and it is accompanied by two nodal circles.

This state of affairs is portrayed diagrammatically in Fig. 5. If we magnified the movements of the diaphragm considerably and then viewed them by aid of a neon lamp or other stroboscopic means, we should see the coil and the outer part of the cone moving outwards and upwards, whilst the inner part moved inwards and downwards, and vice versa. Actually, the so-called nodal circles, where there is minimum motion inwards and outwards, would be very crude, i.e., irregular. This is due, in part, to the seam of the cone upsetting the symmetry and to the paper not being identical in its mechanical properties throughout—"isotropic" is the term used when a substance has identical properties in all directions. In other words, the paper is not isotropic. At this juncture it may be of interest to the experimenter to indicate a simple way of detecting the nodal lines. Let us assume the diaphragm to be coil-driven at its resonance frequency of 2,000 cycles per second. Then, by aid of a button microphone, to which a fairly stiff pointed wire about 4in. long is attached, a battery and a pair of 'phones (and a transformer if necessary), the surface of the cone can be explored. The point of the wire is drawn slowly downwards from the apex. The sound in the telephones will be a minimum when a nodal line is crossed. By drawing a series of pencil lines from the vertex to the base of the cone (these are called generators, since any one of them revolved round the axis would produce a conical sheet) and by exploring each line (generator) as above, and making marks on the lines at points of minimum sound, the nodal figure can be roughly traced. As confirmation of this resonance, we can resort to an impulse test of the form described in *The Wireless*

[2] A mode in which the shape of the cone during motion is the same all round the axis.

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World, April 3rd and 10th, 1929. It will be remembered—if not, the reader can replenish his memory by consultation by his bound volume—that a square waveform is applied to the grid of the power valve. This causes the cone to oscillate, and, moreover, its main resonance can be recorded by means of a special microphone and an oscillograph. The result of a test on the diaphragm of curve 1, Fig. 4, is given in Fig. 6, and here we see the 2,000-cycle resonance corresponding to that in Fig. 4. Evidently it is so powerful that the magnetic field is not adequately strong to damp it out. The resonance at 2,000 cycles per second is quite prominent in Fig. 4, but in practice, apart from transient effects, it is not so serious as the diagram suggests. A better conception is obtained from Fig. 6*a*, where the output is plotted on a decibel basis. We see that the resonance is only 5 decibels (T.U.) above its value at 1,000 cycles, and this is not too serious.

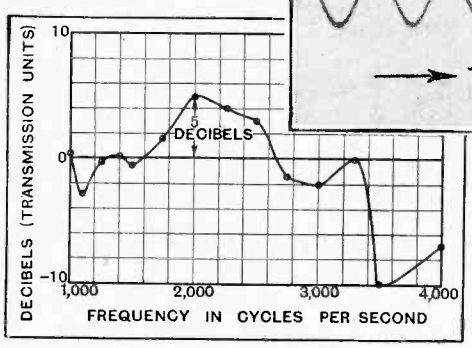

Fig. 6a.—Showing curve 1 of Fig. 4 to a decibel output scale.

Reproduction from the combination is—assuming we insert the lower register at its proper value, by aid of a rubber surround to obtain balance—decidedly lacking in brilliance. This is to be expected, since the output decays above 2,000 cycles, although there is another resonance about 3,250 cycles. The latter, however, is hardly adequate to have much effect, since the output falls away thereafter owing to interference and to transmission loss in the paper.

The Best Gauge of Wire for the Speech Coil.

Suppose that we replace the 28 s.w.g. coil by one of 42 s.w.g. having the same number of turns. Owing to the reduction in diameter of the wire, only one layer is required to obtain 40 turns. This is wound on a paper tube, as before, and bakelised. The result of a test on this arrangement is indicated by curve 2, Fig. 5. The 2,000-cycle resonance is still there, but the slight tendency to resonance at X and that at 3,250 cycles have been magnified enormously, e.g., the output at 4,000 cycles is 20 times its former value. Needless to say, reproduction with the 42 s.w.g. coil was "brilliant." Clearly, then, we have two cases (*a*) a 28 s.w.g. coil which gives insufficient upper register, (*b*) a 42 s.w.g. coil which gives a strong upper register. Where quality is concerned there are so many individual tastes, which one can almost regard as musical creeds, that it is inadvisable to be dogmatic. However, in view of Mr. Holt's letter in *The Wireless World*, March 4th, 1931, asking point blank for the best size of wire, it seems essential to make a definite statement.

As I pointed out in *The Wireless World*, March 30th, 1927, the leakage inductance of a transformer reduces the current at the higher frequencies. Moreover, the results obtained will depend not only upon the loud speaker coil, but upon the transformer—it is assumed, of course, that the ratio is selected to suit the coil. The higher the primary inductance the better

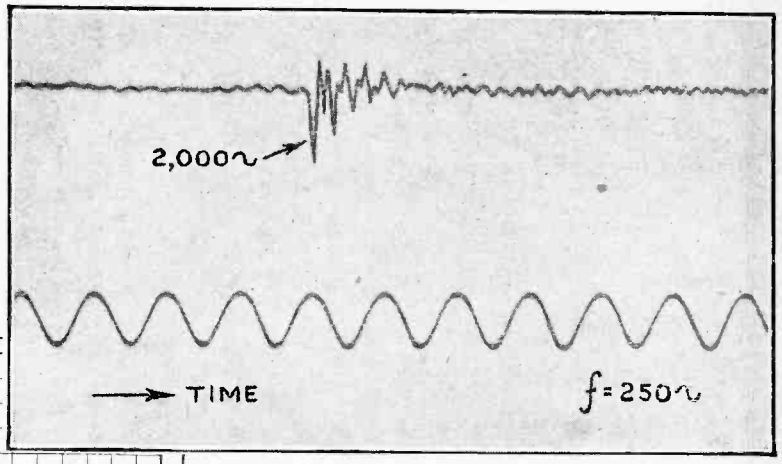

Fig. 6.—Impulse record showing oscillation at 2,000 cycles due to main symmetrical mode of diaphragm whose dimensions are given in Fig. 2.

will be the bass register, assuming the turns ratio to remain constant, but the greater the leakage inductance, and a large amount of this will reduce the upper register. Since the mass, and, therefore, the diameter of the coil is involved, together with the class of paper used, one cannot specify a size of wire which will cover all contingencies. I suggest something between 34 and 40 s.w.g., probably 36 s.w.g., but in the absence of other essential information will not guarantee the nature of the results.

(*To be continued.*)

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BOOK REVIEW.

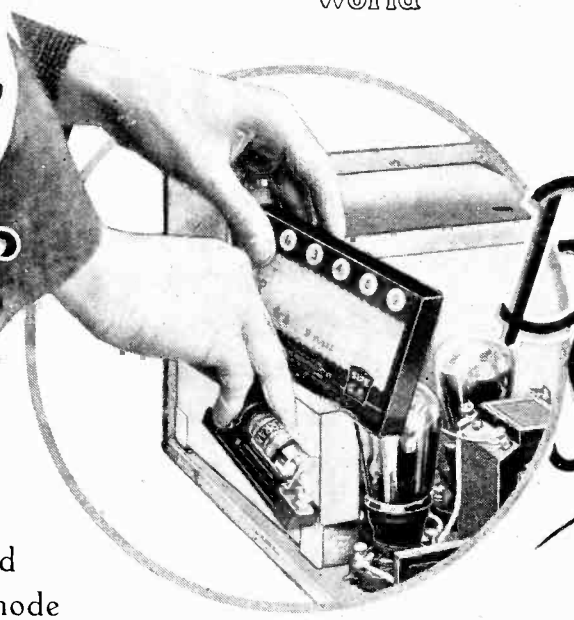
"Talking Pictures and Acoustics." By C. M. R. Balbi, A.M.I.E.E., A.C.G.I. Price 7s. 6d. net. Published by *The Electrical Review*.

The merits and demerits of the two main methods of recording, namely, sound-on-disc and sound-on-film, are fully discussed, together with the system of recording on a magnetised wire which has not at present been developed for use in connection with talking pictures. Adequate attention is paid by the book to the two methods of recording sound photographically, namely, the contour method and the density method.

The various systems which are in use to-day are dealt with practically, and it is quite evident that the author is one who keeps in close contact with the latest developments in the talking picture industry. One of the features of the book which is worthy of special comment is that two entire chapters are devoted to the general considerations of acoustics in order to lead up in a logical manner to special chapters which deal with the design of the ideal studio and the ideal auditorium. Not only are these points dealt with thoroughly in the text, but practical plans are given in order to illustrate various points of architectural design. A good deal of interesting historical information is included in the early chapters. Sir Oliver Lodge contributes a Preface.

The book is attractively bound and is profusely illustrated with a large number of explanatory diagrams and photographs.

Free Bias for Battery Sets



Obtaining Grid Potential from Anode Circuit Resistances.

By D. F. VINCENT, B.Sc.

A PHILOSOPHER with more wisdom than knowledge approached a reader of "The Wireless World" for advice concerning the seemingly paradoxical behaviour of two grid bias batteries—one new and the other old. Besides explaining the paradox, this article also describes a simple method of developing grid potential for battery sets without the use of bias cells.

THE other day I heard a rather startling statement; it ran something like this: "It's all rubbish about grid bias batteries wearing out. Mine didn't show any voltage at all with the meter, so I got a new one and the set wouldn't work with it. When I put the old one back again it went perfectly." As the philosopher was quite certain that he had not got the plus and minus leads mixed up (he was rather that kind of chap) I offered to investigate. I found that "going perfectly" meant a feeble far-away gurgle of a quality that made it difficult to tell whether the original was the B.B.C. Symphony Orchestra or Jack Payne. Of course, the H.T. battery was almost dead. With a dead bias battery as well and the grids more or less unbiased it did make a certain amount of noise, but a new grid bias battery cut the little bit of H.T. that was flowing down to zero. This episode set me thinking. The ordinary everyday B.B.C. listener wants a set that is cheap and toolproof.

Apart from the extra first cost of mains sets, by far the bulk of the listeners have not got current laid on. The battery set is foolproof enough in all respects except the grid bias adjustments. When the valves are correctly biased for a new H.T. battery, the bias will be too great when the battery has run down a bit. Discharge curves vary a great deal, both with the make of battery and the conditions of discharge, and it is not very safe to generalise. However, there is always a more or less steady decline in voltage. Look at Fig. 1. This is one of the last discharge curves published in *The Wireless World* and is typical.

If the set is biased for the initial voltage, then for more than half the life of the battery the set will be over-biased, with loss of power and poor quality, as the power valve will be biased in such a way that any but a weak signal will swing the grid voltage round the bottom bend. If the set is biased for 60 to 70 volts H.T., which is the working voltage of the battery for half its life, then during the early stages the valves will be under-biased, with an unduly large anode current which cannot be utilised. The remedy is to adjust the biases from time to time, but how many of the ordinary everyday listeners have either the necessary meters or the technical knowledge? Now, cheap battery sets can be made foolproof in this respect; the extra expense would

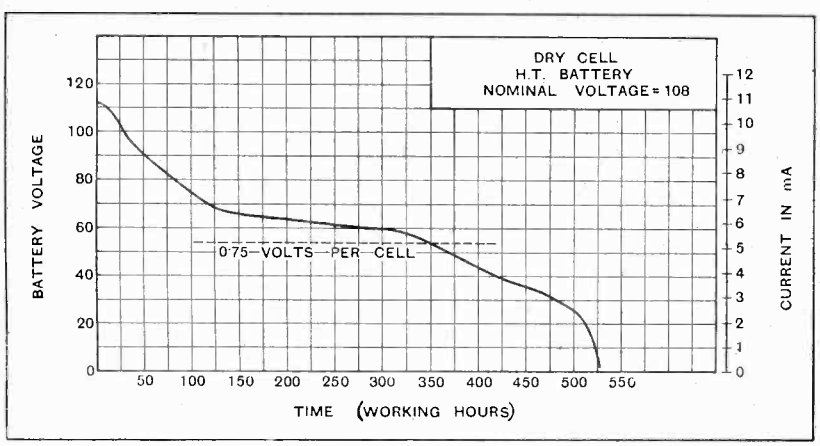


Fig. 1.—A typical discharge curve of an H.T. battery taken in "The Wireless World" laboratories.

Free Bias for Battery Sets.—

be quite small and would be more than repaid in reduced H.T. costs. There are no new principles involved; let me give examples of two circuits I have tried and found to work well. There is the popular 3-valve S.G. receiver. The only extra components are the decoupling of the detector, the biasing resistance and condenser and the resistance in the grid circuit of the power valve. The latter is not necessary if the S.G. valve is decoupled. The disadvantage is that the owner must understand that if he changes the power valve for one of a different type he must also change the biasing resistance. Such a set can be arranged so that the bias is not far out over a large range of H.T. voltages. The decoupling is enough to keep the set stable with almost any amount of resistance in the H.T. so that old batteries can be used up to the last volt.

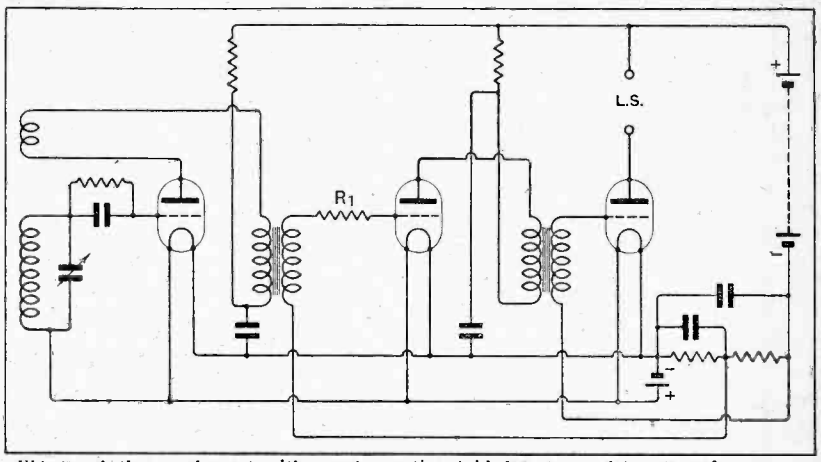
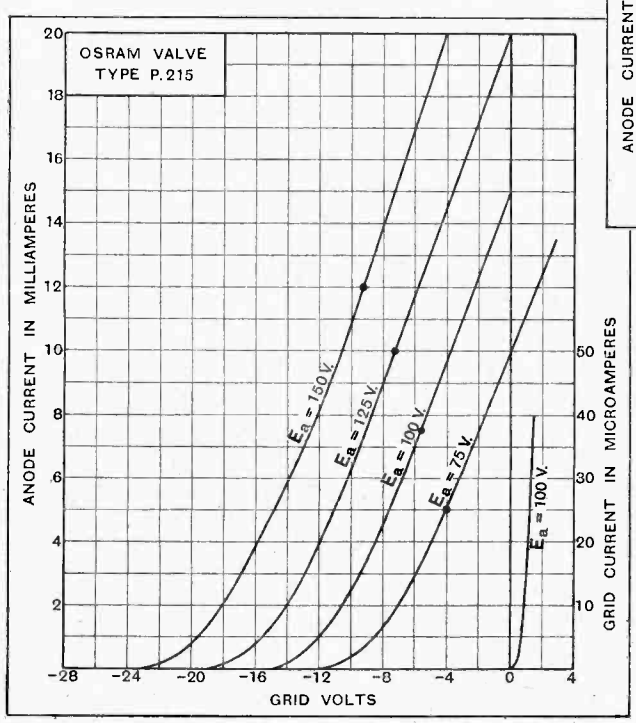


Fig. 2.—A three-valve set with a regenerative grid detector and two transformer-coupled L.F. stages. A free grid biasing circuit is shown.

Fig. 2 is an O-V-2, a set that is very unfashionable, but there are an enormous number of them still in use. I don't suppose anyone would want to build a new one, but for people who don't want the expense of a new set this is a useful conversion for the old one. The decoupling of the second valve will not be necessary in all cases; the same applies to the stopping resistance R_1. It must be understood that there is no one best biasing voltage for a given power valve for all plate voltages; a compromise must be made. An example will make this clear. Fig. 3 shows the makers' curves for the P.215 Osram and PM2 Mullard valves. The curves are marked with the optimum bias (where maximum power consistent with battery economy is the main consideration). The table at the foot of this column gives the bias resistances.

Thus the best resistance for the lowest plate voltages will result in over-biasing at the higher voltages. This is perhaps more of an advantage than a disadvantage, for if it reduces the maximum output with the higher voltages it makes for more economical running and less difference in the power available over the range of voltages used.

The value chosen will depend upon the preference of the owner of the set. If he intends to begin with a voltage of 120 and use his batteries right down to 60, then about 850 ohms for the P.215 or 750 ohms for the PM2 will be suitable. If he wishes for more power and less economy, and intends to begin with 160 volts and use his batteries down to 100 volts, 730 ohms will be suitable for the P.215 and 700 for the PM2. In any case the grid potential will fall as the anode current drops.



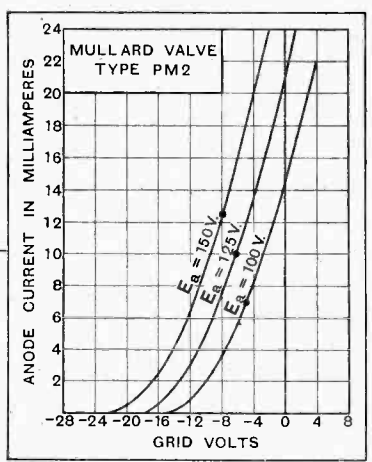


Fig. 3.—Grid volts-anode current curves for two small 2-volt power valves with working grid bias points marked.

Osram P.215.		Mullard PM2	
Plate Volts.	Bias Resistance.	Plate Volts.	Bias Resistance.
75	800 ohm.	100	710 ohm.
100	730 „	125	650 „
125	720 „	150	620 „
150	710 „		

PRACTICAL HINTS AND TIPS.

AIDS TO BETTER RECEPTION.

CALIBRATION WITHOUT METERS.

FOR some reason or another, the valve voltmeter seems to be regarded as the exclusive prerogative of the highbrow research worker: if it were realised how essentially simple this piece of apparatus can be, it would surely be employed more widely by all those who like to have more than a vague idea as to what their receiving apparatus is actually doing.

Calibration of the instrument seems to be the main difficulty, and it is the purpose of this note to describe a rough-and-ready method of carrying out this operation. Although it is not highly accurate, it will give results that are more than useful. Indeed, the present writer had occasion to use it recently at a time when he had not access to any measuring instruments, and is emboldened to put forward this suggestion because he found, on subsequently comparing the extemporised valve voltmeter with a laboratory standard, that the maximum error over the useful working part of the scale was well within 10 per cent.

To carry out the operation, access to an A.C. mains supply of known voltage is essential; all the apparatus necessary is one or more fixed resistances and potentiometers. The more accurately calibrated these resistances are, the more accurate the results will be.

The actual circuit arrangement is given in Fig. 1, from which it will be seen that a high resistance is connected in series with a potentiometer of relatively low value; both these are shunted across the mains supply. The potential gradient along the potentiometer will be proportional to the ratio of its resistance value, as compared with that of the fixed resistance.

To give an example, the mains supply on which the meter was actually calibrated was of 240 volts, and it was desired to make measurements of signal voltages of between 1 and 2 volts. With the relative resistance values shown in the diagram, a potential drop of from zero to about 2.4 volts may be assumed to exist along the potentiometer. It was assumed that resistance changes along the potentiometer track were proportional to its length; thus a paper scale was prepared, marked in voltages from 0 to 2.4.

Other voltage ranges could, of course, be obtained by varying the relative resistance values of the potentiometer and fixed resistance, or perhaps more conveniently, by changing the latter.

It will be clear that the accuracy of calibration will depend, among other things, on whether the supply voltage is maintained at its rated value; to reduce the risk of errors from this source, it is wise to make several calibrations at different times, afterwards striking a mean. As we are here assuming that the resistances used will be taken at their rated values, it will be clear that this introduces another possibility of inaccuracy. However, fixed wire-wound resistors, guaranteed within extremely close limits, are available from several manufacturers, without extra cost, and similarly, some of the potentiometers commercially

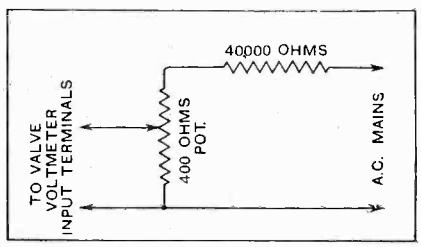


Fig. 1.—Calibrating a valve voltmeter against an A.C. mains supply by the use of a potential divider.

available are surprisingly accurate. As a matter of fact, the Igranic potentiometer actually used for the calibration was found afterwards to have a resistance within 1 per cent. of that stated by its makers.

One cannot always expect such results as this; and indeed, the writer considers himself exceptionally lucky in obtaining such accurate calibration by such a crude method. But a sufficient degree of accuracy to be useful should always be obtainable by the use of common sense.

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L.F. INSTABILITY.

It is generally advised that, when attempting to trace the causes of uncontrollable self-oscillation in an H.F. amplifier, matters should be so arranged that the set is only just oscillating. In this condition it will be particularly responsive to any experimental alterations that may be made, and the beneficial effect of any improvement to the screening system, addition of extra decoupling, etc., will be readily perceptible, as a slight reduction in undesirable inter-stage feedback (which is always responsible for these troubles) will at once stop self-oscillation.

Although it is considerably less effective, a similar plan may be followed when dealing with an unstable L.F. amplifier. Here, of course, we cannot adopt the usual procedure of tuning to the lowest frequency at which self-oscillation takes place, but we can generally find some means of progressively reducing overall magnification so that the set is just on the border-line state between stability and instability, and then attend to the decoupling, etc.

When a pentode output valve is employed an easy and fairly obvious way of doing this, generally without introducing complicating factors, is to reduce screening grid voltage.

In other cases, it may be permissible to connect a variable resistance across the primary of an L.F. coupling transformer, but one should aim at interfering with the frequency characteristics of the amplifier as little as possible; this, indeed, is the main difficulty. With a resistance-fed transformer, it is possible to alter connections so that a number of different step-up ratios may be obtained. Information on this subject was published in the "Readers' Problems" section of *The Wireless World* for May 27th. When R.C. coupling is used a lower value of anode resistor may be fitted.

THE LINK CONTINUOUS GRAMOPHONE.

An Ingenious Record-Changing Device of British Design.

THE automatic gramophone, capable of playing a continuous series of records without any effort on the part of the listener, is an instrument which is the ultimate aspiration of every gramophone enthusiast. In the majority of cases the high initial cost has proved a stumbling block to the acquisition of such a device, but it is probable that in the near future a British-made model will be available to the public at a price in the region of 45 guineas, including pick-up, amplifier and loud speaker.

This instrument has been designed by Mr. Rolls P. Link, of Messrs. Link Machine Tools, 10/18, Millers Avenue, Hackney, London, E.8. Every effort has been made to ensure that the machine shall fulfil all the normal functions of record-changing, and an important feature is that *both* sides of each record are played before it is finally transferred to the "played record" magazine.

Briefly, the method of operation is as follows: The records to be played are piled in their proper sequence on a magazine at the right-hand side of the cabinet. Cardboard spacing discs are fixed to the centre of each record so that scratching of the surface through actual contact between records is entirely eliminated.

The records are handled by an automatic claw which contracts and takes hold of the edge at three points. The claw adjusts itself to the size of the record, and 8in., 10in. or 12in. records can be mixed indiscriminately in the magazine. After the first side has been played the pick-up arm returns to its original position and the claw lifts the record and turns it with the greatest economy of movement. In fact, the claw practically duplicates the movement of the human hand in reversing the record.

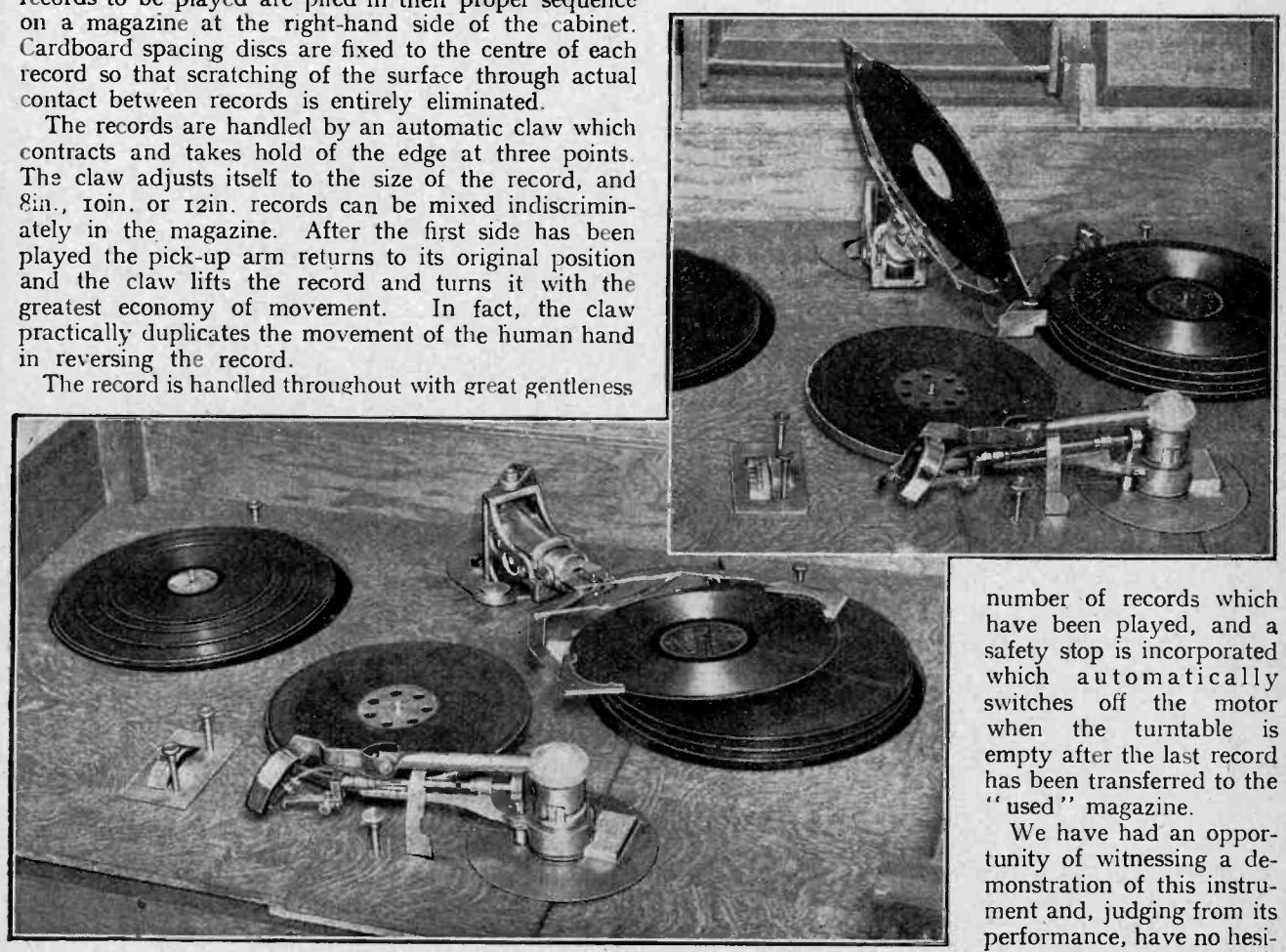
The record is handled throughout with great gentleness and is not allowed to fall or slide at any point in the whole sequence of operations. Incidentally, the right-hand magazine is continuously racked upwards and the left-hand downwards, so that the records on the top of each pile are maintained at the correct level.

The method of placing the needle in the starting groove is noteworthy, as it automatically adjusts itself to the size of the record. The tone arm swings inwards until a light trigger touches the outside of the record, when the needle is immediately lowered on to the plain margin of the disc and the turntable starts to revolve. A bunch of stiff bristles attached to the side of the pick-up engages with the spiral grooves of the record and gradually draws the needle towards the starting groove while the motor is speeding up.

The whole mechanism is operated by a single electric motor, no subsidiary pneumatic or solenoid devices being employed as in some systems.

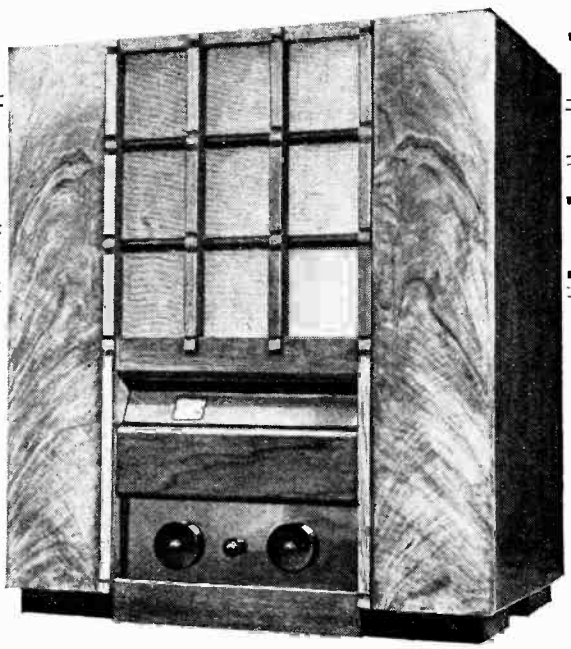
The controls include an indicator dial showing the number of records which have been played, and a safety stop is incorporated which automatically switches off the motor when the turntable is empty after the last record has been transferred to the "used" magazine.

We have had an opportunity of witnessing a demonstration of this instrument and, judging from its performance, have no hesitation in predicting for it a very successful future.



The Link continuous gramophone in action. (Left) A record in transit from the magazine to the turntable. (Top right) The claw in the act of turning over a record.

MURPHY TYPE A3 RECEIVER



ANY discussion relating to this receiver must inevitably commence with the cabinet. Its challenge is sufficiently provocative for it to claim attention even before the technical merits and performance of the chassis. The maker's view is that the broadcast receiver is essentially a modern development, and that if it is to be housed in a "period" cabinet it is only logical that the period should be contemporary. Most people will agree that this object has been achieved without leaning too far towards the extravagantly futuristic. The set should be capable of maintaining its individuality, without actually jarring, in any existing furnishing scheme.

Having accorded the cabinet the attention which it demands, we may pass on to more familiar ground. The makers have adopted a three-valve circuit and have set to work to obtain the highest possible efficiency from each stage. The overall gain has been measured in accordance with the recommendations of I.R.E. Committee on Standardisation, and it is found that an input to the first grid of 230 micro-volts (1,000 kc. modulated 30 per cent. at 400 cycles) is required to give the required standard output power of 50 milliwatts.

The general feel of the controls suggests that a high value of H.F. amplification has been attained, for the receiver relies only to a secondary degree on the use of reaction for its sensitivity and range. The makers state that the H.F stage-gain under normal conditions is of the order of 300. It is somewhat surprising to find, therefore, that the H.F. valve takes its place in a row with other valves without any special screening either for the valve or its anode lead. In all other parts of the H.F. circuit, however, meticulous care has been exercised to remove all traces of feed-back. All components associated with the grid and anode circuits, including the appropriate sections of the wave-range switch, have been separated and screened off.

In order to provide selectivity commensurate with the H.F. stage-gain it has been found essential to employ an input band-pass filter. Inductive coupling has been chosen, and the wave-range switch, in addition to short-circuiting the long-wave coils, also short-circuits the long-wave section of the coupling inductance.

The coils for both the input filter and the tuned-anode circuit are of the basket type and are individually screened in a series of shallow aluminium boxes. Tuning is by means of a Polar "Tub" triple-gang condenser provided with a cord-driven slow-motion drum dial calibrated in wavelengths.

Volume Control.

Before leaving the H.F. stage mention should be made of the method of reaction and volume control. The reaction coils, which are identical with the coupling inductances in the filter circuit, are closely coupled to a pair of similar coils in series with the tuned-anode circuit. A variable resistance in parallel with the reaction coils controls the degree of feed-back without seriously affecting the ganging of the tuned circuits. With the reaction control at zero the signal strength of the B.B.C. stations, and, indeed, of many Continental stations, is not sufficiently reduced, and an input volume-control resistance, mounted on the same spindle as the reaction control, has been included in parallel with the aerial circuit. It is brought into action by a "Local-Distance" switch, and is capable of reducing the input practically to zero. The values have been chosen to give an unbroken range of volume control from zero to the full power of the set. Thus the "Local" maximum volume is equivalent to the "Distance" minimum volume.

A Sensitive Three-valve A.C. Receiver Incorporating a Moving-Coil Loud Speaker.

SPECIFICATION.

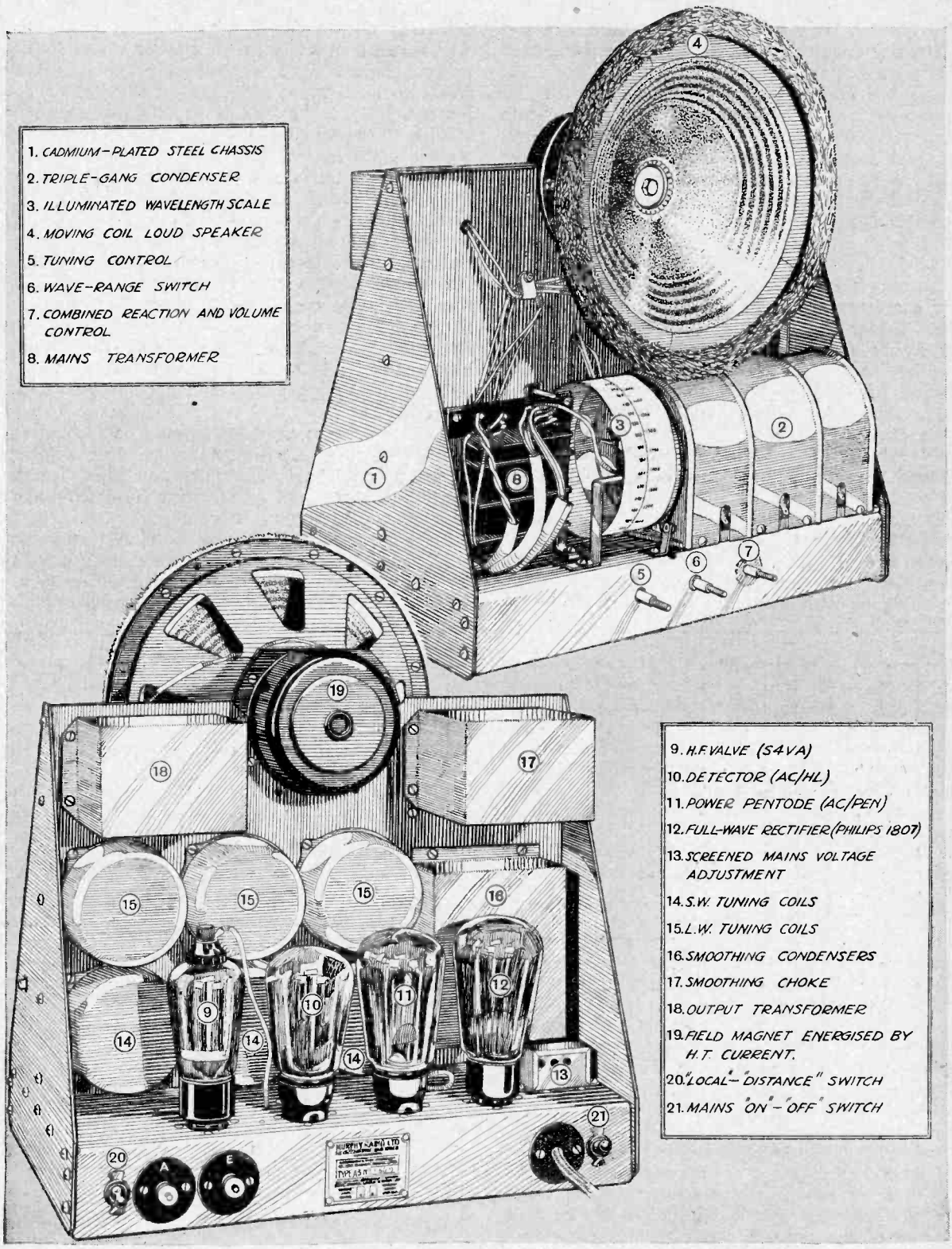
CIRCUIT: Three indirectly heated valves. Screen-grid H.F., power grid detector, power pentode. Band-pass input filter. Full-wave valve H.T. rectifier.

CONTROLS: (1) Tuning. (2) Combined reaction and input volume control. (3) Wave-range. (4) "Local-Distance" switch. (5) Mains "on-off" switch.

GENERAL: Illuminated drum dial calibrated in wavelengths. Self-contained moving-coil loud speaker.

MAKERS: Murphy Radio Ltd., Welwyn Garden City, Herts.

PRICE: 19 guineas including valves and loud speaker.



Constructional details of the Murphy type A.3 chassis.

Murphy Type A.3 Receiver.—

The coupling between the aerial and the filter circuit is through a small series condenser, and aerials of any length from a few inches to 100ft. can be connected without affecting ganging or selectivity.

The detector functions as a power-grid rectifier and is followed by a parallel-fed transformer feeding into the power-pentode output valve. To stabilise the effect of the input capacity of the pentode under working conditions a resistance has been connected across the secondary of the transformer. The working conditions in the detector stage and the overall L.F. amplification have been adjusted to give a range of undistorted power in the loud speaker of from 500 to 1,400 milliwatts. For input equivalent to more than 1,400 milliwatts the detector has been arranged to overload before the pentode. Under these conditions the signal strength fades away instead of producing excessive voltages and their equivalent noises in the output circuit.

Attention has been devoted to the elimination of "pentode whistle" and a special output transformer has been developed to suit the characteristics of the AC/PEN valve and the Rola loud speaker.

The loud speaker field winding is included in the H.T. circuit and is energised by the H.T. current, which it assists in smoothing. It is preceded by an orthodox filter stage in which the choke is tuned to 100 cycles to deal with the output from the full-wave valve rectifier.

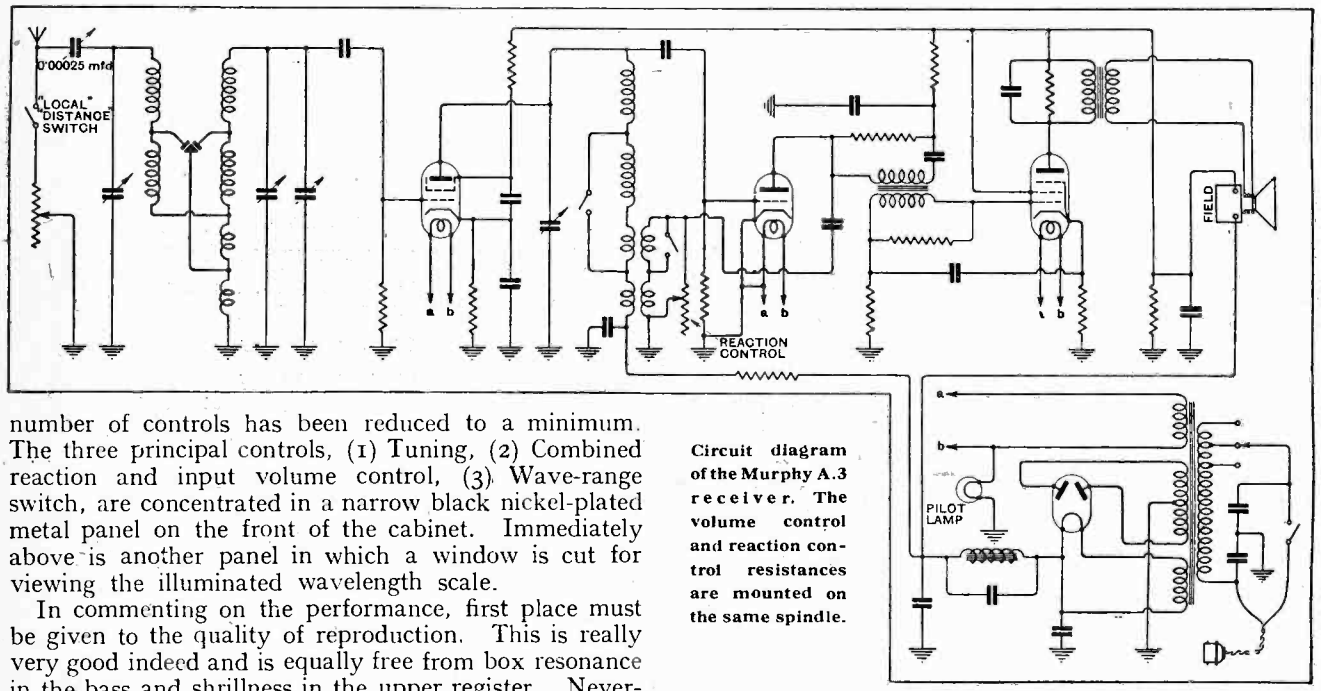
In accordance with the policy of the company the number of controls has been reduced to a minimum. The three principal controls, (1) Tuning, (2) Combined reaction and input volume control, (3) Wave-range switch, are concentrated in a narrow black nickel-plated metal panel on the front of the cabinet. Immediately above is another panel in which a window is cut for viewing the illuminated wavelength scale.

In commenting on the performance, first place must be given to the quality of reproduction. This is really very good indeed and is equally free from box resonance in the bass and shrillness in the upper register. Nevertheless, there is little doubt that frequencies up to 4,500 cycles are well reproduced, and in the bass the pedal notes of the organ are adequately represented. In two searching tests of good quality—the reproduction of the piano and of a woman's voice—the results were extraordinarily realistic.

In spite of the fact that only one H.F. stage is employed, the range is comparable with that of many American chassis employing two or even three H.F. stages. In support of this it may be stated that seven foreign stations were received at programme strength on the medium-wave range in broad daylight. Of these, Brussels (509 metres) and Hilversum (298 metres) were reliable at all times and came in at good volume without critical reaction. After dark fourteen Continental stations were received with reaction at minimum and the control switch in the "Distance" position. By making judicious use of reaction this number could be increased without difficulty to twenty or twenty-five stations. The tests were made within five miles of Brookmans Park with an aerial 50ft. in length. In these circumstances the interference band due to the Regional transmitter extended from 315 to 410 metres, and that due to the National transmitter from 245 to 285 metres. In Central London these figures were reduced to 355-375 metres and 255-268 metres respectively.

The long waves provided seven reliable programmes in addition to 5XX, the selectivity being sufficient to separate Radio Paris, Daventry and Eiffel Tower, but hardly equal to the task of receiving Königswusterhausen with the former stations in operation.

To summarise, the Murphy Type A.3 receiver is a boldly conceived design giving exceptionally good range for three valves, adequate selectivity and a very high standard of quality and volume of reproduction. The controls are simple to operate, and in view of the fact that a moving-coil loud speaker is included the price is very reasonable.



Circuit diagram of the Murphy A.3 receiver. The volume control and reaction control resistances are mounted on the same spindle.

Next Week's Set Review:—
EELEX SHORT-WAVE ADAPTOR.

CURRENT TOPICS

Events of the Week in Brief Review.

SURPRISE ANNOUNCEMENTS AT PARIS SHOW?

The annual Paris Radio Show is to be held this year in the Radio Section of the Colonial Exhibition, from September 3rd to 13th, and we learn that it will probably be opened by M. Guernier, the Postmaster-General. M. Guernier, according to our Paris correspondent, is showing more interest in broadcasting than the majority of his predecessors, which fact is responsible for a growing feeling of optimism among wireless users.

It is understood that, in his opening speech, M. Guernier will have some highly practical announcements to make concerning the future of French broadcasting.

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TRANSMITTER—BUT NO RECEIVERS.

Although France now has a Colonial broadcasting station the discovery has been made that the radio section of the Colonial Exhibition contains not one short-wave set suitable for overseas use! French manufacturers are being urged to "wake up" before America discovers the omission.

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SHORT WAVES FROM PORTUGAL.

Portugal is the latest country to establish a Colonial short wave broadcasting system. The station CTIAA at Lisbon now transmits a Colonial programme every Friday from 10 to 12 p.m. (G.M.T.) on a wavelength of 42.9 metres, with a power of 3 kilowatts. Announcements are made in Portuguese, Spanish, French and English.

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THE FOUR-MILLION RACE.

Will Germany beat Britain in the race for the four-millionth receiving licence? Although the population of the Fatherland is considerably larger than our own, the licence figures remain remarkably close. On July 1st Germany had 3,719,594 registered listeners, while the British total on the same date was 3,756,331.

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PRIZES FOR CONSTRUCTORS.

Cash awards totalling £150 are again offered in the *Manchester Evening Chronicle* radio constructional competition to be held in connection with the Northern Wireless Exhibition at the City Hall, Manchester, from October 7th to 17th.

We understand that this year's competition will specially encourage the production of apparatus suitable for reception from Moorside Edge.

The competition will be divided into four classes. Class I calls for a two-valve, self-contained set, Class II for a crystal receiver and valve amplifier, Class III for a one-valve receiver, and Class IV for a single-valve H.F. unit.

Fuller particulars can be obtained from the radio section of the *Evening Chronicle*, and intending competitors are asked to send their names and addresses to the Radio Editor of that journal at Withy Grove, Manchester.

NEW ITALIAN BROADCASTER.

The new 20 kW. broadcasting station at Florence is to begin its transmissions on October 20th.

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WITHOUT COMMENT.

"The Duke of York has completed a two screen-grid receiver, with which he listens to European stations which, when they hear him tuning in, preface their announcements with 'Your Highness, Ladies and Gentlemen.'"—Australian paper.

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BROADCASTING IN PERPETUITY.

Continuous broadcasting for 24 hours a day ever since October 1st, 1928, is the performance claimed by California's "perpetual broadcaster," KGFJ, of Los Angeles. This makes a total to date of 25,000 odd hours, and we are ready to "hand it" to any American who claims to have listened all the time.

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HAPPY DAYS IN PRISON.

Geelong gaol, Victoria, is the rendezvous of Australia's radio-minded criminals. According to the *British Australian*, the prisoners have bought an all-mains receiver *with their own money*. They did the wiring themselves, making connections to most of the cells where there are earphones, and with the exercise yard, where a loud speaker has been installed.

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AMATEUR-BUILT TRANSMITTER FOR RUNNING COMMENTARY.

Students of the Budapest Technical School constructed the short-wave transmitter and receiver which were used recently to broadcast a running commentary on the Budapest University boatrace. The transmitter, which was carried in a boat following the rival crews, operated on 41.5 metres with a power of 10 watts, and the description was picked up on a receiver connected to a public address system.

Short-wave listeners may be interested to note that the same transmitter operates every Tuesday, Thursday, and Saturday between 7.30 and 8.10 a.m. (G.M.T.). Reports would be welcomed, and should be addressed to M.R.C. Budapest Müegyetern.

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PUBLIC RECEPTION IN RUSSIA.

Public listening saloons are to be erected in the Moscow area by the Soviet broadcasting authorities.

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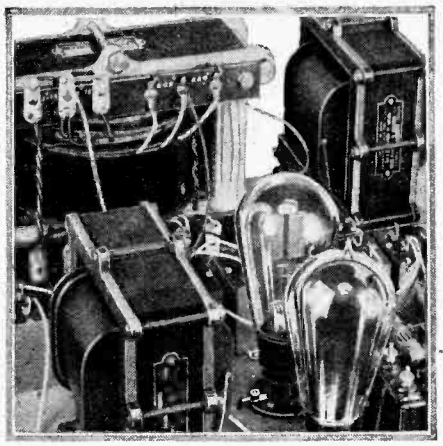
BROADCASTING ELECTRON SHOWER.

Maintaining his reputation as a universal provider of surprises, Mr. Orestes H. Caldwell, an ex-member of the U.S. Federal Radio Commission, startled listeners to WEAF a few nights ago when he broadcast the sound of an electron shower. According to a correspondent, Mr. Caldwell held a battered radium-dial watch to an instrument known as the Geiger counter. The electrons discharged from the radium-coated dial filtered through the counter, and the sound of their striking, as sent through the microphone, resembled that of a fall of lead shot on a tin roof. The experiment was under the auspices of the National Research Council, thus guaranteeing, it seems, that genuine electrons were used and not lead shot.

AMERICA'S NEWEST CONTROL ROOM. A view in the new Chicago broadcasting station of the U.S. National Broadcasting Company.

The Regulation of the Rectifier

Anode Current from A.C. Mains.



By H. B. DENT.

ELECTRICITY is generated to-day in one of two forms: it is either of the direct current variety or in the form of an alternating current. In the case of the first-mentioned, the current flows continually in one direction, and, provided there are no variable obstructions, will maintain a steady value until the supply is interrupted. With A.C., however, the current flows in waves, and continually changes from a positive to a negative sign; hence the familiar manner of illustrating an alternating current as having a sine wave or sinusoidal form equally disposed either side of an imaginary zero line, as illustrated in Fig. 1 (a).

For the H.T. anode voltage to the valves in a wireless set we must have a direct current perfectly free from ripple; consequently, if the electric supply is of the A.C. variety, some means must be devised for converting it into continuous current form. These devices are known as rectifiers, since they permit current to flow through them comparatively easily in one direction but impose a very high resistance to the passage of current in the reverse direction. Few of these devices possess a linear characteristic; that is to say, the current flowing is not always directly proportional to the applied voltage. Consequently, it is customary to provide a regulation curve, the object of which is to show the performance of the rectifier under various conditions of operation.

TO those who have recently converted their sets from H.T. battery supply to A.C. mains operation, the regulation curve of the rectifier may at first seem somewhat puzzling. Changes in the current taken from an H.T. battery within wide limits are not accompanied by changes in voltage, whereas, owing to its internal resistance the H.T. rectifier develops a different voltage for every load. The regulation of the rectifier is here explained in simple terms and a number of practical examples are given.

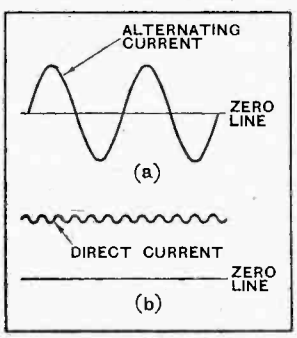


Fig. 1.—Typical form as shown by oscillogram of (a) an alternating current and (b) an unsmoothed direct current.

The method of presenting this information differs widely in many cases. One form is in the nature of curves connecting rectified voltage with A.C. input voltage for certain predetermined values of rectified current, while another form is to take some selected values of input voltage and show the relationship between rectified voltage and rectified current. Still another method is to assume a definite value of input voltage and then give curves connecting the two output quantities for various values of reservoir condenser.

Two Alternative Methods.

Regulation curves for some typical rectifying valves showing two of the alternative forms mentioned above are given in Figs. 2 and 3, while in Fig. 4 is shown the general form taken by the regulation curve relating to a bridge-connected metal rectifier of the Westinghouse type. These curves assume a constantly maintained A.C. input voltage, a condition which will not obtain in a practical case, since even a well-designed transformer will not maintain a constant output under all conditions of loading. As a rule, however, the output voltages on open circuit conditions and at the full load state will not vary more than about 4 per cent. Nevertheless, it might be worth while to take cognisance of this, as will be shown later.

When we are dealing with the design of a set in which a valve rectifier is to be embodied, we can adopt either one of two alternative methods for determining the most suitable value for the voltage-dropping resistances, chokes, and other essential components in the H.T. circuits. One is to fix these values beforehand, calculate the voltages dropped in the various resistances, and so arrive at a value for the unsmoothed rectified voltage necessary to meet the requirements of the particular case in hand, and then, by the aid of regulation curves for the particular style of valve rectifier chosen, determine the A.C. voltage the transformer must give.

Let us take a practical example. Suppose we have under consideration the design of a three-valve set embodying an S.G. valve, a power-grid detector, and a

The Regulation of the Rectifier.—

pentode output valve, and, after assigning suitable values to all the components and having taken into consideration the requirements of grid bias, we decide eventually that an unsmoothed potential of 260 volts at 45 mA.s will meet the case. If the curves we have to hand take the form of Fig. 2, the procedure is to follow along the 260-volt line from the abscissæ up to the point where it intersects the 45 mA. curve. Now, by following along from the point of intersection to the ordinates on the left, we find that a transformer voltage of 235 + 235 should give the required D.C. output. Now if we allow 4 per cent. drop in the transformer secondary the total A.C. voltage must be, in round figures, 250 + 250 volts. Should the particular valve favoured have its curves given in the form of Fig. 3, the procedure is only slightly different. Starting from the 260-volt point on the left, we traverse across until we intersect the 45-mA. line rising from the abscissæ, and so find that a secondary A.C. potential of 250 + 250 volts is necessary. Now, making the allowance suggested above, we arrive at the final value of 260 + 260 volts, in round figures.

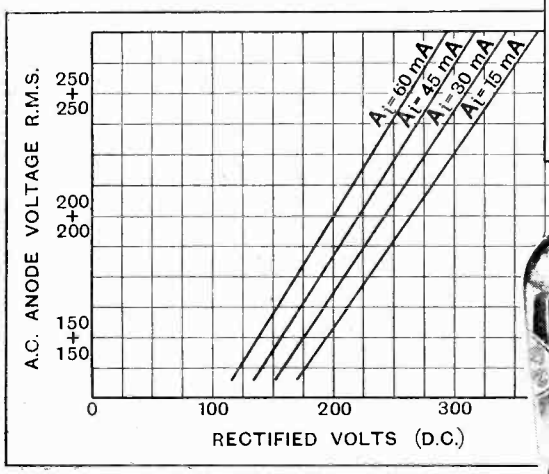


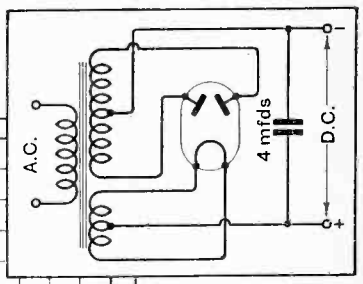
Fig. 2.—Above are shown regulation curves connecting rectified volts and A.C. anode volts for some selected values of rectified current for a full-wave valve rectifier.

The particular style of rectifying device to which the curves in Fig. 4 relate is designed to operate with a predetermined A.C. input voltage. Consequently, when designing a receiver in which one of this type is to be included, the procedure is necessarily modified. For the purposes of illustration, let us take a case where the total anode current is rather heavy—say, 60 mA.s in all—and the output stage will be quite content with an anode potential of the order of 200 volts or so. We can visualise two valves operated in parallel or in push-pull.

Our first concern is to ascertain the available H.T. voltage, before smoothing, with this current load, and the regulation curve tells that we can expect 210 volts. The procedure is then to work backwards from the rectifier, assigning values to the various anode resistances, chokes, etc., so that all valves in the set will be receiving their correct potentials.

A somewhat similar state of affairs would exist in the case of valve rectifiers if the designer was restricted in his choice of a transformer. Here again it would be necessary to start at the rectifier, having previously ascertained the total anode current required, and, working through the anode circuits, assign values for the various components so that each valve will receive its correct operating voltage, or at least a value as near as circumstances will permit.

(Right) Full-wave rectifying valve circuit. The connecting of a 4-mfd. condenser across the output is now standardised



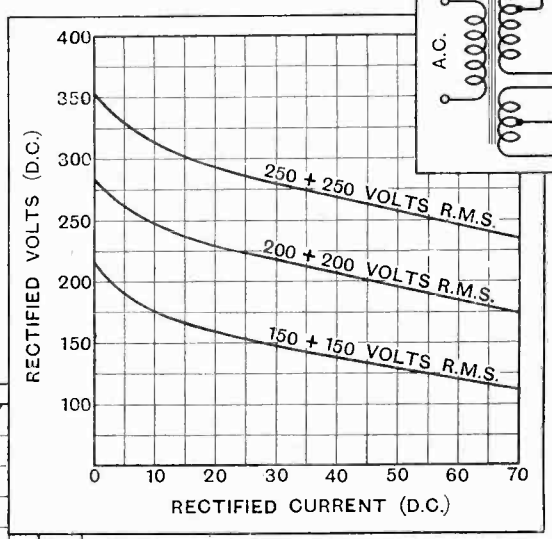
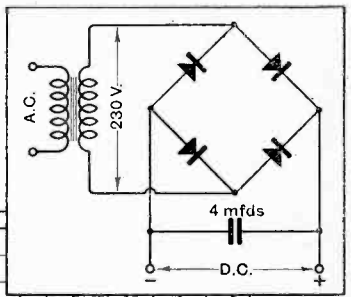


Fig. 3.—Another form of presenting regulation curves. These connect rectified volts with rectified current for some selected A.C. anode potentials, using a full-wave valve rectifier.



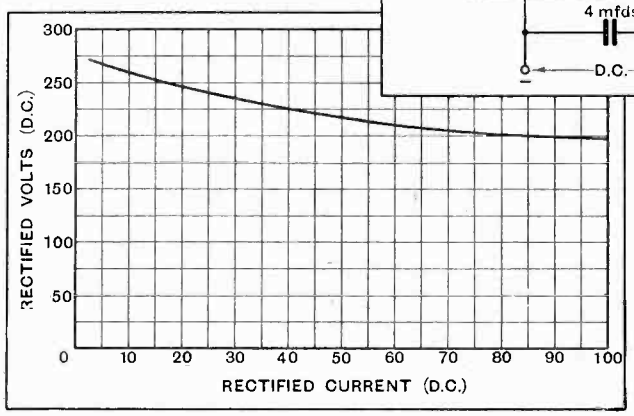


Fig. 4.—Typical circuit arrangement and regulation curve for a metal rectifier connecting rectified volts with rectified current for fixed A.C. input.

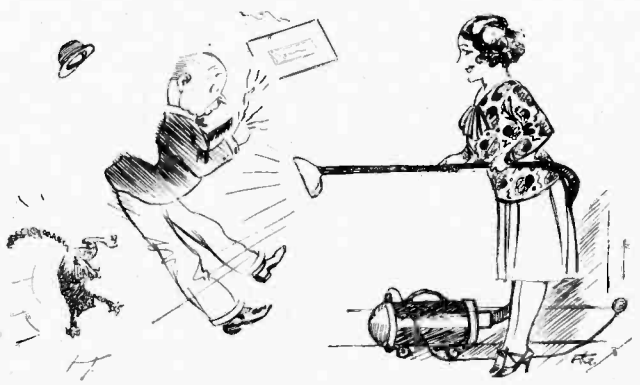
Unbiased — by "FREE GRID"

Wanted: A Vacuum Cleaner.

I WONDER how many of you are plagued as much as I am by itinerant vendors of vacuum cleaners, face lifters, and similar electrical appliances. In the case of vacuum cleaners I would not think of having one of the wretched things in my house, and think I have been fairly successful in queering the pitch of the manufacturers of these radio-destroying monstrosities—in *my* locality at any rate. The trouble is that they are all fitted with the universal commutator type of motor, and while the better makes give little or no offence at first, owing to the fact that carbon brushes, well bedded down, are used, it is not long before a certain amount of "pitting" occurs, with consequent interference not only to one's own reception but to that of one's immediate neighbours.

In the case of the cheaper instruments, however, the interference is terrible, even when they are new; even the best instrument I know—and this, by the way, is not the one which is popularly supposed to be the best—causes interference to a sensitive set. If induction motors were to be fitted all the trouble would be non-existent, and I have proof of this from tests made with various other electrical machinery in my house, including one or two fans and a large electric washer, all of which have induction motors. I have never yet, however, found a vacuum-cleaner maker willing to supply me, at any price, with an instrument having an induction motor, nor have I found any ordinary vacuum cleaner which has been demonstrated to me to fail to give considerable interference on my set—admittedly, a fairly sensitive one—even when it is brand new. The procedure which I have instructed Mrs. Free Grid to adopt when one of these gentry call is as follows:

As soon as the door is opened and he states his desire to come in and demonstrate, she at once asks: "Is your machine fitted with an induction motor?" If he replies "No," he is told not to waste his time demonstrating. Most vendors of these machines, however, are wily enough to trade upon the fact of a woman's proverbial ignorance of electrical matters and say "Yes." Mrs. Free Grid nearly always catches them out, however, by at once asking "Is the commutator a good one?" Most of these people are so ignorant of the wares they sell that they at once fall into the trap and say "Yes," and they become quite indignant when they are summarily dismissed with an injunction to go and teach their grandmother to suck eggs. Quite a few of them, however, have a certain amount of electrical knowledge and skilfully dodge the commutator trap. These are permitted to come in and give a demonstration, and in every case, so far, they have been proved to be liars immediately my radio set is switched on.



Commenced to blow.

The Machine That Blew.

I advise any reader in an A.C. district who wants a little quiet fun at the expense of these unhappy and ignorant salesmen to try this dodge or a variation of it. In D.C. districts, of course, there is no alternative to the use of a commutator motor, but, fortunately, a couple of large-capacity condensers put in series across the motor brushes will completely cure the interference provided that the junction of the two condensers is earthed.

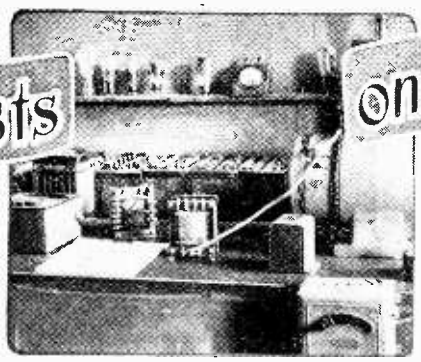
Incidentally, one "smart Alec," who had evidently been warned by other salesmen of my special needs in the matter of vacuum cleaners, did arrive one morning, when I was out, with a very neat-looking "condenser" pack which he had temporarily fitted to the machine. Mrs. Free Grid told me afterwards that his face was a sight for the gods when the vacuum cleaner commenced to blow instead of to suck!

Lightning Arresters.

A friend consulted me the other day concerning the utility or otherwise of a lightning "arrester" in connection with his aerial. As I explained to him, in the case of a "direct hit," the fate of an aerial and its associated receiver would probably be the same whether one of these devices was fitted or not. The main purpose of them, however—at least in the case of those of proper design—is to conduct harmlessly to earth static charges which accumulate on the aerial and also to deal with secondary effects produced by a neighbouring lightning flash which does not actually score a bull's eye.

I read in an American magazine the other day that the average lightning flash consists of a heavy current of fifteen billion amperes, though as these billions are of the American and not of the European variety, the current is not so great as might be at first supposed. I have not the foggiest idea of the value of the current myself, nor do I want to know, but in order to forestall letters to me asking for the value of shunt resistance to use with a three-and-sixpenny voltmeter for the purpose of measuring this current, I would inform readers that the Editor has arranged to have a suitable reply published in the "Readers' Problems" pages of *The Wireless World* if any one has the temerity to write to him and ask the question; arrangements have already been made with the printers to print the reply on an asbestos sheet.

Wireless World Laboratory Tests on New Apparatus



A Review of the Latest Products of the Manufacturers.

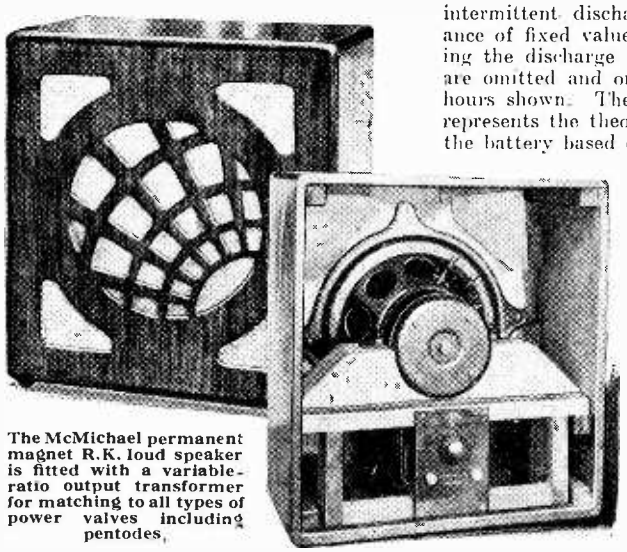
McMICHAEL PERMANENT MAGNET MOVING COIL LOUD SPEAKER.

The unit in this instrument is the well-known R.K. permanent magnet chassis. It has a 10-inch corrugated diaphragm and a massive cylindrical permanent magnet $5\frac{3}{8}$in. diameter × $3\frac{3}{8}$in. deep, giving an effective flux density of the order of 8,500 lines per sq. cm. In the particular specimen tested the output was aurally uniform from 50 to 1,500 cycles, with no perceptible suspension resonance. Above 1,500 the output rose and maintained a higher level up to 5,000 cycles, but showed signs of falling away again at 6,000 cycles (the highest frequency used in the test). The general effect is one of crispness and brilliance with no suggestion of objectionable boom in the bass.

The sensitivity is entirely satisfactory, and is comparable with that of moving-coil loud speakers with mains-energised field magnets.

The unit is housed in a handsome solid walnut case (18in. × 17in. × 9in.), and is securely mounted on substantial wood blocks. The back is acoustically open and is protected from dust by a fabric-covered skeleton panel.

An output transformer with four alternative primary tappings controlled by a rotary switch enables the user to match the loud speaker to his output valve and to make experiments in modifying the quality by trying ratios other than the optimum. The range of impedances available enables the speaker to be matched to all types of output valve, whether triode or pentode.

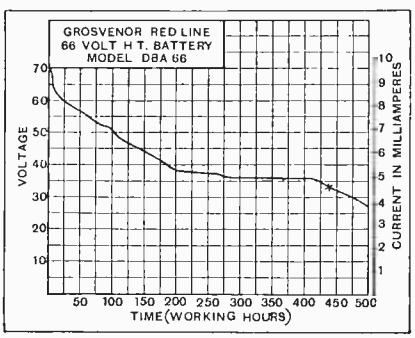


The McMichael permanent magnet R.K. loud speaker is fitted with a variable-ratio output transformer for matching to all types of power valves including pentodes.

The price is 12 guineas and the makers are Messrs. L. McMichael, Ltd., Slough, Bucks.

GROSVENOR RED LINE H.T. BATTERY.

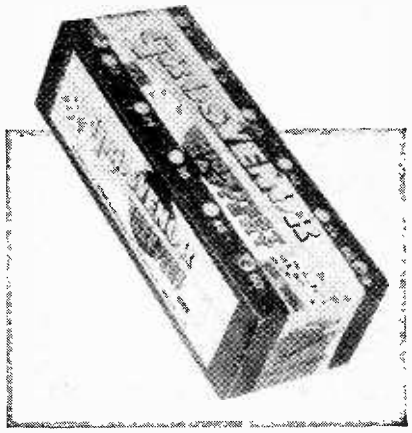
This battery falls within the standard capacity class and is rated at 66 volts



Discharge curve of the Grosvenor Red Line 66-volt dry-cell battery, model DBA66.

nominal. In conformity with our usual custom, the battery was subjected to an intermittent discharge through a resistance of fixed value. In the graph showing the discharge curve, the rest periods are omitted and only the actual working hours shown. The point marked by a x represents the theoretical cut off point of the battery based on the assumption that its useful life terminates when the E.M.F. per cell falls to 0.75 volts. It will be seen, however, that for approximately 200 hours prior to the end point being reached, the voltage is only a shade higher than at the actual termination of the life of the battery. Although the evidence points to a working life of some 435 hours, in view of the above it might be truer to say that about 250 hours is the actual life, since at this stage the adding of a boosting battery in series will most certainly be necessary to raise the voltage to the correct working level.

Calculated on the assumption that the end point of the battery is at the 435-hour mark, each cell gives a capacity of 1.95



Standard capacity 66-volt Grosvenor H.T. battery for light discharge work.

watt hours and there are 44 cells in the battery. The accepted minimum capacity of cells of the size incorporated in this battery is 1.5 watt hours each, having regard to the manner by which the discharge is effected. The quality of the material and the chemicals employed for the construction of Grosvenor batteries are, therefore, of a high standard.

The makers are Grosvenor Electric Batteries, Ltd., 2-3, White Street, London, E.C.2., and the price of this model, the DBA 66, is 6s.

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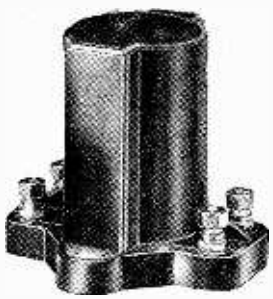

"Isomona" L.F. transformers made in 1 : 3 and 1 : 5 ratios.

"ISOMONA" L.F. TRANSFORMERS.

These L.F. transformers are made in Holland, and are marketed in this country by F. J. Ashton, Ltd., 20, Cheapside, London, E.C.2. Two samples have been submitted for test, one with a 1 : 3 ratio and the other with a 1 : 5 ratio.

Measurements show that without D.C. flowing a primary inductance of 42 henrys

is attained by the 1 : 3 model, but this falls rapidly on passing a few milliamps of D.C. through the winding. With 2 mA. of D.C. flowing, the inductance fell to 25 henrys, and with 4 mA. to 17 henrys. The D.C. resistance of the primary is 2,250 ohms.

The 1 : 5 sample tested showed an inductance of 14.5 henrys with no D.C. flowing, and only 9 henrys with 4 mA. of D.C. To obtain reasonably good results, the steady anode current passing through the primary must be kept exceedingly small, and, furthermore, a valve of comparatively low impedance should be employed. The price of these transformers is 7s. in each case.

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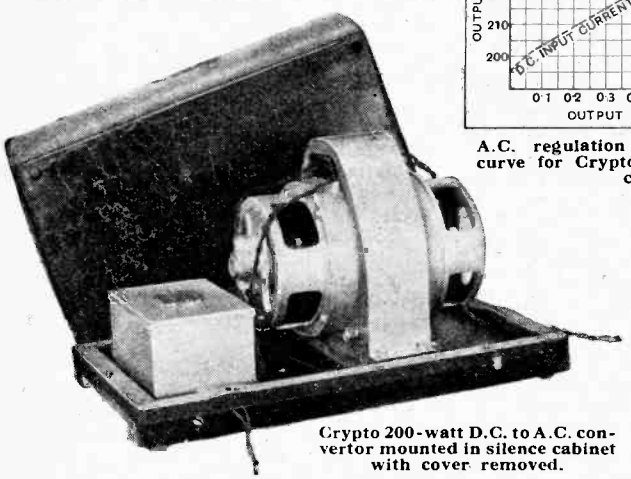
CRYPTO D.C. TO A.C. CONVERTORS.

The latest models of the Crypto machines for converting D.C. to A.C. are now available, mounted in sound-proof cases in which is included, also, a smoothing equipment. Convertors suitable for D.C. supplies of from 50 volts to 250 volts, and giving an output of from 50 watts to 600 watts are now listed.

The model submitted for test is rated to give 200 watts output at 220 volts 50 cycles. Tests showed that the actual rated output voltage was attained when the machine was delivering its full output and that on smaller loads the A.C. voltage was somewhat higher. Suitable adjustment of the connections on the mains



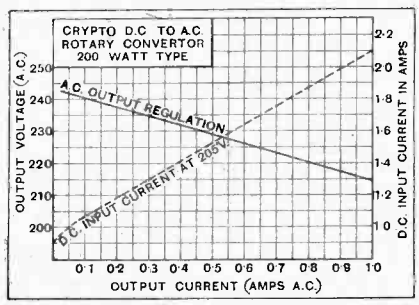
Crypto 200-watt D.C. to A.C. convertor mounted in silence cabinet with cover removed.

transformer in the set, or amplifier, will be advisable when the machine is delivering less than its full load.

The extent of the voltage variation is not unreasonable for a small machine of this type. There is a change of some 20 volts only between open circuit conditions and the full load. The regulation curve shows the measured A.C. voltage at various output loads and gives, also, the D.C. input current at 205 volts. It is a relatively simple matter to compute the efficiency from the data provided by these curves.

The illustration shows the machine in its sound-proof case, but with the cover removed. Mechanical silence is achieved by mounting the convertor on sponge rubber and similar material is used as a seal for the cover, this being fixed in position by six milled-head nuts. A fan on the armature spindle circulates a current of air through the armature tunnel for the purpose of cooling, and four small holes in the cover serve as ventilators. Needless to say, there is no undue rise in temperature.

Perfectly satisfactory results were obtained when using the machine to supply an all-mains A.C. radio-gramophone with M-C loud speaker. There was no trace of induction and no occasion was found to earth the silence cabinet, although a terminal is provided. The smoothing equipment is well proportioned and serves its purpose admirably.



A.C. regulation curve and D.C. input curve for Crypto 200-watt D.C. to A.C. convertor.

The price of the 200-watt model in silence cabinet, as illustrated, is £19 5s., the convertor only costing £14 15s. The makers are Crypto Electrical Co., Ltd., Acton Lane, Willesden, London, N.W.10.

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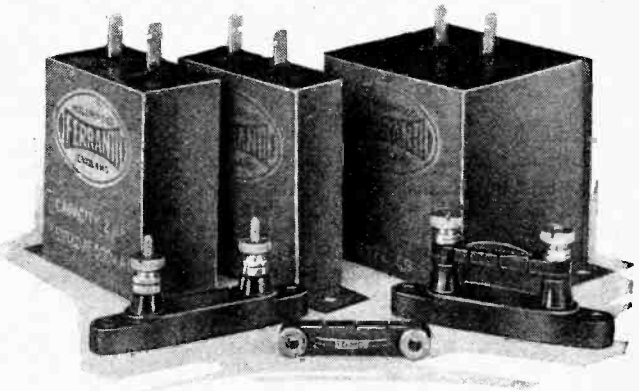
NEW FERRANTI CONDENSERS AND SYNTHETIC RESISTANCES.

A new range of fixed condensers enclosed in metal cases and intended for use in mains sets has been introduced recently by Ferranti, Ltd., Hollinwood, Lancashire. These are tested at 500 volts A.C., and their working potential is 250 volts A.C. 375 volts D.C.

Three sizes are available :—the type C7, 1 mfd., type C8, 2 mfds., and type C9. 4 mfds., the prices being 2s. 4d., 3s. 3d. and 5s. 6d., respectively.

These condensers are fitted with soldering lugs, but the 1 mfd. size can be obtained fitted with terminals, its official description being the type C10, and the price is 2s. 6d.

The new synthetic resistances are intended for use in circuits where the energy to be dissipated is small, such as decoupling resistances in bias circuits and H.F. stopping resistances in the grid circuits of power valves. They are available in values ranging from 20,000 ohms to 5 megohms, and the price is 2s. in each case. Special holders for baseboard mounting cost 9d. each.



New Ferranti mains condensers in metal cases, synthetic resistances and special holders.

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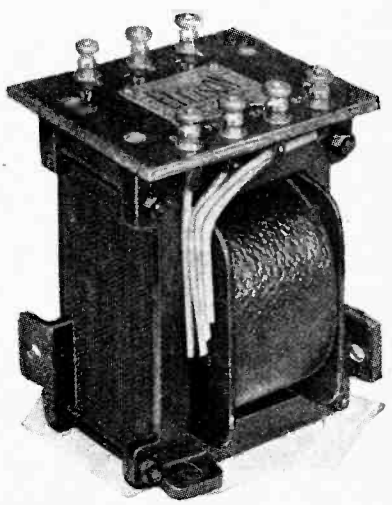
ELLISON FILAMENT TRANSFORMER.

Made by the Ellison Manufacturing Co., Ltd., Dragon Works, Harrogate, this transformer is designed to deliver up to 6 amps at 4 volts. The primary is tapped for 200-, 230-, and 250-volt A.C. supplies of the order of 50 cycles, and the output winding is provided with a centre tap. A test was made on a 240-volt 50-cycle supply, and we found it advisable to employ the 250-volt tapping. The output voltage was exceedingly well maintained, varying only 0.22 volt between open circuit conditions and the full load of 6 amps, the respective values being 4.2 and 3.98 volts (RMS). The price is 21s.



Ellison heavy duty filament transformer giving up to 6 amps. at 4 volts.

BROADCAST BREVITIES

By Our Special Correspondent.

Marchese Marconi's Talk.

Few of us have heard Marchese Marconi's voice. I doubt even whether many of the short-wave "fans," who rarely miss much, have heard the famous Italian speaking from his yacht, *The Elettra.* But to-night Uncle Tom Cobley and all will hear the inventor of wireless speaking about the pioneer days in a talk from the National transmitter at 9.20.

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The Egg Stood Up.

It was a British research worker, I think, who likened Marconi's invention of wireless to that ingenious little artifice of Christopher Columbus, who confounded the wiseacres by proving that an egg could stand up—if you first gave it a gentle crunch at one end. "We all knew about the egg," said the scientist, "but it was Marconi who made it stand up."

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Mr. Whitley Takes Notes.

Immediately the name of Mr. J. H. Whitley, ex-Speaker of the House of Commons, was mentioned in connection with the Chairmanship of the B.B.C., people in the know remarked that such an appointment would be no mere political move to supply Savoy Hill with an august figurehead. And they were right.

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The Big Five.

I hear that Mr. Whitley set a precedent by attending the last meeting of the B.B.C. Control Board. The Control Board is not to be confused with the Board of Governors, which limits itself to broad questions of policy, but is intimately concerned with the practical side of broadcasting, not disdaining to take a hand in programme arrangement where such intervention seems necessary.

The Big Five who comprise the Control Board are Messrs. Gladstone Murray, Roger Eckersley, Goldsmith, and Lochhead, presided over by Sir John Reith or Admiral Carpendale.

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Keeping in Touch.

By deciding to sit on this Board, the Chairman of the Governors has indicated his intention to keep in touch with the routine side of the business, and it would not be surprising if some very practical results were to follow in the course of the next few months.

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The Night School.

Those who hope for a leavening of the Sunday programmes need not expect Mr. Whitley to be their standard bearer; he is, however, strongly opposed to extremes and, if necessary, will not hesitate to curb the zeal of the educationists who would like to make Broadcasting House a rival to that other great night school—the Polytechnic—just across the road.

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"The More We Are Together."

Talking of Broadcasting House, it is interesting to learn that the B.B.C. will use every effort to pack the whole staff into this not over-large building. The staff are known to be very loyal and full of *esprit de corps,* and it now seems that their ideal of working "shoulder to shoulder" will soon be gloriously realised.

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Any Offers?

Certain it is that Savoy Hill will be completely evacuated. The lease has, however, at least forty years to run, and the B.B.C. are wondering who can be found to rent an attractive building containing nine studios—one of them a converted Turkish bath, decorated to resemble a Chinese drawing-room.

THE KING'S BROADCAST. His Majesty photographed before the new microphone during the royal speech at the opening of the King George V. Hospital at Ilford on July 18th.

Paul Robeson in the Studio.

Paul Robeson, whose rich voice seems to have been specially fashioned for the microphone, is to broadcast in October. He will take his original part in "Emperor Jones," the McNeil play in which he first attained fame in London three or four years ago.

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Another German Escape.

Not the least exciting of the "Escape" narratives was that of Herr Justus. Another German is to contribute to the series on August 8th. He is Korvettenkapitän Herman Tholens, who was second in command of the cruiser Mainz, which was sunk in 1914 during the British raid on Heligoland. Taken prisoner, he was sent to a camp in North Wales, whence he got a message to the Fatherland to send a submarine to help him away.

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A Thriller.

On August 6th (National) and 7th (Regional) a thriller entitled "The Bunker at the Fifth," by Marcus Dods, is to be broadcast. A golf course provides the setting for this mystery.

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The Synchronisation Test.

Quite the most daring experiment in synchronised broadcasting yet tried in this country will be carried out on Sunday next, when an attempt will be made to run Newcastle on 479.2 metres—the wavelength of Northern Regional.

It would be difficult to teach the B.B.C. engineers anything fresh about synchronisation, having regard to their long experience of simultaneous broadcasting on the common wavelength of 288.5 metres, but hitherto the practice has been confined to the low-powered and widely spaced relays.

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A Boon to Newcastle.

The engineers themselves do not seem to be highly confident that the test will succeed, but here's luck to them. The result of the test, which will continue throughout August, means a lot to Newcastle listeners, who at present get National fare from their local station and merely a repetition from their only alternative, Daventry 5XX.

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Listening at Street Corners.

I like Mr. St. John Ervine's suggestion that penny-in-the-slot listening posts should be established at street corners. As he explains in "Time and Tide," there are occasions when, being absent from home, one wishes to listen to a programme but can scarcely trespass on the good nature of a private householder.

But why bother to install listening posts? Why couldn't the man-in-the-street pop into a telephone box, insert his twopence, call "wireless," and be switched through to the Savoy Hill control room for a few minutes of Jack Payne?

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A Jackobite Rebellion.

Jack Payne, the Zoo, the weather, and G. B. Shaw are among those phenomena that attract publicity without apparent effort. Jack Payne, for instance, now finds himself the centre of a whirl of controversy. The Jackobite party stand for Jack and none other, while the anti-Jackobites allege that he needs a rest, has consumption, wants to leave the B.B.C., and, in a word, is fed up.

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The Most Popular Turn.

All these allegations are untrue. Jack is not leaving the B.B.C., one reason being that he provides the most popular of all turns at the microphone. Every week listeners send him nearly 400 letters, far in excess of those received by any other department at Savoy Hill. Nor, as has been suggested, is the B.B.C. prepared to pay another £20,000 per annum for an additional band to supplement Jack Payne and his boys.

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.

THE NIGHTINGALE.

Sir,—The article, "Nightingales and Needle Scratch," in the July 15th issue of your paper might, if taken seriously, mislead a number of broadcast listeners.

There has been a certain amount of controversy in the Press as to how the song of the nightingale is broadcast. We have even heard how the poor bird has been caught, caged, and forced to sing—by gentle persuasion or otherwise—into the microphone. It is now suggested that the B.B.C., so as not to disappoint listeners, resort to gramophone records.

I cannot help thinking that the writer of your article has not listened very carefully to the broadcasts of the nightingales, otherwise he would have heard the striking of the surrounding village clocks and other extraneous outdoor noises which accompanied the singing of the birds.

This broadcast has, for the last four years, been made from my home, and, as I have been present upon nearly every occasion, I can assure "Mr. Free Grid" that nothing but a genuine broadcast of the actual bird singing takes place, and that there has been no necessity to resort to any "Maskelyne and Devant" tricks.

G. A. VANDERVELL.

London, S.W.3.

POOR SETS IN SCHOOLS.

Sir,—Your special correspondent, under the heading of "Broadcast Brevities," in a recent issue, refers to a demonstration arranged by the B.B.C. "to provide educational authorities with a standard by which they can judge the quality of reception obtained in Scottish schools," and considers that "it would be a good thing if similar demonstrations could be given in other parts of the United Kingdom."

May I point out that the Central Council for School Broadcasting has arranged several demonstrations for teachers in the past, but the difficulty has been, apparently that the attendance at such demonstrations has not justified the expense.

However, a recent demonstration in Nottingham was quite a success. At that meeting it was evident that a large proportion of the receivers in local schools was obsolete, and (mercifully!) in disuse. Quite a number of teachers explained how they had collected £20, £30, £40, and even £45 "in the early days," and purchased a school receiver which was not now worth £5. Many of these teachers would willingly go to the trouble of raising the required cash for the purchase of new receivers if they knew that they would get satisfactory results this time, and if they knew what kind of receiver to buy.

May I point out that a school receiver :—

(*a*) Need not be "super-selective," since it is used chiefly in the daytime.

(*b*) Must obviously have a generous undistorted power output (B.B.C. recommend 600 milliwatts as a minimum), but that, since speech is required rather than music, a moving-iron speaker is suitable, the latter giving (according to the B.B.C. demonstrator) quite as good *quality* as a moving coil.

Nottingham. B.R.S. 521.

ABOLISH LONG-WAVE BROADCASTING?

Sir,—In these days of complicated tuning arrangements, band-pass filters, and superhets, nobody with any knowledge of receiver design would deny that the greatest problem is to obtain satisfactory results on both the long-wave and medium-wave bands. It is not easy to construct a band-pass filter to work equally well on both wave ranges, and a "superhet," to work well on the medium waves, is poor on the long waves; and switching devices become very complicated. Therefore, why cannot the long-wave stations be gradually abolished, and all broadcasting be done on the medium wavelengths of from 200 m. to 550 m.? The Americans have always confined themselves to this band, even without limiting the numbers of their stations to the extent that exists here, and the design of their sets is very much less complex than ours. Now that our manufacturers have to face the competition of American firms, their chances of keeping level would be greatly enhanced if they had only one wave range to cater for, and the designs could be very much more efficient and yet simple and effective.

American sets with only one range are selling over here, and the purchasers evidently do not feel the loss of long-wave reception, so why cannot our manufacturers follow the same example?

"SIMPLICITY."

Coventry.

Sir,—The Editorial in your July 8th issue concerning the National Transmitter operating on the long wave should, we suggest, be considered of great importance for an additional reason to those that you have put forward.

It is a well-known fact that American radio set manufacturers have not swamped the English markets, because of the inability of their receivers to operate on the long waves. If the National Transmitter merely becomes a duplicate of some medium-wave programme, the chances are that the Americans will flood the market to the detriment of British manufacturers.

The B.B.C. have it in their power, at any rate, to help to stem this invasion.

ROBERT COOMBER,
Worcester. F. W. Coomber and Son.

THE AMATEUR.

Sir,—I do not think Mr. Kay really meant to belittle the amateur's efforts to an extent to justify the vehemence displayed by some of his opponents. On the other hand, your correspondent "N. L. Spottiswoode" is surely overstepping the mark a little when he suggests that the listener owes a debt to radio, not radio to him.

I would say—and I believe the majority of unbiased readers of your journal will agree—that radio has much for which to thank the listener. Does Mr. Spottiswoode imagine that the big valve manufacturers would have reached the present stage of perfection in their products were it not for the tremendous impetus derived from the revenue-producing listener, and do not these remarks apply with equal emphasis to other manufacturers of radio apparatus, transformers, etc.?

Agreed all he says about the work the amateur has done, and continues to do; but is it an essential feature of his work that the science of radio should be developed first and foremost for the broadcasting of standard frequencies, transients and the like? If so, who does Mr. Spottiswoode propose should pay for the stations? The listener? I am afraid such a proposition would fail dismally.

All honour to the amateur and the pioneer, but let us at least have the benefit of his work for the good of the community.

Streatham. A. R. OSBORNE.

Sir,—Mr. Schnell enters the lists from a somewhat different angle—that of the American amateur. That being the case, I have no doubt that most of what he says is correct, as the American enjoys greater facilities and encouragement than does his British contemporary.

I have no doubt that the average British amateur could be of considerable use to the services for relaying of messages, etc., since only enthusiasm and a simple retroactive circuit plus a slight knowledge of the Morse code would be necessary.

The real trouble seems to be that the average amateur pays too much attention to the social side and insufficient to the mathematics of the business, so that he has no theoretical peg (except a few rather doubtful sun spots) on which to hang his practical operations.

Let us clean up this Q.S.L. card business and get down to some real work; then, and only then, can the young amateur of to-day successfully withstand attacks without having to shelter behind some exceedingly useful work done by the old stager.

Worcester Park, Surrey. L. A. C. LAWLER.

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.

The Effect of Environment.

My newly constructed 2-v-1 A.C. mains receiver is lacking in stability on wavelengths below about 300 metres when operated in my own home. On taking the set to another house on the same electrical supply system, I find that there is no sign whatsoever of instability, even at the extreme lower end of the tuning scale.

I have not yet started any attempts to trace the cause of this instability, but should be very interested to know what the effect I have described may indicate.

It seems fairly certain that your own earth connection is of much higher resistance than that at the house in which the set behaved as it should. Of course, there is the possibility that when the second test was made, the mains voltage was extremely low, but we think this can be ruled out.

Modern sets of the more sensitive kind are extremely susceptible to the ill effects of a high-resistance earth connection.

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Superheterodyne I.F. Amplifier.

Would any advantage be gained by replacing the tuned anode coupling between the I.F. valve and second detector of the Band-pass Superheterodyne with another band-pass filter coupling?

Unless considerable alterations are to be made in the design of the set, we cannot recommend this course. The various circuits were planned on the assumption that a certain amount of high-note loss would take place in the I.F. amplifier, and compensation was accordingly introduced in order to prevent over-accentuation of the lower audible frequencies.

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Frame or Mains?

It is quite impossible for me to erect an outdoor, or even a good indoor, aerial. Which would be the more efficient—a frame or a so-called "mains" aerial?

The behaviour of a mains aerial is notoriously inconsistent, and it is quite impossible, without actual experience, to predict what results will be obtained from it in any particular locality. On the whole, however, we think it true to say that an aerial of this kind has as a rule a larger signal pick-up than a frame of the largest size likely to be tolerated in the home.

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Combined Detector and Output Valve.

I was interested in a description (published in your issue of May 13th) of a single-valve loud speaker set for operation on D.C. mains. Unfortunately, I live rather too far from the nearest station for this arrangement to be suitable in my case, but should imagine that, with the addition of a single H.F. stage of relatively low efficiency, a set with sufficient sensitivity could be devised.

If you think that this would be satisfactory, will you please give me a diagram showing how the filament circuits of a two-valve receiver on these lines should be arranged? It is proposed to use indirectly heated D.C. mains valves.

There is no reason why a pentode, acting as a combined detector-output valve, should not be preceded by an H.F. stage, in order that signal input to the rectifier may be increased. A recommended method of connecting the heaters and cathodes is illustrated in Fig. 1; we have added grid circuit connections in order to make clear the method of obtaining bias for the H.F. valve.

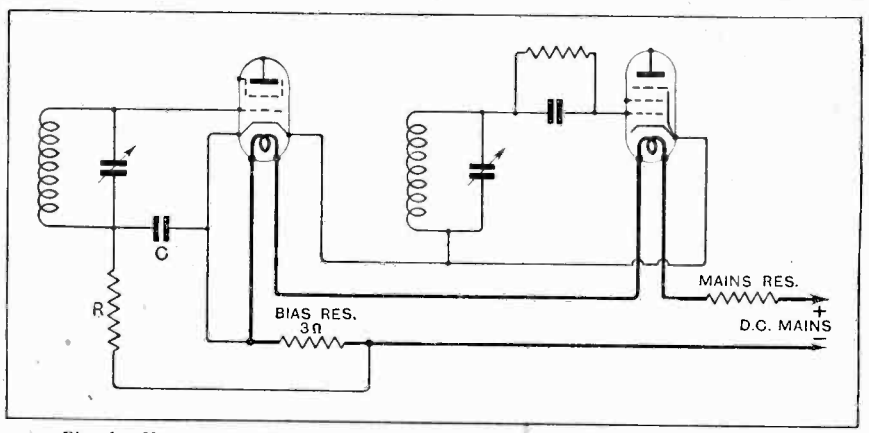

Fig. 1.—Heater, cathode and grid return circuits of a D.C. mains set with combined detector-output pentode and one H.F. stage.

Although a grid circuit decoupling resistance (R) and condenser (C) are shown, it should perhaps be pointed out that these may not be necessary if a low-gain H.F. stage is employed; also it must be realised that slightly more effective smoothing than that suggested in the paragraph to which you refer may be necessary when an extra valve is added.

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The Same Cost.

When charging L.T. accumulators directly from D.C. mains, it is a fact that it costs as much to charge a single battery as a large number of cells?

Yes; assuming a normal supply voltage of about 250, it would be possible to recharge nearly 100 cells for exactly the same expenditure as for a single cell—let alone a single battery. The reason is that when a few cells are being charged, the greater part of the wattage consumed is dissipated in heating a resistance. As the number of cells on charge is progressively increased, the necessary voltage-reducing resistance becomes lower in value, due to the larger back-E.M.F. of the cells, and consequently the wasted wattage becomes less and less until a point is reached where practically no added resistance is required, and where consequently there is no loss.

Fitting an H.F. Potentiometer.

The aerial circuit of my "2-H.F." receiver is as shown on the attached sketch: will you please show me how to fit an aerial input resistance potentiometer to act as volume control?

With a circuit arranged as in your own set, it is a very easy matter to make this addition. The potentiometer may be

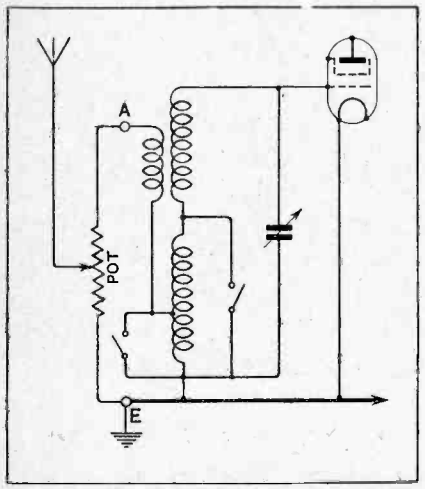

Fig. 2.—Potentiometer volume control added to an existing receiver.

connected externally if desired; all you have to do is to join the ends of the resistance element to the aerial and earth terminals and to transfer the aerial connection to the potentiometer slider.

These connections are shown in Fig. 2. The potentiometer should have a resistance value of from 25,000 to 50,000 ohms.

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Trimmer Controls Regeneration.

An external trimming condenser is connected across the H.F. tuning condenser of the 1-v-1 set which I have just completed. This control does not seem to be working properly, and at a certain setting self-oscillation is produced. I cannot see any reason for this, as the condenser is not in any way associated with the reaction circuit.

We are afraid that this must be taken as an indication that your set is lacking in stability; as soon as the various circuits are brought into resonance at approximately the same wavelength, H.F. oscillation is produced. This, of course, has nothing to do with the trimmer *per se;* the same effect would be evident if the H.F. tuning condenser could be adjusted independently.

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Automatic Bias Conversion.

If it is possible to do so, will you please describe in simple terms how the output valve of a set, originally designed for battery feed, but now deriving its H.T. supply from an eliminator, may be biased automatically, without making any internal alterations?

This is rather a difficult question to answer in general terms, but briefly the procedure is as follows:

Insert a bias resistance of the correct value, as ascertained by calculation, between the H.T. negative terminals of set and eliminator. Next, connect the existing "G.B. negative" lead to the H.T. negative terminal of the eliminator through a 100,000-ohm resistance. Finally, join the point to which the G.B. negative wander lead is connected to the nearest "earth" point through a 2 mfd. condenser.

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Condenser Breakdowns.

Although my 1-v-1 mains-operated receiver generally works well, I have had trouble on several occasions through breakdowns of smoothing and by-pass condensers.

I am sending you a diagram of the set, and should be obliged if you would look over it, and say if there is anything in the circuit arrangement that might account for these recurring condenser failures.

We see that you are using a power rectifying valve of the normal directly heated type, which begins to function almost as soon as the supply current is switched on. The receiver valves, on the other hand, are all indirectly heated, and warm up quite slowly; in fact, they do not pass any anode current until many seconds after the rectifier has reached its normal operating condition.

This means that there will be an initial rise of H.T. voltage, and the condensers will be subjected to a much higher pressure than the normal working voltage. Accordingly, they should have a larger factor of safety than those used in a similar receiver where at least one of the valves is of a type which will begin to consume anode current as soon as the rectifier begins to deliver it.

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Decoupling a Milliammeter.

When I attempt to take a reading of the total H.T. current consumption of my receiver by joining a milliammeter between the H.T. negative terminal of the set and the negative terminal of the H.T. accumulator battery, I find it impossible to get a true reading, as self-oscillation then takes place. How can this be prevented? Would it be possible temporarily to "decouple" the milliammeter in some way?

A measuring instrument connected in the way you describe may be regarded as an addition to the internal resistance of the source of H.T. supply. This being so, the decoupling resistances included in the normal manner in a receiver should be effective in preventing self-oscillation.

Possibly, however, as you are using an H.T. accumulator battery, presumably of low internal resistance, you have found it unnecessary to include these decoupling devices, and it would certainly be very wasteful to do so merely for the sake of making a measurement of anode current. We suggest that the simplest way of obtaining a true reading is temporarily to short-circuit the input grid impedances of all H.F. and L.F. valves. In the case of a normal type of receiver, this should not have any effect on anode current, but will prevent the possibility of self-oscillation either at high or low frequency.

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Spoiling a Filter.

In order to reduce the sensitivity of my receiver for local-station work, I propose to fit a two-way switch, so that the normal filter coupling condenser of 0.01 mfd. may be replaced by a capacity of 1 mfd., which I find gives adequate coupling when very strong signals are being received.

One can hardly countenance this proposed arrangement. By using such a weak inter-circuit coupling as that provided by a condenser of 1 mfd., there will be no tendency whatsoever for the filter tuning to broaden sufficiently to embrace sidebands, and the main object of this arrangement will be defeated. Worse still, this loss on sidebands will take place when strong local transmissions, from which high quality is naturally expected, are being received.

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FOREIGN BROADCAST GUIDE.

COPENHAGEN

(Denmark).

Geographical position: 55° 41′ N., 12° 35′ E.

Approximate air line from London: 598 miles.

Wavelength: 281 m. Frequency: 1,067 kc. Power: 1 kW.

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

Standard Daily Transmissions.

07.30 B.S.T. (weekdays); 08.30 (Sun.), physical exercises; 08.30, relay of Cathedral service (10.00 Sun.); 12.00, luncheon-hour concert; 15.30, musical broadcast; 20.00, main evening programme; 23.00, dance music (Sun., Tues., Thurs., Fri., Sat.).

Male announcers only. Call: *Kökenhavn Kalundborg* (phon.: *Key-oben-harven Karl-oond-borr*) *og Danmarks kortbölgsänrör* (short wave transmitter). Announcements in Danish only, except for transmissions of international interest, when details are also given in the French, German and English languages.

No interval signal, but end of transmission is frequently marked by three strokes on a gong.

When late broadcasts are carried out a time signal and chimes are relayed from the Copenhagen Town Hall at midnight C.E.T.

Closes down with the words: *Hermed er programmet slut for iaften* (Herewith the programme terminates to-day); *Vi meddeler dem programmet for imorgen* (we give you to-morrow's programme) *Glem ikke at soette antennen* (don't forget to earth your aerial). *God nat, God nat* (Good Night).

The National Anthem, *Der er et yndigt Land*, is played on occasion.

Relays: Kalundborg, 1,153 m. (260 kc.), 10 kW.; Skamlebaek (OXY), 31.51 m. (9,520 kc.), 0.5 kW.