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AND RADIO REVIEW
(18th Year of Publication)

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

Sources of Revenue for Broadcasting.

THE stupendous task of building up the broadcasting service in this country has from the outset necessitated a continual extension of the demands for funds. The requirements of broadcasting, even in the earliest days, were great, but the annual expenditure then was but small by comparison with the sum involved to-day, after many years of additions to the commitments of the B.B.C., many of which are self-imposed tasks complementary but not essential to broadcasting as a service.

Increasing expenditure on the part of the B.B.C., necessitating the finding of additional revenue, has had the effect of making the Corporation ever on the look-out for means to an end, the end being always more funds to meet the growing expenditure.

To illustrate this point, there was a time when the B.B.C. gladly supplied photographs of their stations' apparatus, etc., for publication without charge. To-day a Photographic Department takes all B.B.C. photographs for publication, and a reproduction fee is payable by any paper reproducing them. Special numbers of B.B.C. publications are produced as an excuse for charging a higher rate for copies, and in every direction we see the grasping attitude which the Corporation is cultivating.

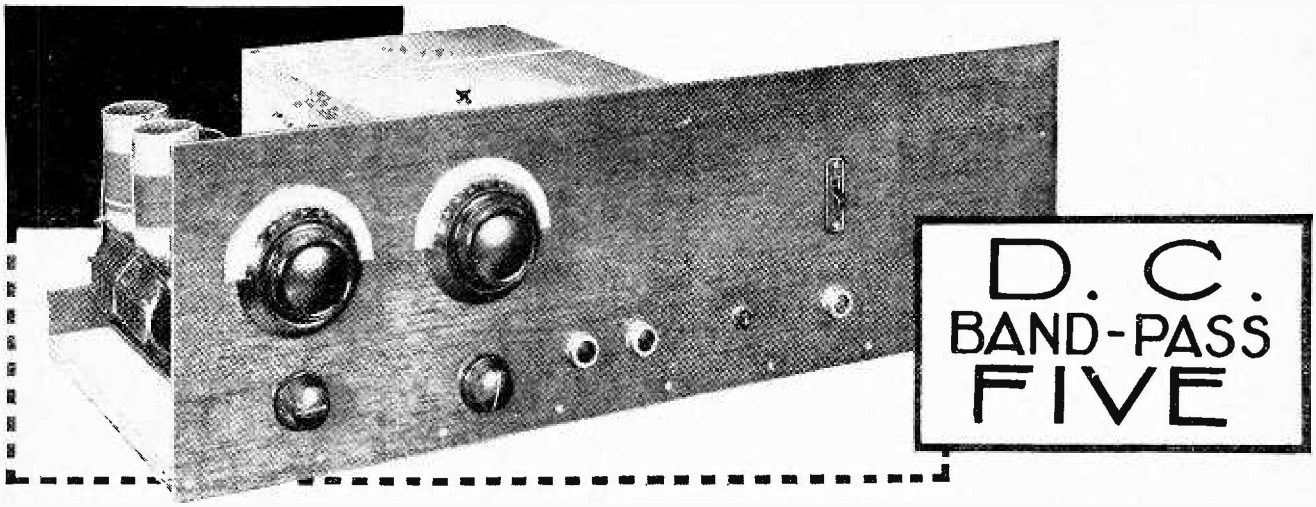
Is it surprising, therefore, that we should look with suspicion on every fresh move which the B.B.C. takes? We have no quarrel with the Corporation in endeavouring to advance its revenue by means which may be considered legitimate and proper.

In January of last year, after commenting on the outcry which the publication of *The Listener* produced, we added: "Perhaps the recent outbreak may serve to revive the efforts of the entertainment industry to safeguard themselves against encroachment which they have every reason to fear. In the plans for the new Broadcasting House we observe that a super studio, with accommodation for 1,000 members of the public, is promised. Whether the B.B.C. derives box-office receipts from such an audience or not, in either case it would seem to us that this is equivalent to the establishment of a B.B.C. theatre or concert hall in direct competition with those privately owned."

B.B.C. Applies for Entertainment Licence.

In a recent issue of the *Daily Telegraph* we read that the B.B.C. had applied for a music and dancing licence in respect of their new giant studio, which, if granted, would permit the B.B.C. to admit the public on payment of an admission fee. It was explained by the B.B.C. that they wished to obtain the necessary powers to use them only if thought fit. In other words, they wish to have at their disposal a new source of revenue to be gained in competition with the existing entertainment industry, and to create a precedent to enable them to extend these activities as and when they please in the future.

In This Issue



A Four-stage Long Range Screen-grid Receiver.

By L. E. T. BRANCH, B.Sc.

THOSE who possess direct current mains in their houses have at their command a very convenient and cheap source of energy supply for wireless purposes. If the voltage is sufficient to operate a fairly generous output stage they can congratulate themselves on being able to avoid incurring the cost of a heavy mains transformer and rectifier. The present receiver is designed for operation on any D.C. supply from 200 to 250 volts, push-pull being adopted in the output stage in order to obtain, among its other advantages, a good undistorted output, without employing excessively high voltages. The filaments of all the valves are arranged in series, which has the advantage of permitting the removal of any valve from its socket while the set is working without doing any damage to other valves.

The filaments of the output valves are rated at 0.25 ampere, and one of them is shunted with a resistance which by-passes the high-tension current of the other one.

This is more important than might otherwise be thought. We are so used to feeding valve filaments in terms of the applied voltage, that we are liable to forget that a 10 per cent. increase in current means a considerably excessive voltage is produced across the filament, and would, no doubt, damage the valve. It will be noticed that the filament of the valve V_5 is in the negative H.T. return lead of the valve V_4, and for this reason the anode current of V_4 is by-passed through the resistance R_4. The other valves are shunted with suitable resistances because their filament current consumptions are less than 0.25 ampere. Here again the anode current of the detector valve is passed through the filaments of both the H.F. valves, and since this anode current is 10 milliamperes, the current flowing along the wire W is 0.25 ampere when that in the wire X is 0.24 ampere.

A red signal light G_1 provides an easy means of indicating whether the set is "on," and also acts as a fuse. Two green signal lights G_2 and G_3 are incorporated in the filament circuit, and by ganged switches show clearly whether the receiver is set for "medium waves," "long waves," or "gramophone." These lights were included in the first place almost as an experiment, and it was only during subsequent manipulation of the receiver that it was discovered that they are a real convenience and well worth incorporating, especially as their cost is quite small. One control operates all the switches. It will be noticed that if the filament current is followed in from the negative supply it first passes through the push-pull valves and then to the first H.F. valve, next to the second H.F. valve, and, finally, to the detector. This arrangement is very convenient in the general design of the circuit, and, among other things, has the merit of confining heavy speech currents to the output stage. It also enables a maximum high-tension voltage to be applied to the output valves. An external resistance is necessary to absorb the unwanted voltage associated with the filaments. The current carried by this resistance is 0.24 ampere, but since the voltage to be absorbed by it will depend upon the mains voltage, this latter must be taken into account when estimating the value of resistance required.

The method of detection adopted is the well-known "power-grid" employing a very low impedance valve with approximately 140 volts on the anode, and a posi-

SPECIFICATION.

All Mains D.C. Receiver with two Screen-grid Stages.

HIGH SELECTIVITY by means of ganged circuits and inductively coupled pre-selector.

POWER GRID DETECTION giving good sensitivity and high quality.

PUSH-PULL OUTPUT affording adequate power output with silent background.

PRE-H.F. VOLUME CONTROL, which together with pre-selector, minimises cross modulation.

GANGED WAVE-CHANGE SWITCHING.

PROVISION FOR GRAMOPHONE PICK-UP.

TWO-DIAL CONTROL.

D.C Band-pass Five.—

tive bias of half the filament voltage of the valve ensuring a linear characteristic.

It will be noticed that all the anode current passes through the primary of the transformer. The AF5C will stand up to 30 mA. without mechanical breakdown, while at 9 mA. the inductance is about 70 henrys, which, with a valve of 8,500 ohms impedance, gives excellent low-note reproduction, a 50 cycle note being reproduced at 95 per cent. of its full value. Since the anode current flowing when no signals are being received is 9-10 mA., the efficiency of detection is high. Further, the L.F. amplification is such that, since the output valves overload at about the same time as the detector, the quality of the reception is of the highest order. In fact, the whole set is designed in order to give first-class quality from the local station, good quality transformers is carefully avoided, and in this way the tuning condensers gang correctly, although the step-up ratio of the first medium-wave transformer is approximately 1 : 4, and the ratio of the second transformer is 1 : 2.

A high-frequency transformer having a high step-up ratio r imparts considerable selectivity, because the tuning condenser causes a large capacitative load to be thrown across the primary, this load being $C \times r^2$ where C is the capacity actually in use across the secondary. This large effective capacity can be considered as providing a very free path for the untuned, and, therefore, unwanted signals. Two condensers are exceedingly easy to gang, and great accuracy results with the expenditure of very little effort.

The band-pass filter is of the inductively coupled type which provides fairly constant peak separation over the

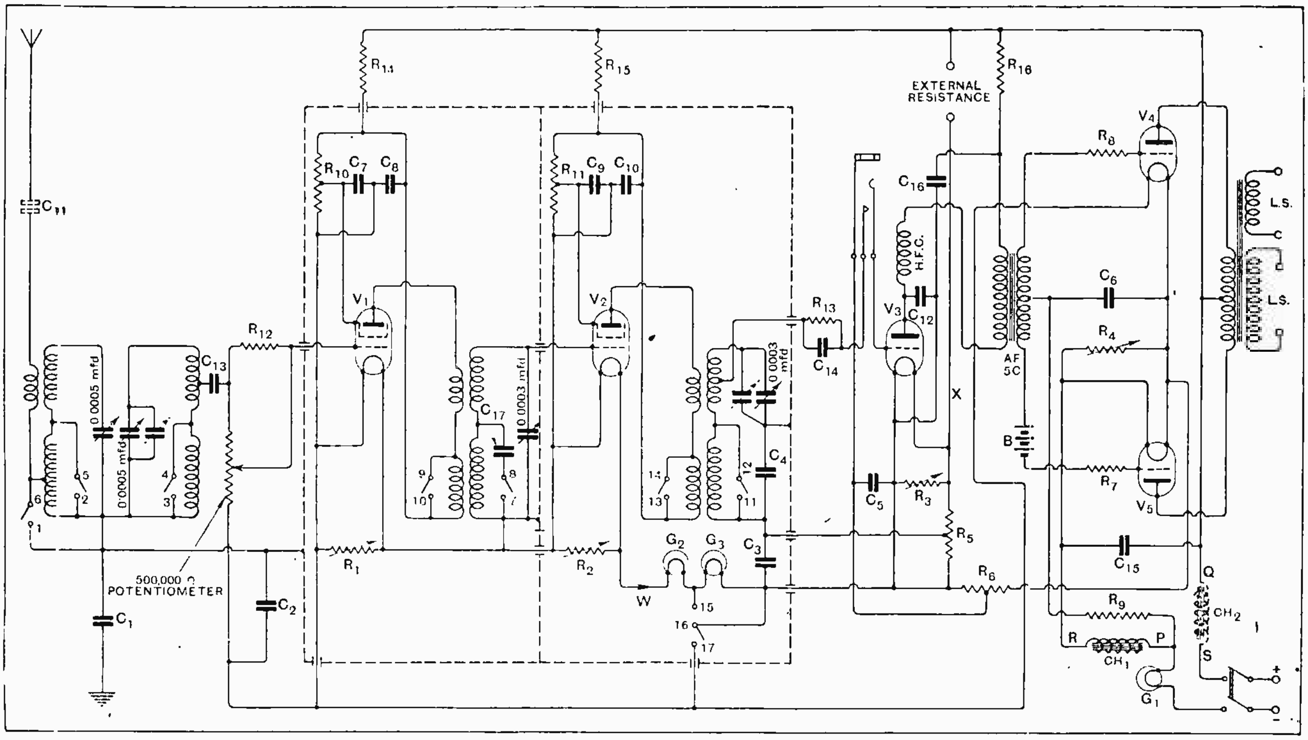


Fig. 1.—The circuit diagram. C_1, C_2, C_3, C_4, C_5, C_6, 1 mfd.; C_7, C_8, C_9, C_{10}, 0.1 mfd.; C_{11}, C_{12}, 0.001 mfd.; C_{13}, 0.0003 mfd.; C_{14}, 0.0001 mfd.; C_{15}, 8 mfd.; C_{17}, 0.003 mfd. R_1, R_2, 0 to 50 ohms; R_3, 0 to 30 ohms; R_4, 0 to 400 ohms; R_5, R_6, 20,000 ohms, centre tapped; R_7, R_8, 25,000 ohms; R_9, 100,000 ohms; R_{10}, R_{11}, 60,000 ohms, centre tapped; R_{12}, 50,000 ohms; R_{13}, 250,000 ohms; R_{14}, R_{15}, 10,000 ohms. C_{16} see text.

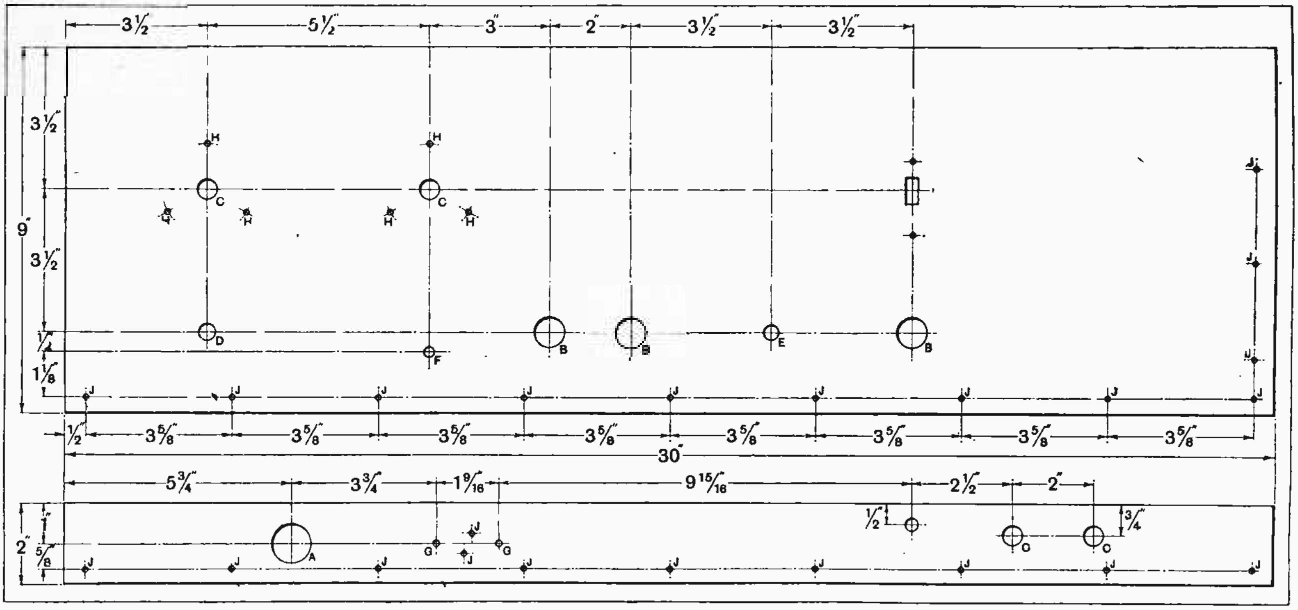
from distant stations coupled with good range and selectivity.

Of the two H.F. stages, one is sharply tuned, while the other is more flatly tuned, and since for local reception the sharp one is preferably cut right out, the result is of the best when we remember that a band-pass filter is included before the first H.F. valve. The H.F. valves are transformer coupled, fairly efficient coils being used in order to employ a high step-up ratio in one stage, thus obtaining high selectivity. It might be argued that "good" coils are not necessary in a receiver of this kind, but in this particular case they are just as easy to wind as less efficient ones. Capacity coupling between the primary and secondary of the whole tuning scale. The amount of inductive coupling between the band-pass coils on both wavelength ranges depends solely upon their distance apart and the relationship between their axes, as described in last week's issue of *The Wireless World*.

The medium-wave coils of the present set consist each of 66 turns wound upon 2in., i.e., 5 cm. diameter formers, so arranged that d can be either 8.5 cm. or 10 cm. The cross-sectional area of a 2 in. coil is 20 sq. cm., hence the inductive coupling when the distance between the centres, $d = 8.5$ cm., is

$$\frac{A^2N^2}{1000\,d^3} = \frac{20^2 \times 66^2}{1000 \times 8.5^3} = 2.85 \text{ microhenrys.}$$

This is sufficient coupling to retain well fre-

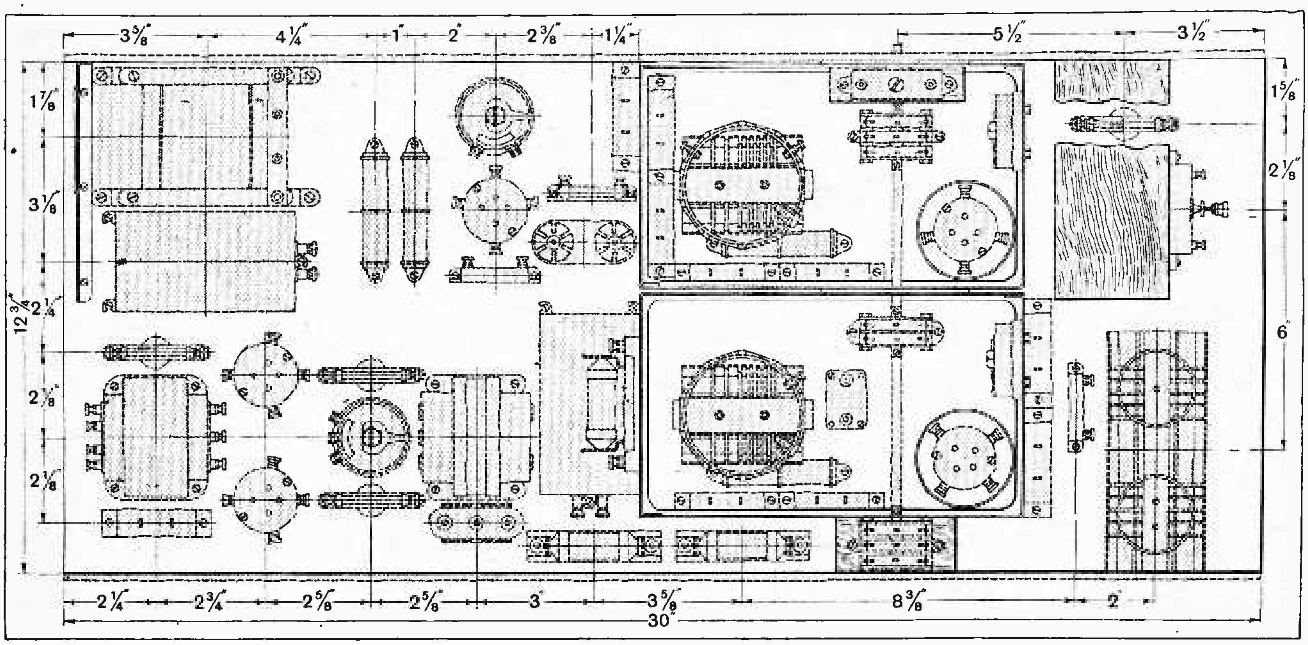


Dimensional data of the panel and terminal strip.

quencies up to 5,000 cycles. When $d=10$ cm., the coupling is 1.75 microhenrys, and the high notes are still present to great advantage, while selectivity is improved. The coils are arranged so that in a moment one can change from one value to the other.

On the long waves A=32 sq. cm., N=200, while d is fixed at 7.5 cm. Hence, the coupling is $\frac{2A^2N^2}{1,000 \times d^3} = \frac{2 \times 32^2 \times 200^2}{1000 \times 7.5^3} = 195$ microhenrys, which ensures adequate reproduction of the high audio-frequencies. Preferably, a single short-circuited turn of fairly heavy gauge wire is wound exactly mid-way between the coils. In this way the mutual inductance is reduced to approximately 100 microhenrys, and while a little signal strength is lost, the selectivity is increased.

The medium-wave aerial coil of the band-pass filter has a small primary winding to which the aerial is connected. This primary is connected to a tapping on the long-wave coil in order that by a simple switching operation the ratio of the turns in the aerial to those of the whole coil remains the same on long and medium waves, thus ensuring that the capacitative load thrown by the aerial across the tuning condenser is the same on both



General layout of the components on the baseboard.

D.C. Band-pass Five.—

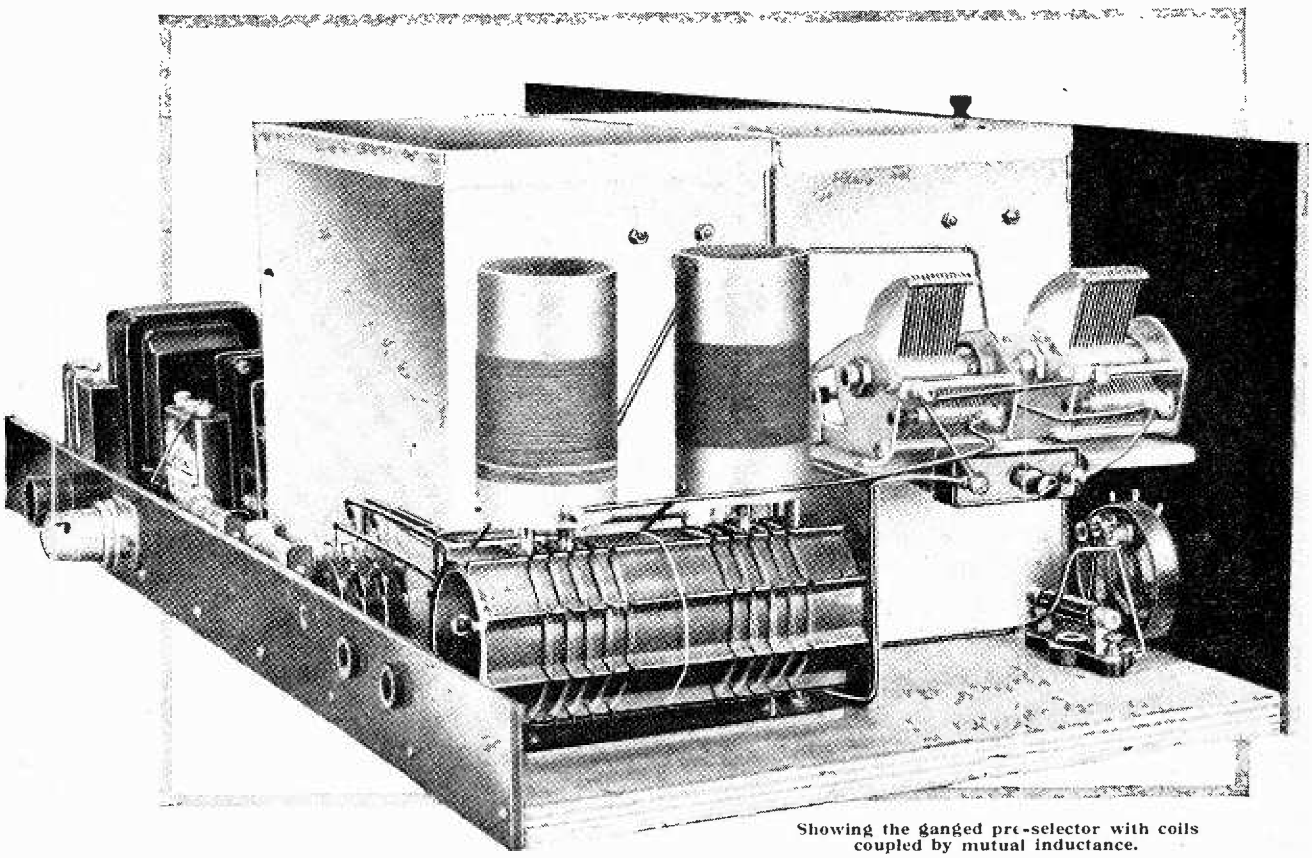
wavelength ranges. With an outdoor aerial it is advisable to use an 0.001 mfd. condenser in the aerial lead to isolate this latter from the mains. This component is shown as C_{11} in dotted lines.

It should be noticed that for tuning the high-frequency transformers, condensers of 0.0003 mfd. capacity are preferably used. The secondary inductances of the transformers are high, and the result is to avoid sharp tuning and bad high-note loss.

No grid-bias is used on the high-frequency valves, consequently, only the new Cossor screen-grid valves[1] can be employed, since grid current does not flow in these valves until the grid is one volt positive. The denser C_{16} of 8 mfd. for the detector anode feed. Since the 2,000 ohm resistance R_{16} must be retained in the anode feed in order to drop the voltage correctly, it is advisable to be on the safe side and use a 4 mfd. if it is not desired to incur the expense of 8 mfd.

The value of 2,000 ohms given in the present set is to be used only when the mains supply is 220 volts or less. When it is above this amount a 4,000 ohm resistance should be used. Since the feed-resistance is now doubled, the same decoupling effect is obtained by halving the condenser so that now 4 mfd. is ample, while 2 mfd. can be used if desired.

Two large chokes CH_1 and CH_2 are shown for smoothing the mains supply. It is found that unless the mains



Showing the ganged pre-selector with coils coupled by mutual inductance.

volume control is pre-H.F., and takes the form of a grid potentiometer on the input of the first high-frequency valve. The 50,000 ohm fixed resistance which is connected from the arm to the high-potential end of the potentiometer, prevents the series grid-resistance from becoming too great, and, at the same time, the tuning-coil is practically not damped at all when full volume is required on a distance station. Also when the set is in its most sensitive condition the control is more gradual than when the 50,000 ohm resistance is omitted.

When the push-pull valves are reasonably well matched it is not necessary to use a decoupling con- are particularly rough only one of these need be retained. For positively earthed mains simply omit CH_2 and short the wires which go to it. For negatively earthed mains we must retain CH_2, but we cannot just omit the choke CH_1. The voltage drop across this latter is 18 volts, and contributes to the grid bias for the output valves. Hence, if CH_1 is omitted, a *resistance* of 60 *ohms must be used in its place.* When particularly rough mains, for instance, where there mercury-arc rectifiers are employed to energise this receiver, it is suggested that both chokes be retained, and, preferably, another 8 mfd. condenser should be connected across the points PQ or across RS.

The grid bias obtained by the valve V_4 when the choke CH_1 of 60 ohms resistance, or in its place, a 60

[1] See *The Wireless World*, Sept. 10th, 1930, p. 250.

LIST OF PARTS.

1 Bakelised board front panel, 30 × 9 × 3/16in.
1 Bakelised board terminal strip, 30 × 2 × 3/16in.
1 Baseboard, 30 × 12¾in., 5-ply.
2 Variable condensers, 0.0005 mfd. (Polar Universal).
2 Variable condensers, 0.0003 mfd. (Polar Universal).
2 Reduction gear dials and station logs (Burndept Ethovernier).
1 Mains switch (Bulgin S.56).
1 Potentiometer, 500,000 ohms (Rothermel Centralab).
2 Switches, 3-pole (Utility W. 190/3).
1 Switch, 2-pole (Utility W. 190/2).
1 Knob and rods for switches.
3 Flush signal lamp holders (Bulgin D.9).
2 Bulbs, 0.25 amp. (Bulgin Type M).
1 Bulb, 0.3 amp. (Bulgin Type N).
1 Single closed circuit jack (Igranic P.62).
1 Universal plug (Igranic P.40).
2 Screening boxes, 9½ × 5½ × 8¼in. (Magnum).
2 Pre-set resistors, 50 ohms (Igranic 2241/18).
1 Pre-set resistor, 30 ohms (Igranic 2240/17).
1 Potentiometer, 400 ohms (Igranic 2241/22).
5 Valve holders (Burton).
2 Resistances, 60,000 ohms, centre-tapped (Colvern).
2 Resistances, 20,000 ohms, centre-tapped (Colvern).
1 Resistance, 50,000 ohms and holders (Graham-Farish).
2 Resistances, 25,000 ohms and holders (Graham-Farish).
1 Resistance, 100,000 ohms and holders (Graham-Farish).
2 Anode resistances, 10,000 ohms and holders (Ferranti).
1 Anode resistance, 2,000 or 4,000 ohms (see text) and holder (Ferranti).
1 Grid leak, 0.25 megohm.
1 Condenser, 0.0001 mfd. with grid leak clip (Graham-Farish).
1 Condenser, 0.001 mfd. (Graham-Farish).
1 Condenser, 0.0003 mfd. (Graham-Farish).
1 Condenser, 0.003 mfd. (T.C.C. Flat "S" Type).
6 Condensers, 1 mfd. 250v. D.C. working (T.C.C. Type 64).
4 Condensers, 0.1 mfd. 250v. D.C. working (T.C.C. Type 64).
1 Condenser, 8 mfds. 500v. A.C. test, 240 v. working (Hydra).
1 Condenser, 8 mfds. 500v. A.C. test, 240 v. working (Hydra) (C_{16}, see text).
1 H.F. choke (Climax).
2 Semi-variable condensers, 0.0001 mfd.—0.000005 mfd. (Formo Type F.).
1 Push-pull transformer (Ferranti AF5c).
1 Push-pull output transformer, double ratio (Varley DP7).
1 L.F. choke (Savage C/27G). If mains are rough a double choke assembly will be required (Savage D/27G).
2 Mains terminals, aerial and earth (Clix).
1 Batten type lampholder (G.E.C. Pattern F1080)
1 Small plug and socket (Bulgin P.18).
1 Grid bias battery, 4½ volts (Ever Ready UW8).
2 Ebonite formers, 6in. length × 2⅝in. dia., 8-ribbed (Becol).
2 Bakelised formers, 3½in. × 3in. dia.
2 Bakelised formers, 3½in. × 2in. dia.
1 Valve screen, 2½in. long × 2.5/16in. dia. (The "Loud Speaker" Co., Ltd., 2, Palmer Street, Westminster, London, S.W.1.)
14 Pins and sockets, for coils only (Clix).
14 Small terminals, for coils only (Clix).
1 Panel bracket.
Wire, screws, wood, ebonite, sleeving, etc., etc.

Approximate cost, £18.

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

ohm resistance, is used, is the voltage dropped through it, namely, 18 volts plus the 6 volts dropped through the valve V_5. The bias battery B, therefore, has to be inserted to increase the bias on the valve V_5. Although B should, theoretically, be 6 volts, so that each valve is biased to -24, actually a 4½-volt battery is used because it is easy to procure, and the difference of 1½ volts appears to make no difference whatever. There is no way of avoiding the use of this battery unless the secondary of the transformer be wound in two separate sections. However, it is a small item which requires replenishing so infrequently that it need cause no concern.

(To be concluded.)

CLUB NEWS.

Finding Faults.

A talk on the discovery and remedying of faults in receiving sets provided an interesting evening at the last meeting of the Wembley Wireless Society.

Mr. Wallis dealt at some length with a simple method for testing the various parts of the receiving set by the use of a neon tube.

Hon. Secretary, Mr. H. E. Comben, B.Sc., 24, Park Lane, Wembley.

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Preparing for a Change-over.

Although Muswell Hill is not yet on A.C. mains it is certain that the district will eventually be changed over from its present D.C. supply. Thus the lecture given by Mr. E. J. Wyborn, B.Sc., A.C.G.I., on Wednesday, January 14th, was of no small interest to members of the Muswell Hill and District Radio Society, preparing them, as it were, for the power to come—namely, an A.C. supply! Mr. Wyborn, who represents Messrs. E. K. Cole, Ltd., gave an absorbing talk on the design and function of mains transformers. His remarks about smoothing chokes were particularly applicable to D.C. practice.

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"Distance No Object."

The lecture was accompanied by a series of lantern slides depicting in diagrammatic form the operation of mains sets, transformers, and chokes. At the conclusion of his address Mr. Wyborn demonstrated the Ekco three-valve screened-grid mains set, which utilises only a short piece of flex as an aerial. Operated off the D.C. mains, this receiver showed its capabilities amazingly well. Brookmans Park, 10 miles away, was easily eliminated, and distant European stations brought in at full speaker strength. An Ekco moving-coil speaker was used. The set showed itself to be equally capable of handling enormous volume from the local station.

Hon. Secretary, Mr. C. J. Witt, 39, Coniston Road, N.10

A Record Membership?

A membership of one hundred and sixty was reported by the hon. secretary at the annual general meeting of the Bristol and District Radio and Television Society, held at the University on Friday, January 16th, 1931. It was also reported that the attendance at the weekly lectures, demonstrations and debates was steadily increasing.

All local radio enthusiasts are welcome, and are invited to join the society. Full particulars can be obtained from the hon. secretary, Mr. S. T. Jordan, 1, Myrtle Road, Cotham, Bristol.

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Club's New Apparatus.

The Hackney Radio and Physical Society held its ninth Annual General Meeting on January 12th.

The Society's report showed that the year 1930 has been a very successful one. A notable fact was that all the lectures and talks during the year were given by members. Other activities of the Society included a number of field days, and a dinner and dance at the Talbot Restaurant, E.C.

The Society's apparatus at headquarters has been modernised during the past few weeks by Mr. G. V. Colle, and, thanks to Mr. Frederick Squire, the Society has the use of a very fine moving-coil speaker.

The Society holds its meetings at the Hackney Electricity Showrooms, Lower Clapton Road, E.5, every Monday evening at 8 o'clock. An excellent syllabus has been prepared by the Technical Committee for the coming year, and those desirous of becoming members will receive a cordial welcome.

Hon. Secretary, Mr. G. E. Sandy, 4, Meadway, Raynes Park, S.W.

"Touring the Tower of Babel."

The question of whether the listener can learn foreign languages *via* ether was discussed at the last meeting of the South Croydon and District Radio Society, and the conclusion reached was that the first essential was a two screen-grid high-frequency stage set with a frame or indoor aerial.

The Chairman said that, despite many difficulties, there were no doubt many occasions when a student of languages could learn much by a tour of the ether's Tower of Babel.

Hon. Secretary, Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.

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Precept and Practice.

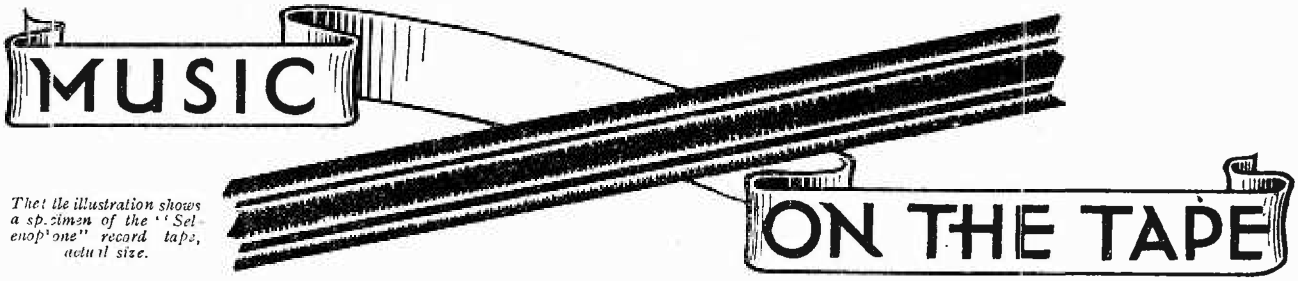
"Good Quality Broadcast Reception" was the title of a lecture and demonstration at the last meeting of the North Middlesex Radio Society, the lecturers being Messrs. Young and Laister.

Mr. Young first dealt with the principles involved in delivering from the loud speaker a faithful "copy" of the sounds radiated from the broadcasting stations. He described a circuit incorporating a power-grid detector, a small power valve being used as a detector; every precaution had been taken to eliminate sources of distortion.

Mr. Laister's part in the programme was to demonstrate a receiver which he had constructed on the lines laid down by Mr. Young. The results certainly justified the care taken. No attempt was made to receive distant stations, but luckily there was some good test material available from Brookmans Park.

Among the points demonstrated was the effect of changing the value of the grid-leak in the detector circuit. When the grid-leak in the detector was replaced by the once almost universal 2 megohm leak, a marked deterioration of quality was apparent.

Hon. Secretary, Mr. E. H. Laister, "Windflowers," Church Hill, N.21



The title illustration shows a specimen of the "Selenophone" record tape, actual size.

MUSIC ON THE TAPE

The "Selenophone": a Light Cell Gramophone.

By A CORRESPONDENT.

SEVERAL disturbing threats have been levelled at the orthodox disc method of recording in the last year or two, but possibly a direct challenge to its supremacy in the realm of sound reproduction comes from a new device manufactured in Vienna and known as the "Selenophone." For the "Selenophone" appears to overcome the primary drawback of the disc, viz., brevity of content. There is literally no limit to the length of performance which can be given by the continuous strip of paper which comprises the "record" in this new instrument.

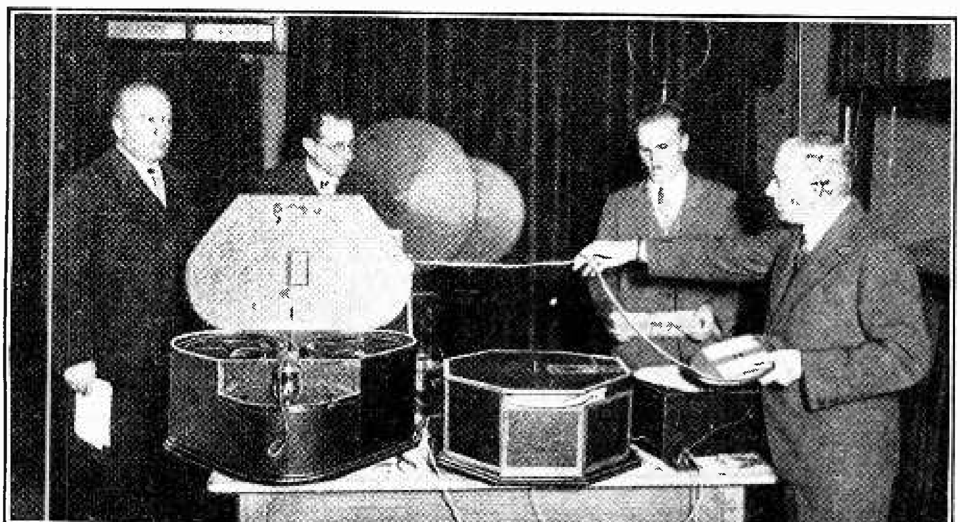
About a year ago the Austrian Selenophone Company, whose "talkie" system, developed by Thirring and Richtera, is well known on the Continent, demonstrated to a select circle a small recording and reproducing instrument embodying the principles employed in film work, but omitting the picture side of the entertainment. The results were then most promising, and the few difficulties which presented themselves are now reported to have been overcome, rendering it now possible to market a home-reproducing instrument comparable in performance with that of the gramophone, and using cheap paper strip records capable of providing about 70 minutes' performance per 300-metre drum.

The Selenophone method employs the well-known "transverse" system of recording, as opposed to the probably more popular "intensity" system, in which the sound strip is occupied by a streak of unvarying width, but varying blackness, corresponding with the changes in frequency. In the transverse system the sound record is represented on the photographic film as a streak of uniform blackness, "jagged" at one edge, each "jag" representing one cycle of the sound wave; the closeness with which one jag follows its neighbour gives the frequency of sound, while its loudness is determined by the size of the jags.

Galvanometer Recording and Selenium Reproducer.

A simple and effective device provides the jagged edge in the Selenophone system. The amplified microphone currents pass along the stretched metallic thread of a string galvanometer. This thread, about 1/10 mm. in diameter and 20 mm. long, is stretched so tightly that its natural frequency is of the order of 15,000 cycles per second. It lies in a very powerful magnetic field, in an air gap of only about 0.6 mm. The poles of the electromagnet are drilled through with a hole in which a system of lenses is fitted which throws the image of a long narrow slot on to the film. The thread is so arranged in relation to the slot that when the former is at rest it prevents half the image of the latter from reaching the film. Owing to the small angle between the directions of thread and image, a very small movement of the thread will cut off or uncover quite a lot of the image. In this way the "jagged edge streak" is produced along the sound strip.

We now come to the reproduction of the sound, the special method of doing which gives the system its name. Here we find, for once, no sign of the ubiquitous photo-electric cell; its place is taken by the special Thirring selenium cell. As is well known, the selenium cell has so much inertia or "lag" that at the higher

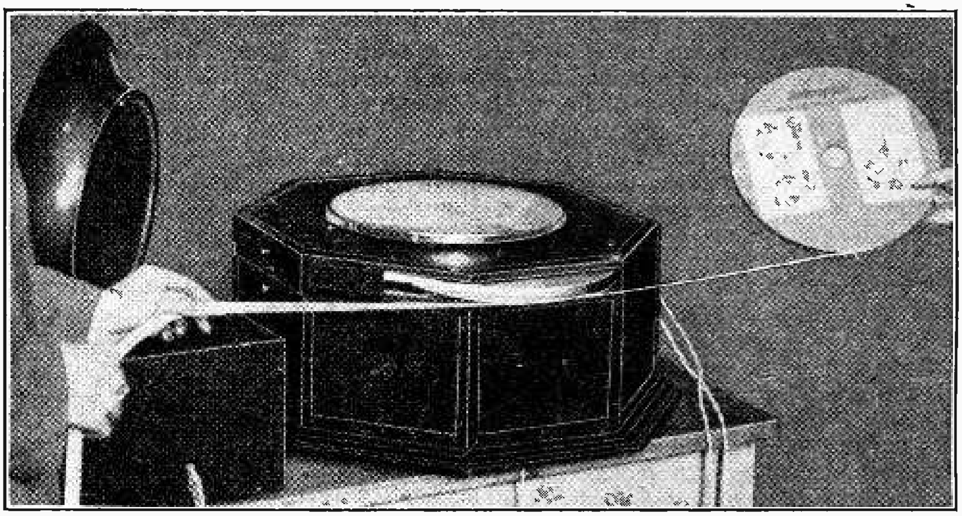


DEMONSTRATING THE "SELENOPHONE." The new light cell gramophone under test in the presence of officials of the Austrian State Broadcasting Company. On the left is M. Oskar Czeika, the Director-General.

Music on the Tape.—

frequencies the amplitude of the reproduced sound falls off seriously. This difficulty is said to be effectively compensated for by the customary method of introducing a resistance-capacity input filter. The background noise, usually troublesome with selenium cells and due to imperfect contact between the selenium and its electrodes, is not noticeable with his cell, and the light-sensitive surface is made so small that a very concentrated beam of light can be focused on it. In this way a high sensitivity is obtained, no very bright source of light is required, and a few stages of amplification are needed.

The use of actual film for home-reproduction purposes would tend to increase costs; the Selenophone Company has, therefore, adopted "records" reproduced on narrow paper tape by means of the offset printing method in which an inked photographic impression of the original on a metal plate is transferred to a rubber "blanket" and thence to the paper. Since the paper and the printing process are cheap, such records fulfil the requirements of a mass-produced article. It must be assumed that, in the case of paper records, the light beam is *reflected* from the paper, not passed through it as is the manner with a film.



A "close-up" of the "Selenophone Junior," specially designed for home use.

The tape, which is 12 mm. wide, carries four separate sound tracks, which are automatically switched in, one after the other, without interruption. Each roll is 300 metres in length; hence we have no fewer than 1,200 metres of record, representing a playing time of about 35 minutes. And it must be remembered that the reverse side of the paper can also be printed on. When we recollect that the ordinary gramophone disc plays for only about three minutes, the extraordinary possibilities of the new instrument become clear, even ignoring the fact that the paper tape is not subjected to the wear caused by a needle, and, also, that a complete roll playing for seventy minutes can be produced at a cost not exceeding that of one gramophone disc.

The reproducer itself is not unlike the ordinary gramophone, though it possesses two turntables, since the tape must be rolled on to an empty drum from a full one.

The "Selenophone Junior," as it is called, passes its output to a loud speaker, and it need hardly be said that the whole apparatus can be operated from the mains.

If it can perform all that is claimed for it, the new instrument opens up a new field of possibilities. The recording of complete operas, symphony concerts, speeches, and broadcast dramas becomes a simple matter. A weekly spoken news bulletin or magazine also becomes possible, a development which would be of immense value to the blind. Last, but not least, the transport of paper rolls requires none of the anxious care necessary in the despatch of gramophone records.

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Books Received.

The National Physical Laboratory, Collected Researches, Vol. XXII, 1930.—A collection of authoritative articles on various wireless subjects which have occupied the attention of the N.P.L. during the past year. The writers include F. M. Colebrook, R. M. Wilmotte, H. A. Thomas, D. W. Dye, E. H. Rayner, S. W. Melsom, A. H. M. Arnold, L. Hartshorn, and J. E. P. L. Vigoureux. Published by H. M. Stationery Office, price £1 net.

The Radio Amateur's Handbook (7th Edition). A manual of amateur short-wave radiotelegraphic communication, including general advice to the amateur, practical articles on receivers, transmitters, aerials, power supply, operating a station, the "Q" code, miscellaneous abbreviations, and a quantity of other useful information. Pp. 218, with numerous illustrations and diagrams. Published by the American Radio Relay League, Inc., Hartford, Conn., U.S.A., price $1.

Radio-Kurzwellen und ihre Eigenschaften, by Franz Anderle. A textbook on the nature and characteristics of short waves, with chapters on reflectors, aerials, crystal control, and other kindred subjects. Pp. 122, with 160 diagrams and illustrations, and 3 maps. Published by Franz Deuticke, Vienna and Leipzig. Price M.6 in paper cover, or M.8.40 in cloth.

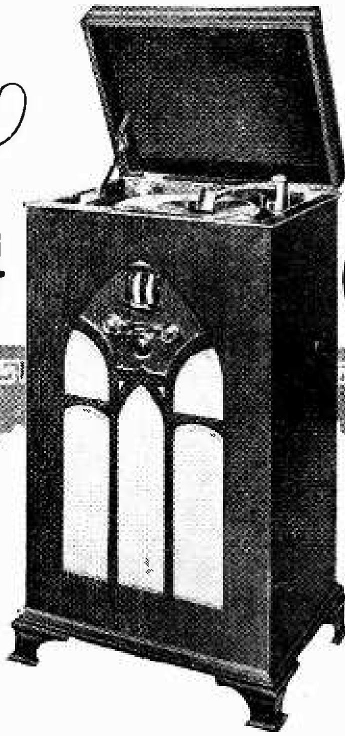
Der Bau Von Überlagerungsempfängern (Building the Superheterodyne Receiver), by Dr. Walter Daudt. The theory of the superheterodyne and practical directions for building a typical receiver. Pp. 48, with 40 illustrations and diagrams, and a sheet of the symbols used in wireless diagrams. Published by Rothgiesser und Diesing A.G., Berlin, price Rm.1.50.

Die Elektrische Schallplatten-Wiedergabe (Electrical Record Reproduction), by Manfred von Ardenne, with descriptions and illustrations of various gramophone pick-ups and other apparatus connected with sound reproduction. Pp. 80, with 69 illustrations and diagrams. Published by Rothgiesser und Diesing, A.G., Berlin. Price Rm.1.70.

Télévision et Phototélégraphie, Principes Fondamentaux, by E. Aisberg, with a preface by E. Belin. A popular explanation of the principles and practice of phototelegraphy and television, with an appendix describing the Belin system. Pp. 172, with 82 illustrations and diagrams. Published by Etienne Chiron, Paris, price frs. 10.

Bel-Canto Radio-Gramophone

Model R.G.4



An A.C. Mains Receiver with — Electrically Driven Turntable.

THERE is no real reason why the ever-popular H.F.-det.-L.F. three-valve circuit, which has proved so successful in receivers intended purely for broadcast reception, should not be adopted as the basis of a radio-gramophone. Its range is wide enough for the average listener's needs, and, as a gramophone reproducer, sufficient magnification for domestic purposes is obtainable from the detector, converted into an L.F. amplifier, in conjunction with the output valve. Even if a comparatively insensitive pick-up be chosen there will seldom be complaints on the score of insufficient volume, particularly if efficient modern valves are used.

The Bel-Canto Radio-Gramophone, with which we are here concerned, is an example of this circuit arrangement. Starting at the input end, it will be seen that an unusual method of volume control, in the form of a potentiometer, actually with a resistance of 25,000 ohms, is adopted. This system has the advantage that it does not introduce any serious disturbance of tuning; although it makes no contribution towards the inherent selectivity of the set, it does allow interference to be avoided by limitation of input.

Indirectly heated A.C. valves are used throughout, and negative bias is applied to the grids by inserting a resistance (with the necessary shunt condenser) in each cathode lead.

A tuned-grid coupling, with parallel choke feed, is employed for the H.F. stage. Medium- and long-wave coils are connected in series, and the latter are short-circuited by a switch in the usual way for waveband changing. A differential condenser, with its moving vanes at earth potential, acts as a reaction control.

Power-grid rectification is a feature of the receiver. The detector works with over 120 volts on its plate, and passes a current of about 6 milliamperes. Thanks to the fact that the grid leak has naturally a low value, it becomes possible to insert the pick-up at the low-potential end of the circuit, so that impulses are fed to the grid through the leak resistance. In this position there is less risk of introducing parasitic noises through the pick-up leads, etc., and switching is simplified.

The detector is coupled to the output stage by means of an auto-transformer (actually a double-wound R.I. "Hypermite" component, with primary and secondary joined in series), which is parallel-fed through the usual resistance-capacity filter. An H.F. stopping resistance is inserted in series with the output valve grid, and the loud speaker is directly connected in its anode circuit. A Bel-Canto loud speaker is fitted; this instrument embodies a large, lightly supported cone driven by a balanced-armature movement.

Anode current supply is through a Mullard D.W.1 full-wave rectifying valve; the smoothing and feed circuits are straightforward and simple. Tappings from the power transformer primary are led to pins mounted radially round a centre contact, and the appropriate connection to suit the user's supply voltage is easily made by means of a special double-contact socket.

A universal motor of the commutator type is fitted for driving the turntable, and an automatic stop is provided;

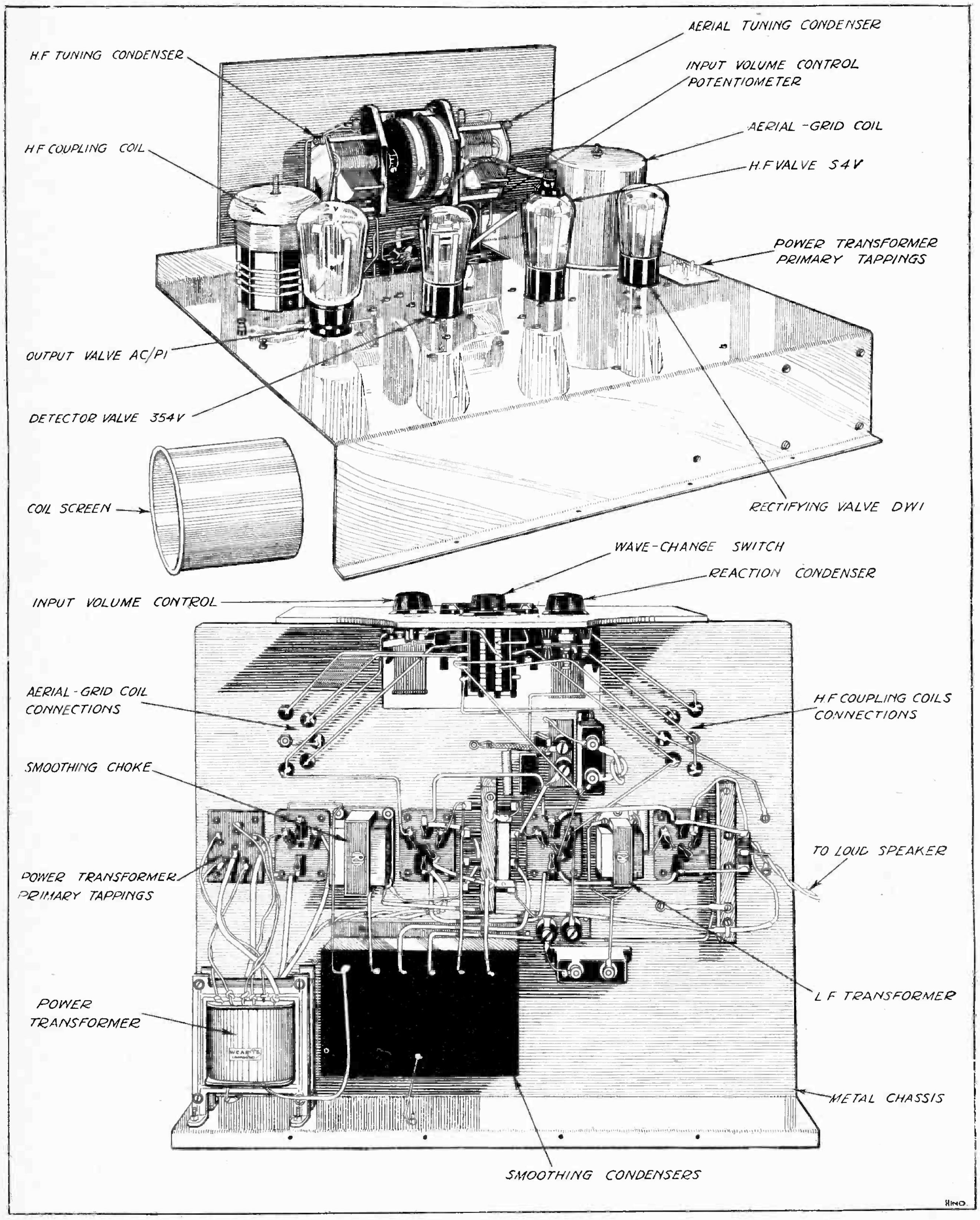
SPECIFICATION.

CIRCUIT: *Screen grid H.F. valve, coupled by choke-fed tuned-grid circuit to a power grid detector. Single L.F. stage, coupled by resistance-fed auto-transformer. Full-wave power rectifying valve.*

CONTROLS: (1) *Independent tuning of input and inter-valve circuits.* (2) *Combined wave-range and radio-gramophone change-over switch.* (3) *Reaction.* (4) *H.F. input volume control.* (5) *Gramophone volume control.* (6) *Mains on-off switch.*

GENERAL: *A.C. mains operation with inside or outside aerial. H.F. input potentiometer. Direct loud speaker connection.*

PRICE: £37 10s. *Makers: Bel-Canto Radio, Ltd., 34-36, Oxford Street, London, W.1.*



Upper and lower sides of the Bel-Canto receiver chassis. One of the coil screens is removed.

Bel-Canto Model R.G.4 Radio-Gramophone.—
this must be in the "off" position when the set is used for radio reception, as the main on-off switch controls the current supply to both motor and power transformer primary.

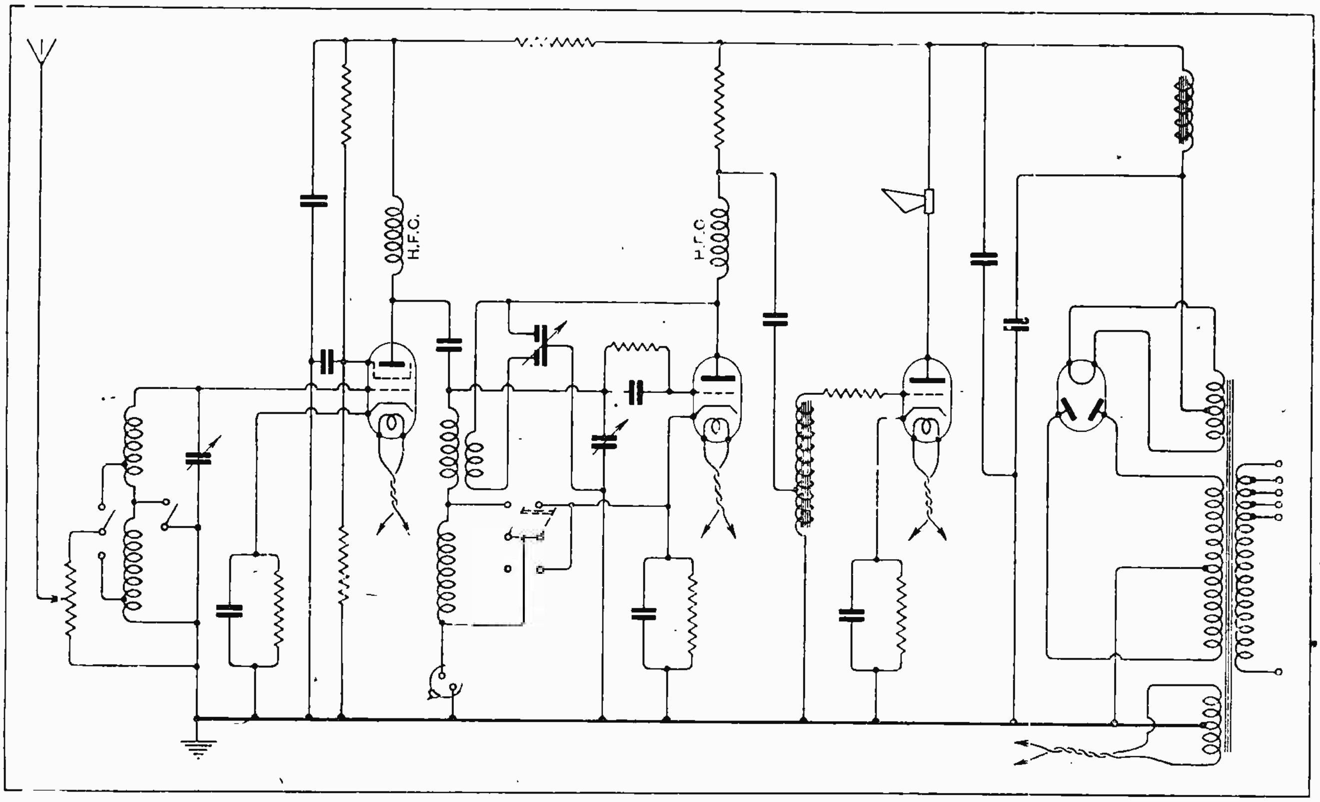
Constructional details of the chassis are clearly shown in the accompanying illustration. The receiver components, with the exception of tuning and reaction condensers, switch and volume-control resistance, are mounted on either side of a large aluminium sheet, which occupies the full width and depth of the cabinet, and can be withdrawn after removing a few wires.

Edgewise thumb-operated tuning drums seem to be hardly the most convenient form of condenser controls when they are mounted on the panel of an upright cabinet receiver of this type, but one soon gets accustomed to them. In any case, the receiver is not intended primarily for long-distance reception, and so the need for operating the dials continuously is unlikely often to arise.

The aerial potentiometer makes a very satisfactory volume control, although most of the signal strength variation is introduced as the knob is rotated through the first few degrees from the "full-on" position. The presence of the potentiometer resistance across a part of the tuned coil has an entirely negligible effect in increasing circuit damping. The set handles very well, tuning and reaction controls operating in a smooth and logical manner. As the condenser drums are mounted side by side, they may be rotated simultaneously over a section of the tuning range. There is hardly any reaction overlap on the medium-wave side, and very little on the long waves.

Sensitivity is ample to ensure the reception of most transmissions with a real programme value, and is about up to the usual standard of a set of its class with A.C. valves. Similarly, selectivity is as good as can be expected from two tuned circuits, and does not seem to be adversely affected by the potentiometer volume control. A short indoor aerial is quite adequate except where consistent long-distance reception is desired.

With regard to the capabilities of the set as a reproducer of gramophone records, it was found that there is a good response over a frequency range from slightly over 100 cycles to 3,000 cycles per second. After this point a gradual falling off is observable, but there is still a detectable output at 6,000 cycles. No resonances are sufficiently marked to be unpleasant, or even to force themselves to one's notice.



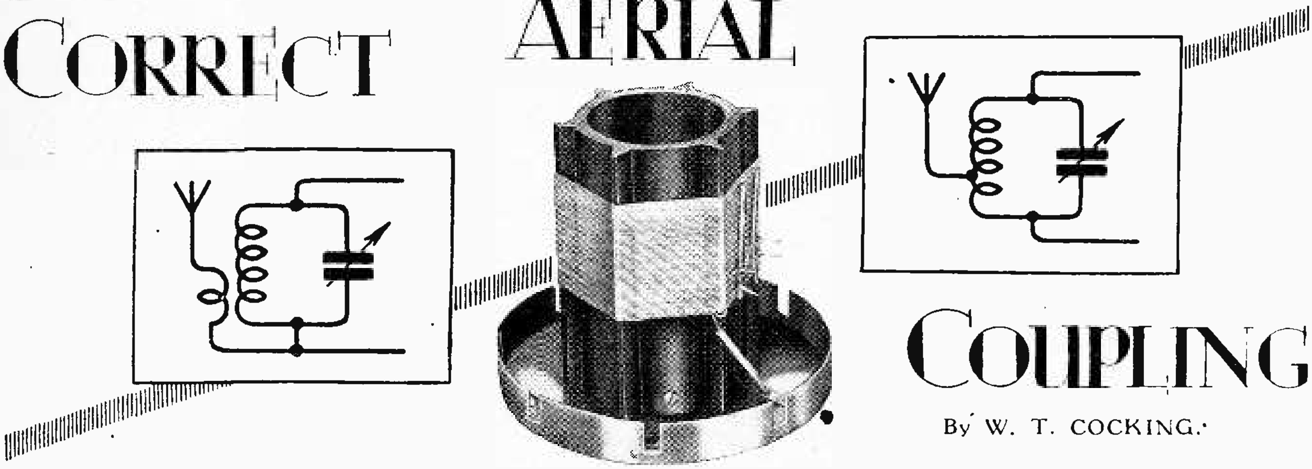
Schematic circuit diagram. A volume-control potentiometer (not shown) is embodied in the pick-up carrier.

When radio signals are being received the performance is substantially that described in the preceding paragraph; the output at the higher audio-frequencies is well maintained, provided that reaction is not used to excess.

In spite of the simplicity of the smoothing arrangement there is a commendable freedom from hum, and no complaint whatever can be registered on this score.

A D.C. model, with indirectly heated valves connected in series, is available at the same price. The general circuit arrangement and layout is similar, but an M.L.4 output valve is fitted.

CORRECT AERIAL COUPLING



By W. T. COCKING.

The Efficiencies of the Band-pass Filter and the Single Circuit Compared.

THE aerial-tuning system is not only of the greatest importance from the point of view of selectivity, but it also determines to a large extent the efficiency of a receiver. Owing to the unique properties of a series-resonant circuit, it is one of the few places where a definite magnification can be obtained without the use of a valve. There is little doubt but that the usual single-tuned circuit, with tapped or "aperiodic" aerial coupling, is the most efficient of the many possible methods; and it would be universally adopted were efficiency the only point to be taken into consideration.

Under modern broadcasting conditions, however, the conflicting problems of selectivity and quality become of almost greater importance. With the single-tuned circuits of Fig. 1, (*a*) and (*b*), it is well known that the lower the H.F. resistance of the tuning coil the greater is the efficiency and selectivity, but the poorer the quality. Since quality is of the utmost importance, a very low-resistance coil cannot be used, and it is then found that the selectivity becomes too low to prevent trouble from "cross-modulation" and "beat-interference."

The remedy for these troubles lies in the use of the band-pass filter, with which sideband cutting can be non-existent. The circuit of a capacity-coupled filter is shown in Fig. 4, and it is reasonable to expect that, since there are two tuned circuits, each with certain losses, the efficiency will be lower than that of the single circuit. It becomes of importance, therefore, to determine the relative efficiency of the two methods of coupling, in order that an estimate can be made of the extra amplification desirable when using a filter.

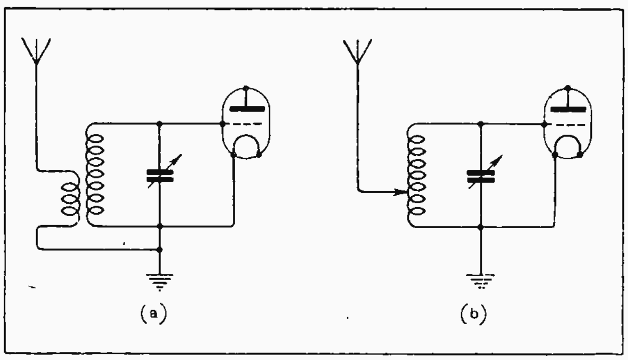


Fig. 1.—One of the most efficient aerial tuning circuits, the commonly used "aperiodic" coupling (a) and tapped aerial coupling (b). A magnification of some 10 times is readily obtainable, with medium-efficiency coils.

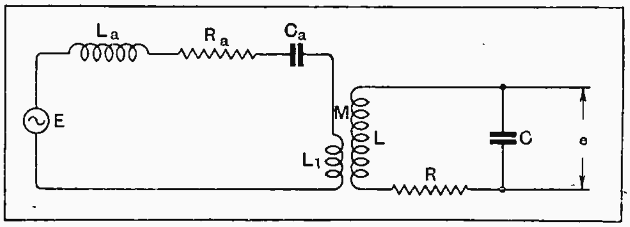


Fig. 2.—The equivalent electrical circuit of Fig. 1. L_a, R_a, C_a represent the aerial inductance, resistance and capacity respectively. L_1 is the primary of the coupling transformer, while L, R and C are the inductance, resistance and capacity of the tuned circuit. M is the mutual inductance between the windings, and E represents the voltage set up in the aerial by a signal.

The Single Circuit.

There is little data available as to the efficiency of the single circuit, and so it is necessary to investigate this well-known circuit before proceeding to discuss the filter. In Fig. 2 is shown the equivalent electrical circuit to that of Fig. 1, in which the aerial inductance, capacity and resistance are represented by L_a, C_a, and R_a, respectively. The voltage set up in the aerial by an incoming signal is represented by the generator E. Now, the complete expression giving the ratio of the voltage *e*, applied to the grid of the valve, to the voltage E, set up in the aerial, is complex. It is well known, however, that the effect of the aerial resistance with the *"aperiodic" aerial coupling* is very small, and may vary within wide limits without affecting the results to an appreciable extent. It becomes permissible, therefore, to assume that this resistance is zero, for the error so introduced is considerably less than that found in practice when an attempt is made to build the circuit to conform with the calculated constants.

TO what extent must signal strength be sacrificed when replacing a single tuned circuit by a capacity band-pass filter? In this article calculations of aerial circuit efficiency are made under different coupling conditions and the conflicting requirements of selectivity, quality and signal strength are carefully examined.

Correct Aerial Coupling.—

The term magnification will be used to denote the ratio e/E, and this must not be confused with the coil magnification, which is equal to $\omega L/R$. Under the condition of zero aerial resistance, the formula (1) in the Appendix enables the magnification at any frequency to be readily calculated; while the magnification at resonance is more easily calculated from formula (2). The curves of Fig. 3 show the results to be expected in a typical case; it is, of course, necessary to assume certain values for the coil and aerial constants, and these will be found in Table I, together with details of the type of coil to which they may reasonably be expected to apply.

The effect of varying the aerial coupling is well brought out by these two curves. Curve A is for a mutual inductance to the aerial of 8.9 μH., and it will be seen that, while the magnification at 1,500 kc. (200 metres) is 11 times, at 550 kc. (550 metres) it falls to only 3 times. An increase in the coupling to 19.35 μH. (curve B) reduces the magnification at 1,500 kc. to 10 times, but increases it at 550 kc. to 5.4 times, and the efficiency over the whole broadcast band varies in nearly a 2-1 ratio instead of about 4-1.

A further increase in the aerial coupling leads to increased efficiency at the lower frequencies, but only at the expense of both reduced efficiency and selectivity at the higher frequencies. There is no point in giving curves for greater degrees of coupling, therefore; and, in practice, one usually compromises with a degree of coupling similar to that of curve B. The magnification obtain-

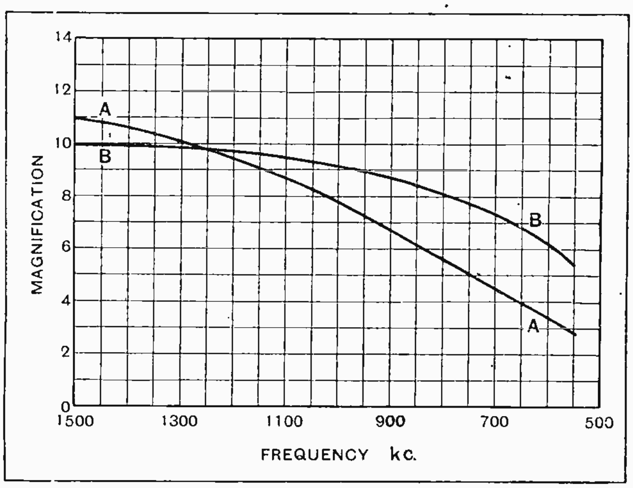


Fig. 3.—The magnification obtainable with either circuit of Fig. 1 can be seen from these curves. Curve A is for a mutual inductance to the aerial of 8.9 μH., and curve B for 19.35 μH., a more usual value. Note the large magnification at the high frequencies.

able with single circuit aerial coupling is too little appreciated, for it is not usually understood that the ordinary aerial circuit gives a voltage step-up of some 10 times without employing a valve.

It is worthy of note that the figures for magnification calculated from the formulæ in the Appendix are directly applicable to receiver design. It is merely necessary to multiply the magnification by the product of the effective aerial height in metres and the field strength in volts per metre in order to obtain the actual voltage applied to the grid of the first valve by a signal, and, therefore, to estimate the amount of H.F. amplification required in any given case.

The Capacity Coupled Filter.

The circuit of a simple capacitatively-coupled band-pass filter is shown in Fig. 4, and formula (4) in the Appendix allows its magnification to be calculated at any frequency, and the simpler formula (5) at resonance only. It can easily be seen that the efficiency of such a circuit depends not only upon the aerial coupling, but also upon the filter coupling. This latter is determined by considerations of the band width required, but with such a simple circuit this remains by no means uniform as the tuning is varied over the waveband.

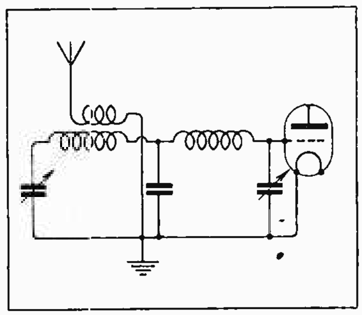


Fig. 4.—The simple capacitatively coupled band-pass filter. Although the efficiency is lower than with the single circuit it offers very decided advantages as regards both selectivity and quality.

As a result, we should expect to find that the efficiency varies more than that of a single circuit. That this is indeed the case can be seen from the curves of Fig. 5, in which curve A is for a mutual inductance to the aerial of 8.9 μH., and curve B for 19.35 μH.

A comparison of these curves with those of Fig. 3 is extremely interesting, and shows up several important facts which have been noted in practice. In each case consider curve B, which represents the degree of coupling, perhaps the most generally satisfactory and the most commonly used. At 1,000 kc. the filter magnifica-

TABLE I.

Aerial constants.		
Inductance	.. .. ..	20 μH.
Capacity ..	.. .. ..	0.0002 mfd.
Resistance	.. .. ..	0
Coil constants.		
Inductance	.. .. ..	200 μH.
Resistance	.. .. at	550 kc., 5.3 ohms.
		750 kc., 7.5 ohms.
		1,000 kc., 12 ohms.
		1,200 kc., 16 ohms.
		1,500 kc., 27.5 ohms.
Coil construction.		
80 turns of No. 26 D.C.C. close wound on 2in. diameter former.		

Correct Aerial Coupling.—

tion is 6.5, which is about 70 per cent. of that of a single circuit; at 550 kc., however, the filter magnification is only 1.6, and the relative efficiency about 29 per cent.; while at 1,500 kc. it is only 2.56 as compared with 10 for the single circuit, or a relative efficiency of 25.6 per cent. That matters cannot be greatly improved by an alteration in the aerial coupling can be seen from an inspection of the curves; for an alteration in the mutual inductance only results in increasing the magnification at the high frequencies and reducing it at the low, or vice versa.

Capacity Filter Less Efficient than Single Circuit.

The difference in shape of the curves of Figs. 3 and 5 is of great interest, since it contains the clue to the reason for the low efficiency of the capacity filter at high frequencies. For all frequencies lower than about 1,000 kc. the filter efficiency falls away at about the same rate as that of the single circuit; but, instead of increasing for the higher frequencies, it again falls off. Now, the curve of Fig. 6 shows the peak separation with this filter, which has a coupling capacity of 0.015 mfd., and it will be seen that the two peaks coalesce at 950 kc. This, then, is the reason for the low efficiency of the capacity filter at high frequencies; the greatest efficiency is always obtained when the coupling is such that the reactance of the coupling component is equal to the H.F. resistance of the tuning coil. This is only possible at one frequency, which, in this case, is about 1,000 kc. For frequencies lower than this the coupling is greater than the optimum, and the double-peaked turning curve is obtained; the efficiency, however, does not fall off rapidly. For frequencies higher than 1,000 kc., however, the coupling is less than the optimum, and the efficiency falls off very rapidly indeed, while the double-peaked tuning curve disappears.

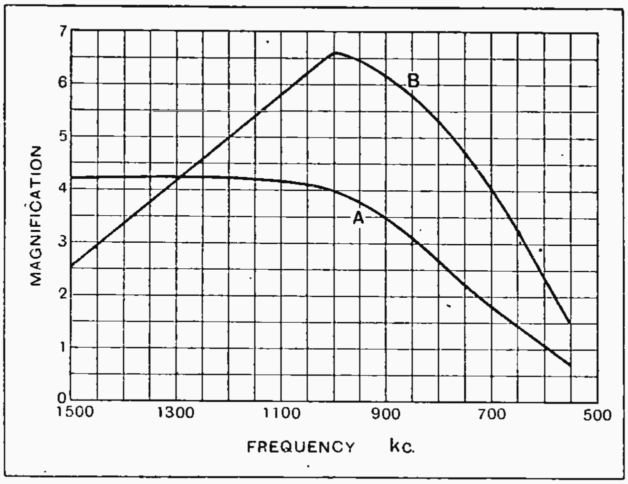


Fig. 5.—The magnification obtainable with a capacity coupled band-pass filter is shown by the above curves. Curve A is for a mutual inductance to the aerial of 8.9 μH., and curve B for 19.35 μH. Note the falling off in efficiency below 1,000 kc., which is due to the filter coupling. A capacity filter is considerably less efficient than a single circuit.

No alteration to the aerial circuit itself will improve the magnification characteristics appreciably at the high frequencies, since the falling off is due to the filter coupling. In no way can the efficiency of the simple filter be improved without at the same time entirely altering the band-pass characteristics. Of the two methods of coupling, inductive is the better on the score of efficiency, since it does not suffer from low efficiency at the high frequencies. Unfortunately, however, it is not very satisfactory, for at this part of the waveband it is liable to become unselective. Progress in filter design will undoubtedly lie in combining the good points to be found in both types of coupling by the use of a mixed capacity and inductance coupler.

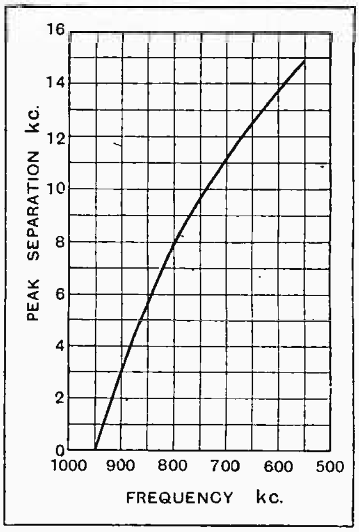


Fig. 6.—The variation of bandwidth with frequency in a capacity filter, with 200 μH., coils and a 0.015 mfd. coupling condenser. The two peaks coalesce at 950 kc., and for frequencies higher than this the efficiency is reduced. (See Fig. 5.)

Before concluding this article it would be well to make some mention of the commonly used circuit in which the aerial is connected through a small fixed condenser directly to the upper end of the tuning coil.

This method has the great advantage of simplicity of mechanical construction, since the use of tapped windings is obviated and the switching for the two wavebands is simplified to a great extent.

It can be shown mathematically that this circuit is fundamentally the same as the "aperiodic" type; for it can be redrawn as the circuit of Fig. 1(a) with the addition of a fixed condenser in the aerial lead. The difference between the two circuits, however, lies in the values of the different components. With the directly coupled circuit, the inductance of the hypothetical aerial winding is the same as that of the secondary, which is also equal to the mutual inductance between them.

Series Aerial Condenser.

Now it has been shown that the best value for the mutual inductance depends upon the aerial reactance; in this directly coupled circuit the mutual inductance is fixed, and so to obtain the best results we alter the aerial reactance by means of the series condenser. In other words, with "aperiodic" coupling we have a more or less fixed value for the aerial reactance, and we adjust the mutual inductance for the optimum results; but with the directly coupled circuit we have a fixed mutual inductance, and so we adjust the aerial reactance in order to obtain the best relation between them.

There are, of course, other considerations involved, for with the directly coupled circuit it is doubtful whether it is justifiable to assume that the aerial resistance is zero. Further considerations as to selectivity,

Correct Aerial Coupling.—

and the apparent change of secondary reactance due to the aerial, will be different in the two cases, so that it is impossible to decide which is the better circuit for general use without a detailed investigation into both.

APPENDIX.

When the aerial resistance is zero, the magnification of the ordinary single tuned circuit with "aperiodic" aerial coupling, is given by:

$$e/E = \frac{M/C}{\sqrt{[\{\omega^2M^2 - AB\}^2 + A^2R^2]}} \quad \ldots \quad \ldots \quad (1)$$

and at resonance this becomes:

$$e/E = \frac{M/C}{\sqrt{[\omega^4M^4 + R^2A^2]}} \quad \ldots \quad \ldots \quad (2)$$

and the optimum value of the aerial coupling is given by:

$$\omega M = \sqrt{RA} \quad \ldots \quad \ldots \quad (3)$$

Under the same conditions, the magnification of a two-stage band-pass filter is given by:

$$e/E = \frac{MX_m/C}{\sqrt{[\{A(R^2 + X_m^2 - B^2) + B\omega^2M^2\}^2 + R^2(\omega^2M^2 - 2AB)^2]}} \quad \ldots \quad \ldots \quad (4)$$

and at resonance this becomes:

$$e/E = \frac{MX_m/C}{\sqrt{[\omega^4M^4R^2 + A^2(R^2 + X_m^2)^2]}} \quad \ldots \quad \ldots \quad (5)$$

and the optimum value of aerial coupling is given by:

$$\omega M = \sqrt{\left[\frac{A(R^2 + X_m^2)}{R}\right]} \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

where M = mutual inductance in henrys.
C = capacity of tuning condenser in farads.
L = Inductance of tuning coil in henrys.
L_1 = inductance of primary winding of aerial coil in henrys.
L_a = aerial inductance in henrys.
C_a = aerial capacity in farads.
R = H.F. resistance of tuning coil in ohms.
X_m = reactance in ohms of the filter coupling.
and $A = (\omega L_a + \omega L_1 - 1/\omega C_a)$
$B = (\omega L - 1/\omega C)$
= 0, at resonance.
e = voltage applied to the grid of the valve.
E = voltage induced in series with the aerial.

CURRENT TOPICS

Events of the Week in Brief Review.

NEWS OF OLYMPIA.

A double-size show is the promise for the 1931 Radio Exhibition. An official of the Radio Manufacturers' Association informed *The Wireless World* that the exhibition in September will occupy the New Hall, as previously, and also the ground, first, and second floors of the Empire Hall.

The Association has, in addition, signed a contract under which the Exhibitions of 1932 and the four subsequent years will be held in the Olympia Main Hall a month earlier than has been the practice in the past.

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P.O. PROSECUTION FAILS.

An interesting case under the Wireless Act was heard by the Bridgwater magistrates last week, when they dismissed a summons against Mr. Joseph Lowe for having worked a wireless receiver without a licence. Mr. Lowe proved to the satisfaction of the magistrates that his valve amplification equipment was used solely for the reproduction of gramophone records.

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ITALIAN CONCERTS FOR AMERICA.

Italy is to provide American listeners with a weekly musical programme, according to an arrangement entered into by the American National Broadcasting Company and the Italian broadcasting organisation. The concerts will be transmitted every Sunday evening from the Rome station, now operating on 25.4 metres.

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INTERNATIONAL RADIO SHOW.

Bordeaux will hold an international wireless exhibition during October next. Manufacturers all over the world are invited to apply for particulars to the Syndicat des Radio-Electriciens de Bordeaux et du Sud-Ouest, 48, Cours d'Alsace-Lorraine, Bordeaux (Gironde).

GRID SCORES QUARTER-CENTURY.

Dr. Lee de Forest has received congratulations on the twenty-fifth anniversary of his invention of the three-electrode valve. The first valve containing a grid, or third electrode, saw the light of day in January, 1906.

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PRISON FOR "PIRATES."

The Austrian postal authorities announce that wireless listeners who fail to take out or renew licences are liable to a fine of £14 or one month's imprisonment.

CHESS BY AMATEUR RADIO.

Six members of the Sydney Chess Club have arranged to play a match by amateur wireless with six chess experts in Otago, New Zealand.

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GERMAN SETS IN BRITAIN.

According to a Berlin message, Great Britain was Germany's best "wireless" customer during 1930, taking radio, telegraphic, and telephonic equipment to the value of nearly £570,000.

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WIRELESS SCHOOL FOR BOYS.

A boys' wireless school has been founded in Middlesbrough by the Rev. L. H. B. Staveley, vicar of St. Peter's Church, and Mr. V. Leggett, emigration officer. Invitations to attend the first meeting, which was held on January 23rd, were extended to two boys of fourteen years or more from each juvenile organ-

THE KITE SET. An official at the Radio Research Board's experimental station at Slough with one of the transmitter-equipped kites used for direction-finding tests. The padded valve is in the container at the end of the stick carrying the battery cells.

isation in the town. A complete radio course has been prepared lasting twelve months.

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WIRELESS AND WINE.

To relieve the slump in the wine industry, the Italian broadcasting authorities are granting free advertising periods in the programmes to wine merchants, who will sing the praises of Bacchus in five languages, says a Turin correspondent.

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MUST WE CORK OUR AERIALS?

A resolution in favour of the compulsory "corking" of all wireless aerials to protect pigeons was passed unanimously at a meeting of the General Council of the National Union of Short-distance Flyers, held in Manchester on January 24th. The resolution ran:—

"That the union reiterate its demand for it to be made compulsory for all wireless aerials to be corked, as the mortality of sporting pigeons is heavily increasing owing to the large number of aerials that have been erected and are likely to be erected on account of the opening of the Regional stations, which would bring back into favour the crystal receiver."

oooo

SPAIN'S NEW BROADCASTING SYSTEM.

Within a month Spain should be enjoying the benefits of a reorganised broadcasting system under the supervision of General Berenguer's Government. The provisional scheme comprises a "National" station of 60 kW. at Madrid, with "Regional" stations at Madrid (30 kW.), Catalona (30 kW.), Andalusia (20 kW.), Valencia (20 kW.), Galacia (20 kW.), and Vascongadas (10 kW.). Half an hour each day will be reserved for Government announcements, and the stipulation is made that commercial publicity shall not occupy more than five minutes in each hour.

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THE BOHEMIAN TASTE.

The Radio Club of Bohemia (Czecho-Slovakia) has just held a plebiscite amongst its members to discover the relative popularity of foreign broadcasting stations. Preferences were expressed by votes as follow: Königswusterhausen, 80; Vienna, 70; Langenberg, 45; Graz, 75; Gleiwitz, 50; Rome-Milan, 40; Toulouse, 30; Frankfurt, 25; Hamburg, 24; Daventry, 22; and Stockholm, 22.

It was discovered that the percentage of members who listened consistently to the national station at Prague was only 20!

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U.S. AMATEURS ASSIST ARMY.

Thousands of American amateurs acted as observers for the U.S. Army Signal Corps on January 23rd and 24th, when an Army Fokker plane equipped with a special short-wave transmitter carried out a round trip by way of Nashville and Louisville to Montgomery, Alabama. Throughout the flight transmission from the plane was maintained on a wavelength of 85.7 metres, and it was the duty of amateurs appointed by the American Radio Relay League to compile a log of all messages received *en route* with particulars of signal strength and fading.

WIRELESS GOODS BY AIR.

Imperial Airways, Ltd., report that nearly 2,000,000 wireless valves have now been carried in their machines between London and the Continent, in addition to approximately £80,000 worth of loud speakers.

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THE LATE SIR WILLIAM BULL, BT., M.P.

In few of the obituary notices which have appeared concerning the late Sir William Bull, who died on January 23rd, has any mention been made of his close association with broadcasting and the wireless industry. Yet Sir William was one of the original directors of the British Broadcasting Company at its formation in 1922, and at the time of his death was President of the Radio Manufacturers' Association, a position he had ably held for many years.

Speaking last week on behalf of the R.M.A., Capt. J. W. Barber, C.B.E., said: "During his service on the Board

A BROADCASTING PIONEER. The late Sir William Bull, whose death occurred on January 23rd, was one of the original directors of the British Broadcasting Company.

of the original B.B.C., Sir William Bull revealed a remarkable capacity for statesmanship; although a director of that company, he never allowed the interests of the public and of the manufacturers to conflict so far as he was able to determine.

"When he was appointed President of the R.M.A. we began to discover exactly how fortunate we were in having as guide and philosopher a man with both the legal and political mind. Sir William Bull was thoroughly interested in the radio industry, and yet was able to be entirely unbiased, and whenever, inside the Association, we differed in domestic policies we all had confidence that Sir William could assess the relative merits of our diverse arguments and produce a thoroughly judicial and scrupulously fair judgment."

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SHORT WAVES FOR THE PRINCE.

Now that the Prince of Wales has passed Bermuda, the range of the normal ship wireless installation will be insufficient to keep him in direct touch with Great Britain, but the Marconi short-wave wireless transmitter and receiver which was specially installed for the Prince's use on the Pacific Steam Navigation Company's liner, *Oropesa*, on which he is travelling, will enable him still to maintain constant and direct communication with this country through the short-wave wireless coast station at Portishead.

No ship fitted with short-wave wireless apparatus for communication with England has yet made the voyage along the South American coast which will be followed by the Prince of Wales.

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"PIONEERS OF RADIO."

Mayors, school-teachers, and parish priests are among the enthusiasts in France who are petitioning for the establishment of a body to be called "The Pioneers of Radio." Its function would be to supply each village community with an experienced representative capable of doctoring wireless sets and giving much-needed advice.

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LISTEN FOR WORLD-WIDE TELEPHONY TESTS.

Throughout the present month short-wave listeners all over the world are urged to make a special effort to pick up a special series of 31.35-metre telephony transmissions from WIXAZ, the new experimental station of the Westinghouse Electric and Manufacturing Company at Boston, Mass. Reports should be addressed to the organisers, the International Short-wave Radio League, Jamaica Plain, Boston, Mass., who will appreciate observations as to signal strength, fading, and other phenomena.

The daily transmission schedule is as follows: 1200 to 1400, 1700 to 1800, 1900 to 2100, and 2300 to 0200 (G.M.T.).

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SURVEY OF WORLD'S BROADCASTING.

There are a mere 24,000,000 broadcast receivers in use in the world, according to Mr. Lawrence D. Batson, of the electrical equipment division of the U.S. Department of Commerce, who has just prepared a remarkable survey of the world's radio markets. One of Mr. Batson's calculations, writes our Washington correspondent, is that it would require 380 million sets to equip all the homes in the world that are within constant listening range of broadcasting stations, a statement which should encourage the radio trade.

Though the book abounds in statistics and is intended primarily for exporters, it contains a good deal of interest for the layman. For example, Mr. Batson observes that in some foreign countries "there is a definite indication of a trend toward the adoption of the American sponsored-programme system."

The report gives very full data concerning the status of foreign broadcasting. Licence fees or broadcasting subscriptions, it shows, vary from 1s. 8d. per set per annum in France to £8 16s. in Turkey.

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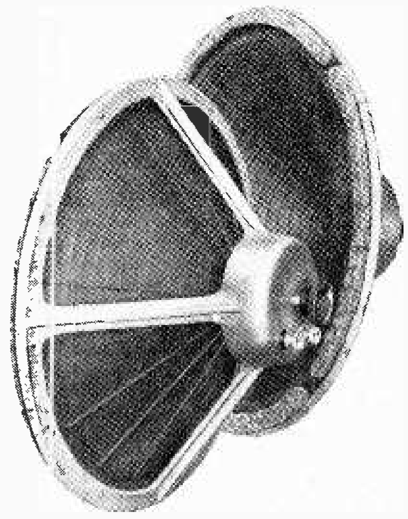
INDUCTIVE BAND-PASS FILTERS.

In the article under the above title in our issue of January 28th the formula after line 14 on p. 79, col. 2, should be $H=\frac{A^2N^2}{1000d^3}$ microhenrys, where A is cross-sectional area and N number of turns.

A Review of Manufacturers' Recent Products.

CELESTION D.20 CHASSIS.

Hi.herto Celestion loud speakers have been produced only in complete cabinet form but a chassis unit for incorporation in transportables and radio gramophones has now made its appearance. The diaphragm, which is of the well-known Celestion reinforced type, has a wide angle, and is supported in a particularly rigid cast-aluminium frame finished in grey enamel. The movement is of the non-differential single-acting type, and is massively constructed throughout. The air gap is adjustable and a high degree of sensi ivity can be obtained.



Celestion type D.20 loud speaker chassis.

The diaphragm is 14in. in diameter, and, as might be expected, the low-frequen y response is above the average. At 50 and 100 cycles the output is only sligh ly less than that of the average moving-coil loud speaker. A resonance, probably due to the reed, occurs at about 300 cycles. From 300 to 5,000 cycles the output is sensibly uniform, apart from a diaphragm resonance at about 2,500 cycles, and above 5,000 cycles there is actually a rise in the characteristic up to 6,000 cycles, the highest frequency tested. Thus the general effect has a crispness and brilliance which is seldom achieved with a diaphragm of such large diameter. The 300-cycle resonance does not affect the reproduction of speech, and, taking the results as a whole, we can state with confidence that only a trained ear could differentiate between the D.20 unit and a moving-coil loud speaker.

The windings have a nominal resistance of 750 ohms, and the impedance varies with frequency as follows :—

Frequency (cycles).	Impedance (ohms).
50	1,590
100	1,930
200	2,920
400	3,550
800	5,650
1,600	9,370
3,200	12,600
6,400	6,800

The unit is made by Celestion, Ltd., London Road, Kingston-on-Thames, and the price is three guineas.

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LEWCOS TWIN TWO-PIN BASE.

This is fitted with four sets of plugs and sockets to accommodate the standard pattern Lewcos two-pin plug-in coils; one set being mounted at right angles to the other set. The base of the unit is moulded in bakelite, and in the hollow recess underneath is a three-pole changeover switch consisting of cam-operated leaves with silver-tipped contacts. This is actuated by an extension rod, thus

Lewcos dual-range coil unit for two-pin coils with wave-change switch in base.

enabling the unit to be mounted on a convenient part of the baseboard, and well back from the panel.

Terminals are fitted for the attachment of aerial earth and reaction leads. In addition, two flex leads are provided which should be attached to one of the terminals on each of the tapped aerial coils.

The makers are the London Electric Wire Co. and Smith's, Ltd., Church Road, Leyton, London, E.10, and the price is 12s. 6d.

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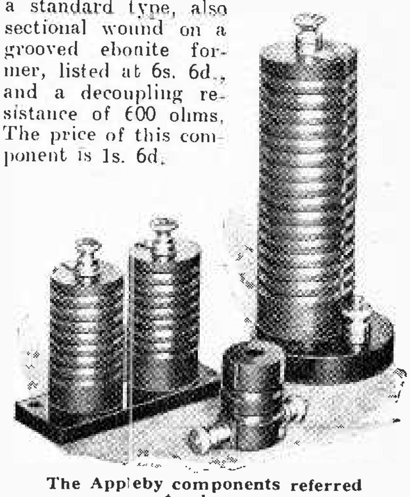
APPLEBY COMPONENTS.

A new range of components has recently been introduced by E. Hetherington Appleby, Chapel Street, Marylebone, London. These include a small binocular H.F. choke, sectional wound, priced at 3s. 9d., a standard type, also sectional wound on a grooved ebonite former, listed at 6s. 6d., and a decoupling resistance of 600 ohms. The price of this component is 1s. 6d.



The Appleby components referred to above.

"VEE" EARTH PLATE.

Where facilities are available a metal plate buried in close juxtaposition to the point where the earth lead enters the building, and for preference immediately below the aerial, forms one of the best earth connections obtainable.

The "Vee" earth plate made by J. B. Trueman, 141, Ince Avenue, Walton, Liverpool, should prove admirable for this purpose. It consists of a square copper plate of 24 S.W.G. measuring 16in. × 16in., to which is firmly attached a length of No. 14 S.W.G. copper wire. Copper is ideal for this purpose, since it does not corrode. The price complete with lead-in cleats is 4s. 9d.

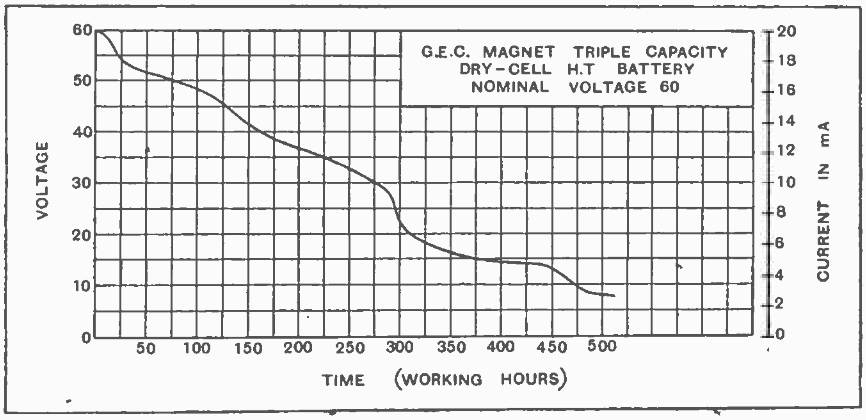
G.E.C. MAGNET H.T. BATTERY.

The battery with which this test report is concerned is officially known as a triple capacity size and listed as type L4903 by the makers, the General Electric Co., Ltd., Magnet House, Kingsway, London, W.C.2. In view of its size it was decided to commence the discharge at 20 mA., which should be well within its capacity. The discharge was not continuous, since dry-cell batteries must be allowed periods of rest during which they partially recuperate, and unless they are given these rest periods the full value cannot be derived from the battery.

G.E.C. Magnet 60-volt triple capacity dry-cell H.T. battery.

Consequently the discharge was restricted to periods of four hours, with similar periods for recuperation. In the graph showing the performance of the battery the rest periods have been omitted and only the actual working time included. There was a fairly rapid fall in voltage during the first twenty-five hours, after which the decline was more gradual. This rate of fall was maintained until the battery had been in use for 290 hours, when a well-defined cut-off was noticed.

This happens to be a distinctive feature of all G.E.C. batteries; they maintain their output at a reasonably high level for a certain time, governed by the type of battery, and then show a rapid fall. In the present case the cut-off point was found to coincide with a drop in voltage per cell to approximately 0.75 volt, which is generally accepted as being the lowest useful limit to which dry cells can be discharged.



Discharge curve of the Magnet 60-volt H.T. battery.

If we accept this as being the useful life of the battery some 290 working hours can be expected when the initial current taken from the battery is of the order of 20 mA. From the discharge curve it can be seen that this represents about 4,200 milliampere hours actual capacity.

The overall size of the battery is 13½in. × 5¼in. × 3in. high. The nominal voltage is 60, and the battery is tapped in steps of 6 volts throughout. The price is 13s. 6d.

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FERRANTI A.F.8 L.F. TRANSFORMER.

The type A.F.8 L.F. transformer is a new model just introduced by Ferranti, Ltd., to meet the demand for an inexpensive component of sound quality. The overall dimensions are quite small in spite of the fact that it embodies a normal type of core, and not one constructed from high-permeability material.

The internal construction follows the usual Ferranti practice, the winding being sectionalised and carried on a special spider-type former. This method of winding assures a low self-capacity. The casing is a neat bakelite moulding with the terminals placed in an accessible position.

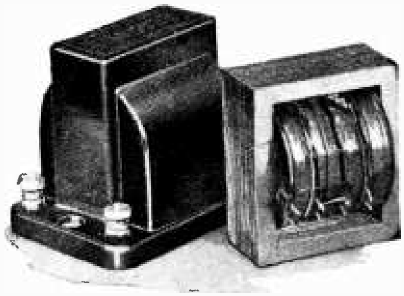
Some measurements were made of the primary inductance at 50 cycles with various values of D.C. flowing and with a small maintained A.C. voltage across the coil. The values found are given in the table below:—

D.C. in mA.	A.C. component in mA.	Inductance in henrys.
0	0.213	62.3
2	0.314	46
4	0.433	30.7
6	0.54	24.3
8	0.64	21

The measured D.C. resistance of the primary winding is 1,040 ohms.

To obtain the best all-round results, it would be advisable to precede the transformer by a valve of medium A.C. resistance, and for preference one not exceeding some 12,000 ohms A.C. resistance. Even so, should the steady anode current rise above 3 mA., it would be best to adopt a resistance capacity feed arrangement, thus deflecting the steady D.C. from the primary winding.

This transformer does not include a condenser across the primary winding as is usual with most Ferranti models. When the transformer follows the detector valve and a differential reaction condenser is employed, no further capacity is desirable, but in other cases a fixed condenser of 0.0003 mfd. in shunt with the primary winding is recommended.



New model Ferranti A.F.8 L.F. transformer and uncased sample, showing the sectionalised method of winding.

The step up ratio of the A.F.8 is 3.5 to 1, and the makers are Ferranti, Ltd., Hollinwood, Lancashire. The price is 11s. 6d.

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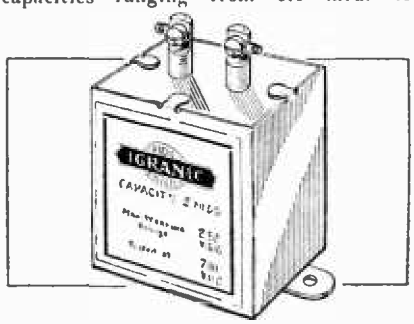
IGRANIC LARGE CONDENSERS.

Included in the new components recently introduced by the Igranic Electric Co., Ltd., 149, Queen Victoria Street, London, E.C.4, is a range of large-capacity fixed condensers of the paper dielectric type. These are made in capacities ranging from 0.1 mfd. to 4 mfds. The price of the first-mentioned size tested at 700 volts is 1s. 6d., a 2 mfds. size of the same test voltage costs 3s., and a 4 mfds. 5s. The 2 mfds. and 4 mfds. types are available tested to 1,650 volts, the price of these being 4s. 2d. and 7s. 7d. respectively.



Igranic 2 mfds. condenser tested to 200 volts D.C.; the working voltage is 250.

Broadcast Brevities

By Our Special Correspondent.

The Prince's South American Speech.

On good authority I learn that the Prince of Wales's speech at the British Empire Trade Exhibition in Buenos Aires on March 14th will be broadcast. If it is at all possible, the B.B.C. will relay the speech to British listeners, either picking up one of the American short-wave retransmissions, or employing the transatlantic Telephone Service.

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When Accent Tells.

This will be one of the first occasions, I believe, that it has been possible to hear a pure English accent across the Atlantic. It is well known that His Royal Highness possesses an ideal microphone delivery, so it would not be surprising if the speech reveals that the indistinctness of previous transatlantic speeches has not been entirely due to atmospherics!

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Combating Interference: An International Move?

Semmering! Another obscure locality which may win renown through broadcasting. For it is at Semmering (Austria) that the Union Internationale de Radiofusion is this week broaching a question of the utmost importance to listeners in all parts of the world.

The Union is about to agitate for an International Conference enjoying the official status of the famous Washington Wireless Conference, but devoted entirely to broadcasting questions.

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Official Laxity.

Hitherto broadcasting has occupied a comparatively unimportant place in the agenda of world wireless conferences, with the result that there is still an astonishing official laxity in matters concerning broadcast wavelengths and power. The feeling of the Broadcasting Union is that if the Governments of the world can be persuaded to take an intelligent interest in the subject, much of the existing confusion in the broadcasting ether would disappear.

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Representing 100,000,000 Listeners.

The delegates at Semmering and, a little later in the year, at Copenhagen, will prepare a scheme for submission at the great wireless conference to be held in Madrid in 1932.

It is estimated that the delegates at Semmering this week represent more than a hundred million listeners.

oooo

Objections to Italian Proposal.

The greatest enthusiasm for a broadcasting conference is being shown by Italy and a proposal is already afoot that the first meeting should be held in Rome, which was recently the venue for the International Cinematograph Congress

I understand, however, that the B.B.C. is offering objections to this proposal on the grounds that the Italian capital would give the gathering too national a flavour; Savoy Hill prefers an international centre like Berne or Geneva.

"Music and Dancing."

Surely it is not surprising that the entertainment industry sees something ominous in the application of the B.B.C. for a music and dancing licence in respect of the new "Broadcasting House." Armed with such a concession, the B.B.C. could legitimately admit paying audiences—incidentally, at competitive prices.

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An Official View.

In a chat with a Savoy Hill official last week I was assured that the B.B.C. hopes to secure a licence in the interests of the staff. Several staff dances are held throughout the winter season in a public hall rented for the occasion, and it is the custom to make a nominal charge. With the large studio at Broadcasting House available, the renting of a public hall is held to be unnecessary. "It is possible," added my informant, "that on certain occasions when members of the public would be admitted to broadcast performances a contribution to a charity would be useful."

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In the Name of Charity.

It is interesting to note that listeners are now admitted to the new Edinburgh studio for a nominal sum, the proceeds being devoted to charity.

I wonder whether the entertainment industry will always condone competition of this kind, provided that what it loses goes to charity? And, further, whether "charity" will cover contributions to the consequently impoverished members of the entertainment profession?

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The Boat Race.

The Oxford and Cambridge boat race will, as usual, be described in a running commentary broadcast on Saturday, March 21st.

Probably more people listen to the Boat Race relay than to any other sporting event broadcast by the B.B.C.

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Lady Balloonist—and Others.

"The Pursuit of Pleasure," which is Mr. Lance Sieveking's programme for February 12th and 14th, will give listeners the atmosphere of night life during the past two centuries.

The characters include Mozart, Grimaldi, Handel, Jenny Lind, Henry Irving, Madame Bonzo, the lady balloonist, Marie Lloyd, Sir William Sterndale Bennett, and a host of others who helped to drive away dull care in the days of our grandfathers.

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Saturday Afternoon.

Two o'clock on a Saturday afternoon is the time, I understand, when a million toiling sons of Britain, having just returned from their work, sit down to a "mid-day" repast. At present the B.B.C. chooses this moment to conclude the lunch-time concert of restaurant music, and the workers are left to munch more or less in silence. I am glad to hear that the "O.B." department is thinking of postponing the opening of the Saturday lunch-hour concert by half an hour, so that the session (as they call it in America) will last from 1.30 to 2.30.

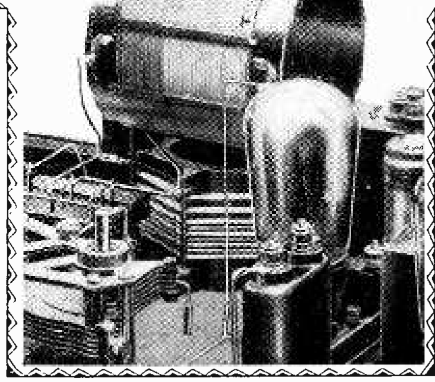
MUSSOLINI BROADCASTS. The Duce is an enthusiastic believer in the powerful influence of broadcasting. This recent photograph shows him in a characteristic attitude at the microphone.

Hunting for a Voice.

At the time of writing, Mr. Philip Ridgeway is still searching for a female "personality" voice which shall make our loud speakers ring with freshness, charm, and freedom from accent—Cockney, "refaned," or any other kind. He is collecting material for "The Ridgeway Parade," which comes back to the microphone on March 2nd (National) and March 3rd (Regional).

"I can only describe what I want as the pure, young English voice," he says. He has already given auditions to more than a hundred girls!

Theory of the H.F. Transformer



The Reaction Between Primary and Secondary Windings.

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

(*Continued from page 90 of previous issue.*)

An alternating-current transformer consists essentially of two coils so arranged that a certain degree of mutual inductance exists between them. An alternating current flowing in either one of them will cause an electro-motive force of the same frequency to be generated in the other. In the case of power transformers for low-frequency work the two coils are wound on a single iron core, for the purpose of obtaining the highest possible degree of magnetic coupling between them. With such an arrangement practically the whole of the lines of magnetic force produced by a current in one of the windings are linked up with the turns of the other, the *coefficient of coupling* being very nearly unity.

As a general rule, however, it is not permissible to employ iron cores for high-frequency transformers because the power losses incurred in the iron rise very rapidly as the frequency is increased, and in many instances it is essential to have a more or less loose coupling or low value of coupling coefficient between the windings. For these reasons a high-frequency transformer usually consists of two inductive coils whose relative positions are so fixed that the required amount of magnetic coupling exists between them. There are several ways in which the primary and secondary windings can be disposed relatively to each other, but all arrangements involve the same principles. The turns are wound on non-magnetic formers and the coefficient of coupling is always less than unity.

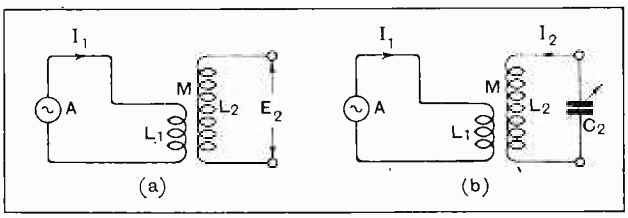


Fig. 1.—Theoretical circuit diagrams of a high-frequency transformer (a) with secondary circuit open, (b) with secondary winding tuned to resonance by means of a condenser C_2. M is the mutual inductance between the windings whose self-inductances are L_1 and L_2. The coupling coefficient is $k = \frac{M}{\sqrt{L_1 L_2}}$

The primary winding of a transformer is the one which is directly connected to the source of current, that is to say, the one to which electrical power is supplied. The secondary winding is the one in which the voltages and currents are entirely due to the magnetic influence of the current in the other.

In nearly every instance either the secondary winding or the primary winding of a high-frequency transformer is tuned by means of a condenser to resonance at the operating frequency. Since it is nearly always the secondary winding which is tuned in this way we shall deal chiefly with the latter arrangement as regards the theory of the tuned transformer. (If both primary and secondary circuits are tuned the circuit as a whole becomes a filter, whose theory is not so simple as that of a transformer).

Phase Differences between Primary Current and Induced E.M.F.s.

Let us assume that a high-frequency transformer consists of two coils whose self inductances are L_1 and L_2 henrys respectively, disposed relatively to each other in such a way that the mutual inductance between them is M henrys. Suppose, further, that an alternating current whose R.M.S. value is I_1 amperes is driven through the coil L_1 by means of an alternating current generator A, as shown in Fig. 1 (*a*). Then, as explained in the previous article dealing with mutual induction,[1] the alternating voltage generated or induced in the second coil L_2 will be

$$E_2 = \omega M I_1 \text{ volts} \quad \ldots\ldots\ldots\ldots \quad (1)$$

where $\omega = 2\pi \times$ frequency, and this electromotive force, produced in the secondary coil, lags by just a quarter of a cycle behind the primary current.

Similarly, the self induced E.M.F. or back E.M.F. in the primary coil itself is given by $\omega L_1 I_1$ volts, and also lags by a quarter of a cycle behind the current and magnetic field producing it. Thus, if a simple vector diagram is drawn in which the current is represented by a vertical straight line OI_1, as shown in Fig. 2, the primary back E.M.F. and the secondary induced E.M.F. can be represented respectively by two lines OE_1 and OE_2 drawn horizontally to the right. For the present it is assumed that the secondary coil L_2 is on open circuit, as shown at (*a*) in Fig. 1, and that no self-capacity effects exist in either coil or between the coils, so that the coupling is purely magnetic.

Since the induced E.M.F. in each coil is given by the product of the primary current and the reactance

[1] See *The Wireless World*, January 28th, 1931.

Theory of the H.F. Transformer.—

(ωL_1 or ωM, as the case may be), it follows that *if the R.M.S. value of the primary current is one ampere the induced E.M.F. becomes numerically equal to the reactance*, and from this fact we can evolve a simplified definition of reactance, particularly suited to the explanations to follow. Namely, the reactance of a circuit is numerically equal to the back E.M.F. produced by a current of 1 ampere, the phase difference between the voltage and current being just 90° or a quarter of a cycle.

Similarly, *the resistance of a circuit is numerically equal to the opposing voltage set up by a current of 1 ampere in the circuit, this voltage being exactly 180° out of phase with respect to the current.* The question of phase difference is a very important one indeed, especially where interaction occurs between two circuits each carrying alternating currents. For instance, if a certain circuit is carrying a current I_1, and if an alternating E.M.F. is induced into this circuit by the action of a neighbouring one, the exact effect on the first circuit mentioned depends almost entirely on the phase relationship between the current I_1 and the induced voltage caused by the presence of the second circuit. For instance, if the induced voltage is 180° out of phase with respect to the current, that is to say, always in direct opposition to it, the effect is equivalent to the addition of resistance. Or if the induced E.M.F. lags by 90° the effect is the same as adding inductive reactance to the circuit. In general, when the voltage introduced into the circuit is somewhere between 90° and 180° out of phase with respect to the current, the effect is the same as adding both resistance and reactance in series with the circuit. These are the conditions which arise when the secondary winding of a transformer is allowed to carry a current, that is to say, the apparent impedance of the primary winding depends on the nature of the load across the secondary coil as well as on the actual inductance and resistance of the primary winding.

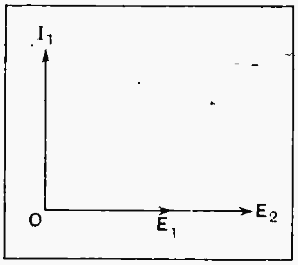


Fig. 2.—Vector diagram showing the phase difference between the primary current I_1, and the voltages E_1 and E_2 generated by this current in the coils L_1 and L_2 respectively of Fig. 1 (a).

Conditions when Secondary Circuit is Tuned.

On connecting a circuit or "load" of any kind across the terminals of the coil L_2 in Fig. 1 (*a*) a current will, of course, flow round the closed circuit thus formed. If Z_2 is the impedance of the complete closed secondary circuit the current will be $I_2 = \frac{E_2}{Z_2}$ amps., where E_2 is the E.M.F. set up in L_2 by the action of the current I_1 in the primary coil. The phase position of this secondary current will depend on the ratio of reactance to resistance in the circuit.

Now suppose that the secondary coil L_2 of Fig. 1 (*a*) has a condenser of capacity C_2 farads connected across its terminals, as shown at (*b*) in Fig. 1, and further suppose that this capacity tunes the secondary circuit to complete resonance with the frequency of the voltage induced in L_2 by the current in L_1. Under these conditions the condensive reactance $\frac{1}{\omega C_2}$ completely neutralises the inductive reactance of the secondary coil, and the impedance of the closed circuit becomes numerically equal to its effective resistance R_2 ohms. The secondary current is therefore $I_2 = \frac{E_2}{R_2}$ amps., *and is exactly in phase with* E_2.

Reaction of the Secondary Current on the Primary Coil.

The main object in view at the present juncture is to find out the precise effects of the tuned secondary circuit on the apparent impedance of the primary winding of the transformer. Fortunately, the theory is greatly simplified by the fact that the electro-motive force and current in the secondary circuit are in phase with each other. But, in any case, the reactions which occur in the circuits will be most easily explained by first treating an actual transformer of known constants numerically, deriving theoretical expressions subsequently.

Let us then suppose that the primary coil inductance is $L_1 = 100$ microhenrys and the secondary inductance is $L_2 = 200$ microhenrys and, further, that the mutual inductance between the coils is $M = 70.7$ microhenrys. With these values the coefficient of coupling between the coils is $k = \frac{M}{\sqrt{L_1 L_2}} = 0.5$ or 50 per cent. Assume that the secondary circuit is to be tuned to a frequency of 1,000 kilocycles or 10^6 cycles per second (corresponding to a wavelength of 300 metres) by means of a suitable condenser. Then at this frequency the quantity $\omega = 2\pi \times$ frequency will be 6.283×10^6 radians per second. To complete our list of constants, let the high-frequency resistance of the primary coil and

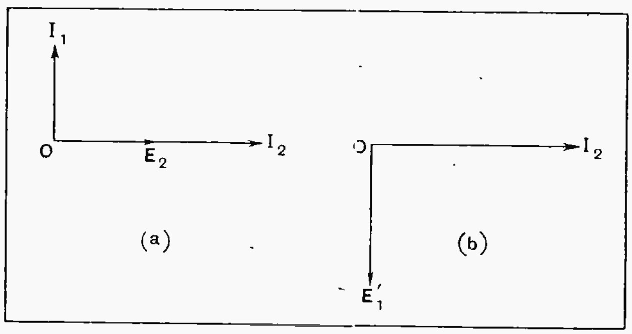


Fig. 3.—Vector diagrams showing the phase differences between the primary and secondary currents when the secondary circuit is tuned to resonance. E_1' is the voltage induced back into the primary winding by the current I_2 in the secondary coil.

of the secondary circuit each be 10 ohms, so that $R_1 = R_2 = 10$ ohms.

The primary coil alone, with the secondary winding either on open circuit or removed altogether, will be $Z_1 = \sqrt{R_1^2 + (\omega L_1)^2}$ ohms. This equals ωL_1 approximately, since R_1 is small compared with ωL_1, the

Theory of the H.F. Transformer.—
numerical value being 628.3 ohms. But knowing beforehand that the current in the tuned secondary circuit is bound to influence the primary circuit, we do not know the relationship between the primary applied voltage and the primary current. We must first find the exact effect of the secondary current, and perhaps the easiest method of procedure is to assume some definite value of current in the primary coil L_1. Accordingly let us assume that the current in the coil L_1 is $I_1 = 50$ microamps., the frequency being 10^6 cycles per second. This current will induce an E.M.F. whose value is $E_2 = \omega M I_1$ volts in the secondary coil, from equation (1) above. Now in this instance ωM works out to 444 ohms, so that $E_2 = 444 \times 50 \times 10^{-6} = 0.0222$ volt in the secondary coil, *and this voltage lags just 90° behind the primary current.* Thus, in Fig. 3 (*a*), if OI_1 represents the primary current, the voltage E_2 will be in the direction OE_2 at right angles to OI_1 and to the right.

Now when the secondary circuit is tuned to complete resonance the resulting current is given by $I_2 = \frac{E_2}{R_2} = \frac{0.0222}{10} = 0.00222$ amp. or 2.22 milliamps. and is in phase with E_2. Thus, in Fig. 3 (*a*) the vector representing this current will lie in the same direction as OE_2, being indicated by OI_2 in the diagram.

The voltage developed across the tuned secondary circuit will be $\omega L_2 \times I_2 = 1.257 \times 2.22 = 2.79$ volts.

Effects on the Primary Coil.

We now come to the main point in the calculation, namely, the determination of the effects of the tuned secondary circuit on the impedance of the primary coil. Just as the current in the primary coil induces an E.M.F. in the secondary, so will a current in the latter generate a voltage in the primary additional to the normal back E.M.F. of self induction; and the phase relationship of this voltage to the primary current determines the nature of the reaction, that is to say, whether it will produce an apparent change in the primary resistance or reactance, or both simultaneously.

Let E_1' denote this extra E.M.F. induced in the primary coil. Its value will be $E_1' = \omega M I_2 = 444 \times 0.00222 = 0.985$ volt. As in the previous case, this voltage will lag behind the current producing it by 90°. The vector OI_2 has been selected from Fig. 3 (*a*) and redrawn in Fig. 3 (*b*) in the same direction as before, and the voltage E_1' is here represented in its correct phase position by the line OE_1' drawn vertically downwards, that is, lagging by 90° behind OI_2, because the vectors are always assumed to rotate in a counter clockwise direction about the point O.

We are immediately concerned with the phase relationship between the primary current I_1 and the voltage E_1' in the primary circuit arising from the secondary current, so that by superimposing the two diagrams of Fig. 3 we obtain the required information. The combined diagram is shown in Fig. 4, where E_2 has been omitted for the sake of simplicity. We see at a glance that OI_1 and OE_1' are in exact anti-phase, that is to say, E_1' is just 180° out of phase with respect to the primary current. *This means that the voltage induced in the primary coil by the current in the tuned secondary coil is directly opposing the flow of primary current.*

Apparent Increase of Primary Resistance.

Now, it was explained above that it is only in the case of pure resistance or its equivalent that a counter voltage is set up in exact opposition to the current at all times. It follows, then, that the effect of the secondary current in the tuned circuit on the primary coil is virtually to increase its resistance. The extra or apparent resistance introduced in this way is given in magnitude by Ohm's law by dividing the voltage E_1' by the current I_1, its value being therefore $R_1' = \frac{E_1'}{I}$ ohms. In the present case $E_1' = 0.985$ volt and $I_1 = 50\mu A$, so that $R_1' = \frac{0.985}{50} \times 10^6 = 19{,}700$ ohms.

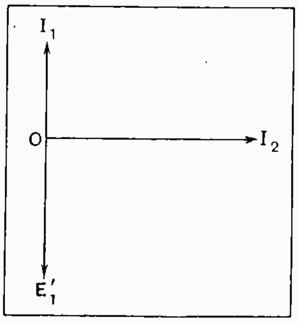


Fig. 4.—Vector diagram obtained by combining the diagrams (a) and (b) of Fig. 3, the transformer secondary being tuned to resonance.

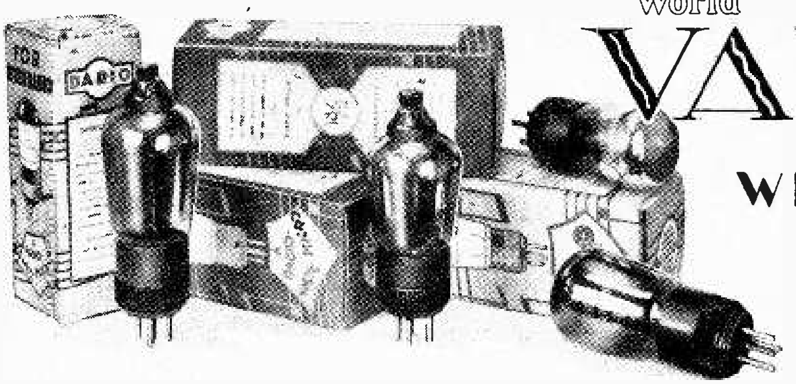
Compared with this large figure the actual or ohmic resistance (10 ohms) of the primary winding fades into insignificance, and thus there is no point in designing the primary winding to have a low actual resistance—the thinnest wire compatible with mechanical strength will suffice.

A further important conclusion resulting from our calculation is that the *reactance* of the primary coil is not in any way affected, because the secondary current does not induce any component of voltage at right-angles to the primary current, or 90° out of phase. The reactance of the primary coil itself is $\omega L_1 = 628$ ohms, and therefore the apparent impedance of the primary coil when the secondary circuit is tuned to resonance at 1,000 kilocycles per second is $Z_1' = \sqrt{19{,}710^2 + 628^2} = 19{,}720$ ohms, so that even the reactance is negligible compared with the apparent increase of resistance. This apparent high resistance of the primary winding constitutes the *dynamic resistance* of the tuned transformer.

The voltage which must be applied to the terminals of the primary winding to drive 50 microamps. through it with the secondary tuned to resonance is equal to the product of current and dynamic resistance, namely, $50 \times 10^{-6} \times 19{,}720 = 0.986$ volt. The voltage developed across the secondary circuit was seen to be 2.79, and therefore the actual step-up effect or voltage magnification given by the transformer is $m = \frac{2.79}{0.986} = 2.8$ times.

In the next part of this article simple theoretical formulæ will be developed for calculating the dynamic resistance of tuned transformers in terms of the constants of the windings, and the effects of the primary circuit reactance on the tuning of the secondary circuit will be considered.

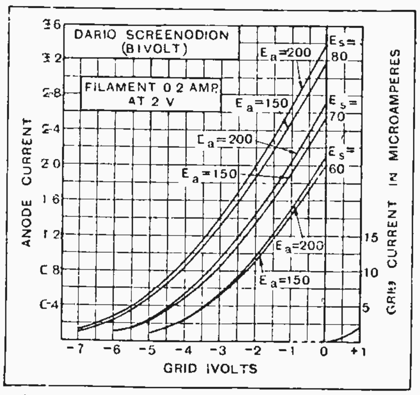
(To be continued.)



VALVES WE HAVE TESTED

Four Representative Specimens Chosen from the Dario Range of Valves.

DARIO valves are made in France and handled in this country by the Impex Electrica, Ltd., 538, High Road, Leytonstone, London, E.11. The complete range of receiving valves comprises some eighteen different types, the majority of which are fitted with two- and four-volt filaments, the six-volt type being apparently unfavoured in France since there are no specimens of this particular class available. Included in the samples sent in for test were some indirectly heated valves designed for operating from a step-down transformer delivering between 3.5 and 4 volts A.C.



Grid volts-anode current curves of the Bivolt Screenodion with various values of screen potential.

Rather than deal very briefly with each of the eighteen specimens, many of which show quite familiar characteristics, it was decided to devote the space available to a more comprehensive test and report on those of greater interest, such as the screen-grid battery valve, its A.C. counterpart, an A.C. detector, and the two-volt hyper-power valve

SCREENODION (BIVOLT).

This is a screen-grid H.F. amplifier fitted with a 2-volt filament. The anode terminal is mounted on the top of the bulb and the other contacts located on a 4-pin base cup in the usual manner. Its nominal characteristics are:—

A.C. resistance, 250,000 ohms.
Amplification factor, 250.
Mutual conductance, 1 mA/volt.
Maximum anode potential, 200.
Normal screen voltage, 80.

A set of curves were prepared connecting anode current and grid voltage with various screen potentials. Grid current was found to start at zero grid volts, consequently it will be satisfactory in practice to operate the valve with a grid bias of $-1\frac{1}{2}$ volts when the maximum anode voltage is applied. Measurements were then made of the A.C. resistance, amplification factor and mutual conductance under these operating conditions with 60, 70 and 80 volts on the screen grid, the results being tabulated below:—

Screen volts.	A.C. Resistance (R_o)	Amplification factor (μ)	Mutual Conductance (g)
60	800,000 ohm	400	0.5 mA/volt.
70	390,000 ohm	210	0.6 mA/volt.
80	310,000 ohm	210	0.68 mA/volt.

There is very little change in these values with higher screen potentials, the drain on the H.T. battery increases, but to no good purpose. Between 70 and 80 volts would appear to be the most satisfactory screen potential.

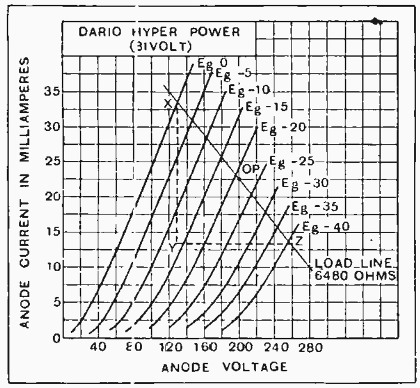
The anode-grid capacity is given as 0.005 micro-mfds., so that a 1 : 1 ratio transformer would appear to be the optimum coupling. With this arrangement selectivity is likely to be rather poor unless a very good band-pass input circuit is adopted. With normal tuning arrangements a 3 : 1 ratio step-up is advised, and, assuming a dynamic resistance of 250,000 ohms for the tuned secondary circuit, a stage gain of 53 can be assured. With a secondary coil of solid wire and giving some 150,000 ohms for the dynamic resistance of the circuit, the stage gain will fall to 32, approximately.

HYPER POWER (BIVOLT).

This is a 2-volt super-power output valve having the following rated characteristics:—

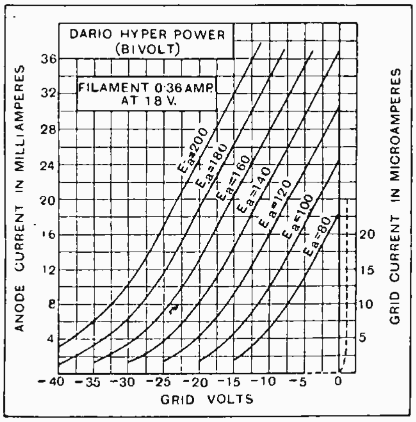
A.C. resistance, 2,700 ohms.
Amplification factor, 5.
Mutual conductance, 1.8 mA./volt.
Maximum anode voltage, 200.

Although the largest power handling valve in this class, so far as we are aware, the maximum undistorted power, allowing 5 per



Anode volts-anode current curves of the Bivolt Hyper-power valve. From these can be ascertained the most suitable loud speaker impedance, also the maximum power output.

cent. second harmonic, that it will deliver was found to be 320 milliwatts from the specimen tested. This figure was obtained by preparing a set of curves connecting anode volts and anode current for equal increments of grid bias. The optimum loud speaker impedance was then determined and the power triangle sketched in. The optimum loud speaker impedance to obtain maximum power output is of the order of 6,480 ohms at mean speech frequency.



Grid volts-anode current curves of the Dario Bivolt Hyper-Power valve. Average values under working conditions. A.C. resistance 3,250 ohms, amplification factor 5.2 and mutual conductance 1.6 mA/v

Good results should be forthcoming with reasonably sensitive cone-type moving armature loud speakers, but two valves in parallel will be required to operate a moving-coil model at its best. With the maximum anode voltage, a grid bias of about 22 volts should be applied, the average anode current then being of the order of 22.5 milliamps. The sample tested was dead hard and grid current started at zero grid volts.

Since the average reed-type loud speaker has an impedance of about 5,000 ohms at 400 cycles the speaker may be fed through a straight - forward choke - capacity filter circuit, the need for this being obvious in view of the comparatively high anode current.

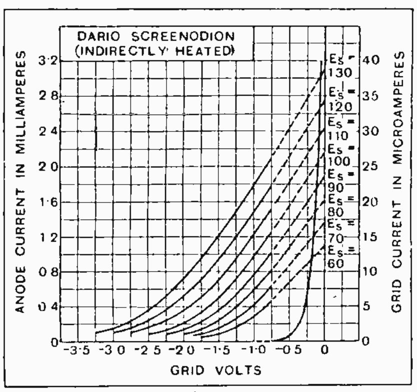
SUPER-SCREENODION (INDIRECTLY HEATED).

Designed for A.C. circuits, this valve operates from a step-down filament transformer giving between 3.5 and 4 volts, the current taken by the heater being approximately 1.2 amps. Its rated characteristics are:—

A.C. resistance, 1,000,000 ohms.
Amplification factor, 1,000.
Mutual conductance 1 mA./volt.
Maximum anode potential, 250.
Maximum screen volts, 150.

The anode and screen voltages are somewhat higher than usual for valves of this type, and where these potentials are readily available, it would be well to apply them. With a view to ascertaining the performance of the valve with voltages of the order more generally used, a set of curves were prepared connecting grid volts and anode current for various screen potentials from 60 to 130 volts, the anode voltage being maintained at 200 volts.

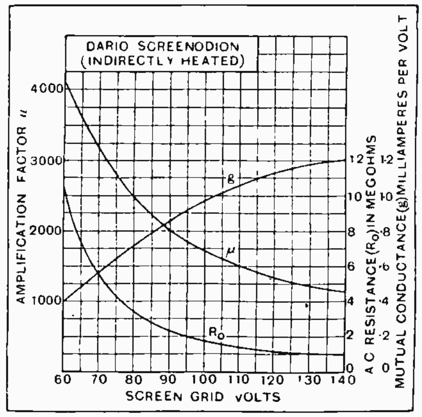
Grid current was found to commence at -0.75 volt bias; consequently under normal amplifying conditions at least -1.25 volts grid bias should be used. Under working conditions only a very small grid swing is permissible if distortion in the waveform is to be avoided in the anode circuit, especially when the valve is coupled to a tuned circuit of comparatively high dynamic resistance. Therefore, a screen potential of the order of 100 volts may be used in practice with an anode voltage of double this value and the grid bias stated above.



Grid volts-anode current curves of the Screenodion for various screen potentials. The anode voltage is maintained at 200 throughout.

These being the minimum safe operating voltages, further measurements were made of the electrical constants shown by the valve. The amplification factor was found to be 1,700, the A.C. resistance 1.75 megohms, and the mutual conductance 0.97 mA./volt. In all screen-grid valves these constants vary widely with change in screen potential and grid bias. Curves connecting the three principal constants for various values of screen voltage at a fixed anode potential of 200 volts and a grid bias of -1.25 volts have been prepared and are reproduced herewith.

The rated characteristics apply apparently to working conditions using the maximum voltages all round, as an examination of these curves show a definite improvement with higher screen potentials. In



Relationship between A.C. resistance R_0, amplification factor μ and mutual conductance g with 200 volts on the anode and various screen potentials. The grid bias is 1.5 volts throughout.

many cases Continental valve rating has been found to apply to working conditions.

The anode-grid capacity is stated to be 0.0045 micro-mfds., and with the constants found by measurement using the voltages chosen for this test, the maximum stage gain with an unneutralised circuit calculated at 200 metres is 205. Since this postulates a transformer of about unity ratio, the selectivity may not be all that could be desired, and, on substituting this for one with a step-up ratio of 3 : 1, the tuned circuit of which shows a dynamic resistance of 250,000 ohms, a stage gain of 80 may be reasonably expected.

Through the range of measurements made, the screen current was considerably less than 1 mA., and in many cases below 0.5 mA. Screen potential should, therefore, be taken from a potentiometer, which might be designed to pass about 3 mA. to give good voltage regulation. A series resistance is definitely not advised. The anode is brought out to a terminal on the top of the valve in the usual manner, and a five-pin base cap is fitted, the centre pin connecting with the cathode and the heater connections brought out to the normal filament pins.

SUPER DETECTOR (INDIRECTLY HEATED).

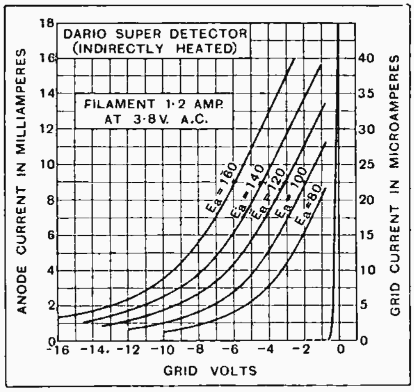
Although designated a detector valve, it would be more in keeping with its characteristics to place it in the category of small-power L.F. valves, since it will serve equally well as a first-stage low-frequency amplifier. The rated characteristics are:—

A.C. resistance, 7,500 ohms.
Amplification factor, 15.
Mutual conductance, 2 mA./volt.
Maximum anode voltage, 150.

The heater is designed to operate at between 3.5 and 4 volts, the current taken being of the order of 1.2 amps. Grid current was found to start at −0.7 volt grid bias, so that the valve would seem to be suited for use as a power-grid detector by returning the grid circuit to the cathode. Care must be taken to keep the anode current within reasonable bounds, and an actual anode voltage of between 80 and 100 would be about the best value. Even so, the anode current will rise to approximately 12 mA., but may vary with different specimens.

As an intermediate L.F. amplifier with 150 anode volts and a grid bias of −6 volts, the steady anode current will be of the order of 7.5 mA.

Under amplifying conditions, the measured A.C. resistance was 7,150 ohms, the amplification factor 14.3, and the mutual conductance 2 mA. per volt. A five-pin base is fitted with the cathode connection in the centre, the remaining pins being disposed in the usual manner, the filament pins being, in this case, the heater connections. The arrangement conforms with the accepted practice in this country.



Grid volts-anode current curves of the A.C. Super Detector (indirectly heated) valve. Average values under amplifying conditions, A.C. resistance 7,150 ohms, amplification factor 14.3 and mutual conductance 2.0 mA/v.

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.

MULTIPLE BROADCAST.

Sir,—Your article on multiple broadcast is especially interesting to me as for some years I have been trying to get the ordinary Press to publish my scheme for a way out of the present chaos in the ether. (The earliest I can find in my returned M.S.S. is one dated October 29. 1929.)

This is simply the scheme of von Ardenne reversed.

I suggest that:

(a) Each country is allocated a fundamental wave which is radiated, perfectly synchronised, by all its stations.

(b) Each station then imposes on this its local HF wave—these local waves avoiding heterodyne with fundamental (or its harmonics).

(c) This local frequency is then modulated at L.F.

The receiver, as von Ardenne states, would need two stages of detection.

Surely this is the way out of our present trouble?

I know that my knowledge is lacking in the scientific side, but von Ardenne's plan bears out once more the possibility of a scheme which I have grown tired of inflicting on patient editors.

WILLIAM B. WEST.

Deal.

THE STENODE.

Sir,—The article in which Dr. Robinson seeks to explain the principles of his Stenode receiver can hardly be allowed to pass without comment. Not having access to the original paper, I must perforce take the abstract as it stands.

The author begins by throwing doubt on the application of Fourier analysis on the ground that "there can be no discontinuity in the nature of the physical response" of a circuit with a square-topped resonance curve, as the signalling speed is varied. I cannot see the force of this argument. A square-topped resonance curve implies a discontinuity in the response to a varying carrier frequency; why, then, should we deny the possibility of a discontinuity in the response to a varying modulation frequency? And if we do not get such an effect in practice, it is because in practice we do not get circuits whose response falls off suddenly and completely to zero.

Leaving the square-topped response curve, Dr. Robinson then proceeds to discuss the effect of modulated oscillations on a tuned circuit, and comes to various conclusions which he apparently wishes us to regard as new, but which can, in fact, be deduced much more easily and rigorously by the usual methods. For it is well known that reducing the decrement of a circuit does not diminish its response to frequencies well away from resonance, but increases its response to frequencies in the immediate neighbourhood of resonance. The sidebands are not reduced, but the carrier wave is increased; and as the amplitude of the sidebands is a measure of what Dr. Robinson calls the *absolute* modulation, it follows at once that the latter is unaffected, although the *percentage* modulation is reduced.

When he comes to the question of an interfering carrier wave, however, Dr. Robinson merely states that its effect is "small," but from what has just been said it is obvious that it is *not* small; like the sidebands (or, if you prefer it, the absolute modulation) it is just as great in the case of a circuit of very low decrement as in any other. The alleged explanation, then, turns out to be no explanation at all, and on top of this comes the admission that the Stenode does not, in fact, eliminate the interference, and that "other means" have to be adopted to do so!

This would seem to indicate that some of the claims previously made were misleading. Would it not be more satisfactory if Dr. Robinson were to give us, instead of theories of doubtful value, a precise description of the experimental facts which those theories are intended to explain?

The audible effects of an interfering station may be divided into two parts:—

(1) The actual speech or music.
(2) Heterodyne tones (including the heterodyning of the interfering sidebands by the carrier of the wanted station).

A theoretical consideration of the Stenode receiver as hitherto described (making reasonable assumptions as to the rectifier characteristic) indicates that it would eliminate (1) without affecting (2). If the interfering station is more than about

10 kc/s. away, only (1) occurs, and in such cases, therefore, the Stenode circuit may prove to be a useful alternative to the band-pass filter. With smaller separations the second type of interference predominates, and the arrangement would appear to confer no great advantage.

If the results of this analysis give a fair indication of the behaviour of the receiver, it would not appear to entail any great revolution either in theory or in practice. In view of the fact that the device has already been advertised to the public, it is surely not too much to ask for a straightforward scientific statement of what it will actually accomplish?

Oxford. N. L. YATES-FISH.

RECEPTION OF AMERICA.

Sir,—I wish to bring to the notice of fellow readers the fact that conditions are very favourable for long-distance reception. I have myself received several American stations on the medium waveband at headphone strength on an S.G. three-valve set. Amongst those I have heard announced are WTG, Atlantic City, WGY, New York, and WJG, New York. The strength and clearness of these stations are good enough to repay any enthusiast who cares to stay up till the early hours to listen to them. R. W. CAPEWELL.

Stoke-on-Trent.
Jan. 12th, 1931.

EFFICIENCY OF LOUD SPEAKERS.

Sir,—The efficiency of loud speakers is raised in your issue of December 31st. As Mr. Barclay remarks, the efficiency is now greater than it was for the short horn and reed-type speakers used in the early days. Provided the diaphragm moves as a whole the efficiency is obtained from measurements of resistance and inductance in air and in vacuo. The efficiency $\eta = \frac{R_m - k^2 R_{m_v}}{R_e}$ where R_m is the motional resistance in air, i.e., the difference between free and fixed resistances: R_{m_v} is the motional resistance in vacuo, k is the ratio of the motional impedance in air to that in vacuo, and R_e is the resistance when the system moves in air. Another method is to measure R_e in air with the driving agent (coil or reed) free and then with it fixed. R_m is the difference between the two, excepting that it includes diaphragm losses, since the diaphragm moves in one case but not in the other. It will be convenient to refer to the value thus obtained as the apparent radiation resistance. A series of measurements have been made by Mr. G. A. V. Sowter and myself, from which η_a can be calculated. We are, unfortunately, not the proud possessors of the necessary vacuum chamber and pump, so that the results are apparent values, i.e., η_a. The diaphragm loss should not be serious below 1,000 cycles, but it increases at the higher frequencies. In fact, in reed-driven apparatus, removal of the diaphragm does not affect the output above about 8,000 cycles, although this is due in part to interference.

Data are given in the accompanying table showing the apparent efficiency of (1) a reed-driven conical diaphragm 18 inches in diameter with a baffle 3 feet square, (2) the writer's M.C. loud speaker with a baffle 6 feet square, (3) both speakers if their diaphragms behaved as rigid discs in infinite baffles.

Frequency (cycles per second).	Apparent efficiency %	Efficiency with Rigid Disc %	Apparent Efficiency %	Efficiency with Rigid Disc %
	Reed.	Reed.	Moving Coil.	Moving Coil.
300	6	40 (resonance at 305 ~ .)	16.1	4.3
500	8.4	13.3	15.9	4.3
1,000	7.1	2.88	18.3	3.5
2,000	7.7	0.43	7.9	0.69
3,000 .. .	1.4	0.12	12.6	0.26

With a rigid diaphragm the reed-driven type resonates at 305 cycles, and its efficiency is 40 per cent. If the iron loss and the winding resistance were not so high, the efficiency would have been much greater. As the frequency rises, the efficiency gradually fades into insignificance—in fact, the [efficiency/frequency] curve is just like the selectivity curve of a tuned radio circuit. Due to diaphragm "break-up," the apparent efficiency of the *actual* speaker is uniform from 300 to 2,000 cycles, after which it falls, due to diaphragm loss and interference, a point which I have discussed several times in this journal.

The results for the M.C. speaker are somewhat different. From 300 to 1,000 cycles the actual diaphragm gives apparently four times the output from a rigid disc, whilst at 3,000 cycles it gives over *forty* times that from a rigid disc. The reason is simply that the coil and diaphragm form a complex resonating structure which "breaks-up" throughout the audible range. The drop in efficiency at 2,000 cycles should be noted. It extends over a fairly wide frequency band, and is characteristic of M.C. speakers, although it does not always occur at this frequency. Owing to the inclusion of diaphragm losses the above efficiencies are somewhat optimistic, but in the aforementioned M.C. loud speaker one might expect efficiencies from 5 to 10 per cent. over a certain frequency range. These results prove very definitely that rigid diaphragms are not desirable for loud speakers. In a forthcoming article,* the M.C. speaker is reviewed in the light of our recent research. It is shown that the upper register is due in part to the diaphragm *per se*, but mainly to the flexibility and resonances of the coil itself, i.e., its ability to take up an oval shape—thereby distorting the diaphragm—as when pressed between one's fingers. If experimenters will use a well-resined violin bow on the edge of the coil my meaning will be clear.

When the valve resistance is added, the overall efficiency of valve and speaker is reduced considerably. For example, with a valve resistance of 3,000 ohms the efficiency of the above M.C. speaker falls from 16.1 per cent. to 6.6 per cent., whereas with a pentode it is about 1 per cent. The efficiency η is, of course, only a criterion of the power output when the current is constant at all frequencies, e.g., the pentode case. With a low-resistance triode the increase in resistance and reactance of the speaker reduce the current, and, therefore, the output at high frequencies.

Again, by plotting an [efficiency/frequency] curve for the range 30 to 10,000 cycles and taking the main value $\left[\frac{\text{area}}{\text{base line}}\right]$ η can be reduced to a comparatively low value according to the extent of the response curve of the speaker. A discussion on this would be too protracted for inclusion here.

So far as I am aware, the most efficient loud speaker is the moving coil—15ft. horn variety of the W.E. Co. used for cinemas. Over a wide range it is 30 per cent. or more efficient. This high value of efficiency is due to the resistive air load on the diaphragm being greater than in the ordinary speaker.

Some freak values of η_a may be of interest to show what can be achieved at resonance frequencies. The diaphragm of the above M.C. speaker resonates on its surround at 18.5 cycles, and the efficiency exceeds 90 per cent. The efficiency of a thin aluminium disc driven by a M.C. and resonating at 120.5 cycles was 97 per cent., whereas at 250 cycles it was only 2 per cent. The A.C. resistance of the coil was about 1 ohm, whilst the radiation resistance was 37.5 ohms—a truly efficient arrangement.

Those interested will find some of the above points treated in detail in the "Philosophical Magazine," pp. 1-54, January, 1931.

London, S.W.1. N. W. McLACHLAN.
Jan. 2nd, 1931.

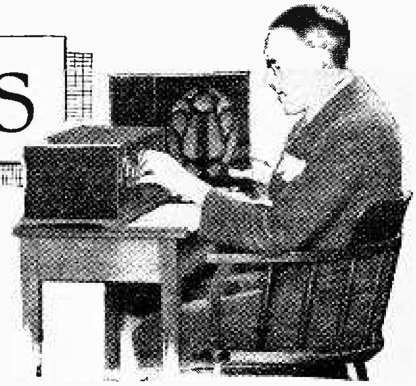
WIRELESS RELAY SERVICES.

Sir,—As a regular reader of your paper I have read with interest your remarks and the replies on the subject of wireless relay services. I would like to point out that this method of wireless distribution has been in use nearly three years in this district, and in some instances three and four programmes are given; the subscribers choose whichever they desire. A few advantages of the service are as follows: (1) Low initial outlay. (2) Low rental. (3) Twelve-hour service. (4) Freedom from electrical interference (tramways, etc.). (5) No upkeep cost, such as batteries, valves, etc. With regard to tramway interference, we have taken a number of good receivers from people resident on the car routes in exchange for our relay service. A further interesting point is that some of our subscribers get first-hand knowledge of good wireless reception and buy receivers, a step which would not otherwise be taken in numerous cases. J. PRESTON.

Briercliffe Wireless Relay Station,
Harle Syke, near Burnley.

* In the issues of January 21st and 28th, 1931.

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.

Failing Emission.

I am using an "L" class valve as a first-stage L.F. amplifier, and have just noticed that quality is greatly improved when grid bias for this valve is reduced from 4½ volts to 3 volts. My H.T. and L.T. accumulators are in good condition, and the usual tests fail to reveal any fault. Can you tell me why this change should have taken place?

If we can assume that no abnormally high resistance has developed in the anode circuit, it is logical to conclude that the emission of your valve has fallen off considerably.

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Increased Output: Shorter Life.

I have found that the current obtainable from my eliminator can be increased by fitting a larger condenser across the valve rectifier output. Is it likely that any harm will be done by retaining this extra capacity as a permanency?

It is risky to attempt to increase the output of a rectifying valve by operating it in a manner other than that intended by the manufacturers; its working life is likely to be seriously reduced by doing so.

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Condenser Working Voltage.

When designing an eliminator, I take it that the large condenser joined across the H.T. rectifier output will be called upon to withstand a higher voltage than the remainder of the condensers used in the unit. Is this correct?

Yes, the unsmoothed rectifier output, together with a ripple voltage component, is applied to this condenser. It is generally agreed that it should be capable of dealing with a voltage equal to twice that of the unsmoothed rectifier output.

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Pentode Detection.

I should like to obtain a larger output from my anode bend detector (at present a 20,000-ohm triode), so that the succeeding resistance-coupled output valve may be more nearly fully loaded on signals from the local station. Would it be worth while to use a pentode as a detector?

Your detector is obviously called upon to deal with quite large H.F. inputs, and in these circumstances a pentode would give good results. For a given input, it should provide an output of about twice that obtainable from a triode of normal characteristics.

Two-station Reception.

Will you please tell me what is the simplest form of circuit for the reception of two alternative programmes, with a switch change-over from one station to the other? If it is possible, I should like to use ready-made components. It is proposed to adopt a detector-L.F. circuit with reaction.

We cannot think of any simpler arrangement than the modified Hartley circuit shown in Fig. 1. Ordinary centre-tapped coils may be used, and entirely separate tuned circuits are provided for each wavelength.

Input from the aerial, and consequently the selectivity of the set, may be controlled by operation of the aerial series condenser C, which may have a value of about 0.00025 mfd. If it is necessary to depend to any very great extent on reaction, it would be convenient to insert a semi-variable condenser, C_1 (shown in dotted lines) in the appropriate lead of whichever circuit is found to oscillate most freely. A maximum capacity of from 0.0003 to 0.0005 mfd. would be right for this component.

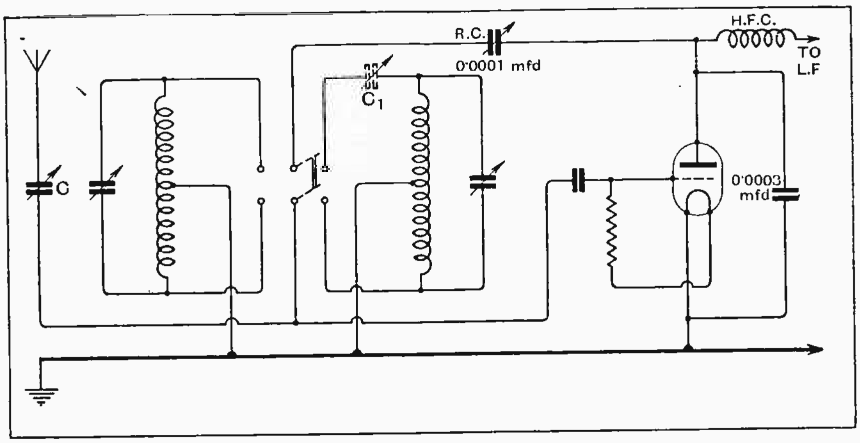

Fig. 1.—An easily assembled circuit for reception of alternative programmes.

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Grid Voltages Undisturbed.

I am thinking of using 2-volt screen-grid battery valves in combination with a 6-volt detector and output valve. Is it possible that the insertion of the necessary L.T. voltage-reducing resistance will upset the grid bias?

No; provided that the voltage-reducing resistance is inserted in the L.T. positive lead and that the grid return leads are taken to L.T. negative, through a bias battery where necessary, there is no possibility of trouble through the combination of valves with different filament voltages.

○○○○

Frame Aerial Switch.

Will you please tell me what was the actual type of switch used in the construction of the "Dual Range Frame Aerial" described in your issue of January 7th?

This was a "Utility" switch, made by Wilkins and Wright, Ltd., and described as the "anti-capacity change-over" type.

No Volts to Spare.

(With reference to previous correspondence). . . . *You suggest that incipient L.F. oscillation might be prevented by using decoupling resistances of higher value, if this course is possible. Unfortunately it is not, as there is no surplus voltage; indeed, the detector and first-stage L.F. amplifier are being run at considerably below their rated anode voltages. Will it be necessary for me to reduce magnification, or is there any less drastic remedy that can be tried?*

As you cannot very well use larger decoupling resistances, the alternative plan is to increase the capacity of the associated by-pass condensers.

A Long-wave Filter.

Will you please give me a circuit diagram of a capacity-coupled aerial input filter for long waves only? This is to precede a screen-grid H.F. valve, and I should like to use ganged condensers with electrically connected rotors for tuning both the filter and the H.F. stage.

A circuit diagram of a suitable arrangement to fulfil your requirements is given in Fig. 2. We have not assigned a value to the coupling condenser C_m, as this will depend on the design of your tuning coils.

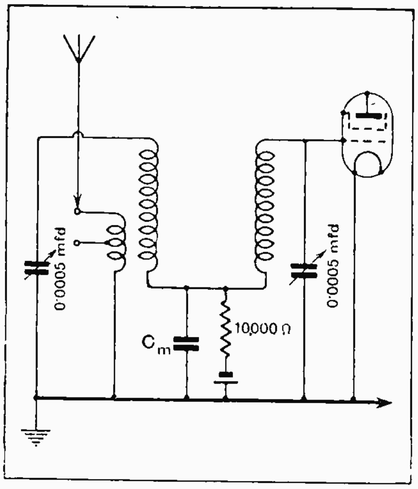

Fig. 2.—Circuit arrangement of a capacity-coupled filter for long-wave reception. Alternative aerial couplings are provided.

Testing an L.F. Transformer.

Suspecting that my L.F. transformer was faulty, I recently made a test with 'phones and a dry battery. There appears to be continuity through both windings, but the loudest click is produced when the testing apparatus is joined across the secondary terminals. Surely this is wrong. Is not the secondary winding usually of much higher resistance than the primary?

Your transformer would appear to be faulty. There is doubtless a break in the primary winding, and the click heard in the phones is due to the flow of charging current into the capacity existing between sections of the coil. There is the additional possibility that there is a built-in primary condenser.

Normally, the primary winding of a transformer has a much lower resistance than the secondary.

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H.F. and L.F. Decoupling.

Will you please examine the circuit diagram of my proposed H.F.-det.-L.F. receiver (on which values are marked), and say if it is in order? Tuned anode coupling is to be used for the H.F. stage, on the score of simplicity and economy. I am not aiming at extremely high magnification.

A receiver constructed on these lines should give satisfactory results, but you have overlooked the fact that L.F. impulses may be passed back to the detector grid *via* the H.F. coupling coil, which we note is actually a tuned anode coil connected as an auto-transformer. To prevent the possibility of L.F. reaction, the decoupling components in this circuit should have values that will deal effectively with low-frequency currents. Instead of a resistance and condenser of 600 ohms and 0.1 mfd. as shown in your diagram, we recommend 20,000 ohms and 2 mfds. respectively.

o o o o

An Improvised Potentiometer.

I have a simple H.T. battery eliminator with two positive terminals, one of which gives maximum output, while the other is connected through an internal-series resistance, variable in steps. This eliminator proves to be suitable for operating a 1-v-1 set, but it is impossible to obtain the correct operating voltage for the screening grid of the H.F. valve. Do you advise me to fit a high-resistance potentiometer, or is there some simpler way?

No doubt the present series resistance has too low a value for reducing screening grid voltage, and in any case a potentiometer is best for purposes of regulation. As an easy way out of your difficulty, we suggest that a fixed resistance, of some 40,000 or 50,000 ohms, should be joined between the screening grid and negative filament terminals of your H.F. valve holder.

o o o o

Separating H.F. and L.F. Components.

My 2-v-1 receiver is quite stable on the medium waveband, but self-oscillation is produced when all its circuits are tuned to a long-wave signal. I believe this is due to the action of H.F. currents in the L.F. amplifier. Will you please tell me how to determine whether this assumption is correct?

A test may be made by connecting, as a temporary measure, an abnormally large condenser between detector anode and earth. A capacity of at least 0.002 mfd. should be used, and, if instability is cured by this addition, it may be assumed that your present H.F. filtering devices are inadequate.

o o o o

Increased Range.

Interference from the local station is so strong that distant reception is impossible over a large part of the tuning scale, and I am considering the fitting of an input filter to my H.F.-det.-L.F. three-valve set. Do you consider that this addition will reduce its range to a serious extent?

In your locality it will no doubt be necessary to operate any receiver having a single-tuned input circuit with an aerial coupling much below the value giving loudest signals. But when a filter is fitted it should be possible to adopt a much closer aerial coupling; in consequence, although the addition in question will in itself introduce some loss, there will probably be a net gain in sensitivity rather than a loss.

Tunable Interference.

Since anode current from my H.F.-det.-2-L.F. receiver has been derived from D.C. mains through an eliminator I have been troubled by intermittent interference, which is mainly confined to the lower end of the long-wave tuning scale, although it is faintly audible on other wavelengths. I suppose that this is due to H.F. energy generated by electrical machinery connected to the same supply mains, and should be glad if you would suggest how it might be prevented.

We expect that your assumption is correct, and you are advised to connect an H.F. choke—which must, of course, be of adequate current-carrying capacity—in each lead from the mains to your eliminator.

o o o o

Tapped Coupling Coil.

With regard to the "Flexible Two" receiver, described in your issue dated December 31st, 1930, I am not quite clear as to how connection is picked up with the contact brush of the selector switch. Should No. 10 switch stud be earthed?

This stud is joined to the extreme end of the long-wave coupling coil, and should not be earthed. Connection can most conveniently be made to the brush by joining all the back studs of the switch together and also to earth. The back studs are those mounted on the plate which is nearest to the panel. An insulated spindle is supplied with this type of switch.

FOREIGN BROADCAST GUIDE.

BRNO

(Czechoslovakia).

Geographical position : 49° 12′ N. ; 16° 37′ E.

Approximate air line from London : 752 miles.

Wavelength : 342 m. Frequency : 878 kc. Power : 3 kW. (temporarily).

Time : Central European (one hour in advance of G.M.T.).

Standard Daily Transmissions.

08.00 G.M.T. (Sun.), relay of promenade concert from Carlsbad ; 09.00, concert (Sun.) ; 10.15, gramophone records ; 11.00, time signal, carillon (from Prague) ; 17.15, Germany transmission (concert or talks) ; 19.00, main evening programme ; 21.20, relay of concert, dance music from Moravska-Ostrava, or organ recital from Beranék Cinema (Prague).

Frequently exchanges programmes with Prague, Moravska-Ostrava and Bratislava.

Man announcers. Call : *Allo Radio Journal Brno* (phon. : Broono). Announcements are sometimes made in German and French.

Closes down with good-night greetings (*Dobrou Noc*), followed by Czech National Anthem (*Kde Domov Muj*).

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Avoidable Interference.

THE attention of listeners is being concentrated more and more on the problem of avoidable interference, which is produced by local electrical apparatus or machinery, such as motors, tramways, and electric signs. We have seen it suggested that undue concern is being shown over this problem, and it is stated that up till now listeners have managed very well without serious interference with reception, so that there should be no reason why they should all at once wake up with the idea that interference of this kind has suddenly become intolerable.

But if we consider the facts, it will be obvious that interference that can quite well be regarded as intolerable to-day, a year or two ago could have been endured. The amount of electrical machinery in use has increased very substantially in the past few years, thereby augmenting the sources of interference, and at the same time the average sensitivity of wireless receivers has increased by leaps and bounds, until to-day interference which was normally almost inaudible provides at the best a seriously increasing background noise to programmes of stations at any distance. It must be remembered too, that public interest in distant reception has increased, thus providing another reason why local electrical interference to-day appears as a more serious matter than formerly.

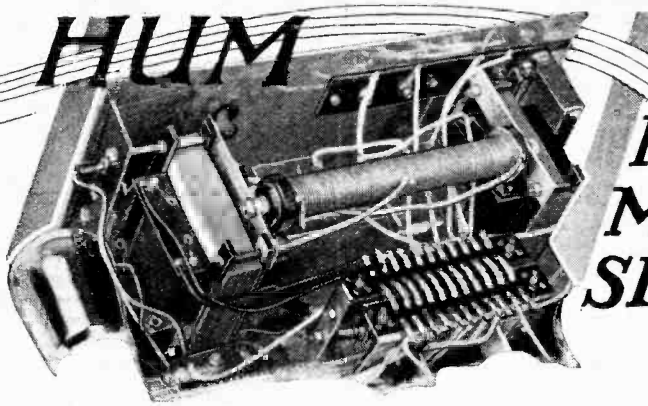
The idea of being able to lessen interference of this nature at the receiver has long since been abandoned as theoretically impracticable, and the only effective remedy lies in curing the trouble at the source. Unfortunately, it is not illegal to radiate electrical interference until a listener is able to show that such action is interfering with the quiet enjoyment of his rights. It would be generally conceded, we believe, that reception of broadcasting is to-day a part of the amenities to which an individual is entitled, but it normally rests with him to lodge the complaint and take action where his enjoyment of broadcasting is being interfered with from such causes.

The only other remedy is for those responsible for causing interference to voluntarily take what steps they can to effect a cure. A good deal of research work has been done recently, notably by the General Electric Company, to devise means for reducing the causes of electrical interference. The B.B.C., too, has taken a keen interest in the matter on behalf of listeners, but there is room for much more active efforts yet before the cure can be general; more especially is it desirable that the ever-increasing body of users of electrical apparatus should be educated to appreciate the circumstances in which radiation can take place and the methods of cure which can be resorted to.

Those who are responsible are mostly unaware themselves of the trouble which they are causing and would, we believe, in nearly all cases most readily co-operate when once they were shown how a remedy could be effected.

In This Issue

TRACING HUM IN MAINS SETS



How to Obtain a Silent Background.

Systematic Stage-by-stage Tests.

By W. T. COCKING.

EVERY reader who has experimented with mains receivers must at some time or other have experienced the annoyance of hum. The locating of the source of trouble is by far the most difficult part of the problem, but once it is found its cure is usually fairly easy. In order to illustrate the principles involved, the commonly used circuit of Fig. 1 will be taken as a basis for discussion, and the modifications necessary for other circuits will become apparent. It will be assumed that the complete apparatus is built into one unit, and that it performs satisfactorily with the exception that there is excessive hum.

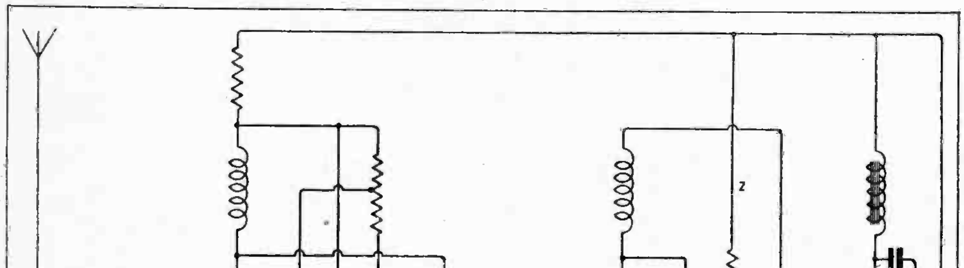


Fig. 1.—A typical three-valve receiver. The elimination of hum is carried out in stages; by short-circuiting the points a, b, the output stage is isolated, and can be dealt with by itself. Similarly, by short-circuiting the points e, f, the detector is isolated from the H.F. stage. The condenser C_6 is for the purpose of eliminating a particular type of modulation hum.

It will be realised that a systematic investigation of the set is essential, for the hum may be introduced in many places at once, and the elimination of one source alone often makes little audible difference. The obvious starting point is the loud speaker; it is very unlikely, although not impossible, for there to be hum in a reed-drive-type speaker, but it is a very probable source of trouble if it be of the mains-energised moving-coil type.

The procedure to be adopted, therefore, is to connect the moving-coil to the loud speaker terminals on the set in the usual manner, and to switch off the set, leaving only the field energised. Any hum must now be due to the field supply, and must be eliminated in one of the many well-known ways. If the field be of the low-voltage type supplied by a metal rectifier, the trouble can usually be cured by connecting in parallel with

Tracing Hum in Mains Sets.—

the winding an electrolytic condenser of high capacity. With a high-voltage field winding supplied by a valve rectifier, or D.C. mains, it will usually be necessary to add a smoothing choke in series with the winding, in addition to a 2 mfd. or 4 mfd. condenser in parallel with it.

THE fundamental principles of mains-operated receivers are now so well known that it is readily possible to design a set with the assurance that, when completed, it will give no trouble from hum. In general, however, this presupposes a "clean" layout with considerable distances between the components, which makes for a large and unwieldy set. Where a compact receiver is desired such assurance is hardly possible, for the necessary proximity of components is one of the greatest sources of hum. In this article it is shown that hum can be traced methodically by examining the receiver stage by stage.

The Output Stage.

Having made certain that the loud speaker introduces no hum one can tackle the set in earnest. The first step is to make sure that there is no electro-magnetic interaction between the output choke, or transformer, and the mains transformer. To do this disconnect the choke from the valve and H.T. supply, and connect across it a resistance equal in value to the anode A.C. resistance of the power valve, as shown in Fig. 2a for choke and Fig. 2b for transformer coupling. Under these conditions there should be no audible hum whatever and if this be the case, the connections may be put back to normal. If hum be found, however, the choke or transformer must be rotated, or moved to a different position in the set, until a position is found which gives silent operation. Trouble in this portion of the receiver is rather unlikely, for no amplification follows the output circuit, and any pick-up is not likely to be at all serious.

The next step is to isolate the output stage, and to do this we short-circuit the secondary of the intervalve transformer by connecting a length of wire between the points a, b, Fig. 1. We have proved the loud speaker and output circuit to be free from hum, and any hum with the intervalve transformer secondary short-circuited must obviously be due to the H.T. supply, the grid bias supply, or the filament of the power valve.

The latter is the most easily tested by heating it temporarily from an accumulator, when the possibility of trouble in the filament supply ceases. An accumulator is not always available, however, and in this case the return lead *c* to the centre tap on the mains transformer should be disconnected and connected instead to the slider of an adjustable potentiometer, which in turn is connected across the valve filament *yy*, as shown in Fig. 3. If a position can be found on the potentiometer at which the hum is absent, then it is due to the filament supply; the mains transformer tapping is out of balance, and the potentiometer should be retained permanently.

If no better results are obtained by the use of a potentiometer, however, the trouble must lie in the H.T. or grid bias supply; unless the valve used is one with a thin filament and itself introduces hum, or there is an excessive capacity between the different windings on the mains transformer.[1] The H.T. supply is most easily tested by increasing the capacity, say, by 4 mfd., of the condenser C_1; if this results in an improvement it is the smoothing circuit which is at fault. The choke inductance must be increased or the capacity of the condenser C_1, or both, in accordance with well-known principles;[2] a further possibility, however, lies in electro-magnetic induction between the smoothing choke and the mains transformer, and the effect of rotating the former should be tried. The grid bias supply may be tested by connecting an additional 4 mfd. capacity across the condenser C_2, or across the bias resistance R_1. If any improvement results, a condenser of the correct capacity should be connected permanently in these places, or in extreme cases an additional choke can be used.

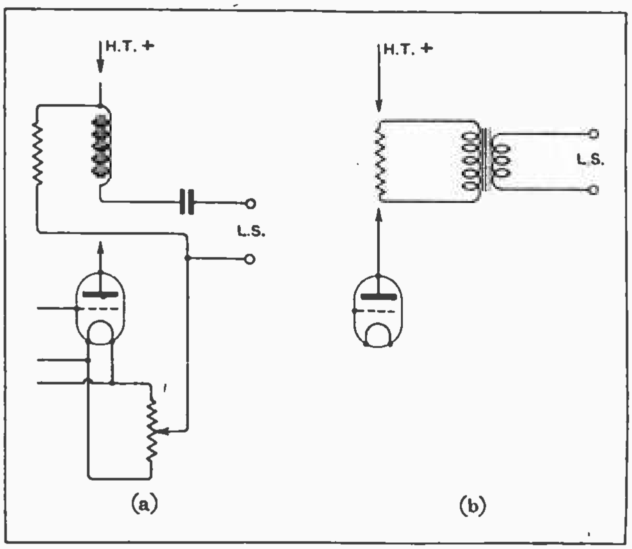


Fig. 2.—The method of testing for electro-magnetic pick-up in the output circuit is shown in the above figures; (a) is for the case of an output choke, and (b) for a transformer. The H.T. supply and the valve should be disconnected as shown, and a resistance connected across the choke or transformer.

The Detector.

We next come to the detector and its intervalve coupling, and the short circuit to the L.F. transformer secondary should be removed. Now this transformer is, perhaps, the most likely source of hum in a compact set, and very careful attention should be given to its position. The test is the same as that for an output transformer; the primary must be disconnected, and then connected to a resistance whose value is equal to the normal working resistance. That is to say, in the case of the circuit of Fig. 1, a resistance equal to the internal valve resistance, some 10,000 ohms for an AC/HL-type valve; but where a resistance-fed transformer is used, the resistance should be equal to the valve resistance and the coupling resistance in parallel, some 6,000-7,000 ohms for an AC/HL and the circuit of Fig. 4.

[1] See *The Wireless World*, page 652, December 10th, 1930.
[2] See "Smoothing," November 19th, 1930.

Tracing Hum in Mains Sets.—

The necessity for this primary shunt resistance during testing is to simulate the working conditions as far as hum pick-up is concerned; it will be found that without this resistance there is a very large amount of hum, which is not normally audible, while if the transformer primary be short-circuited, all hum vanishes. Having connected the correct value of resistance across the transformer primary, it should be rotated to the position

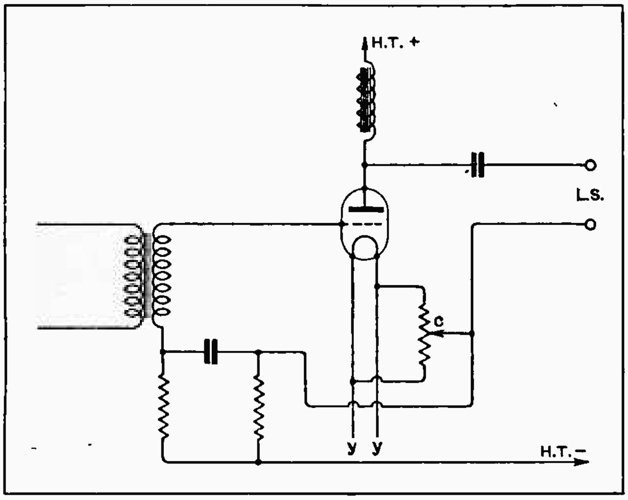


Fig. 3.—The alternative connections to the filament are shown in this illustration; the potentiometer should be of low resistance and adjustable. This form of connection is likely to give less hum than the centre-tapped mains transformer of Fig. 1.

of minimum hum; and in order to do this, it is, of course, necessary to replace the normal connections to it by sufficiently long flex leads. It may be mentioned that simple rotation will not always cure hum, and the transformer must sometimes be turned on its side, or in some other curious position.

When a suitable position has been found for the transformer, its primary should be reconnected, and the grid of the detector valve short-circuited to the cathode by connecting a length of wire between the points *d*, *e*, in Fig. 1. Any hum is now due to the H.T. supply to the detector, and more smoothing is indicated. The effect of adding capacity to the condenser C_3 should be tried, and if there be an improvement, a larger capacity should be connected permanently in that position. In a few cases, of course, an excessively large capacity may be needed, and it is then more economical to add an additional choke and condenser at the point *z* in the H.T. supply.

The next step is to check the detector grid circuit, which can be done by removing the short-circuit between the points, *d*, *e*, and applying it to the other side of the grid condenser; that is, to the points *e*, *f*. At the same time, the connection between the condenser C_4 and the tuned circuit should be broken. The detector grid is now connected directly to the cathode through the grid leak and condenser, and any hum will usually be due to electro-static pick-up on the grid. This will occur if the heater wiring is placed close to the grid of the valve, but more usually it is due to pick-up from a higher voltage source. The positions of the wiring in the H.T. rectifier and smoothing systems should be examined, but the most likely source of trouble is the mains transformer. Fortunately, screening is often of great use in eliminating electro-static pick-up, and the effect of enclosing the detector together with its grid leak and condenser in an earthed metal box should certainly be tried. In this connection it must not be forgotten that interaction between the valve electrodes themselves can occur, and the writer once traced a persistent hum to interaction between the electrodes of the H.T. rectifier and the detector valves, which were rather close together; the trouble was cured by screening.

The H.F. Stage.

Having cured hum as far as the grid circuit of the detector, the short-circuit between the points *e*, *f*, should be removed. There should still be no hum, and in the very rare case when it is found that this alteration introduces it, it can be cured by rotating the tuning coil itself. Next reconnect the condenser C_4 to the tuned circuit, and test for hum. During this test the set must be so tuned that no signal is audible, for this may give rise to modulation hum, which will mask other effects. Any hum which can now be heard must be due to the H.T. supply to the H.F. valve, and appropriate additions should be made to its smoothing circuit, and also to the grid-circuit bias resistance by-pass condenser C_5. In the absence of a signal, the set should now be perfectly quiet, and with no trace of hum, beyond, perhaps, one foot from the loud speaker cone.

Modulation Hum.

Now it may quite possibly be found that when a station is tuned in, a fairly strong hum becomes evident. This is known as modulation hum, since the hum actually modulates the carrier of the incoming signal, and it is often difficult to cure. There are several causes of modulation hum, and each has its own remedy. In the first place, it may be caused by insufficient

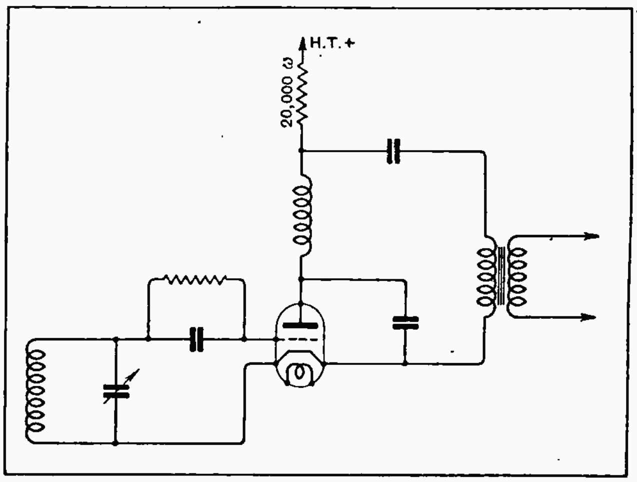


Fig. 4.—The parallel feed transformer-coupled circuit; when testing for electro-magnetic pick-up in the transformer, the primary shunt resistance must be less than the valve resistance. It should be equal to the valve resistance and the coupling resistance in parallel in order to simulate working conditions.

Tracing Hum in Mains Sets.—

smoothing of the grid bias and H.T. supplies to the H.F. valve. The former is the more prevalent source of trouble, and it may be necessary to use a total capacity for C_5 of Fig. 1 of about 4 mfd. before the hum can be cured. Extra capacity across the other H.F. by-pass condensers should also be tried.

Another source of trouble lies in the H.T. rectifier valve; this may generate H.F. oscillations which are modulated by the A.C. mains. This state of affairs can be cured by adopting the rectifier circuit shown in Fig. 5, where the valve is prevented from oscillating by the two condensers C, which should have a capacity of 0.1 mfd. and be tested to at least 1,000 volts [3]

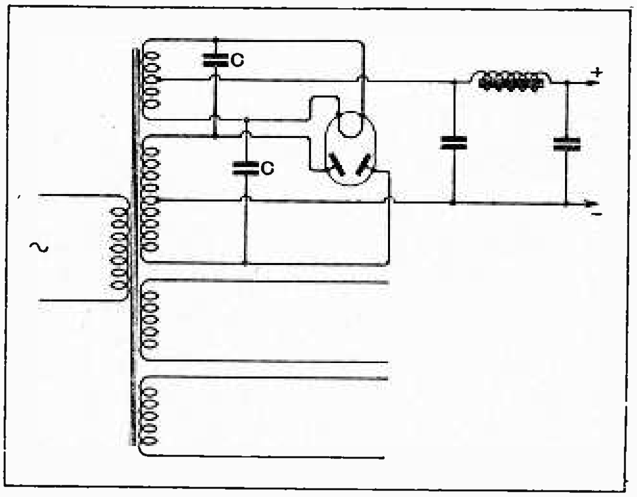


Fig. 5.—The addition of the two condensers C to the H.T. rectifier prevents the valve from generating H.F. oscillations, which would be modulated by the mains and cause hum.

In the writer's experience, however, the most troublesome source of modulation hum is the supply mains; and this particular form can occur even when no H.F. stage is used. The cause of this type of hum is rather obscure, but it is apparently due to the presence of H.F. currents in the mains leads. The cure is simple and satisfactory; a condenser C_6 (shown dotted in Fig 1) should be connected between one of the mains leads and earth. The best capacity must be found by experiment, but a value of 0.0005 mfd. is often sufficient; in some cases, however, a capacity of 0.001 mfd. or 0.002 mfd. may be found necessary. The full mains voltage is connected across this condenser, and so it is very important that it should be rated for continuous working on not less than 250 volts A.C.

It will usually be found possible to eliminate all traces of hum by a systematic search conducted on the above lines, and the whole principle lies in working backwards from the loud speaker, and checking each point in turn. During this process a watch should be kept for high-resistance connections, since these are a prolific source of hum from electro-static pick-up; apart from badly soldered joints, they will be found most frequently in valve holders and plug-in coils. There is always the chance of a faulty valve, and this is the most likely source if the strength of the hum is variable. In obstinate cases the effect of using a potentiometer for the connection between the cathodes and heaters of the indirectly heated valves should be tried, as recommended for an output valve.

[3] Correspondence, page 26, January 7th, 1931.

Transmitters' Notes.

R.S.G.B. Tests and Competition.

The annual tests on the 28 mC. waveband have not proved very satisfactory up to the time of writing. Conditions have been against long-distance reception, and we understand that very few transmitters were able to establish connection with distant stations; in fact, the only one of whom we have yet heard was G5BY, Mr. H. L. O'Heffernon, who managed to get across to the 8th District of U.S.A. on January 11th.

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Low Power Tests.

Preparations are being made for the "One Watt Week" in April, in which competitors will be limited to an input of 1 watt of pure D.C. supplied by accumulators or dry batteries. The tests will begin on Saturday, April 11th, and finish on Saturday, April 18th, and the times on each day will be from 21.00 to 08.00 G.M.T. We hope soon to be able to publish further particulars of this interesting competition, which is being organised by Mr. M. W. Pilpel, G6PP. It is understood that the points scored will vary from 1 to 5 in proportion to the distance, and that no pre-arranged schedule will be allowed.

An Eltham Enthusiast.

Mr. K. J. Freeman (2ADL), 189, Well Hall Road, Eltham, S.E.9, asks us to state that he is willing to co-operate with any amateur transmitter in his experiments. He stands by for telephony at the following times: Saturday, 14.00-20.00 G.M.T. on the 40-metre waveband; Sunday, 09.00-18.00 on 40 metres, and 18.00-20.00 on 80 or 150-175 metres, and will also be ready to listen throughout the night on 40 metres for long-distance telephony by arrangement.

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NEW CALL-SIGNS AND CHANGES OF ADDRESS.

G2DC J. Drudge Coates, Burleigh, Manor Rd., Farnborough Park, Hants.
G2OC (ex 2BIC), L. R. Seal, 90, Wollaton Rd., Beeston, Notts.
G2XH A. S. Williamson, 103, Rushdale Rd., Meersbrook, Sheffield.
G2XT (ex 2BZT), J. R. Wilson, 23, Salter's Rd., Gosforth, Newcastle-on-Tyne.
G2XU C. W. Shillam, 36, Bayswater Ave., Redland, Bristol.
G2XX F. Wilson, 85, Risca Rd., Newport, Mon.
G2XY H. T. Littlewood, 82, Stainburn Crescent, Chapel Allerton, Leeds. (Change of address.)
G5MI I. F. Meiklejohn, Royal Signals Mess, Aldershot.
G5YH C. H. Chorley, 78, Nightingale Lane, S.W.12.
G6ZP (ex 2BPU), A. J. Perkins, 127, St. Asaph Rd. Brockley, S.E.4. (Transmitting on 1.5, 7 and 14 mC. and welcomes reports.)
G6PA H. C. Page, Plumford Farm, Ospringe, Nr Faversham, Kent. (Change of address.)
G6RH R. Holmes, 446, London Road, Isleworth, Middlesex. (Change of address.)
G6SR S. Rowden, Rosebank, Pilrig Street, Edinburgh.
2ABW E. Gankrodger, 4, Montrose Villas, Chewton Rd., Keynsham, Somerset.
2ADC F. S. Mizen, 28, Brunel Rd., Bridgwater Rd. Nr. Bristol.
2ADL K. J. Freeman, 189, Well Hall Road, Eltham, S.E.9.
2ADM A. J. Peck, 21, Greere Rd., E. 15.
2AIN H. A. White, 39, Royston Ave., Wallington, Surrey. (Change of address.)
2AMZ F. R. Drew, Frampton Cotterell, Nr. Bristol.
2AWV R. W. Wright, 42, Cedar Road, Aintree, Liverpool.
2BAJ J. F. Stanley, The Frith, Aldington, Mersham, Kent.
2BVL A. E. Brookes, 19, Alexandra Rd., Uplands, Bedminster Down, Bristol. (Change of address.)
2BXP A. N. Le Cheminant, 21, Raymond Rd., Victoria Park, Bristol.
2BXZ W. A. Clark, 89, Laburnham Ave., Garden Village, Hull.

INDIA.

VU2FZ Capt. de Lisle Carey, R.A.M.C., c/o Messrs. Grindlay & Co., Ltd., Bombay (transmitting C.W. on 7 and 14 mC, and will welcome reports).

Recent Developments in America

The R.C.A. Superheterodyne. Micro-Synchronous Radio.

Home Recording and Filmoradio.

By A. DINSDALE.

NOW that the furore over the Atlantic City, New York and Chicago radio shows has died down, and the winter radio season is in full swing, it is possible to review the radio-set position in the United States with some degree of calmness, and endeavour to pick out the most outstanding developments of the 1930-31 season. There are three such major developments, for all of which the Radio Corporation of America, as the virtual monopoly patent holders, may be said to be responsible: (1) the return of the superheterodyne; (2) the still further development and perfection of T.R.F. (tuned radio frequency) sets; and (3) the introduction of home recording into all electric gramo-radio sets. A fourth innovation is just now beginning to loom up over the horizon, viz.: the incorporation in gramo-radio sets of a moving-picture film projector, making use of the Bell-Howell home cinema equipment.

TO readers of *The Wireless World* the many meritorious advantages of the superheterodyne are too well known to require reiteration here, and the same applies to its disadvantages as present in the older models. In America the superheterodyne has been out of fashion for a number of years for two reasons. From the buying public's point of view it was a case of "give a dog a bad name and hang him." From the manufacturers' point of view the patent position was so obscure that nobody knew for certain who had a cast-iron right to issue a manufacturing licence; consequently, and very naturally, nobody was willing to risk his money on the manufacture of a set which, when all was said and done, was not so very superior to other types of set which could be manufactured and sold without fear of complications.

The position to-day is that the patent situation has been definitely cleared up, and the R.C.A. has the monopoly of superheterodyne patents. The development and improvements which have been effected in screen-grid valves and associated equipment have enabled many of the old difficulties to be overcome, and the superheterodyne is once more a desirable set. The R.C.A. has recommenced the manufacture of an improved model, and licensed a number of competitors to do likewise. Very few competitors can afford the licence, however, for it is of a very dictatorial character and requires a terrific cash deposit or advance on account of royalties—something in the neighbourhood of £20,000.

Two views of the R.C.A. superheterodyne are shown in the composite illustration. This receiver has nine selective circuits, three at radio frequency and six at intermediate frequency, which in this case is 175 kc. In order to eliminate as much interference as possible prior to signal amplification, "pre-selection" at the incoming broadcast frequency is adopted. It is also desirable in a superheterodyne to have a relatively high signal level at the grid of the first detector, or frequency changer. In the receiver under review, therefore, there are two tuned circuits ahead of the first valve, and these circuits are so arranged that they reject unwanted interfering signals, being coupled so that great attenuation results in the case of frequencies lying outside the desired band.

The coupling between the H.F. and first detector valves is a capacity-coupled H.F. transformer which, together with the valve, gives a uniform amplification of about thirty over the broadcast waveband. The oscillator circuit is a conventional one for use with a standard 3-electrode valve, and consists of a tuned grid circuit with an anode reaction coil coupled to it. The grid is connected to the mid-tap of the tuned grid circuit to minimise changes in the oscillator frequency which might result from a change of valves. The tuning elements of the oscillator circuit are so arranged that the oscillator frequency is always approximately 175 kc. higher than the frequency to which the H.F. system is tuned.

The intermediate frequency amplifier consists of three transformers and two valves. The first I.F. transformer

Recent Developments in America.—

is connected to the "local-distance" switch so that when it is in the "local" position the selectivity of the circuit is slightly impaired by the introduction of resistance. This results in a wide acceptance band which prevents any possibility of side-band cutting, and ensures the highest-quality reception on local stations. When the switch is thrown to the "distant" position the tuning of the transformer is made very sharp, so that, at the expense of quality, interference is minimised when listening to distant stations.

The transformer consists of a tuned primary connected in the plate circuit of the first detector, and a tuned secondary connected in the grid circuit of the first I.F. valve. The secondary is partially shielded from the primary in order to loosen the coupling and improve the selectivity. The entire transformer is mounted in a copper can to keep the losses at a minimum and at the same time shield the transformer windings from other parts of the circuit. When the local-distance switch is thrown to the local position a resistance is connected across the primary and another resistance is placed in series with the secondary winding.

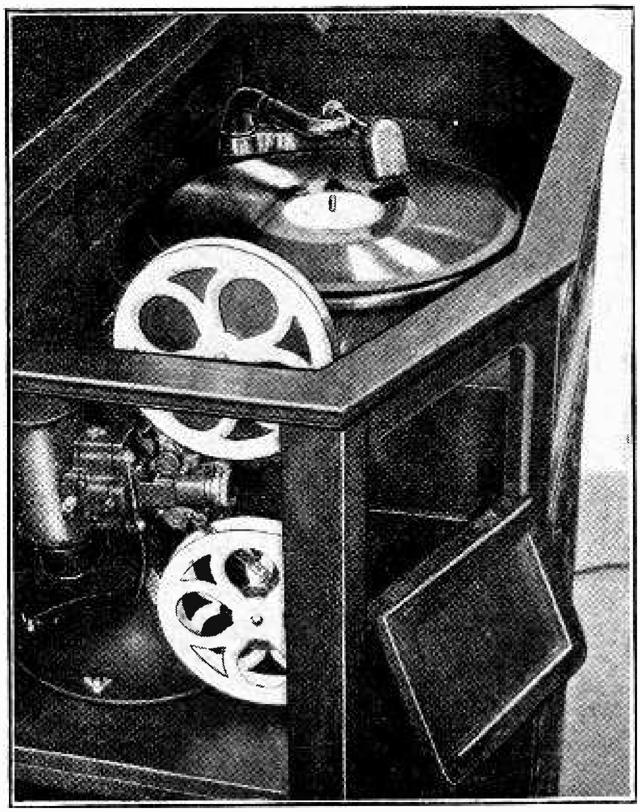
Avoidance of High-note Loss.

The second and third I.F. transformers are both alike, and consist of tuned primary and secondary coupled tightly enough to give a broad-top resonance characteristic with high attenuation to frequencies outside the desired band. These transformers are mounted in iron cans to shield them from other parts of the circuit, and to add sufficient loss to prevent double peaks in the resonance curve. For accurate tuning, all three I.F. transformers have adjustable condensers across both primary and secondary windings.

Anode-bend rectification and a single L.F. stage complete the circuit, two power valves connected in push-pull feeding the dynamic speaker through an output transformer. Great care has been taken in the design of the cabinet to prevent that bane of the compact, all-in-one receiver, cabinet resonance. Volume control is effected by varying the control grid bias on the H.F. and first I.F. amplifier valves. This gives a balanced reduction in amplification at both radio and intermediate frequency when the volume control is turned down.

In the power supply a full-wave rectifier valve is used, and the filter system is specially designed to eliminate hum from the loud speaker. The entire set is, of course, designed to operate off the almost standard American 110 volt 60 cycle A.C. mains. The loud speaker field is used as one of the chokes of the filter, so that the total rectified current flows through its winding, thus providing a powerful magnetic field. The filaments of all valves are of the indirectly heated cathode variety. All grid returns are earthed, and most of the valves are self-biased by their plate current flowing through resistances in their cathode circuits, which reduces any chance of coupling through common resistance.

As regards the performance of the receiver, the degree of selectivity is so high, in both positions, that a considerable amount of side-band cutting takes place.



FILMOPHONE-RADIO. Home talkies, home movies, gramophone and radio in one instrument. Side view showing movie projector, gramophone turntable and pick-up. A front view of the complete equipment in its containing cabinet is shown in our title illustration.

Performance.

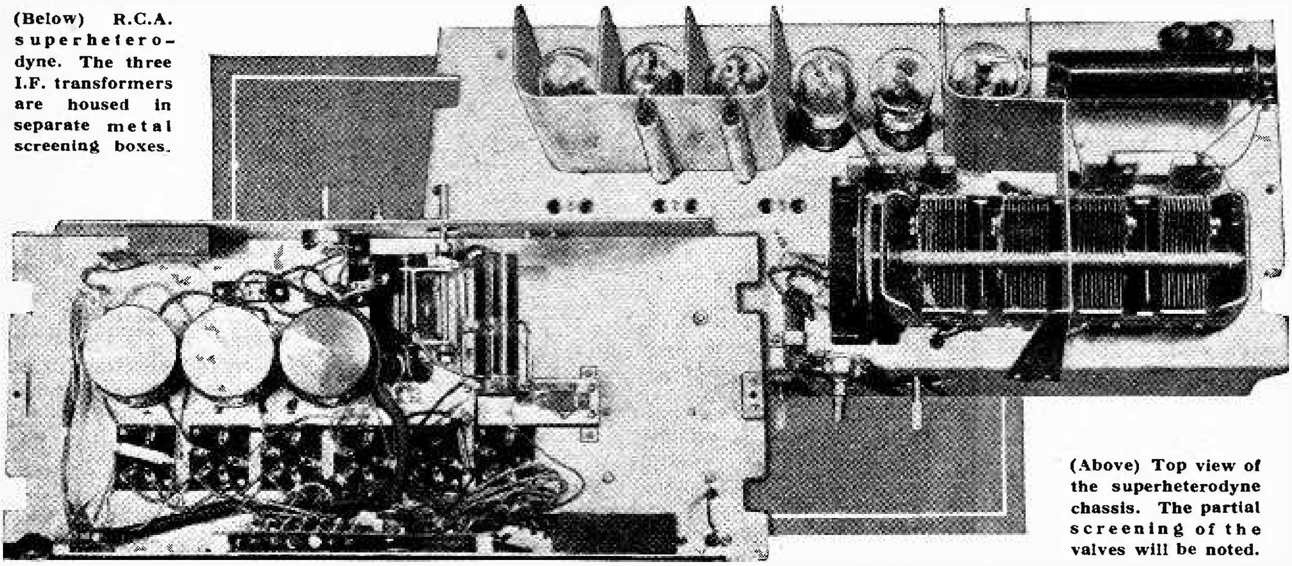
Maximum response takes place between 300 and 1,000 cycles, after which the response falls off rapidly. But to an American any receiver which does not reproduce with a most decided boom or drummy effect in the lower register is definitely bad; he likes his bass (pronounced "base," please, to avoid any misunderstanding!), and plenty of it, so the R.C.A. superheterodyne meets his requirements. In some models there is included with this superheterodyne an electric gramophone and home recording set. The T.R.F. models provide for three screen-grid H.F. valves, power detector, and two L.F. stages, the second of which mounts two power valves in push-pull.

It is in the tuned circuits of this receiver that we encounter the so-called micro-synchronous principle of tuning. In the first place, tuning is effected by means of a single knob on the front of the cabinet. This knob is only turned for fine tuning; for rough tuning it is swung laterally across a long horizontal slot in the panel, carrying with it a celluloid indicator which sweeps across a scale calibrated in kilocycles. The knob itself is attached to one end of a lever, the other end of which is attached to a round plate, or cam wheel, around the circumference of which are arranged the five variable tuning condensers. Each condenser is connected to the edge of the cam wheel by means of a lever, and is pivoted

Recent Developments in America.—

or supported at one point only. The side of the condenser opposite the pivot point is free to move within certain limits. A roller on top of the chassis is attached to this moving side of the tuning condenser.

The driving action, which produces a scissors-like motion in the condensers when the tuning lever is operated, is not from the rollers, but is through the micarta connector links which are attached to the five metal rods fastened to the underside of the cam wheel. Thus, the condenser moves in two ways—a comparatively large amount due to the action of turning the cam wheel, and a very small amount on one set of plates due to the roller on top of the chassis following the irregular track around the outer edge of the cam wheel. This last-mentioned movement is the compensating motion which is the secret of micro-synchronous tuning, for, by means of adjusting screws, each condenser can be individually adjusted before the receiver leaves the works, so that all five circuits are exactly in tune at any setting of the dial, thus ensuring maximum efficiency at all times.



(Below) R.C.A. superheterodyne. The three I.F. transformers are housed in separate metal screening boxes.

(Above) Top view of the superheterodyne chassis. The partial screening of the valves will be noted.

Gramophone Refinements.

The gramophone turntable is driven by an induction-type motor, and micarta gears replace the metal gears formerly used. A heavy felt pad, permanently impregnated with vaseline, replaces the governor friction leather formerly employed. These two items, it is claimed, assure absolute quietness of operation and perfect speed regulation. The motor is started simply by lifting the pick-up arm and moving it to the right beyond the outer edge of the record. A starting switch lever is thus eliminated.

The pick-up is of a new flexible impedance type, with oil damping, and the pick-up arm itself has several distinctive features. In appearance it can best be likened to a cobra's head. It is counter-weighted at the back to prevent excessive record wear, and it is weighted at the two sides of the wide front portion to prevent the twisting action which, with the ordinary tone arm, would be imparted to the tone arm from the needle.

Perhaps no other feature of the combination instruments is quite so fascinating as home recording, which opens up a new and unlimited field of home entertainment. The small hand microphone is operated in conjunction with the L.F. amplifier of the wireless set, the output of which is fed back through the electric pick-up, causing the latter to vibrate in such a manner as to record on a special disc. This home recording is available for either microphone or wireless by simply turning the control switch in the gramophone compartment. Thus, either a home-made or a wireless programme can be recorded.

As soon as the record is made, the control switch can immediately be turned back to "Record Reproduction," and, using the same special recording needle, the record can be reproduced right away without any previous processing. A small weight is placed on top of the pick-up when recording, so as to provide the additional mass necessary to ensure correct engraving of the record grooves. This weight is always removed when reproducing. The records themselves are of the unbreakable variety, and can thus be sent by post to friends. They measure six inches in diameter and play for one minute twenty seconds.

The recording of wireless programmes is accomplished in the same manner as microphone recording, except that the output of the detector valve is substituted in the circuit for the microphone. In both cases monitor reproduction of comparatively low volume is obtained in the loud speaker during the recording.

The quality of reproduction from these records does not, of course, in any way approximate that of commercial gramophone records, but they are, nevertheless, surprisingly clear and free from distortion. Their playing time might, however, be increased with advantage.

What may be termed the very last word in home entertainment is an instrument which incorporates in one

Recent Developments in America.—
console: home movies, silent or talking, radio, and gramophone. This departure has just been announced by Messrs. Bell and Howell, of Chicago, well-known camera manufacturers. A Bell and Howell film projector, utilising standard 16 mm. home-movie size film, is used for the pictures, and a Howard chassis is the basis of the radio portion of the instrument. A gramophone turntable is so arranged that it can be operated at either the standard speed for ordinary gramophone records, or 33⅓ r.p.m. when the records for talking pictures are played. Thus, either silent or talking pictures can be shown, or the pictures may be shown to the accompaniment of either the wireless programme or an ordinary gramophone record not synchronised with the film. In addition, of course, either the wireless set or the gramophone is available independently.

This development has been inspired by the growing list of silent and talking films for home entertainment which can now be obtained in the United States from photographic dealers. Radio and gramophone combinations have already been worked out satisfactorily, but the additional problems involved in balancing the other units with the film projector have not previously been so successfully solved.

These developments provide ample evidence that the wireless receiver, once the hobby of a few enthusiastic and highly technical amateurs, is rapidly developing and being associated with other inventions to the end that it shall provide the basis of a single instrument capable of delivering, at will, every form of home entertainment. In operation, these compendiums of entertainment are practically one hundred per cent. dependable; in outward form they are pleasing to the most æsthetic taste; and their application is rapidly becoming universal—at least, in America.

DESIGNING AN EFFICIENT ALL-WAVE RECEIVER.

Overcoming Tuning Condenser Difficulties.

ALTHOUGH it is possible to use a short-wave receiver with tolerably good results on the broadcast band by means of suitable plug-in inductances, the converse is by no means true. The average broadcast receiver usually contains switching arrangements for changing over to the long waveband when desired, and various other arrangements, including the layout, designed to give maximum convenience on the wavelengths upon which programmes are usually sent out. The result of this is the existence of various stray capacity effects which, while having negligible effect on broadcasting wavelengths, have such serious results on the short waveband as to preclude all possibility of satisfactory reception. Apart from this the fact that the tuning condensers in an ordinary broadcast receiver usually have a maximum capacity of 0.0005 mfd. presents further difficulties, since even if an attempt is made to use them only from minimum up to a capacity of 0.00015 mfd., tuning becomes exceedingly critical, as it is all crowded into a few divisions of the condenser scale, whereas in the case of a receiver specially designed for short waves the use of tuning condensers having a maximum capacity of 0.00015 mfd. enables the full scale of the dial to be employed.

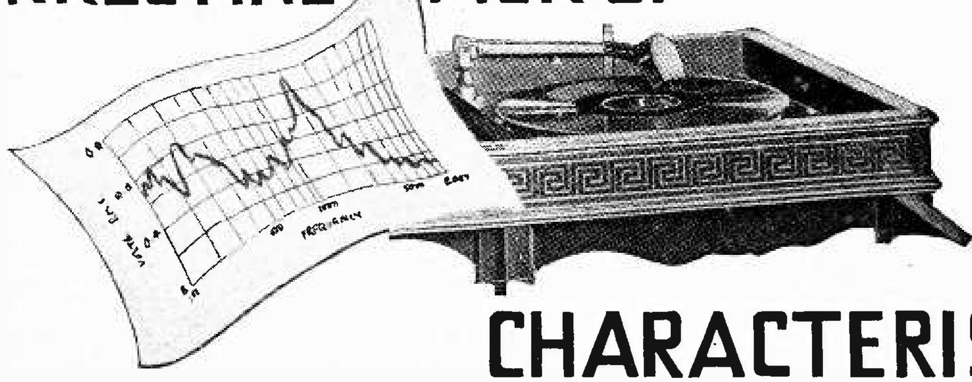
Fitting a Parallel Condenser.

The only difficulty likely to arise when using a short-wave receiver on the broadcast band is also due to the tuning condensers, which, as already mentioned, usually have a low maximum capacity. No difficulty will be experienced, of course, in winding suitable plug-in inductances to cover the normal broadcast band, but the high L/C ratio will not be very conducive to good selectivity. In order to overcome this, and also in order to enable the receiver to be used on the long-wave broadcasting band without the necessity of an unduly large number of plug-in coils, it is advisable to make provision for the external connection of a 0.0003 mfd. condenser in parallel with each existing tuning condenser of the short-wave receiver.

It is quite a simple matter to mount terminals on the panel which are connected internally to the fixed and moving vanes of the tuning condensers. If care is taken in choosing the position of these terminals so that the internal connecting wires are short and direct, there will be not the slightest detrimental effect on the performance of the receiver on short waves. In this manner it is possible to construct an all-wave receiver which is really a practicable and worth-while proposition. By winding suitable coils it will be possible to use it for listening-in to aircraft telephony transmission on 900 metres, which is a wavelength just missed by a large number of broadcast receivers with the dual-wavelength type of tuning.

"NOISES OFF." A glimpse in the "effects" studio at Munich during the broadcasting of a play in which the aids to realism included a drum, Klaxon horn, air pistol, megaphone, steel chain, and a dinner plate.

CORRECTING PICK-UP CHARACTERISTICS



How to Make Use of a Simple Filter to Remove Resonances.

By H. E. WATSON, D.Sc.

EVEN for those who do not possess the means for measuring output voltages, attempts at modifying the quality from a gramophone pick-up form an interesting and instructive study using the ear alone as a guide, and there are few pick-ups on the market which will not respond to the treatment. The practical data given in this article will assist in removing the resonance peak which commonly occurs in the upper register.

AN inspection of the characteristic curves of gramophone pick-ups, published in *The Wireless World* for March 26th and April 2nd, 1930, reveals the fact that the majority of them exhibit a resonance peak in the neighbourhood of 3,000 cycles. Although a rising characteristic is desirable to counteract high-note loss in the amplifier, a pronounced peak not only introduces unpleasant quality owing to exaggerated overtones, but also may cause overloading of the amplifier on the high notes.

It occurred to the author that a defect of this type could be cured very easily by the use of a simple band-stop filter, and a few experiments showed that an excellent characteristic could be produced at small expense. A small choke was made by winding 1,800 turns of No. 33 S.W.G. enamelled wire on part of the core of a burnt-out L.F. transformer with a cross section of ½in. × ½in. The choke and a condenser were connected in series across the pick-up terminals, a 50,000-ohm potentiometer volume control forming the output load. The arrangement is shown in Fig. 1.

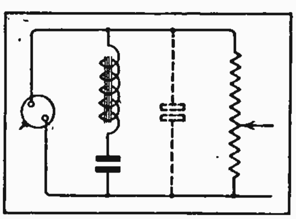


Fig. 1.—A band-stop filter consisting of a choke and condenser in series, shunted across the pick-up.

In order to test the effectiveness of the system, measurements were made using a B.T.H. pick-up. A characteristic for the pick-up alone was first plotted, with the help of H.M.V. standard records, the output being measured on a Moullin voltmeter. The curve agreed very closely with the one given in *The Wireless World*, but the observations required a considerable time, and correction of the values to a constant amplitude was rather tedious. It was found that almost identical results could be obtained in a few minutes with the Parlophone gliding-tone record, by recording galvanometer readings every five turns. With a little practice, no difficulty was experienced in counting turns and writing down readings simultaneously, the only essential being a piece of paper attached to the turntable, which gave an audible click at each revolution. This method is not very reliable in the neighbourhood of resonance peaks owing to the lag in the movement of the galvanometer needle when the displacement is rapid, and it may miss minor resonances, but as these variations cannot be detected by ear, strict accuracy is unnecessary. The record is also unsuitable for frequencies much below 500, but as the present experiments were confined to resonances in the high notes, the wide scale in

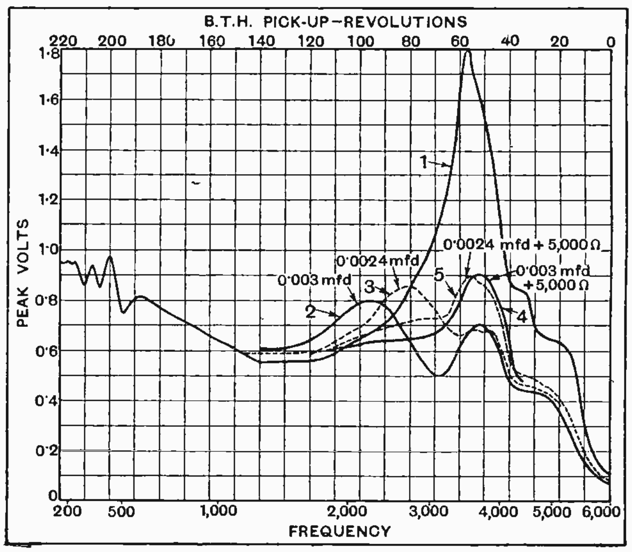


Fig 2.—Curves showing the effect of different compensating filters on the characteristics of a B.T.H. pick-up.

Correcting Pick-up Characteristics.—

this region, as shown on the diagrams, was a distinct advantage.

Fig. 2 (1) shows the output characteristic of the newest type B.T.H. pick-up with a medium "chromic" needle. The voltage at the resonance peak is nearly double that at any other part of the curve, and consequently overloading may easily occur on the high notes.

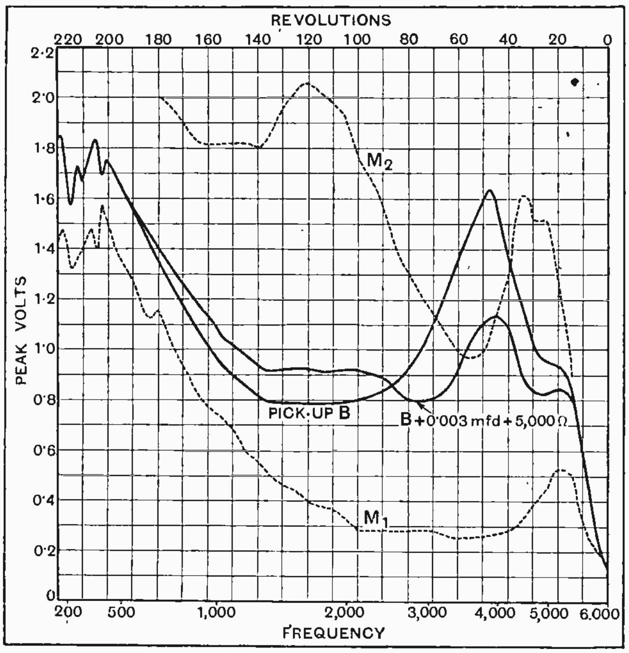


Fig. 3.—Curves M_1 and M_2 show the effect of working a Marconiphone pick-up into an unsuitable load. The characteristic of pick-up B is considerably modified by introducing a filter.

The introduction of the choke and a 0.003-mfd. condenser reduces the curve to the shape shown in (2), while with a 0.0024-mfd. condenser (3) the resonance peak disappears altogether. A 5,000-ohm resistance in series diminishes the effect of the filter and gives curves (4) and (5) with a distinct peak. Intermediate values can be obtained with smaller resistances. It will be seen that the value of the condenser is by no means critical.

It must be remembered that although the curves (2) to (5) appear irregular, the variation is scarcely detectable even by a very critical ear. The effect of the filter as a whole is, however, quite appreciable in the form of an improvement in quality.

When the pick-up was shunted by a 0.125-mfd. condenser there was a pronounced resonance peak at 500 cycles, this being an electrical resonance, whereas the 3,500-cycle peak is due to mechanical resonance. It might be expected, therefore, that the introduction of a 0.001-mfd. condenser in parallel, as indicated in Fig. 1, would produce resonance at about 5,600 cycles or rather less, allowing for lead capacity, and thus improve the output at this frequency. Measurements showed that a condenser of this size did increase the output at very high frequencies, but the increase was so small that it would make no appreciable difference.

Fig. 3 shows characteristic curves for a pick-up almost identical in construction with the B.T.H. instrument, taken from a commercial radio-gramophone (pick-up B in the diagram). The bass output in this case is larger than that from the resonance peak which occurs just below 4,000 cycles, so that overloading would take place first on the low notes. The effect of the filter is less marked, but is still detectable by a softening of the quality.

The experiments so far described were made with the object of deliberately altering the characteristics in order to obtain improved results. However, it may not be out of place to point out that unintentional variations of equal or greater magnitude may be easily produced by using a pick-up in an unsuitable circuit. This was strikingly brought home to the author on substituting a Marconiphone pick-up for those previously tested, using the same potentiometer, but no filter. The output in the upper register was very small, as shown by the lowest curve (M_1) in Fig. 3. On disconnecting the potentiometer, the upper dotted-line curve (M_2) was obtained, showing an output three to five times as much as before.

Important Effect of Connecting Cord.

In the case of the two other pick-ups, the 50,000-ohm output load introduced a small difference, but it was evident that the present effect was of an entirely different order. As the curve with no load still differed considerably from the one given by *The Wireless World*, attention was next directed to the cord connecting the pick-up to the amplifier. This was a flat twin braided telephone cord of a common type, 12ft. long, belonging to another pick-up. Subsequent measurement showed the capacity between the leads to be about 0.0005 mfd. and the power factor to be poor, the D.C. insulation resistance being 24 megohms.

On disconnecting the cord and using two short independent leads to the voltmeter, the remarkable peak

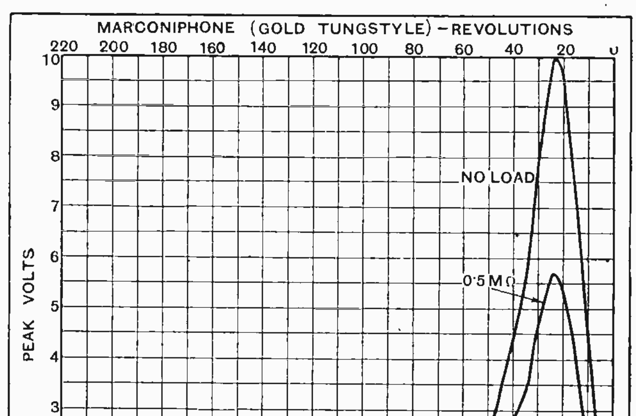


Fig. 4.—The capacity and power factor loss of a long connecting cord are strikingly brought out by these curves.

Correcting Pick-up Characteristics.—
voltage of 9.8 was obtained at 5,000 cycles, as shown in Fig. 4. A 0.5-megohm load, as recommended by the makers, reduced this to 5.7, but even so it is evidently inadvisable to connect the pick-up to a valve with only 2 or 3 volts grid bias. Another curve shows that connection of the cord, as well as the resistance, almost causes the disappearance of the peak. The vertical scale in Fig. 4 is one-fifth that of Figs. 2 and 3, and the two broken-line curves of Fig. 3 have been reproduced in Fig. 4 to show the relative magnitudes.

These curves, as well as others which cannot be discussed in the present article, show that the pick-up under consideration depends to a large extent upon electrical resonances for its successful operation, and great care should be exercised when connecting it to an amplifier. It must also not be forgotten that the characteristic rises very considerably below a frequency of 200, and due allowance must be made for the high voltages which may be developed on low notes. The question of low-note output has not been dealt with here as it has been discussed several times previously.

CLUB NEWS.

How to Manage a Set.

Valuable hints on the management of wireless sets were given by Mr. Scott Sessions in a recent talk before the Golders Green and Hendon Radio Society. In the course of his professional work of testing sets, Mr. Sessions had gained useful experience concerning the most likely sources of breakdown and the mistakes most often made by novices. He mentioned the case of a large and costly set in which the grid-bias battery was accidentally disconnected. The result was that the heavy current drawn from the H.T. battery ruined the valves, transformers, chokes and condensers, and involved a heavy repair bill.

In the subsequent discussion Col. Ashley Scarlett emphasised the necessity of a milliammeter with every set.

Hon. Secretary: Lt.-Col. H. Ashley Scarlett, 60, Pattison Road, N.W.2.

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Radio in Bermondsey.

The classes held at the Bermondsey Men's Institute continue to flourish. Sections for intermediate and advanced work did very well during last term, and it has now been found expedient to start a third class for beginners, due largely to the number of new members who have applied for membership since reopening after the Christmas vacation.

An attractive series of lectures and demonstrations has been planned for the rest of the session, and all interested are invited to apply at once to Mr. G. Hall, Headmaster, Bermondsey Men's Institute, The Alma L.C.C. School, Southwark Park Road, Bermondsey, S.E.1.

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A Ferranti Demonstration.

That Messrs. Ferranti, Ltd., are friends of the amateur radio societies was amply borne out at the meeting of the Muswell Hill and District Radio Society on Wednesday, January 28th, when Mr. Garside, representing that firm, made a journey especially from Lancashire to give a talk. Furthermore, the company sent a large packing case full of apparatus for the demonstration.

Mr. Garside demonstrated a large four-valve instrument in an oak cabinet. Utilising S.G. amplification it operated off the D.C. mains by means of four of the new type indirectly heated valves. A large variable resistance and provision for the use of either a moving coil or an ordinary speaker were only two of the novel points about this receiver, the power-handling qualities of which were particularly noteworthy.

Hon. Secretary: Mr. C. J. Witt, 39, Coniston Road, N.10.

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For Short-wave Beginners.

A paper intended as an aid to the newcomer to short-wave work and entitled "Listening on Short Waves," was read by Mr. Harold Hodgens, Chief Radio Instructor, City of Dublin Technical Institute, before members of the Transmitters' Section of the Wireless Society of Ireland on Monday, January 26th.

Having dealt with the allocation of the short wavelengths, Mr. Hodgens went into details of day and night range and skip-distance effect, mentioning particular cases of the Chelmsford B.B.C. station and the Continental stations at Eindhoven and Zeesen. The variation of signal strength with the seasons was illustrated by graphs giving the received signal intensity for two New York stations.

Hon. Secretary: Mr. H. Hodgens, 12, Trinity Street, Dublin.

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Catering for Everybody.

The Kentish Town and District Radio Society began its new session in good style on Tuesday, January 13th, when a lecture of especial interest to the transmitting members was delivered on the subject of "The Theory and Practice of Crystal Control."

On the following Tuesday, the 20th January, the popular taste was catered for by a series of tests of loud speakers, using sound test records. The club arrived at some interesting and also some surprising conclusions, one of which was that the club speaker was still capable of giving a good account of itself!

The beginners' lectures were continued from the point reached last session, with two lectures on the 16th and 23rd January on Induction and Self Induction.

Hon. Secretary, Mr. C. J. Townsend, 14, Hamilton Street, N.W.1.

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Transformer Hints.

A lecture on "Transformers" by Mr. J. Baggs, of Messrs. Ferranti, Ltd., proved a great attraction at a recent meeting of Slade Radio (Birmingham).

After dealing with the earliest commercial use of transformers, the lecturer passed on to describe the firm's latest product, the A.F.8. Constructional details and characteristics were given, and the effects of back coupling and of two transformers in a receiver were described. Valuable information was given concerning impedance, inductance, output chokes, resistances, D.C. resistances of speakers, and different types of output.

Details of the Society may be obtained on application to the Hon. Secretary, 110, Hillaries Road, Gravelly Hill, Birmingham.

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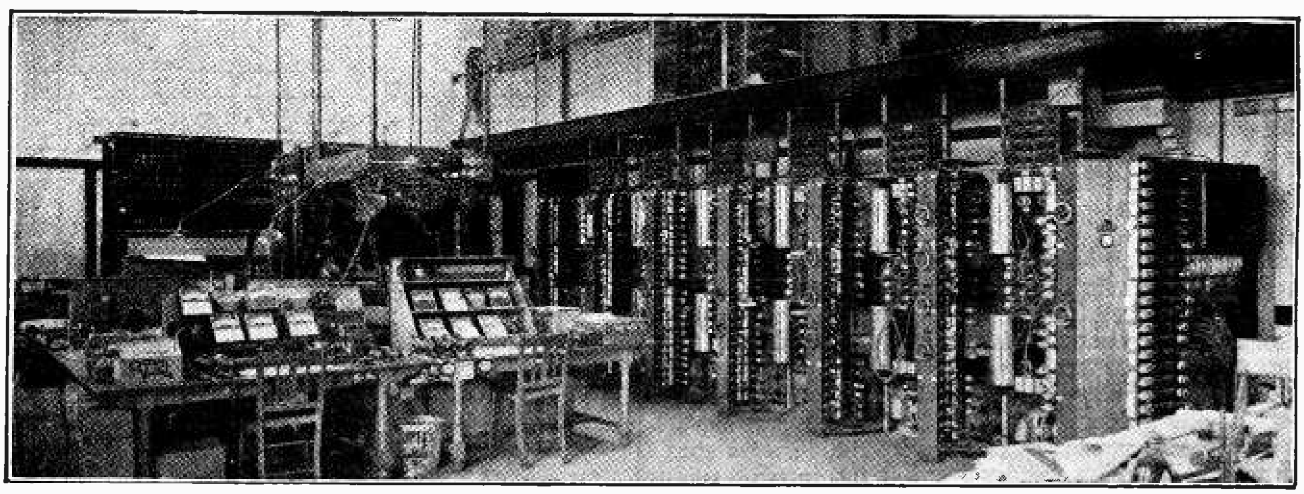
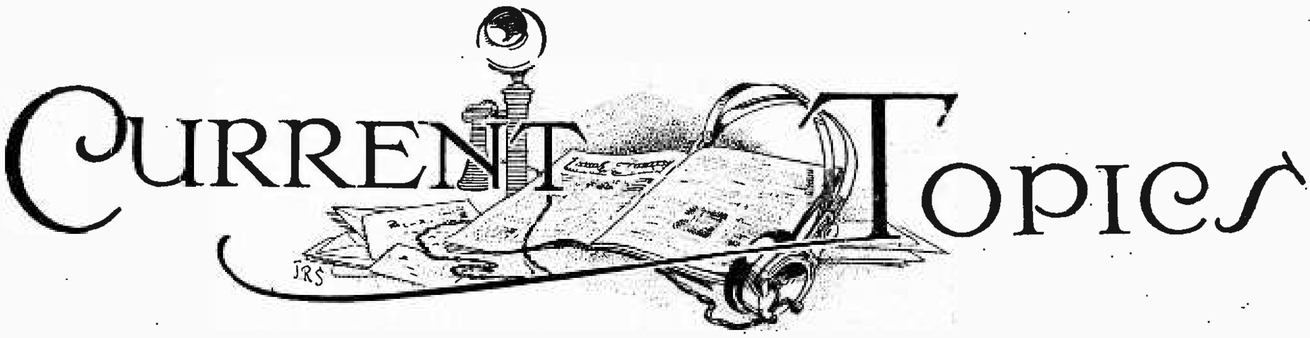
The Stenode and Television.

"The Stenode Radiostat and its Application to Television" is the title of the lecture and demonstration to be given this evening (Wednesday) before the Television Society by Mr. E. L. Gardiner, B.Sc. The meeting, which opens at 7 p.m., will be held at University College, Gower Street, London, W.C.1. Non-members of the Society may obtain cards of admission on application to the head office of the Society at 4, Duke Street, Adelphi, London, W.C.2.



TESTING THE LIFE OF VALVES. Equipment installed at the Wembley laboratories of the General Electric Company for maintaining close control of the life performance of valves under working conditions.



Events of the Week in Brief Review.

CHANTICLEER CALLING.

Radio-Beziers (France) has adopted the cockcrow as an identification signal.

NEW POLISH STATION.

The new 20 kW. broadcasting station at Vilna (Poland) will be opened in March. The wavelength will be 312 metres.

BILINGUAL PROGRAMMES IN BELGIUM.

Belgium's new State-controlled broadcasting scheme came into force on February 1st, when the National Broadcasting Institute made its first dual transmission from the Velthem station. French programmes are sent out on 508.8 metres and Flemish on 333.5.

VATICAN CITY CALLING.

To-day (Wednesday) will feature in Italian radio history as the occasion of the official opening of the Vatican City wireless station. Special significance attaches to the event owing to the presence of the Pope at the inaugural ceremony. We understand that the preliminary transmissions will be made on 50.26 and 19.84 metres.

RADIO TELEGRAMS FROM AEROPLANES.

The Lufthansa Air Service has inaugurated a radio telegram service in conjunction with the German postal authorities. Passengers on the regular routes can now hand telegrams to the wireless operator on the 'plane for despatch to a ground wireless station and thence to the nearest telegraph office for delivery to any address in Germany.

RADIO SMUGGLING IN CZECHO-SLOVAKIA.

A wireless receiver, believed to be one of a number smuggled into the country from Germany, has been captured by the Czecho-Slovakian police at Leipa, Bohemia. The police suspect that a regular traffic exists in radio sets which escape import duty.

NEW ITALIAN RESEARCH CENTRE.

The erection and equipment of Italy's new radio research station is the main task to be undertaken in 1931 by the Italian National Council of Research, of which the Marchese Marconi is president, writes our Turin correspondent. The council will also investigate precision methods of wavelength measurement.

100 KW STATION FOR LUXEMBURG.

A French syndicate has obtained a contract from the Grand Duchy of Luxemburg for the construction and operation of a 100 kW. broadcasting station.

SHORT WAVES FOR LIGHT WEIGHTS.

John J. Long, chief engineer of WHAM broadcasting station, Rochester, U.S., has applied to the Federal Radio Commission for a test permit for the "useless frequencies" between 50,000 and 100,000 kc. (6 to 3 metres). His object is to develop lightweight transmitting and receiving equipment for aircraft.

FORTHCOMING EVENTS.

WEDNESDAY, FEBRUARY 11th.

Golders Green and Hendon Radio Society.—Annual dinner. At 7 p.m. At the Brent Bridge Hotel, Hendon.

Muswell Hill and District Radio Society.—At 8 p.m. At Tollington School, Tetherdown, N.10. Lantern lecture: "Simple Facts about Radio," arranged by the Mullard Wireless Service Co., Ltd.

North Middlesex Radio Society.—At 8 p.m. At St. Paul's Institute, Winchmore Hill, N.21. Loud Speaker night.

Television Society.—At 7 p.m. At University College, Gower Street, London, W.C.1. Lecture and demonstration: "The Stenode Radiostat and its Application to Television," by Mr. E. L. Gardiner, B.Sc.

THURSDAY, FEBRUARY 12th.

Radio Society of Great Britain.—Joint informal meeting with Lensbury Radio Society. At 6.15 p.m. At the Lecture Theatre, 16, Finsbury Circus, E.C.2.

Slade Radio (Birmingham).—At 8 p.m. At the Parochial Hall, Broomfield Road, Erdington. Lecture and demonstration: "Dynamic Inductor Speakers," by Messrs. M. B. Simmonds and G. T. Peck.

MONDAY, FEBRUARY 16th.

Hackney Radio and Physical Society.—At the Electricity Showrooms, 18-24, Lower Clapton Road, E.5. Discussion: "The Design of L.F. Amplifiers."

SHORTER WAVES FOR THE SOS?

An international regulation reserving a band of short waves exclusively for SOS calls is urged by Capt. S. C. Hooper, director of U.S. Naval Communications, who points out that the 600-metre wavelength is often inadequate over vast expanses of water like the Pacific, Indian and South Atlantic Oceans. He contends (writes our Washington correspondent) that the maximum daylight range on this wavelength rarely exceeds 500 miles, and that an alternative short wavelength would guarantee reception over much greater distances.

RADIO AT LILLE FAIR.

A wireless section will be included in the famous Lille Commercial Fair, which will be held from April 4th to 19th. Contrary to the previous custom, radio demonstrations will be permitted.

COHERER INVENTOR "HONOURED."

M. Edouard Branly, who invented the coherer, and is generally regarded as France's "pioneer of wireless," was recently fêted at a demonstration in his honour at the Sorbonne. Unfortunately, the meeting was poorly attended, and the Paris *Soir* remarks bitterly that many professed admirers of the *savant* were conspicuous by their absence.

R.S.A. LECTURE ON TELEVISION.

Mr. W. G. W. Mitchell, B.Sc., joint hon. secretary of the Television Society, will deliver a lecture entitled "Developments in Television" at a meeting of the Royal Society of Arts at John Street, Adelphi, London, W.C.2, on Wednesday, February 25th, at 8 p.m. Apparatus illustrating the principles of television will be exhibited. The chairman will be Sir Ambrose Fleming, M.A., D.Sc., F.R.S.

BEYOND A JOKE.

A wireless prank carried out by students of Yale University came to an abrupt end a few days ago when the ringleaders were warned by the Federal Radio Commission that they were liable to fines of £1,000 and imprisonment for five years. The students had transformed a radio receiver into a low-power transmitter, and although their original intention was merely to startle the district with strange calls, they grew more enterprising and attempted to sell "time on the air" to local merchants.

SHORT WAVES FOR GENTLEMEN.

"Short waves have donned evening clothes. They have gone 'class,'" runs a circular which we have received from an Altoona, Pa., U.S.A. radio manufacturer who is marketing a new superheterodyne short-wave adaptor for the ordinary radio receiver. "Short-wave reception has definitely left the category of merely a pastime for nuts, cranks, and wild-eyed experimenters," continues the refined writer, who explains that "one can now listen to short-wave signals without mussing one's hair or being on speaking terms with kilocycles, audio frequencies, capacities, impedance, or other obstructions to normal enjoyment."

The news that short waves are now "classy" will come as a great relief to our readers, many of whom must have been leading a Jekyll and Hyde existence.

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REGIONAL SCHEME FOR NORWAY.

Ninety per cent. of Norway's population will be within "single-valve range" of a broadcasting station if a new scheme of reorganisation prepared by the Norwegian Chamber of Commerce and the Telegraph Department is passed by Parliament. The scheme provides for a total of forty-one main and relay transmitters to replace the existing ten.

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PERPLEXED.

From the Editor's Postbag, Croydon Paper :—

AERIAL LOOPS.

A resident, I note, has attached several wire loops to his radio aerial and a number of little black condensers along it. I wonder if any of your readers can tell me whether there is any advantage gained by these. Do they give greater selectivity or stronger volume? AMATEUR.

Carshalton Hill.

Our office boy suggests that the object is to condense the signals to enable them to pass through the loops.

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LECTURING OVER THE ATLANTIC.

Sitting in an armchair in his home at Oxhey, Herts, at 1.45 a.m. on Friday January 30th, Mr. C. C. Paterson, president of the Institution of Electrical Engineers, delivered a "lantern" lecture to members of the Engineering Institute of Canada, who were assembled in their lecture theatre in Montreal, 3,000 miles away.

The lecture was transmitted by direct radio-telephony from this country to Canada. The circuit was from the Post Office Rugby station and the Bodmin beam station of the Imperial and International Communications Company to the Canadian Marconi Company's station at Yamachiche. Landline communication was established between Mr. Paterson's home and Bodmin and Rugby, as well as between Yamachiche and Montreal.

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GERMANY'S "BROADCASTING HOUSE."

A Radio Museum will be one of the interesting features of the Berlin "Funkhaus"—the headquarters of German broadcasting. The new building is already in use, but the museum and several other departments are not yet completed (writes a correspondent).

The main studio occupies the centre of the building and measures 130ft. by 70ft. It is 40ft. high and is provided with a gallery running round three sides. Ingeniously housed in a compartment on the fourth side is a large organ.

There are two smaller studios fitted with movable walls, permitting the size of the studios to be regulated according to the type of performance for which they are required. All the studios are fitted with special soundproof windows of a type designed at the Heinrich Hertz Institute in Berlin. Through these the control engineers can observe the proceedings in the studio while listening to the performance on loud speakers.

The Funkhaus occupies a dominating position in the western suburbs of Berlin adjoining the famous Radio Exhibition grounds.

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SETS FOR BLIND LISTENERS.

More than 7,500 wireless receivers, mostly crystal sets, have been distributed to blind listeners in various parts of the country in connection with the "Wireless for the Blind" Fund, the total sum collected by the end of January being £30,000.

Work has now begun on the delivery of 5,000 single-valve sets to blind listeners in districts which are beyond the crystal service area of a broadcasting station. To serve areas still more remote an order has just been placed for 1,000 two-valve sets.

The committee of the Fund states that the amount still needed for sets alone, apart from any question of maintenance, is estimated at about £15,000. Donations should be sent to the offices of the Fund, 226, Great Portland Street, London, W.1.

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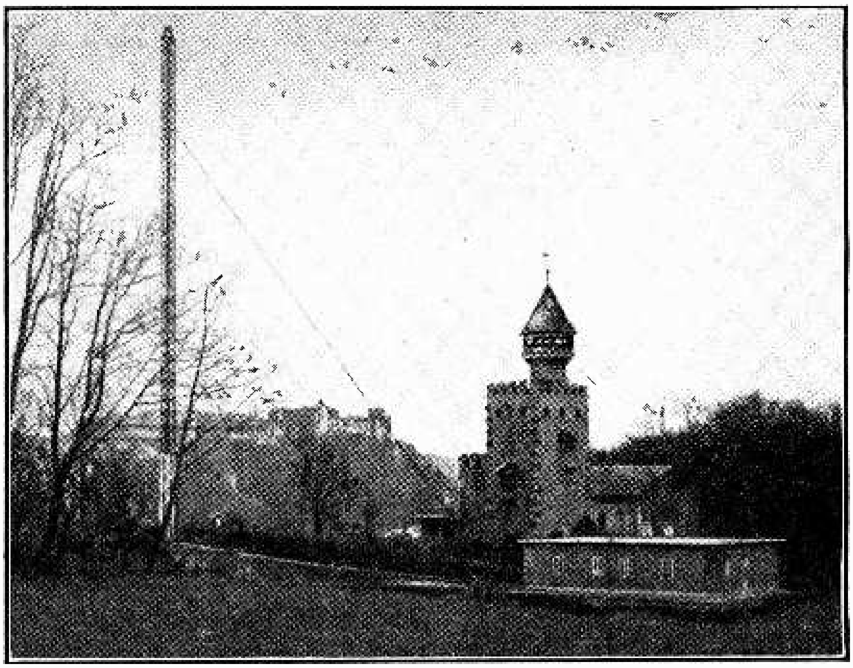
RADIO'S DEBT TO DR. DE FERRANTI.

A point of special interest to wireless enthusiasts was mentioned by Mr. Frank Bailey, managing director of the City of London Electric Lighting Company, in his recent lecture on the "Life and Work of Dr. de Ferranti, F.R.S.," at the Manchester College of Technology. "As far back as 1888," said Mr. Bailey, "Ferranti obtained a patent for the idea of an electrical main composed of thinly insulated wires so put together that each wire has the same average distance from the centre of the main. As the frequency of the supply during the life of this patent rarely exceeded 100, this idea had no great development, but, with high frequency wireless work, it is now in common use, and sometimes called Litz wire.

"Another patent of the year 1888 related to the first and master effort to provide a perfect means of smoothing and filtering any ragged edge or unevenness in the flow of a uni-directional current. Incidentally, it is a clear anticipation of the audio transformer, and users of wireless apparatus ought to feel grateful that here at any rate is something *free*. There is only one claim, and, put briefly, it is 'to equalise strength of current by means of a self-induction coil or coils or condenser,' and there are three drawings which prove the genius of the patentee. Not content to place one coil in series, he provides for another in parallel, and then suggests a combination of the two, which is the modern audio transformer."



A NEW RELAY.—Salzburg, Austria, the birth-place of Mozart, was recently honoured with a new broadcasting station relaying the Vienna programmes. The photograph shows the castle and gives a good idea of the picturesque surroundings.

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FREE LICENCES FOR THE BEDRIDDEN?

Whether the Government could be persuaded to grant free wireless receiving licences to permanent invalids was discussed at the recent annual meeting of the Manchester and Salford Society for the Provision of Wireless for the Bedridden Poor. It was stated that for the past year the fees paid for licences amounted to nearly a third of the Society's expenditure.

The Committee is anxious to hear of anyone willing to "adopt" a case in which a set has already been provided.

Unbiased —by "FREE GRID"—

Caution.

I notice that certain Continental receivers which are quite unscreened, although having several stages of H.F., have lately been advertised in the columns of certain daily papers. The price is certainly attractive, but I should advise intending purchasers to be wary, as a multi-stage H.F. set which requires no screening probably requires no volume control either.

A Pick-up Plea.

The position of the jack usually supplied for the connection of the gramophone pick-up is, I find, very awkwardly placed in most sets. It is usually situated somewhere at the back of the set in an un-get-at-able position, and, since in most cases it is so connected that it is not possible to leave it in circuit when the receiver is being used for radio work, the whole business of connecting or disconnecting the pick-up is very temper-trying, especially in the case of a heavy set. I realise, of course, that in most cases its position is determined by the necessity of the avoidance of a long lead hanging on to the grid of the first valve of the gramophone amplifier, but some makers seem to have deliberately exercised Machiavellian ingenuity in making the use of the pick-up as difficult as possible, although whether this is by accident or with malice aforethought I cannot say.

Surely in these enlightened days there is not the slightest reason why the gramophone pick-up connection should not be made a permanent fixture, the actual pick-up itself being thrown in and out of circuit by a simple switch mounted on the front of the panel. It is no use arguing that serious loss of efficiency would result owing to the fact that one terminal of the switch would always be permanently connected to the grid of the valve. The days of low-loss circuits in commercial sets have gone for ever—if, indeed, they ever existed—and the slight extra "loss" caused by this wire would be negligible. In the case of certain sets it is actually necessary to remove the back in order to connect up the pick-up, and this almost makes me think that certain radio manufacturers are fearful lest the electric gramophone, pure and simple, should become more popular than the radio receiver itself.

American Memories.

The picture of the Cortlandt Street Radio Market in New York City, which was recently published in this journal, brought back memories of the first triode which I ever *purchased*. This was actually in Fulton Street, one of the many drab thoroughfares at the back of the Woolworth building, of which Cortlandt Street is another. I still have it in my possession, and, curiously enough, the filament is still intact, although it has long been out of action. It cost me ten dollars, I recollect, but it never did very much for its living. The principal memory which I associate with it is

"You mean 'toob'?"

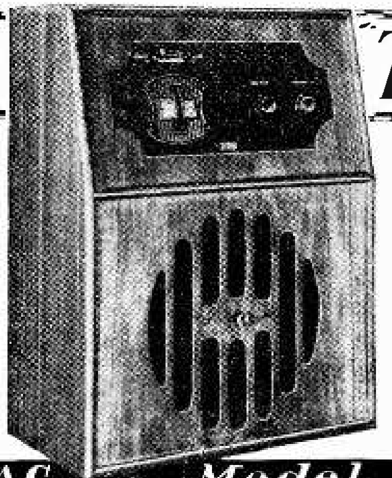
the look of bewilderment which I received from the shop-assistant—sorry, sales clerk—when in a moment of mental aberration I called it a wireless valve instead of a radio "toob."

A Bad Sign.

The other week I was asked by a friend to make a major modification to an all-electric receiver which he purchased somewhat over a year ago; he required the alteration in order to bring the set completely up to date. Naturally, he could not expect the makers of the set to undertake this work, and as the local dealer seemed shy of tackling the job I agreed to do it. A cursory examination of the set, which was very compactly built, showed me that I should save myself a lot of time if I had the theoretical circuit diagram of the instrument before me. I accordingly wrote to the makers of the instrument explaining the circumstances, and asked them if they would be good enough to supply me with the necessary printed diagram. Their reply was somewhat ambiguous, it merely stating that they were *unable* to give me a circuit diagram. They probably meant that they were unwilling to do so, although, since I found out on disembowelling the set that most of its components were of foreign origin, I might have been justified in assuming that their knowledge of the set did not extend beyond the importation of the parts and the assembly of them from a blue print. If this is so, I shall have much pleasure in supplying them gratis with a copy of the diagram, which I eventually worked out after much tedious wire-tracing; indeed, the disposition of the parts was so peculiar, and the wiring so unnecessarily complicated, that it almost seemed that it had been deliberately "scrambled" in order to prevent the ordinary amateur from finding out the theoretical circuit diagram. The circuit, however, proved to be a very ordinary affair, and I could only conclude, therefore, that after all they simply did not want me to know the circuit.

I have referred previously in these notes to this reluctance on the part of certain manufacturers to disclose what they called their mystery circuits, and I thought that the practice had quite died out. It seems very foolish, as any rival manufacturer who desires to know the circuit has only to buy a set and put one of his technical men on to the tedious but straightforward task of tracing it out. When information of this kind is refused I think that one is fully justified in concluding that the manufacturer has got something unsound in the design of the set which he does not want his more enlightened customers to get wind of.

LOTUS Mains Transportable



A.C. Model

Natural Quality of Reproduction of Both Speech and Music.

Range and Selectivity of a High Order on Short Waves.

THE mains transportable is a type of receiver which is steadily gaining in popularity. With its self-contained loud speaker and frame aerial it presents a neat and compact appearance which makes an immediate appeal to those with an instinct for orderliness. While retaining all the best qualities of its illustrious ancestor, the battery-driven portable, it is able to give a far better output from the point of view both of quality and volume; the H.T. voltage is always up to concert pitch and the cost of running for, say, 200 hours—the average life of a portable H.T. battery—is about 4d. compared with 18s. 6d. for H.T. replacement and L.T. charging in the case of the portable.

The cabinet design in the Lotus All-Electric Transportable is of a type which has previously met with considerable success in battery portables. Standing vertically on a ball-bearing turntable, it has a sloping control panel above the loud speaker fret. The cabinet is cut away to frame the controls so that the whole of the interior of the set (with the exception of the loud speaker) can be withdrawn without disturbing condenser dials or control knobs.

The receiver chassis and power unit are mounted inside the wooden framework supporting the short-wave aerial winding. Both are very completely screened, and the receiver chassis, which is subdivided into two compartments, is provided with a readily detachable clip-on back, giving easy access to the valves. The screening-box of the power unit is provided with ventilating louvres, and the cover is removable for adjustment of the mains transformer primary and insertion of the valve rectifier. The power unit is mounted on a shelf immediately below the receiver chassis, and to facilitate removal of the cover on the power unit the shelf can be drawn forward after extracting two fixing screws. The length of the multiple cable connecting the two units is just sufficient to permit this operation, and does not leave an undue amount of slack with the power unit fixed in position.

SPECIFICATION.

CIRCUIT: Three valves. Screen-grid H.F. (tuned transformer coupling), leaky grid detector with reaction transformer coupled to pentode output valve. Direct loud speaker feed. Full-wave valve rectifier.
CONTROLS: (1) Tuning controls, independent side-by-side drum dials. (2) Wave-range switch. (3) Reaction. (4) Post-detector volume control.
GENERAL: Provision for gramophone pick-up. Self-contained frame aerial. Turntable in base of cabinet.
PRICE: £25 10s. Makers: Garnett, Whiteley & Co., Ltd., Lotus Works, Mill Lane, Liverpool.

The control panel carries side-by-side drum dials for tuning the aerial and H.F. amplifier circuits, a wave-range key switch, and knobs for controlling reaction and L.F. volume respectively. The metal panel is screwed to the face of the receiver chassis, and is finished in brown crystalline enamel. Hand capacity effects are entirely absent.

The receiver circuit employs three valves (H.F., det. and L.F.). The first two have indirectly heated filaments, while the third valve—a pentode—is directly heated from a separate filament winding on the mains transformer.

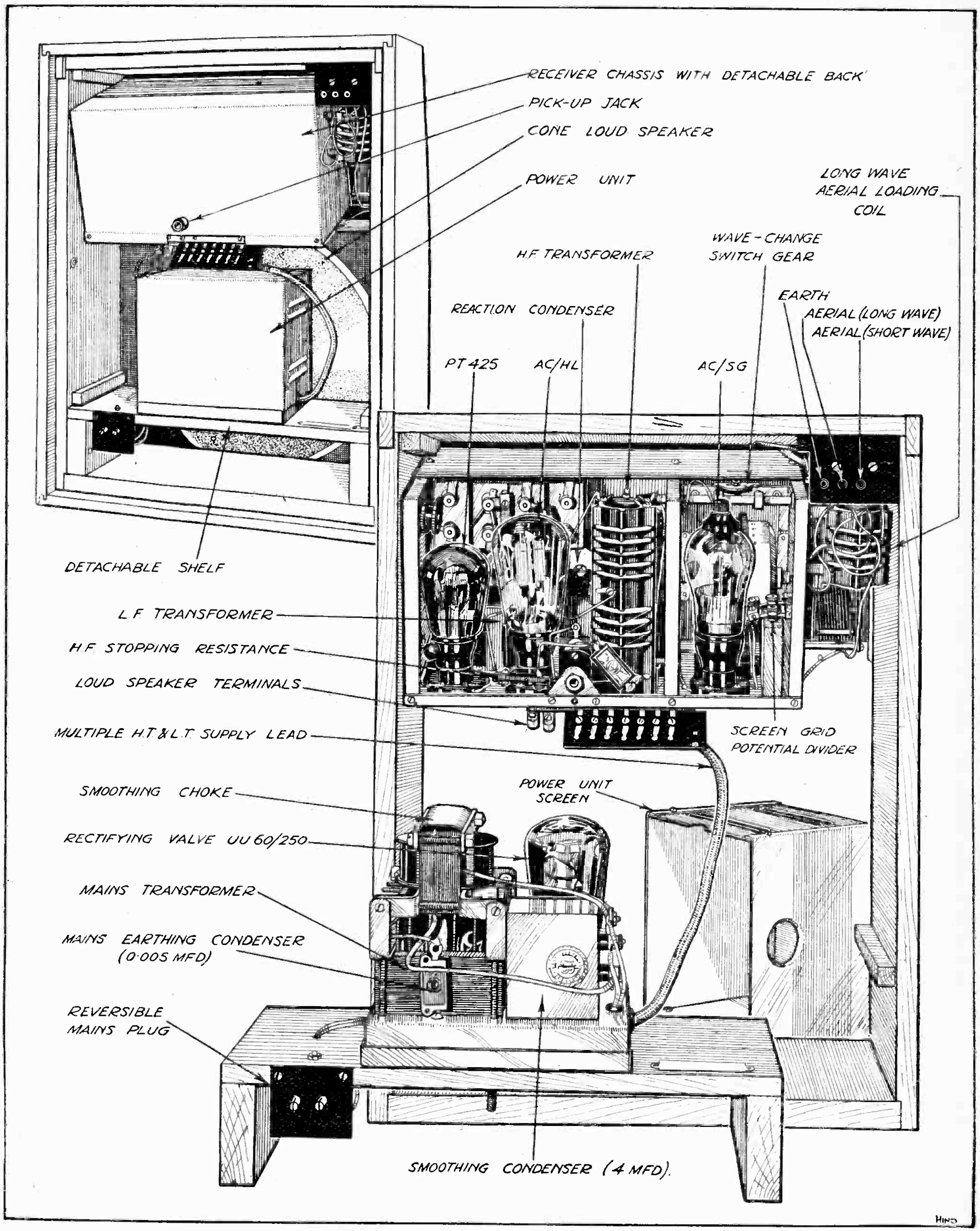
Aerial Circuit Connections.

The aerial circuit consists of a short-wave frame aerial wound round the interior framework of the set. It is loaded for long waves by a separate inductance, and provision is made for the attachment of an external aerial and earth. There are two aerial sockets, and, when changing from short to long waves with an external aerial, the lead-in must be moved to the appropriate socket, as both long- and short-wave windings are provided with tapping points to reduce aerial loading. Wave-range switching is accomplished by a system of switches which are ingenious adaptations of the well-known Lotus jacks. They are operated by a horizontal brass push-rod running parallel to the control panel and controlled by the wave-range key.

The screen-grid H.F. valve is followed by transformer coupling. A 2in. diameter ribbed and slotted ebonite former carries the transformer windings and also a reaction winding, which is capacity-controlled from the detector anode.

The detector functions as a grid rectifier with zero bias. The bias resistance shown in the detector cathode lead in the circuit diagram is for the gramophone pick-up, and comes into play only when a plug is introduced into the jack switch at the back of the receiver chassis. Bias for the H.F. and L.F. valves is also obtained from separate cathode resistances, a separate centre-tapped filament winding being incorporated for the directly heated pentode.

The detector is followed by L.F. transformer coupling to the pentode. Post-detector volume control is provided by a variable resistance in parallel with the L.F. transformer primary. A resistance is connected in



Layout of components in the Lotus Transportable. The power unit can be pulled forward for removal of the aluminium screen.

Lotus Mains Transportable A.C.—

series with the grid terminal of the secondary winding in order that stray H.F. currents may be prevented from reaching the loud speaker leads. In a compact receiver of this type, in which the frame aerial and loud speaker are in close proximity, an H.F. stopping device is essential if back coupling between the output and input circuits is to be avoided. The stopping resistance also assists in keeping down the higher audio-frequencies, which are generally over-emphasised by the pentode. A compensating condenser and resistance are also connected in parallel with the loud speaker winding with the same end in view.

H.T. Smoothing.

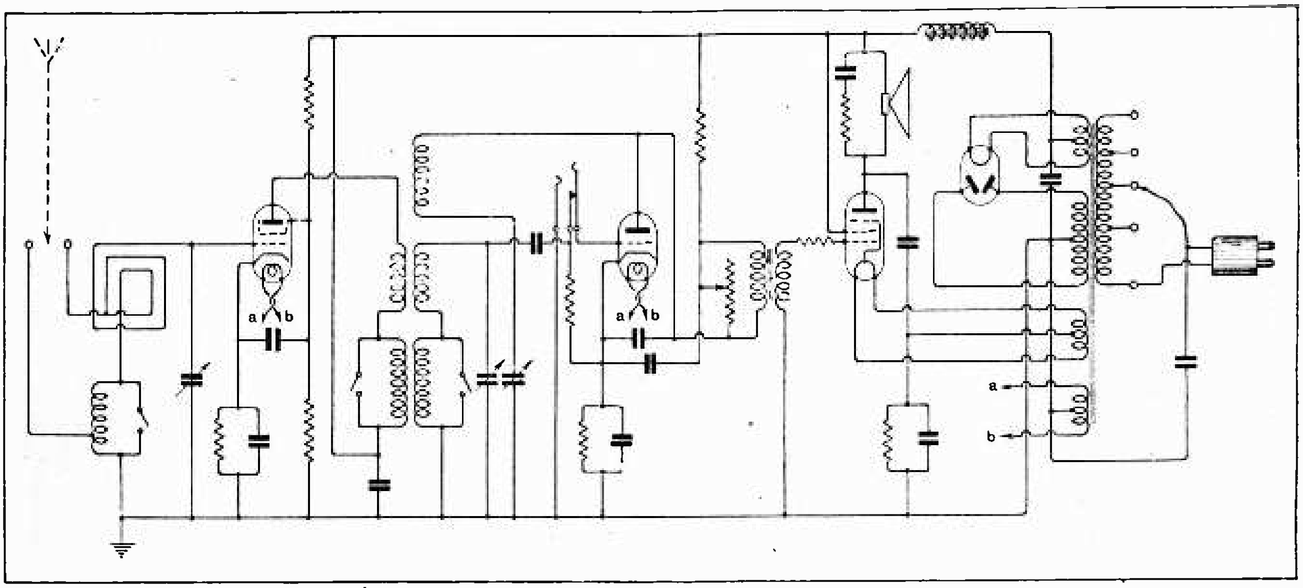
The power unit contains the mains transformer, a full-wave valve rectifier, the usual 4 mfd. rectifier output load, and a smoothing choke. It is surprising to find that no by-pass condenser is connected on the receiver side of the smoothing choke, which is connected in the H.T. lead. Further, only the detector anode circuit is decoupled. Yet there is no trace of motor-boating under working conditions.

In spite of, or perhaps because of, the rather unconventional arrangement of the smoothing circuits there is literally no trace of mains hum. When first switched on there was, however, a distinct background hiss. Reversal of the mains plug at the back of the set considerably reduced this interference, which is of a high-frequency character and enters along the supply mains.

The selectivity on the short-wave range is of a high order, and at a distance of only five miles from Brookmans Park there was a clear space of 33 degrees between the two stations without any trace of background. Actually, under these conditions the National transmitter (261 metres) extended from 236 to 272 metres and the Regional (356 metres) from 333 to 369 metres. In the free space between the two stations nine foreign stations were tuned in—two at full programme strength. The total number received on short waves (excluding 5GB) was 22, and of these at least nine could be enjoyed for long periods without fading or interference.

The instruction book gives an approximate calibration of the tuning dials, and in the receiver tested this calibration was found to hold within two metres over the whole of the short-wave range. The long-wave range, in which the frame aerial is loaded by a small coil seen at the right-hand side of the screening in the pictorial diagram, is not so sensitive as the short. Daventry (5XX) is quite satisfactory, but an outdoor aerial would be necessary in order to enjoy the long-wave foreign transmissions at reasonably good strength.

A happy compromise has been effected in the matching of impedance values in the output circuit of the pentode, with the result that the quality of reproduction is very pleasing indeed. We award the designers full marks on this score, for quality is difficult to achieve with a boxed-in loud speaker movement of small dimensions. There are no objectionable resonances, and the reproduction of both speech and music has a natural and unforced quality.



Schematic circuit diagram of the Lotus receiver chassis and power unit.

Outstanding Features.

The exceptionally good performance on short waves, the pleasing quality of reproduction, and the neat layout are the three outstanding features of the set. The frame-aerial reception on long waves might be improved with advantage, but those who have had an opportunity of hearing this set will agree that the number of stations available on the short-wave range more than compensates for this deficiency.

The makers are Messrs. Garnett, Whiteley and Co., Ltd., Lotus Works, Mill Lane, Liverpool, and the price of the receiver in oak, mahogany, or walnut is £25 10s. This includes valves, royalties, and accessories such as gramophone pick-up, jack and reversible mains plugs.

D.C. Band-Pass Five

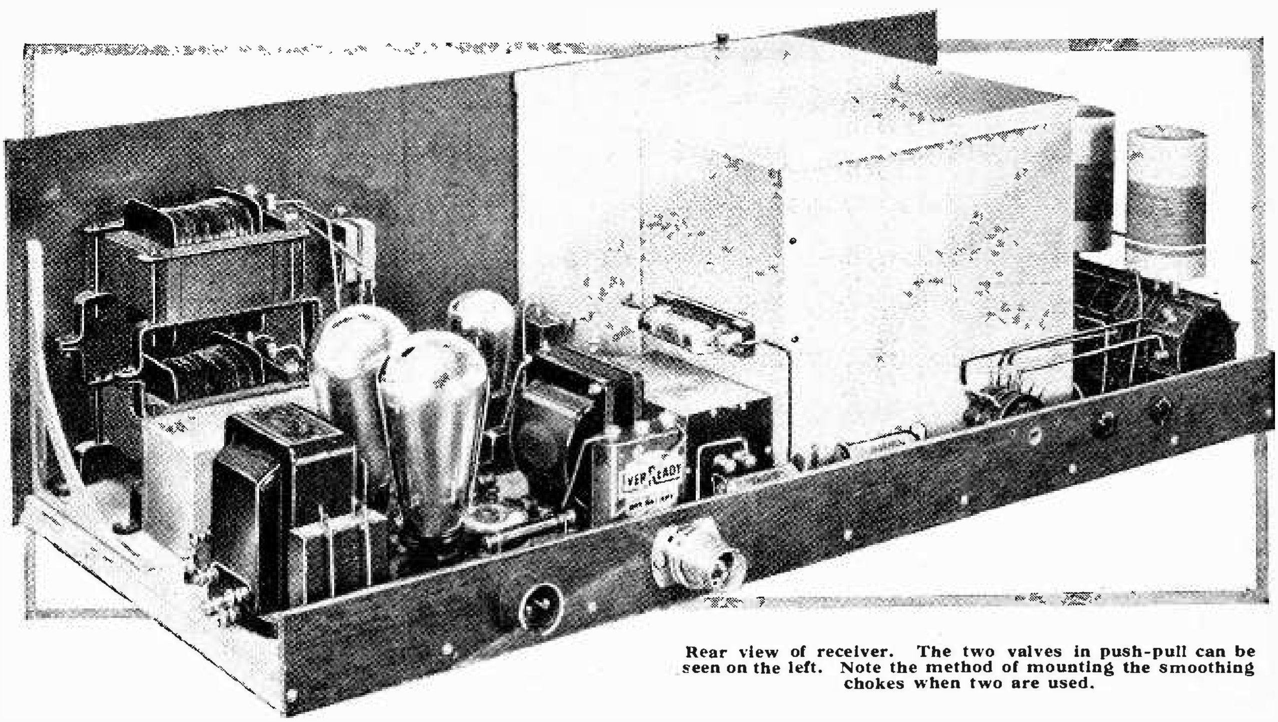
Coil Details. Hints on Construction.

By L. E. T. BRANCH, B.Sc.

(Concluded from page 110 of previous issue.)

ALTHOUGH the baseboard is rather large, being 30in. × 12¾in., the weight is kept down by using ⅜in. ply with two ¼in. thick battens underneath at each end, thereby leaving a space under the rest of the baseboard to take some of the wiring. The panel is $\frac{3}{16}$in. thick, and is 30in. × 9in. A terminal strip 2in. wide of the same thickness is used right along the back of the baseboard and carries the terminals as well as the mains supply socket, and also the socket for connecting the external resistance. Since the current flowing through this resistance is approximately 0.24 ampere, its value should be $\frac{E}{0.24}$ ohms where E is the voltage to be absorbed. With a 4-volt detector the voltage dropped through all the valve filaments is approximately 20. Another 18 is lost if one choke is employed for the smoothing. Hence $E = M - 38$ where M is the mains voltage. When two smoothing chokes have to be employed $E = M - 56$. Table I shows suitable values for the external resistance for different mains voltages. The simplest way to test the suitability of the resistance is to measure the voltage obtained across the filament of the valve V_1, which should be not more than 6 volts.

Only two screening boxes are employed, the coils and valve for each stage being in their appropriate boxes.



Rear view of receiver. The two valves in push-pull can be seen on the left. Note the method of mounting the smoothing chokes when two are used.

TABLE I.

Mains Voltage.	One Choke.	Two Chokes.
	Ohms.	Ohms.
200	680	600
210	720	640
220	760	680
230	800	720
240	840	760
250	880	800

Screening covers are used to shield the part of each valve below the internal screen and the grid wire for each high-frequency valve enters its box at the point where the valve screen touches the side of the box. These screens must be in metallic contact with the boxes.

Three holes must be drilled through the bottom of the front box and one through the bottom of the back box to accommodate the wires carried under the baseboard. A small metal plate washer of about 14 gauge aluminium should be placed on the tuning condenser spindles between the two boxes to prevent the two sides becoming clamped tightly together. Another washer, which need only be 18 gauge, should be placed between the panel and front box. When fastening down the switches see that they are correctly in line. If the

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interconnecting rods do not fit tightly any play will cause the back switch to lag in its action. Pieces of wood $\frac{1}{2}$in. thick and about $\frac{1}{4}$in. smaller each way than the inside dimensions of the boxes, are screwed down at the bottom. The switch which is behind the back box must be supported on a small piece of wood of the same thickness. The connecting rods of the ganged switches are all in metallic connection with one another, and should also be connected at a suitable point of the screening boxes in order to keep the rods at earth potential.

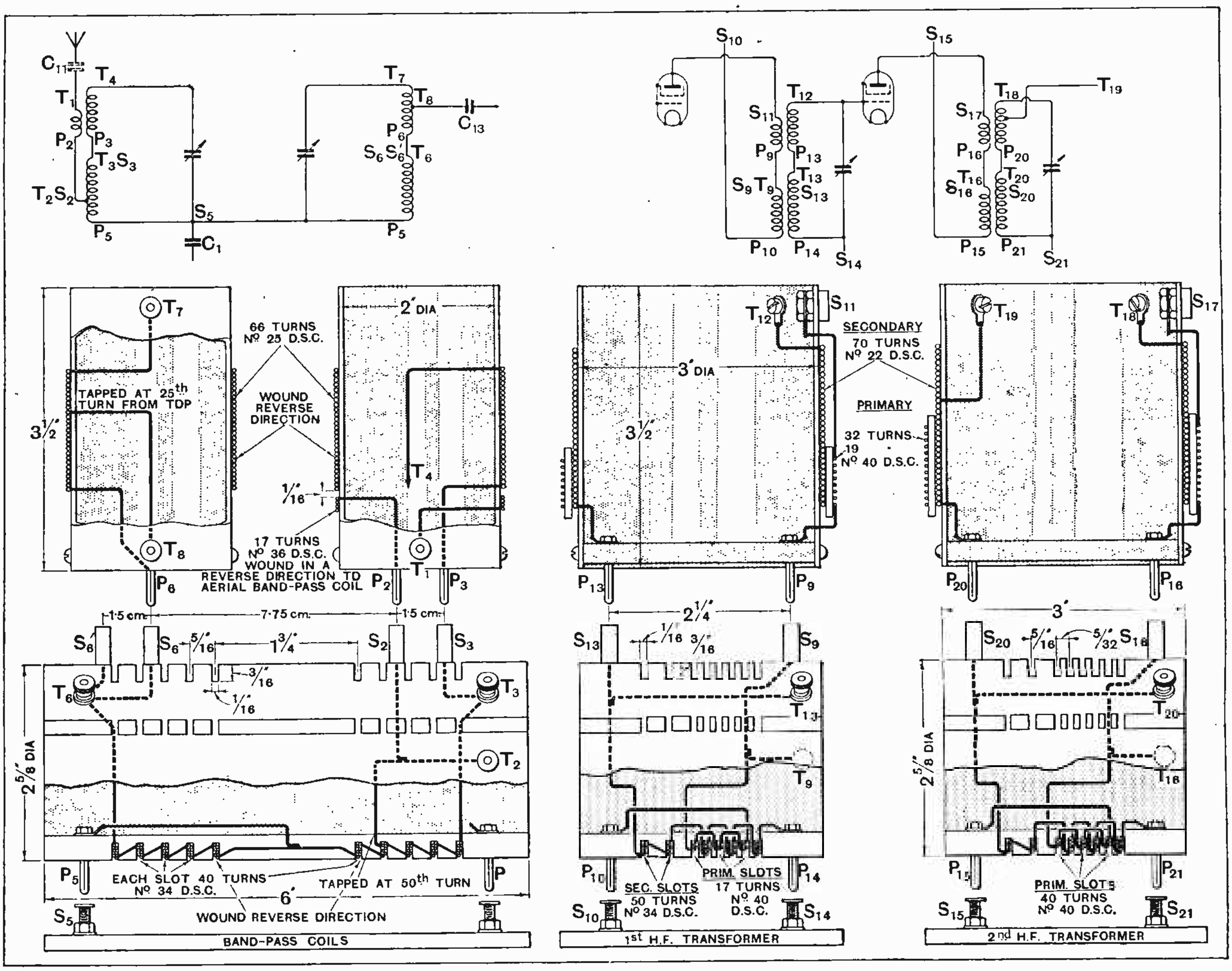
When the switches are turned full over to the right the long-wave coils are shorted and one green signal is illuminated. With the switches in their central position two green lights appear and the long-wave coils are all brought into operation. By turning the switches full over to the left both green signals are extinguished as well as the filaments of the H.F. valves, and the set is now suitable for gramophone reproduction purposes. When wiring the switches Table II will be found to be useful in checking the connections. The unnumbered points are not used. The same lettering is used throughout.

The S.G. filament shunting resistances are mounted on the sides of the boxes. The trimming condenser in the front box is mounted on a piece of wood near the top so that it is adjustable by means of a screwdriver inserted through a hole in the lid.

The tuning condensers which are associated with the band-pass filter coils are mounted on a small platform formed of one upright piece of $\frac{1}{4}$in. five-ply, $3\frac{1}{4}$in. high by $2\frac{3}{4}$in. wide, and one horizontal piece, $6\frac{1}{8}$in. long by $2\frac{3}{4}$in. wide.

When commencing the wiring it is advisable not to have any of the coils in position. The long-wave coils are inserted when as much wiring as possible has been done without them. When inserting in the boxes the small strip bases of the coils see that the distances from the sides of the boxes are the same in each case. If this is not done trouble in ganging may be experienced.

After connecting up the terminals on the long-wave coils to their appropriate points the short-wave coils are inserted and the last few connections are made. The



Dimensional data of the pre-selector coils and the H.F. intervalve couplings for both wavebands. The secondaries of the H.F. transformers are identical, thus ensuring satisfactory ganging.

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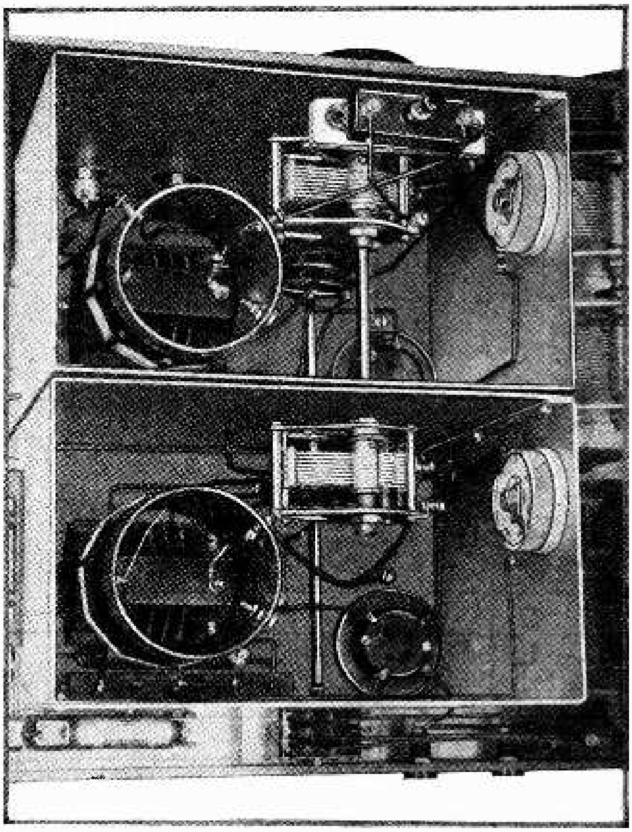
coils are of a semi-plug-in type, and are quick and easy to insert or extract.

The medium-wave band-pass coils are wound on two bakelised formers, 2in. diameter and 3½in. long, and consist of 66 turns of No. 25 D.S.C., which occupies 1⅝in. winding space. These coils must be wound in opposite directions, otherwise capacity effects are introduced which considerably modify the filter. The grid coil is tapped at the twenty-fifth turn from the top, and the tapping brought to the terminal T_8. In both coils the low-potential end is at the bottom, and simply connected to the plugs P_3 and P_6 respectively. The high-potential end of the aerial band-pass coil is connected to the terminal T_4 while that of the grid coil connects to the terminal T_7. At the bottom of the aerial coil of the band-pass filter there is wound a small earial winding of 17 turns of fine covered wire. The gauge is not critical, and No. 36 D.S.C. is suitable for this purpose. A space of $\frac{1}{16}$in. is left between this coil and the main coil. The 17-turn winding should be wound in the opposite direction to the 66-turn winding on the same former. The top end of the fine winding is connected to the pin P_2, while the lower end goes to the terminal T_1.

The long-wave coils of the band-pass filter are both wound on the same ribbed ebonite former, which is 2⅝in. diameter and 6in. long. The dimensions and positions of the slots are clearly shown in the illustration, each slot containing 40 turns of No. 34 D.S.C. wire, the aerial one being tapped at the fiftieth turn from the low-potential end. The coils thus consist of a total of 200 turns each, and must be wound in opposite directions with the two ends near the centre of the former, both joined to the pin P_5 as these are the low-potential ends. The tapping is connected to the socket S_2 and the terminal T_2. The high-potential end of the tapped coil is connected to the socket S_3 and the terminal T_3. The high-potential end of the other long-wave coil is connected to both the two sockets S_6 and S'_6, and also to the terminal T_6. The pin P is only used to help support the coils. Corresponding lettering is used in the other diagrams, so that no mistake is likely to be made in wiring up. If increased selectivity is desired a short-circuited turn of heavy-gauge wire, e.g., No. 20, must be included in the manner indicated in the first part of this article.

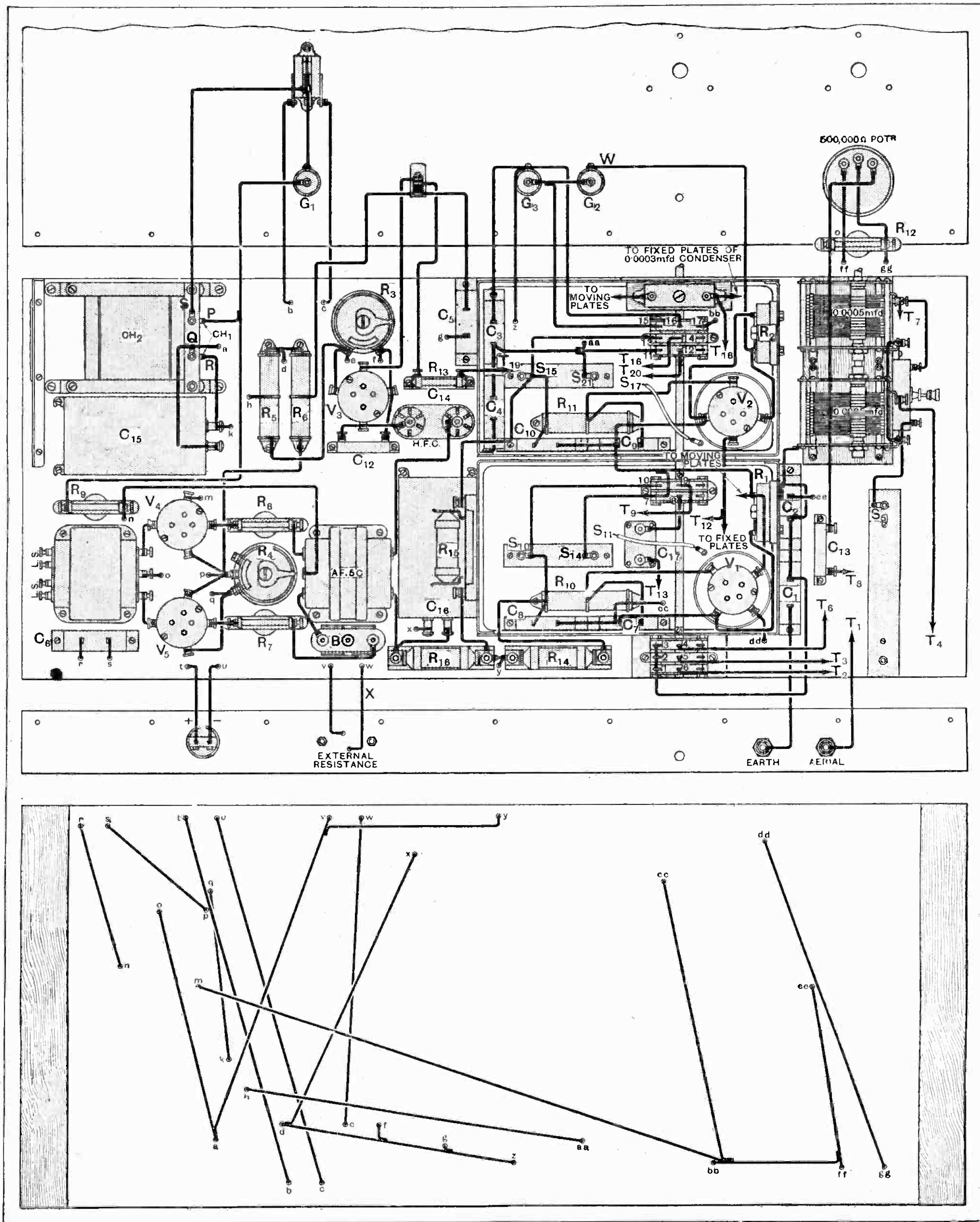


Plan view showing ganged intervalve couplings. The cylindrical portions of the valve screens are removed.

TABLE II.

Switch Point.	Coil Connections.	Switch Point.	Coil Connections.
1	S_5	10	S_{10}
2	S_5	11	S_{21}
3	S_5		
4	T_6	12	T_{20}
5	T_3	13	T_{16}
6	T_2	14	S_{15}
7	S_{11}	15	See Fig. 1.
8	C_{17}	16	
9	T_9	17	

The medium-wave H.F. transformers are both wound on bakelised formers of 3in. diameter and 3½in. long, and have 70 turns of No. 22 D.S.C. wire. The one for use in the front screening box—that is, immediately before the detector—is tapped at the 25th turn from the top, and the tapping brought to a terminal T_{19}. Since the tuning condensers are ganged, it is imperative to see that the number of turns, and also the lengths of the windings, are identical. The low-potential ends are connected to the pins P_{13} and P_{20}. The high-potential ends, which are at the tops of the coils, are joined to terminals T_{12} and T_{18} on the coils. Ten spacers $\frac{3}{32}$in. thick are then placed round the bottom half of the coils, and in the case of the first H.F. transformer 19 turns of No. 40 D.S.C. wire are wound on, while in the second H.F. transformer 32 turns of the same wire are used. Not less than ten spacers should be employed, otherwise the capacity introduced between the primary and secondary flattens the tuning considerably when the long-wave coils are in operation. These fine windings must be wound in the same direction as the secondaries. The bottoms of these windings are connected to the pins P_9 and P_{16}, while the top ends are brought to the sockets S_{11} and S_{17} at the top ends of the coil formers. When the coils are in the set these sockets receive plugs which are connected to the anodes of the screen-grid valves. The long-wave H.F. transformers are wound on ribbed ebonite formers 2⅝in. diameter and 3in. long, the windings being clearly shown in the coil diagram. The primaries and secondaries are, as usual, wound in the same directions. The



The wiring plan above and below the baseboard. The drilling data for the panel and terminal strip illustrated in last week's issue are as follows: A, 1 in. dia.; B, ¾ in. dia.; C, ½ in. dia.; D, 7/16 in. dia.; E, 3/8 in. dia.; F, ¼ in. dia.; G, 5/32 in. dia.; H, drilled and tapped 5 B.A.; J, 1/8 in. dia.

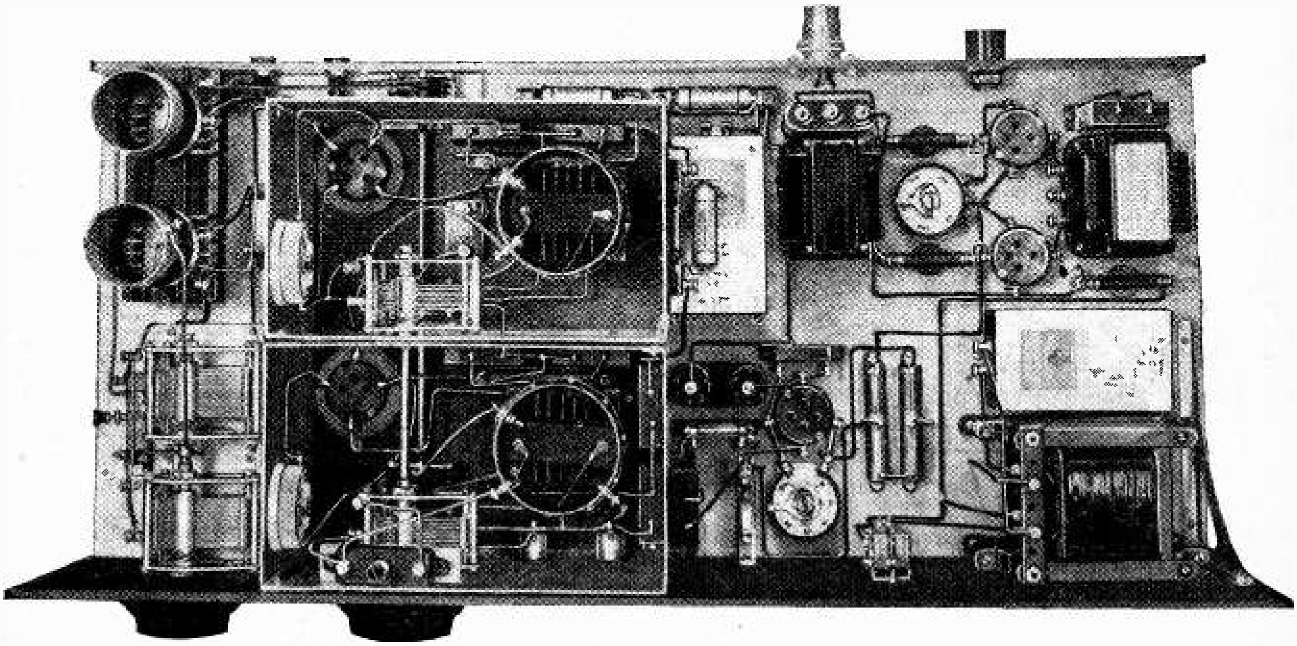
D.C. Band-pass Five.—

low-potential ends of the secondaries are joined to the pins P_{11}, P_{21}, respectively, while the high-potential ends go to the sockets S_{13} and S_{20} and the terminals T_{13} and T_{20}. The low-potential ends of the primaries are joined to the pins P_{10} and P_{15}, and the high-potential ends to the sockets S_9 and S_{16}, and also to the terminals T_9 and T_{16}.

If the greatest selectivity is required, the medium-wave band-pass grid coil is plugged into the socket S'_6 —that is, in the farthest position from the aerial coil—in which case the coupling is 1.85 microhenrys. If your mains are earthed on the positive side, you may have decided only to wire in the choke CH_1 and omit CH_2. If the negative side is earthed you will have CH_2; but, unless your supply is rough, you will have omitted CH_1, and in its place have inserted a fixed 60-ohm resistance. In either case the next thing is to insert two Bulgin fuse lamps, type M, in the green signals, and a type N in the red signal. Ordinary battery valves are used, and for this reason the set is easily adaptable for battery operation. Two Cossor S.G. 220 valves are required for the H.F. stages, and by means of plugs connect their anodes to the sockets provided on the coils. An L410 type valve is required as the detector. The shunt resistances of the S.G. valves should be set at 35-40 ohms, while that across the detector should be 24-27 ohms. The shunt across the output valve V_5 should be set at 300 ohms to pass the anode current of the valve V_4.

The bias values, obtained by employing the set in the standard way, are suitable for the Marconi Osram P.625 or Mullard P.M.256 valves in the output when the mains are 230 volts or above. Below this mains value it is advisable to take the 4½-volt grid battery from the grid of the valve V_5 and insert it in the corresponding position in the grid of V_4, but reversed so that the positive end is nearest the grid. In this way the valves are biased to approximately 19 volts. The corresponding Cossor P.625 output valves can be used in push-pull at this bias.

The set is not really intended for use with valves of the P.625A. type, which require a large grid bias, but they can be used if a resistance of 60 ohms is inserted in series with the choke CH_1. This resistance increases the bias up to 40 volts when the 4½-volt grid battery is used in the grid of the valve V_5 with its negative end nearest the grid. Alternatively, a grid bias battery of 18 volts may be inserted in series with the decoupling resistance R_9—either side of R_9 is satisfactory.



The completed receiver without valves, valve screens and lids to screening boxes. The layout is quite straightforward and the spacing of components generous.

Since it is a simple matter to operate the set on one H.F. stage by connecting the anode of the first S.G. valve to the socket S_{17} of the coil in the second stage, it is suggested that the set be started up in this way. In fact, when the highest possible quality of reception is desired from the local station only one H.F. stage should be used.

In case the inductances of the coils are not quite identical it is advisable to adjust the condensers in the following way. With both H.F. stages operating, and the trimming condensers set to minimum, turn the volume control practically to the bottom and set both dials for the London National Station. Now adjust the trimming condensers if it is found that an improvement can be effected. If the aerial capacity is slightly lower than the average (as with a short aerial) the condenser tuning the aerial coil will require trimming, whereas if the aerial capacity is a little high the condenser tuning the grid coil will require trimming. Next, turn the dials for a station near the top of the dial, e.g., the Midland Regional, and adjust the condenser vanes on the spindles.

Now return to the lower end of the dials and repeat the operation upon more distant stations, such as Cork

D.C. Band-pass Five.—
and Budapest. The tuning over the whole range should then be found satisfactory. Any tendency towards oscillation should be quenched by turning down the volume control. If the adjustment of the vanes on their spindles is found to be more than about two degrees it is best to check the inductances of the coils. The easiest way of doing this is to change over the tuning condensers.

When operating the volume control a peculiar effect will be noticed. For instance, imagine the set is tuned in fully to a powerful station, and the volume control is very low so that only very quiet signals can be received. Now, on increasing the volume control, signal strength will increase at first and then, after reaching a maximum value, it will actually decrease. The decrease is due to overloading of the detector valve, and is peculiar to any set which is designed so that the output stages overload at about the same time as the detector. The method which should be adopted when tuning in to a powerful station is to set the volume control very low and, when attempting to increase it after tuning full in, just check first that the volume is not increased by decreasing the volume control.

If this latter is found to be the case it shows that the detector was overloaded and the volume control had not been turned low enough when tuning in. There is another corollary to this. If the volume control is too high when tuning in, the station will appear to have two strong peaks one or two degrees apart. The middle of this is the correct setting, and the volume control should be turned down, when the volume should increase.

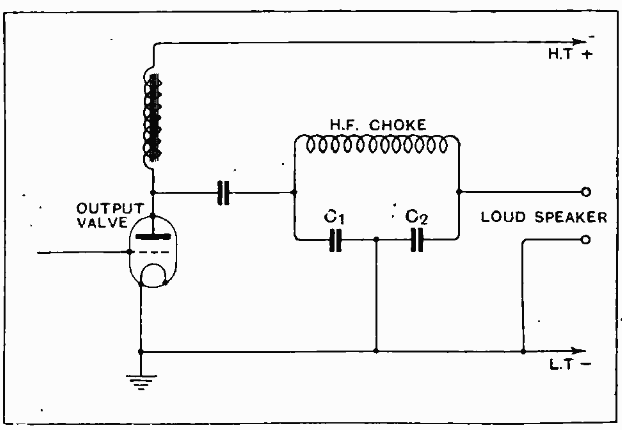
When the gramophone is operated, turn the wavechange switch so that both the green lights are extinguished. The H.F. valve filaments are then shorted so that no filament current flows through them, and also a negative bias of 3 volts is automatically given to the detector valve so that it functions correctly as an amplifier. In the list of parts in last week's issue two valve screens should be included.

KEEPING THE H.F. WITHIN BOUNDS.

The Use of a High-frequency Choke in the Output Circuit.

It is sometimes found that a receiver, especially when tuned to stations on the upper broadcasting band from 1,000 to 2,000 metres, is inclined to depend for its stability on the position of the loud speaker. One may observe, for example, that the receiver tends to oscillate if the loud speaker leads are brought anywhere near the aerial lead-in, or perhaps the tuning or reaction adjustments are upset if the speaker is handled or moved.

The inference to be drawn from misbehaviour of this kind is that high-frequency currents are present in the loud speaker leads, giving rise to an amount of back-coupling that depends on their position. The trouble is more likely to occur on the upper waveband, because the usual precautions adopted for by-passing stray H.F. impulses away from the L.F. amplifier are very much more effective on the short waves than on the long.



By interposing a radio-frequency choke filter arrangement as shown, H.F. impulses can be prevented from passing to the loud speaker.

A cure may generally be effected, without detriment either to the volume or the quality of reproduction, by a combination of a high-frequency choke (which must be wound with a generous amount of wire if it is to be effective on the long waves) with either one or two condensers, making a filter circuit which is interposed between the "live" speaker lead and the set. Often one condenser only (C_1) will be needed; the complete filter, with both condensers, is an almost infallible cure. The greater the capacities of C_1 and C_2 the more effective the filter will be, but if the capacities chosen are too large a loss of the higher audio-frequencies will result. A total capacity of 0.001 mfd. is generally very suitable from both points of view, but this figure may be increased considerably if the speaker impedance is not too high.

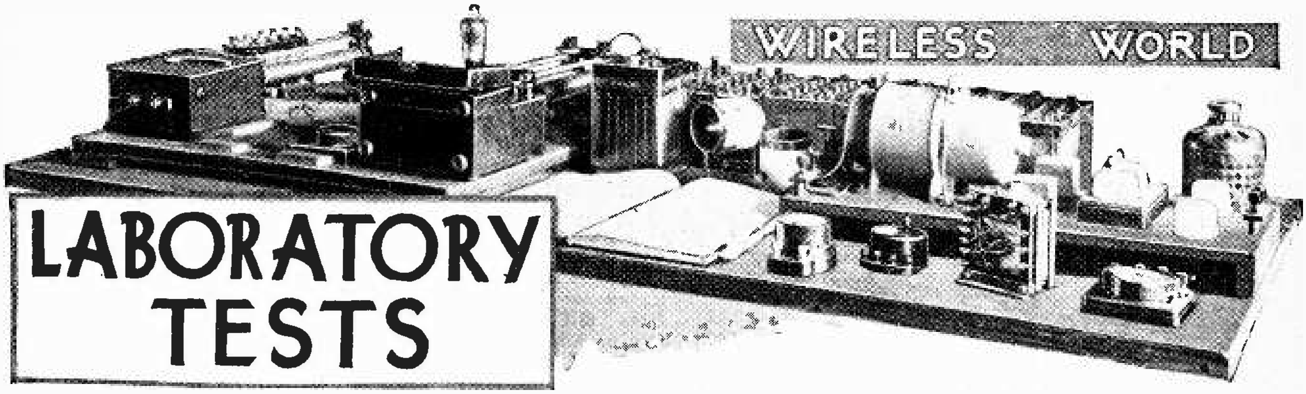
A. L. M. S.

BOOKS RECEIVED.

The Practical Electrician's Pocket Book, 1931. Edited by F. H. Robinson. The 23rd annual edition of this well-known pocket book, containing a mass of useful information, tables, data, etc., relating to all branches of electrical engineering, including a short section devoted to wireless and a tabular list of particulars of electrical supply throughout Great Britain and Ireland, giving the supply voltages in all the principal towns. Pp. 560+lxxii., with numerous diagrams and illustrations. Published by Electrical Trading and Electricity, London, price 2s. 6d. net.

Rundfunk Jahrbuch, 1931. The year-book of the Reichs-Rundfunk Gesellschaft, Berlin, relating the progress and performance of the various broadcasting organisations in Germany, with articles on technical matters, events of the past year, and numerous other features. Pp. 417, with 248 illustrations. Published by Union Deutsche Verlagsgesellschaft, Berlin.

Données Numériques de Radioélectricité, compiled by R. Mesny, and extracted from Vol. VII of Tables Annuelles de Constantes et Données Numériques. Comprising 18 pages of useful formulæ and data taken from standard publications during the years 1925-1926. Published by Gauthier-Villars et Cie, Paris, and by McGraw Hill Book Co., Inc, New York. Price: Paper Fcs. 35, cloth Fcs. 40.



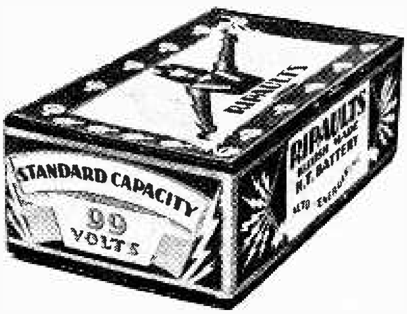
LABORATORY TESTS

A Review of Manufacturers' Recent Products.

RIPAULT'S 99-VOLT H.T. BATTERY.

This is a standard-capacity dry-cell type battery having a nominal voltage of 99, and measuring 9½in.×5¼in.×3¼in. These dimensions will permit the battery to be used in portable sets, since the space allotted is usually of this order. Tappings are provided at 9-volt intervals throughout the battery, and in addition the first 9-volt portion adjacent to the negative end is sub-divided by further tappings of 1½ volts each. Grid bias up to 9 volts can be derived from this section, but, of course, at the expense of reducing the available anode voltage by the amount required for this purpose.

With a view to ascertaining the working life of the battery, it was subjected to a discharge test extending over a prolonged period. Intervals for recuperation were allowed, but in the discharge curve

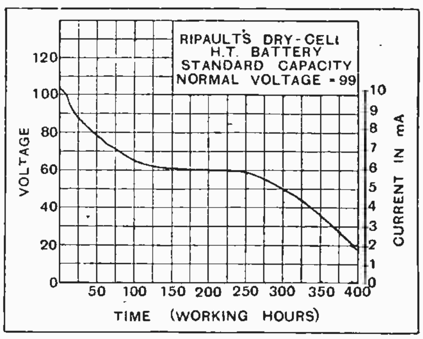


Ripault's British-made 99-volt dry cell H.T. battery of standard capacity.

reproduced here only the actual working hours have been included. The initial current was set at 10 mA., and the terminal voltage at the commencement of the test was 104. This fell rather rapidly during the first 100 hours, but during the following 150 hours there was very little change in the voltage. During this period it was maintained at 60 volts.

At the end of 250 hours' work a sharp decline set in, which was continued without break until the battery was exhausted. This natural cut-off point coincides with a drop in voltage to 0.9 per cell, a value which is generally accepted as being the lowest useful limit of discharge for dry cells.

If we accept this as being the useful life of the battery, it can be shown that a capacity of some 1,750 mA. hours can be obtained with an initial discharge as high as 10 mA.



Discharge curve of Ripault's 99-volt dry-cell H.T. battery.

The well-maintained voltage after the early decline, coupled with the rapid fall after a prolonged life, are two very commendable features.

This battery is a British product, the makers being Ripault's, Ltd., 1, King's Road, St. Pancras, London, N.W.1, and the price is 15s.

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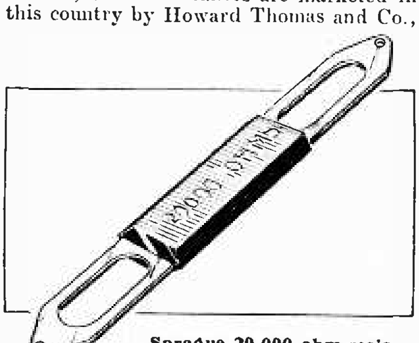
SPRAGUE RESISTANCES.

Made by the Sprague Specialities Co., U.S.A., these resistances are marketed in this country by Howard Thomas and Co., Ltd., Morley House, 320, Regent Street, London, W.1. The resistance element consists of a synthetic material, and moulded into the two ends are long soldering tags.



Sprague 20,000-ohm resistance with long soldering tags.

Sprague resistances are available in values ranging from 5,000 ohms to 5 megohms, and they are rated to dissipate 1 watt. A sample 20,000-ohm size was measured, its resistance being 19,000 ohms. A further measurement was made after a current of 2 mA. had been passing for a considerable time. There was no change in the resistance value.

The price of these resistances is 1s. each.

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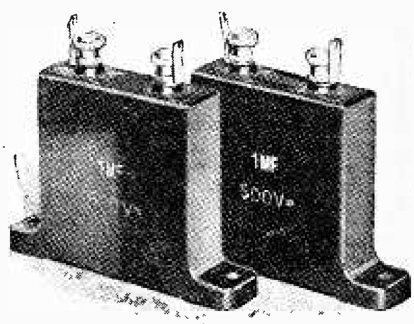
FRANKLIN CONDENSERS.

We have recently received some samples of the new large-capacity fixed condenser marketed by the Franklin Electric Co., Ltd., 187, 189, Ilford Lane, Ilford,



Franklin 500-volt and 1,500-volt D.C. test 1 mfd. condensers. Both are the same size externally.

Essex. These are encased in moulded bakelite containers arranged for upright mounting, and are supplied in sizes ranging from 0.1 mfd. to 4 mfds. Two types are available, the one tested at 500 volts D.C. and the other at 1,500 volts D.C. Prices are according to size and test voltage; for example, a 0.1 mfd. 500-volt test type costs 1s. 6d., its 1,500-volt counterpart costing 2s. 3d. A 4-mfd. 500-volt type is priced at 5s., and the same size tested to 1,500 volts D.C. is listed at 10s.

"POPULAR" STATION INDICATOR.

The purpose of this device is to assist in the reception of distant stations when a frame aerial type receiver is used. The opened indicator is placed on the table

"Popular" station indicator for use with portable and frame aerial type receivers.

and orientated until the compass needle points to the name of the station required. The portable set is then rotated so that the plane of the frame is parallel with the indicator. In this position it is correctly set for reception of that particular station.

Loose cards are provided for use in the principal cities in this country, and instructions are given as to the method of calibrating the indicator for places not so provided for.

The makers are the Dampad Rubber Co., Ltd., 5-7, Market Street, Finsbury, London, E.C.2, and the price is 5s.

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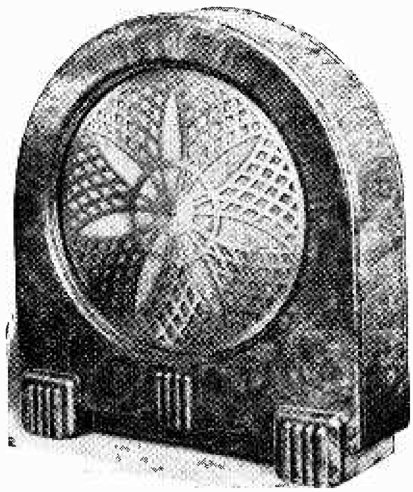
TWO NEW PHILIPS LOUD SPEAKERS.

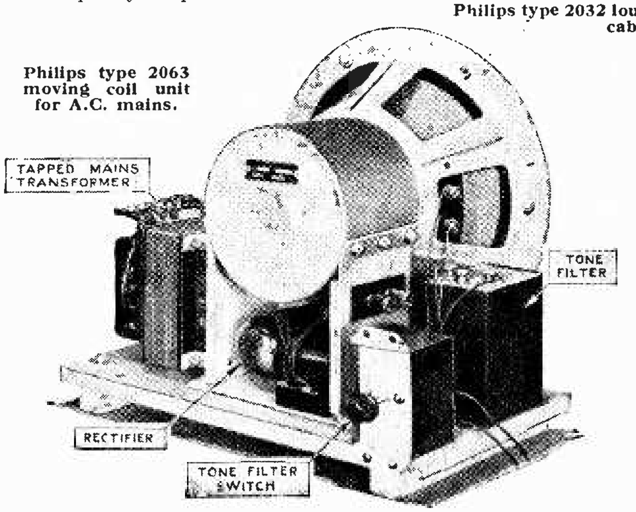
Type 2032.—The non-adjustable moving iron movement and cone unit are enclosed in a moulded "Philite" case, the back of which is well ventilated to reduce box resonances. The average impedance of the winding is 5,000 ohms, but the impedance rises considerably at very high and very low frequencies (14,500 ohms at 50 cycles, 32,900 ohms at 6,400 cycles). The frequency response is from 100 to 3,500 cycles with a major resonance between 150 and 200, and a sharply defined subsidiary resonance at 2,200 cycles. Between 300 and 2,000 cycles, however, the output is uniform. The sensitivity is somewhat below the average, but the non-adjustable movement has been set to handle a considerable power input. The price is £3 10s.

Type 2063.—Designed for operation from A.C. mains, this moving-coil unit is suppled with field current from a type 506K full-wave valve rectifier. The diaphragm is 8in. in diameter, and is driven by a low-impedance moving coil. Full details of the output transformer ratio required for valves of various A.C. resistances are given in the instruction leaflet.

Our tests revealed that the sensitivity is above the average, while the reproduction is characterised by exceptional brilliance in the upper register from 3,000 to 6,000. From 3,000 down to 50 cycles the output, although at a lower level, is uniform, apart from a slight resonance between 100 and 200 cycles. To meet the demand of those who object to the effect of the high frequency response, a filter and switch have been included in the equipment. The effect of this filter is to introduce a well-defined cut-off at 3,500 cycles, but our own preference is for the full high-frequency response up to and above 6,000 cycles. In some circumstances, however, the filter is indispensable in eliminating high-frequency interference and mush.



Philips type 2032 loud speaker in moulded cabinet.



Philips type 2063 moving coil unit for A.C. mains.

Undistorted power inputs up to 5 watts can be satisfactorily handled by the unit. The workmanship throughout is of a high standard and the performance places the type 2063 unit in the highest class of moving coil loud speakers. The price complete with the filter and switch is £12 10s., and supplies are distributed by Messrs. Philips Lamps, Ltd., 145, Charing Cross Road, London, W.C.2.

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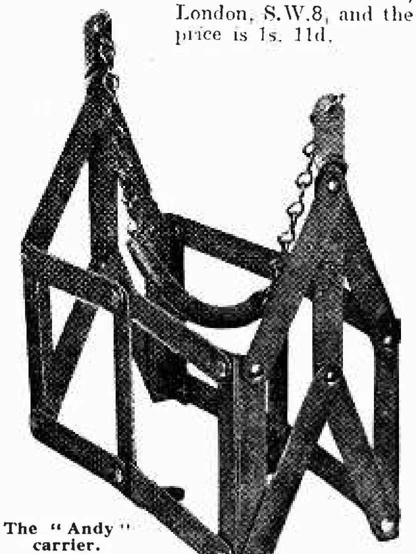
"ANDY" ACCUMULATOR CARRIER.

Made of lead-coated metal, the "Andy" carrier can be adjusted to fit any shaped accumulator up to 6in. square. A rubber-covered carrying handle is fitted. The makers are Beaufoy and Co., 87, South Lambeth Road, London, S.W.8, and the price is 1s. 11d.



The "Andy" carrier.

CATALOGUES RECEIVED.

Igranic Electric Co., Ltd., 149, Queen Victoria Street, London, E.C.4.—Illustrated loose-leaf catalogue of new season's components and accessories. Also a 20-page booklet dealing with the Igranic-Elkon rectifiers and their uses.

oooo

Varley (Oliver Pell Control, Ltd.), 103, Kingsway, London, W.C.—1930 catalogue of receivers, components and accessories.

oooo

Dayzite, Ltd., 17, Lisle Street, Leicester Square, London, W.C.2.—104-page catalogue describing the proprietary receivers, components and accessories handled by this firm.

oooo

Belling and Lee, Ltd., Queensway Works, Ponders End, Middlesex.—Illustrated booklet describing the new range of connectors recently introduced.

oooo

Radio Instruments, Ltd., Purley Way, Croydon, Surrey.—New season's catalogue of receivers, mains units, components and other accessories.

BROADCAST BREVITIES

By Our Special Correspondent.

More Regional Rumours.

Now that the Scottish station is under construction thoughts are turning to Western Regional, and already the public can take its choice from a fine crop of freshly gathered rumours, mostly contradictory. They are inspired, for the most part, by the news (authentic) that B.B.C. engineers have been investigating sources of water supply in Somerset.

oooo

Search for Water.

The question of water supply is always the first to be tackled, and during the past week the broadcasting officials have been prosecuting enquiries in the Bridgwater neighbourhood. This fact has been taken to mean that Bridgwater is the B.B.C.'s choice for the Regional station.

oooo

An Unwanted Neighbour.

That Bridgwater will not be chosen is as certain as the fact that the Marconi beam station already occupies the best site in the district. Incidentally, the B.B.C. is not anxious to have such a neighbour!

oooo

Testing in the "Wee, Sma' Hours."

Not for several years have the broadcasting engineers of different nations cooperated in tests of the kind now being conducted in the early hours of the morning by London Regional and Mühlacker. Most of the experimentation is going on at the German end, and it is noteworthy that the engineers at Mühlacker are taking great pains so to adjust the modulation system that the minimum interference is caused to other stations.

Both in Germany and England the tests are being listened to on special receivers.

oooo

Four Years Ago.

The last international test of importance in Europe occurred four years ago with the inauguration of the then revolutionary Geneva plan, when the whole of Europe's broadcasting stations changed their wavelengths in a single week-end.

The whistling and shrieking on that auspicious Sunday night conjured up an oscillator's paradise, but I doubt whether it was so very much worse than a normal night in 1931.

oooo

The Boxing Broadcast.

Numerous friends who disclaim any interest in boxing have confessed to me that they sat through every round of the Brown-Kirby fight as it was broadcast by the B.B.C. One man who usually retires promptly at 10 p.m., nearly froze at a cold grate waiting for the knock-out that never came.

The relay was an entire success and a triumph for the "O.B." department, which is surely one of the hardest-worked organisations within Savoy Hill.

oooo

A "Deputation" of Two Hundred.

Mr. Gerald Cock, who is "O.C." of the department, can tell queer tales of his experiences when in search of fresh material. Sometimes when he is not the sleuth he is the ambassador. When in Wales a short time ago he was informed that several listeners wished to question him on B.B.C. policy. He proceeded to the agreed rendezvous, expecting to meet a small deputation, and was not a little dismayed to find himself confronted by 200 gesticulating Welshmen.

oooo

A Football Broadcast.

Fortunately the gathering was presided over by a chairman who blended firmness with tact, but it was Mr. Cock's verbal agility and presence of mind that turned a hostile demonstration into a gathering of gentlemen unanimous in their admiration for the B.B.C.

I hear that the latest outside broadcast to be arranged is a running commentary on one of the semi-finals of the Football Association Cup matches on March 14th.

oooo

Is the B.B.C. "Running" the Census?

If the 1931 Census omits any man, woman or child in the United Kingdom, it will not be the fault of the B.B.C., for the Corporation is taking quite a surprising interest in this decennial event. Not content with organising a series of six weekly talks on the subject—the first is by the Registrar-General, Mr. S. P. Vivian on Tuesday next, February 17th—the B.B.C. has prepared an historical leaflet which contains a specimen census form and an invitation to listeners to correspond with Savoy Hill if they foresee any difficulties in rendering the returns. It is hoped that questions can thus be answered by those taking part in the talks.

On April 1st.

Once again the B.B.C. are displaying their wonted fondness for "one over the eight," by deciding to replace the Northern Regional orchestra with a combination of nine players on April 1st. Remembering, however, the gibes thrown at them when they followed the same plan at Birmingham, the B.B.C. are rigorously excluding any mention of the term "Nonet."

oooo

The Ideal Combination?

I learn from the Music Department at Savoy Hill that nine players are considered to provide an ideal studio combination just suited to the needs of the microphone. Usually the instruments comprise two violins, viola, 'cello, bass, and pianoforte, together with woodwind of the flute, clarinet, and oboe types. There is no brass.

oooo

Crumbs of Comfort.

The only word of consolation which can be offered to Northern listeners on the loss of their orchestra is that this nine-piece assemblage will contain the cream of Northern orchestral talent and that it will be augmented from time to time for performances on a larger scale. Performances by the B.B.C.'s main orchestras will be available through the new Northern Regional transmitter.

oooo

Birmingham University Broadcast.

Sir Oliver Lodge's speech proposing "The Memory of the Founder, Sir Josiah Mason," and Sir Austin Chamberlain's speech proposing "The University of Birmingham," will be relayed from the Jubilee Celebration Dinner of the Birmingham Guild of Graduates (London Branch) at the Trocadero Restaurant on February 20th to Midland Regional.

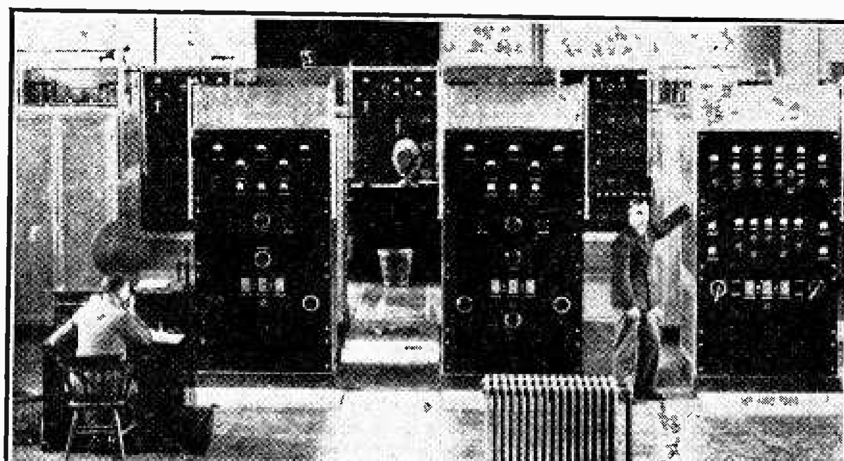
oooo

Hair-greying Course (continued).

From the Savoy Hill Postbag:—

Question: Are you using an outside, inside, or frame aerial?

Answer: Inside—lead-in outside.



PROGRAMME EXCHANGES WITH ANTIPODES? Newly erected short wave transmitters at Hillmorton, Rugby, for the Post Office telephony service to the United States, Australia and South Africa. The possibility of relays to and from Australia by this new link has been discussed at Savoy Hill.

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.

STANDARD TERMINOLOGY.

Sir,—Mr. W. H. O. Tweeny was quite correct in stating, in his article on "Talking Films," in your issue of January 28, that the TU or transmission unit is "unfamiliar to many people in this country," the reason being that it was superseded some time ago by the more appropriate term decibel (abbreviation db.).

Apart from the general desirability of adopting standard terminology, the need is particularly pressing in this case, as TU now represents the traffic unit (the unit of traffic flow), which is defined by the British Engineering Standards Association as "a unit employed in estimating the amount of switching equipment required in automatic exchanges to carry the traffic."

Sydenham, S.E.26. BERNARD C. HOLDING.

EXCEPTIONAL RECEPTION.

Sir,—I wonder if other readers of *The Wireless World* noticed very exceptional conditions this evening (January 27) 8.30-9.30 p.m. in reception on the wavelengths 950-1,400 metres.

My set is S.G. det. L.F. mains-driven, outside aerial, L-type, about 60ft. by 30ft. high. I normally receive Oslo and Motala at good loud speaker strength; Moscow T.U. and Leningrad at weak loud speaker strength. To-night all have been abnormally strong, Moscow and Leningrad being quite as strong as Daventry. There is no possibility of wrong identification, both being announced frequently: Moscow was giving announcements in English and requesting listeners to write to the station with comments and suggestions.

Reception on medium waveband seemed normal; there were very considerable atmospherics on the long wavelengths. Weather: Cloudy, cold, raining and windy. I should be very interested to know whether these were local conditions at Cambridge, or whether these conditions were widespread. Perhaps some of your readers can suggest an explanation.

There was no fading; Leningrad overloaded the push-pull output stage, two Mazda A.C./P. driving a large Blue Spot cone speaker, unless volume control was used, and then could still be heard some 50 yards outside the house.

Cambridge. SCIENTIST.

RADIO DEALERS AND RADIO SOCIETIES.

Sir,—During the last few years the membership of the many radio societies which used to exist throughout the country has fallen to a very great extent, so that in many cases they are supported only by the really hard-boiled enthusiast.

This change is undoubtedly due not to any diminution in the interest in radio, but to the fact that its technical development has now reached a stage where a certain amount of knowledge is necessary if progress is to be made by any amateur, and, in consequence, it tends to become rather beyond the understanding of the man who used to be the backbone of the average radio society.

The time, however, seems to the writer to be ripe for a general resuscitation of radio societies, and, if necessary, the creation of entirely new societies in large numbers throughout the country, and I would suggest that such societies should obtain their membership mainly from the radio retailer and others associated directly with the radio industry, and possibly with the music trade.

If this proposal could be put into force and the membership of individual societies made appreciable (say an average membership of not less than 50) such societies would, I feel sure, be warmly welcomed by manufacturers as enabling them, by means of lectures and demonstrations, to get in direct touch in a very simple manner with those who have a really live interest in the sale of radio apparatus, and (of equal importance) knowledge of that apparatus and its after-sales service.

Whilst a large proportion of the membership might consist of radio traders, the serious radio enthusiast would also be included, and the arrangement would, in the opinion of the writer, be advantageous to all parties concerned.

Perhaps other readers of your journal may wish to express views on this particular subject which the writer considers to be of considerable importance from every point of view.

Manchester. J. BAGGS.

CENTRING OF RECORDS.

Sir,—As an ardent gramophonist since I was seven years of age, and as a contributor to the gramophone Press, I feel that I must drop you a line in reaction to one or two references I have seen in your publication recently regarding gramophone reproduction.

I am quite convinced that the gramophone disc-producing companies have not yet paid sufficiently concentrated attention to what we call the "centring" of a record. Take any dozen records, place them on a standard gramophone turntable one at a time, noting the lateral sway of the tone-arm (or pick-up arm). Perhaps three of them will preserve a steady spiral tracking towards the turntable spindle, and the remainder will show a decided oscillatory motion during its creep inwards.

I have heard many people exclaim that the hole was not in the centre of the disc; but this is erroneous. The trouble lies in the pressing of the recorded matter out of centre with the spindle hole. Only the quickest ear can detect this maddening lack of attention to detail in manufacturing, when a piece of music having a lively tempo is played, but when sustained notes are being rendered, or if the music is of more stately character, the veriest tyro in musical appreciation cannot help but place his hands over his ears and shriek with horror. This is the most important point in the otherwise phenomenally fine pitch of perfection in the recording of to-day. I do not know whether the turntable spindle of the amplifier at the B.B.C. is of less than the standard size or not, but I do know that the awful wailing of some records leads me to suppose that this is the case.

Hampstead, N.W.6. FREDERICK JACKSON.

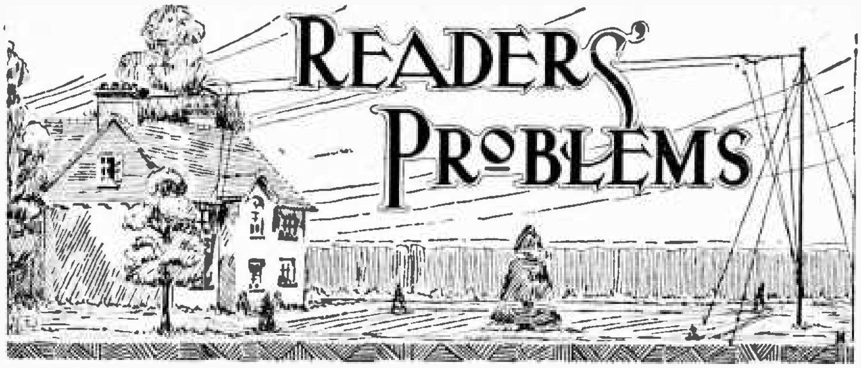
THE STENODE.

Sir,—I disagree with Dr. Robinson's hypothesis that "there can be no discontinuity in the nature of the physical response as we go from a signalling speed of one per second to one of 5,000 per second." Of course, there is no sharp discontinuity; but there is a progressive change in the response throughout the frequency range. An adequate reason for this is the fact that the response of tuned circuits is essentially a phenomenon concerned with E.M.F.s, which have a perfect sinoidal form and are therefore uniform and continuous. An E.M.F. of limited duration can be an approximation only, and as the duration is decreased by increasing the signalling speed the approximation becomes less close. The only method of investigating theoretically the response to a non-uniform E.M.F. is to analyse it into a number of sinoidal components (e.g., carrier wave and sidebands); if the legitimacy of this process is denied, it should follow that the converse process of combining two frequencies to form a heterodyne is also inadmissible.

I think Dr. Robinson would agree that if an aperiodic instrument were used to measure the electro-magnetic field at a point within range of several C.W. transmitters, it would indicate a single resultant field of complex wave-form; this must be interpreted by analysis into components corresponding to the different transmitters, with frequency differences of perhaps 20 kc. each. Can he show any reason why there should be a discontinuity which invalidates this process when the analysis indicates components with a frequency separation between 50 cycles and 5,000 cycles (i.e., a carrier and sidebands)?

In conclusion, I would like to point out that although a decrease in damping may cause an increased absolute response to a certain range of modulation frequencies it will cause a decreased absolute response to any frequencies which suffered much proportional loss in the original circuit.

Berkhamsted. D. A. BELL.



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.

Stroboscopic Speed Indicators.

The periodicity of my A.C. supply is non-standard, and consequently the ordinary stroboscopic device will not function as an indicator of the speed of rotation of a gramophone turntable. Will you please tell me how to calculate the number of "spokes," so that I may make one for myself?

The number of black bars on the disc can be determined by multiplying the frequency of the supply mains by 120, and dividing the product by the required speed (in revolutions per minute) of the turntable.

o o o o

Bias Resistance Calculations.

Although I believe the necessary instructions have been published several times, I am unable to trace a reference to the method of determining the correct value of resistance for use in an automatic grid-bias circuit. Will you please give me the formula?

This information can be obtained by applying Ohm's law in the form of $R = \frac{E}{I}$. In this formula R is the resistance required, E the bias voltage to be developed across the resistance, I the total current (in amperes or fractions of an ampere) to be passed through the resistance under operating conditions.

o o o o

Hum and Loud Speaker Characteristics.

After rebuilding my A.C. receiver and changing over from half-wave to full-wave rectification, I am disappointed to find that A.C. hum, though still not excessive, is distinctly worse than before; this in spite of the fact that the smoothing arrangements are unchanged. Can you suggest an explanation?

By fitting full-wave rectification you have doubled the hum frequency, and no doubt have brought it up to a periodicity to which the loud speaker is capable of responding to a greater extent than formerly. Further, it is likely that the present ripple frequency is magnified to a greater extent by the L.F. amplifier of the receiver. The remedy is to include more effective smoothing.

Series Filaments.

The usual advice, that a receiver in which a fault has developed should be tested by the stage-by-stage method, seems hardly to apply to the "All D.C. Three," in which the valve filaments are connected in series. In consequence, it is impossible to eliminate a valve without putting the whole set out of commission. I am having a certain amount of trouble with this receiver. Do you think it would be worth while to make resistances (of the same value as that of the valve filaments) for temporary insertion in each valve holder?

Although it is true that individual valves cannot be removed, it is quite unnecessary to do as you propose. Provided that the grid and anode circuit inpedances of any valve that is to be eliminated are temporarily short-circuited, it is possible to make stage-by-stage tests in the ordinary way.

o o o o

Increasing Undistorted Output.

Is there any way of increasing the power output obtainable from the Band-pass Superheterodyne without impairing its characteristics, and without introducing any serious modification into the design?

We suggest the use of a P.T.625 pentode output valve, which will provide some 1,500 milliwatts, as opposed to the 500 milliwatt output of the specified valve. It will be best to retain two-volt valves in the remaining positions.

o o o o

The Prophet's Mantle.

I am about to buy a new power transformer, and if you think that the tendency in the future will be to use higher anode voltages I propose to obtain an instrument capable of delivering considerably greater pressures than are actually required at present. I assume that there will be harm in having an excess voltage?

Care must be taken not to apply a higher voltage to your rectifier—of whatever type—than it is intended to handle. With this proviso, it is all to the good to choose a transformer which will enable you to construct an eliminator with a generous voltage output; by doing so it will become possible for you to make the decoupling arrangements of your receiver all the more effective. We cannot hazard an opinion as to the future, but doubt if appreciably higher voltages than at present will ever be used—in domestic receivers, at any rate.

o o o o

Double-wound Aerial-grid Transformer.

In the published description of the "Flexible Two" receiver it was stated that under certain conditions it is advantageous to use separate aerial windings for the input coil. Will you please give me a sketch showing how these windings should be placed in relation to the tuned coils?

It will be found convenient to place the extra aerial windings in the positions shown in Fig. 1. The short-wave winding may be supported on thin strips of insulating material laid over each of the coil former ribs, while the corresponding long-wave coil may best be wound in a narrow groove formed by cutting slots in each rib. No. 38 D.C.C. and No. 40 D.S.C. wire would be suitable for the short- and long-wave windings respectively.

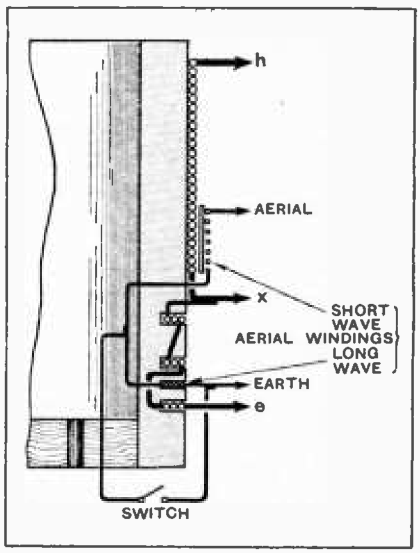


Fig. 1.—Construction of double-wound aerial-grid transformer.

It will be necessary to obtain a change over switch with an extra pole so that the long-wave aerial winding may be short-circuited in the manner shown.

o o o o

Power Transformer Modifications.

The power transformer described in "The Wireless World" for January 22nd, 1930, is suitable for my requirements, except that a voltage of 300 is needed across each H.T. secondary section. Will you please tell me how to modify the winding?

You should add 300 turns to each secondary bobbin, and as the bulk of the winding will naturally be increased by this addition, it will be necessary to use No. 38 enamelled wire.

Ganged Switches.

Instability in my "2-H.F." receiver has been traced to the use of a metal connecting rod between the ganged wave-changing switches: the set is completely stable when this rod is temporarily removed. Will you suggest how this source of interaction may be removed?

The transference of H.F. potentials from one circuit to another can generally be avoided by earthing the connecting rod—at more than one point, if found necessary—through a direct path of low resistance. But it is probably better to use links of insulating material between the various sections of the control rod.

○○○○

Half-wave Rectification.

For local station reception I intend to build the "Regional One" receiver as described in your issue of August 13th, 1930. I already have a power transformer capable of giving a large current output, but with a centre-tapped H.T. winding providing only 150 volts between each end and the tapping: it occurs to me that this component might be used if I adopt half-wave rectification, which should be adequate for a receiver that is obviously largely immune from "hum." Of course, an extra 4-volt transformer will be obtained for feeding the valve heater, as my present transformer does not include a winding for this purpose. Will you please give me your views, and, if possible, a circuit diagram showing the necessary modifications to the "Regional One."

If your transformer is capable of giving a sufficiently large output, there is no reason why it should not work satisfactorily in conjunction with a half-wave rectifying valve; the output from such a rectifier, after a reasonable amount of smoothing, should be quite adequate for feeding an A.C. pentode connected as a combined detector and output valve. A circuit diagram (omitting the H.F. input circuit) is given in Fig. 2.

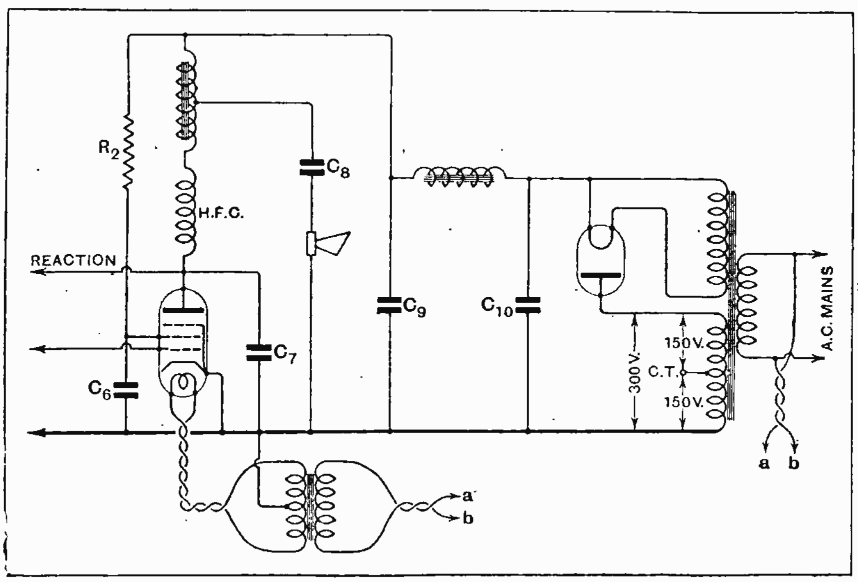


Fig. 2.—Obtaining a higher voltage by the use of a half-wave rectifier in the "Regional One" receiver. The transformer H.T. secondary tapping is ignored.

○○○○

Heat Dissipation.

I am constructing a compact D.C. Receiver, and am finding considerable difficulty in devising a voltage-reducing resistance which will absorb the necessary power without getting unduly hot. A large resistance wound with thick wire takes up too much room, while a small one raises the temperature inside the container to an extent that is greater than can be tolerated. Will you make a suggestion?

This is a fundamental problem, and the dissipation of even 30 or 40 watts calls for adequate ventilation. You might mount your resistance in a sub-base, making good provision for the circulation of air, or, alternately, it might be mounted external to the receiver, with a protective cover of perforated metal.

○○○○

Designing a Reaction Coil.

I wish to add a reaction coil to my H.F. transformer, which was originally intended to precede an anode-bend detector. Medium- and long-wave windings are connected in series, and are supported concentrically on the same ribbed former. How many turns would be necessary for a single reaction coil to be effective on both wavebands?

It is hardly possible to design a reaction coil by other than empirical methods, and, in any case, we have hardly sufficient data on which to make a definite recommendation. It is suggested, however, that you should start with 40 turns of fine wire, and that this winding should be placed considerably closer to the long-wave secondary winding than to the corresponding medium-wave coil.

FOREIGN BROADCAST GUIDE.

VELTHEM-LOUVAIN

(Belgium).

Geographical position: 50° 52′ N.; 4° 43′ E.
Approximate air line from London: 218 miles.

Wavelength: 338.2 m. Frequency: 887 kc.
Power: 12 kW. (eventually 15 kW).

Time: *Greenwich Mean Time.
**Belgium adopts B.S.T.*

Standard Transmissions.

18.00, G.M.T. outside broadcast (Sun.); 20.00, talk; 21.15, gramophone records or concert (Sun., Tues., Thurs., Fri.). Special test transmissions are made on Sundays between 11.0 and Mid-day.

Man and woman announcers. Call: (for the K.V.R.O.), *Hier Velthem, de Katholieke Vlaamsche Radio Omroep*; (for S.A.R.O.V.) *Hier Socialistische Arbeiders Radio Omroep voor Vlanderen*, abbreviated to *Hier Sarov*.

Announcements are made in both Flemish and French.

Opening signal (for SAROV broadcasts): imitation of carillon from Malines Cathedral.

Closes down with *Goede Nacht*, followed by Belgian National Anthem (La Brabançonne).

Push-pull Output.

Will it be necessary to have a separate 4-volt L.T. winding for feeding the heaters of A.C. valves used in a push-pull circuit?

It is not essential that push-pull output valves should be heated from a separate transformer output, but it is generally preferred that this should be done, particularly when automatic bias is provided.

○○○○

Mains Feed for a Superheterodyne.

I have recently tried an eliminator for supplying anode current to my superheterodyne receiver, which, incidentally, is of rather out-of-date design. It is noticed that rather more hum is produced than is pleasant, and that it is particularly noticeable when the receiver is tuned to a carrier wave. What can I do to improve matters?

We recommend that you should add extra smoothing in the oscillator anode feed circuit, and if this does not have the desired result, similar precautions should be taken with regard to the supply to the intermediate-frequency amplifier.

○○○○

NOTE.

"All-wave Reception."

With reference to a published reply under the above heading in *The Wireless World* of January 21st, we are reminded by Messrs. Burne-Jones and Company, Ltd., that they also manufacture a set—the "Universal Three"—for the reception of all broadcasting wavelengths between 15 and 2,000 metres. This receiver was reviewed in our issue for August 14th, 1929.

The Wireless World AND RADIO REVIEW (18th Year of Publication)

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Radio Societies.

IN our issue of last week a contributor to our Correspondence columns, writing on the subject of the amateur radio societies, put forward the suggestion that a revival of interest in societies could be brought about by appealing to the radio retailers and service men throughout the country and adapting the activities of the societies more particularly to their requirements.

Even though, at the time of writing, that letter has only recently been published, we have had sufficient evidence to show that it has provoked a good deal of interest and some criticism. A number of readers have asked that we should give our support to the proposal and encourage other readers to express their views on how best the proposal might be carried out.

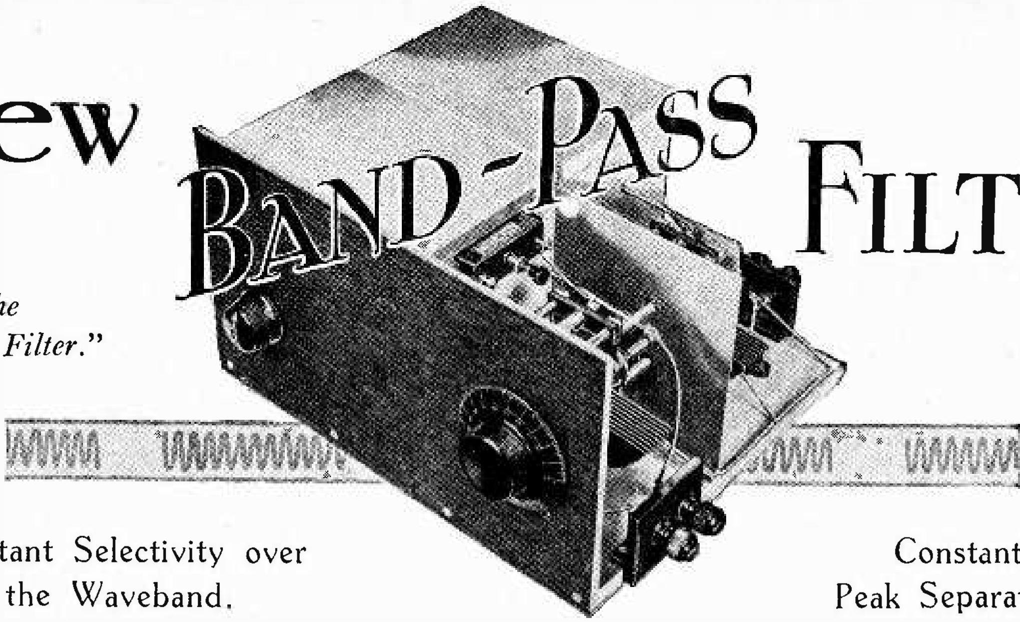
Our correspondent remarked in his letter last week that the membership of the many formerly active radio societies which throughout the country had fallen to a very great extent. This statement is undoubtedly true, but there are outstanding exceptions; some of the radio societies are to-day carried on with greater enthusiasm than at any time in their history, but everything appears to depend upon whether a society has a definite policy to pursue and an aim over which the members can enthuse. We therefore think that to encourage all those who are engaged in the wireless industry in any capacity where technical knowledge is required to join local radio societies would be an excellent move, and it would be very gratifying to the manufacturers to feel that, when they had a new set to demonstrate, they could take it down to a local society and talk about it to an audience largely composed of those who would subsequently be called upon to sell and to service it.

One of the difficulties which radio societies have to contend with to-day is obtaining lecturers for their meetings. As it is, the manufacturers do supply lecturers in fair numbers, but they would be much more ready to do so and to go to pains in the preparation of the subject matter and the choice of representatives if they felt that they were by that means getting into direct touch with those individuals whose interest in their products might subsequently be of the utmost importance to themselves.

There are many points to be considered in connection with this proposal, and for the time being it is sufficient to invite our readers, and particularly those who are actively concerned in the management of radio societies at present, to contribute their views on the suggestion. If a success is to be made of conducting radio societies on the new lines suggested, then it is undoubtedly from those who have already had wide experience in connection with societies that we must look for suggestions. We have no doubt that it will be said that already many of those engaged in the wireless industry are members of local societies, but we believe that they are mostly members by reason of their amateur status rather than as members of the wireless industry.

In This Issue

New Band-Pass Filter



The "Mixed Filter."

Constant Selectivity over the Waveband.

Constant Peak Separation.

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

THE reprisal method of combating interference between European broadcasting stations gains new adherents every month. Power is answered by still more power, resulting in the creation of a vicious circle, and the European ether may soon begin to resemble an arena for rival town criers. Meanwhile the humble listener finds, to his dismay, that with simple tuning devices certain stations cannot be separated, and he is somewhat bewildered in attempting to choose a method of obtaining better selectivity.

Of the various schemes available none seems to have so many advantages as the coupled circuit, band-pass filter, or pre-selector—call it what you may. Not only does it confer the benefit of far better selectivity, but the whole range of audible frequencies in the transmission can be retained, due to the flat top of the response curve. While the capacity and inductive band-pass filters developed in this country by *The Wireless World* represent an important advance in receiver technique, in certain circuits their excellent characteristics can be made to hold only over a limited waveband. In Fig. 1 response curves for inductive (dotted line) and capacity (full line) filters have been plotted for three important wavelengths—those of the London National, London Regional, and Midland Regional stations. The coupling components L_m and C_m of fixed value have been chosen to give the best peak separation at the middle of the wave-range.

It will be seen that with the inductive filter the selectivity is distinctly poor at the wavelength of the London National station, although the curve is sufficiently flat-topped to retain sidebands. The capacity filter at this wavelength, on the other hand, shows only a single peak which is less flat, but the selectivity is good. On London Regional's transmission the two filters give an almost similar response, whilst on the Midland Regional the peak separation of the capacity filter is sufficiently great to give double tuning. The inductive filter on the upper wavelengths tends to become more selective, and the peaks to get closer together.

WHETHER the coupling in a band-pass filter is effected by fixed capacity or inductance, change of selectivity and peak separation is likely to occur as one tunes across the wavelength range of the set. A new method of filter coupling is described in this article, resulting in the achievement of constant peak separation and constant selectivity over the tuning range. Constructional details of a practical filter are given, and should provide the reader with the necessary details for introducing the arrangement into his set as a pre-selector.

For the sake of comparison, the response of the well-known single tuned circuit is given by the dotted curve in Fig. 2. Here there is an inordinate lack of selectivity with the London National station, but as the ratio of tuning capacity to inductance increases as we go up the wavelength scale, the selectivity improves and the single peak becomes sharper.

Next to the response curve of the single circuit is that of the mixed capacity-inductance band-pass filter (full-line), which it is the purpose of this article to describe. Before giving full details of this new tuning unit it would be as well to discuss one other characteristic of the four tuners, namely—sensitivity or signal volts developed, as measured by the height of each curve against the vertical scale. So much attention has been paid to the selectivity-cum-quality problem that the question of selectivity-cum-quantity has been rather neglected, the word "quantity" referring to signal strength. None of the three filters gives as great a signal strength as the single circuit, although the mixed

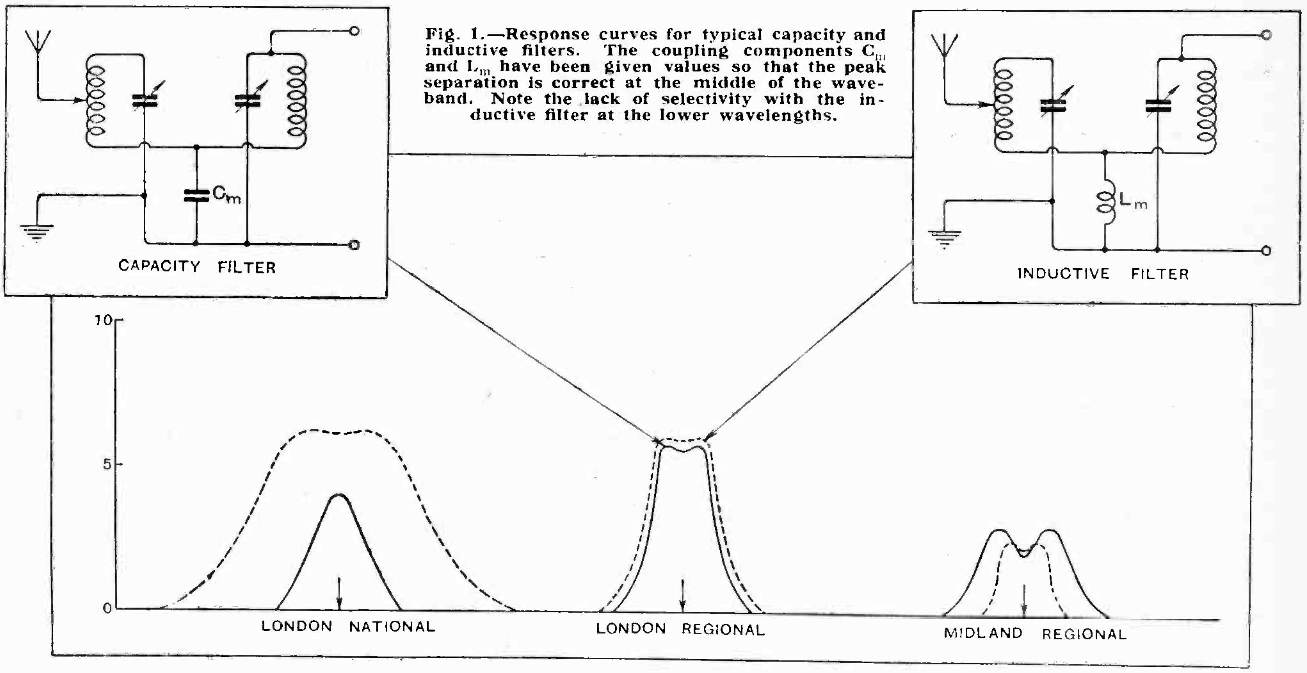


Fig. 1.—Response curves for typical capacity and inductive filters. The coupling components C_m and L_m have been given values so that the peak separation is correct at the middle of the waveband. Note the lack of selectivity with the inductive filter at the lower wavelengths.

filter falls only a very little short. The capacity filter on the London National wavelength gives poor signal strength, as does also the inductive filter at the top end of the tuning scale. At the middle of the scale the two filters of Fig. 1 share equal efficiency, but their curves do not rise vertically to the same height as those either of the single circuit or the mixed filter.

Summarising, it can be said that a fixed capacity-coupled filter can give a definite peak separation only at one wavelength; below this figure the coupling becomes deficient or too loose, and signal strength drops; above the given wavelength double-humped tuning may be too pronounced. Both these conditions cause uneven selectivity and inconstant peak separation over the waveband. As already explained, the inductive filter suffers from poor selectivity at the lower wavelengths, and although peak separation tends to decrease at the upper end of the range, the variation is not very great, and the filter certainly does not offend in this respect as much as the capacity type. It will be shown that the mixed filter not only gives constant selectivity and constant peak separation from about 240 to 600

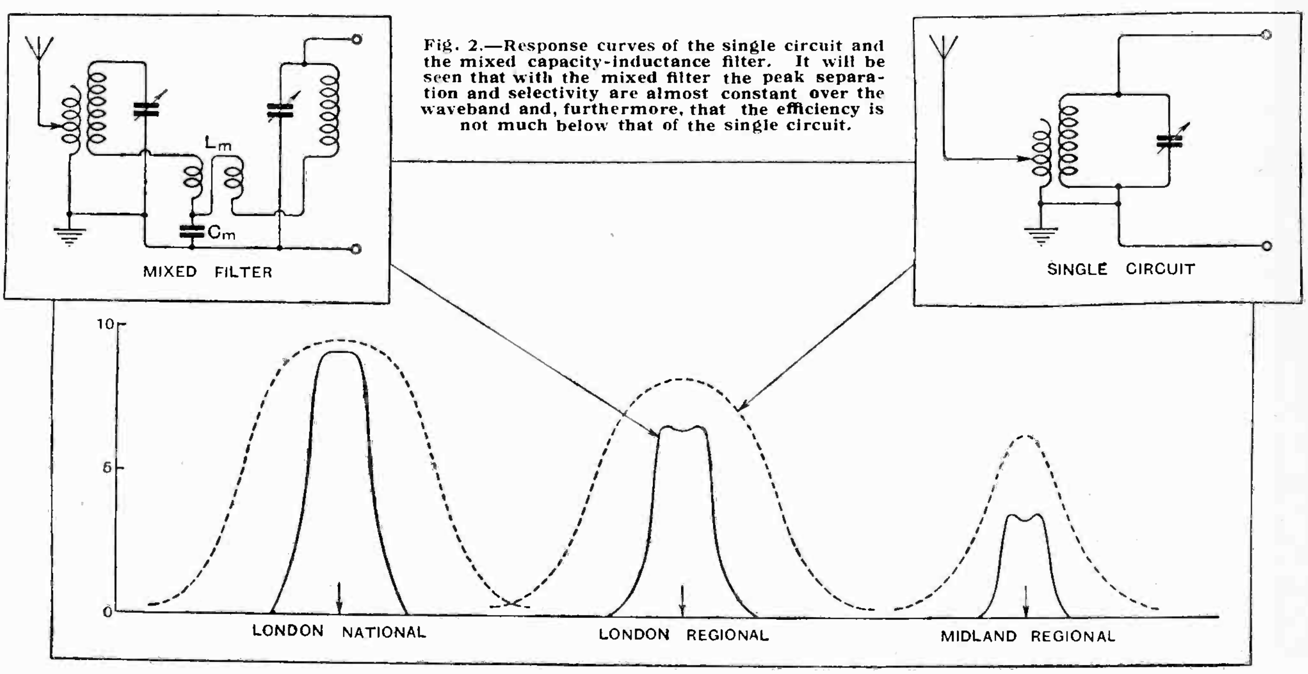


Fig. 2.—Response curves of the single circuit and the mixed capacity-inductance filter. It will be seen that with the mixed filter the peak separation and selectivity are almost constant over the waveband and, furthermore, that the efficiency is not much below that of the single circuit.

New Band-pass Filter.—

metres, but that the signal strength obtained is greater than that from either of the simple filters. The twelve response curves in Figs. 1 and 2 have been made assuming the same aerial coupling and valve-damping conditions in each case.

In tackling the question of constant peak separation in a filter, various coupling arrangements suggest themselves. Five different methods are given in Fig. 3, where the coupling component is shown in a dotted enclosure in each case. The first (*a*) includes a variable coupling condenser, the rotor of which is controlled by the spindle of the ganged tuning condensers. A special condenser with a maximum value of about 0.02 mfd. is required, and, unfortunately, the price becomes prohibitive. An inductive coupling with a baby variometer actuated by the ganged tuning control is shown at (*b*). For the total movement of the tuning-condenser control the inductance of the variometer would need to change through only about one microhenry. While not being impossible to make, such a small component would need almost the skill of a watchmaker.

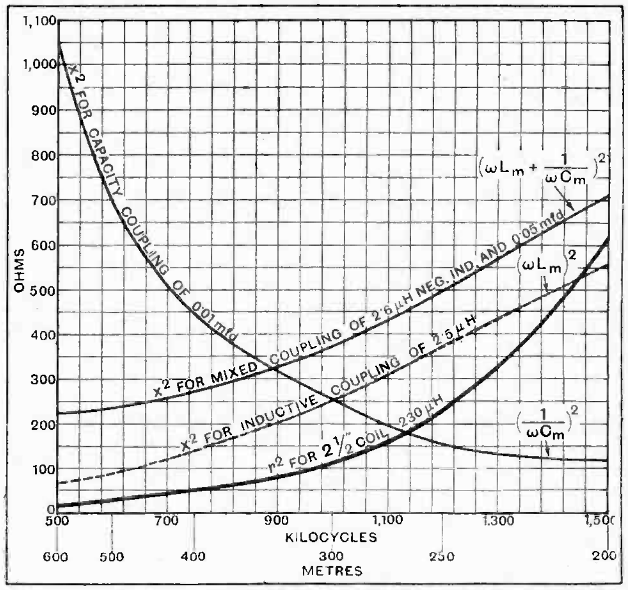


Fig. 4.—By plotting a curve of the high-frequency resistance of a tuned circuit and comparing it with curves for the impedance of various couplings, it is possible to choose the best form of coupling to give constant peak separation.

The Importance of Negative Inductance Coupling.

Greater promise would seem to come from a coupler not requiring variable control. Fixed-capacity coupling suffers from reduction of peak separation in the opposite direction to that of fixed-inductive coupling; why not, therefore, mix these two forms of coupling, as in Fig. 3 (*c*), and smooth out their individual deficiencies to form the ideal constant filter? It is found that there are no values of inductance and capacity in series which give as constant peak separation as that due to capacity or inductive coupling taken alone, and we know, from Fig. 1, that neither of them is entirely satisfactory. Perhaps capacity and inductance in parallel, as in Fig. 3 (*d*), will help. Here again, even at resonance of the coupler or either side of resonance, the peak separation over the waveband is less constant than with either component part—whatever values be chosen.

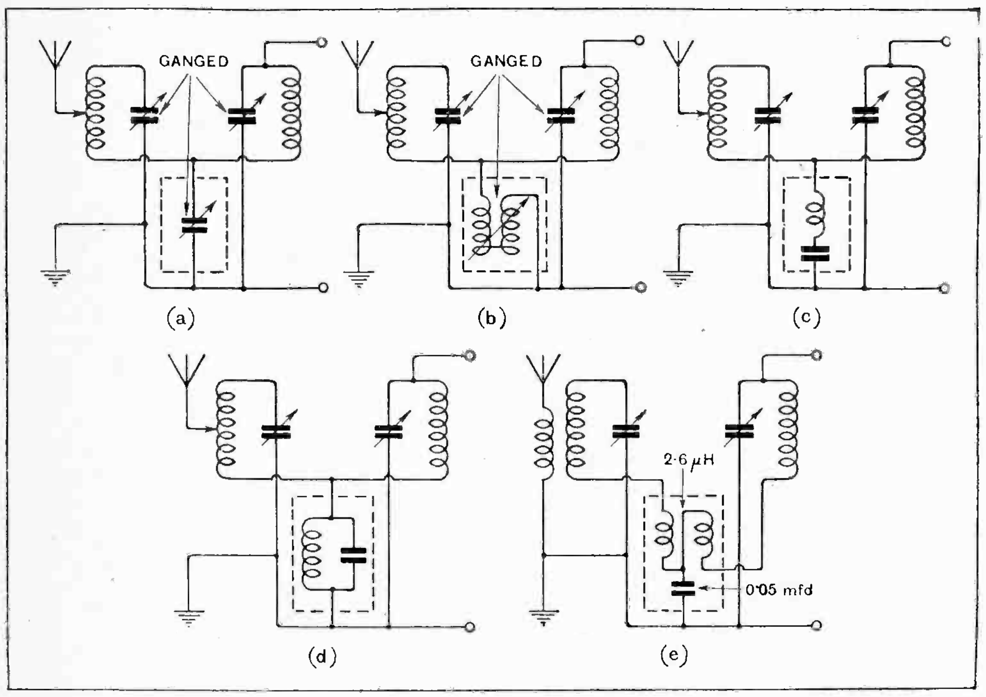


Fig. 3.—Five suggested methods of obtaining constant peak separation. The first two, (a) and (b), have variable couplers but are difficult to construct. In (c) and (d) the desired results cannot be obtained, while the filter shown at (e) gives nearly ideal characteristics.

It will now be as well to study the formula for peak separation, which is

$$\frac{\sqrt{x^2 - r^2}}{2\pi L}$$

cycles, where x is the impedance of the coupling device, r the high-frequency resistance of one of the tuned circuits (the tuning coils and condensers are assumed to be matched), and L the inductance in henrys of one coil. It is quite evident that change in wavelength (i.e., frequency) does not affect $2\pi L$, and we are left to consider $x^2 - r^2$. How can we make the difference between these two remain the same between 200 and 600 metres? Let us plot the square of the high-frequency resistance against frequency of a typical

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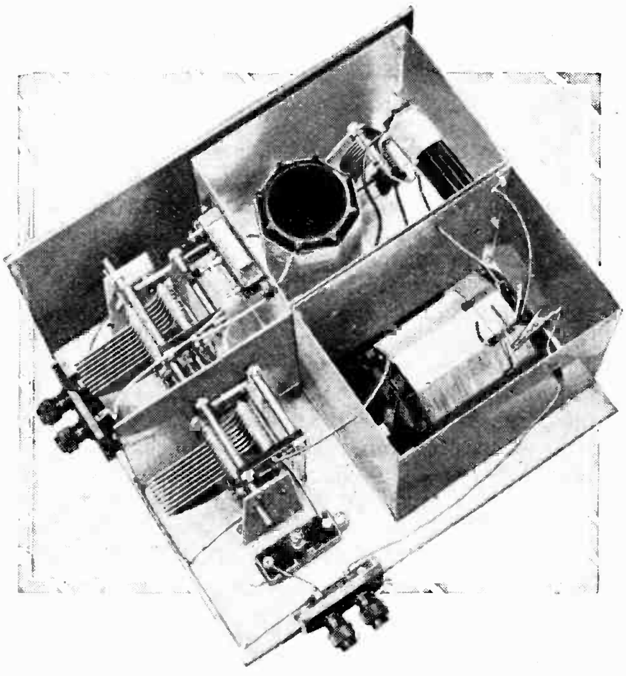
tuned circuit with a $2\frac{1}{2}$in. coil. This is quite easy, as we have only to square the figures already given by A. L. M. Sowerby[1] in an article on small coils. The curve obtained is shown as a heavy line in Fig. 4. There is nothing we can do to alter its shape except by the use of Litz, and then the change is only slight. If we can obtain another curve parallel to it representing the square of the impedance with frequency (x^2) of some coupling device, we shall have achieved our object, for when the vertical distance between the two curves representing x^2 and r^2 respectively is constant across the waveband, obviously $x^2 - r^2$, and hence the formula for peak separation will give the same value over the waverange concerned. The first coupling device to be taken is a fixed condenser of 0.01 mfd.—the value commonly employed in capacity filters. The impedance of this capacity with frequency can be found very rapidly by reference to *The Wireless World* Radio Data Charts, and x^2 is got by squaring the figures obtained. The curve is seen to be anything but parallel to the r^2 curve, thus explaining the misbehaviour of the capacity filter. Where x^2 is less than r^2 there is no peak separation at all, and at the other end of the x^2 curve it can be seen that the difference between x^2 and r^2 is too great to give normal separation of peaks.



Plan view of the unit. The lids of the screening boxes have been removed.

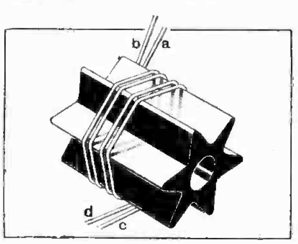


Fig. 5.—Winding the negative mutual inductance for the mixed coupler. In all 26 turns of No. 22 D.C.C. are wound on a 1-inch ribbed former.

The next coupling to be examined is the fixed inductive type having a typical value of 2.5 microhenrys. When the impedance of this is squared (x^2) and plotted, it will be seen that the curve (dotted line), although not parallel to r^2, is much nearer our ideal than the capacity curve, but still is not good enough. A clue to the solution of the problem is given by Fig. 3 (*c*) where the impedance of the series coupling circuit is got by subtracting the impedance of the condenser from that of the inductance. As these two vary oppositely, their difference causes the combined impedance to change very considerably with frequency, and we are farther from our objective than ever; but if we were to find a coupling circuit represented by the simple adding together of inductive and capacitative impedance in a series circuit we should obtain a curve likely to be of the right shape.

For further details of the mathematics of this type of mixed coupling where the coupling impedances are additive, the reader is referred to an article by E. A. Uehling, in the September, 1930, number of *Electronics*. Suffice it to say that the coupling impedance x becomes:—

$$-\left(\omega L_m + \frac{1}{\omega C_m}\right)$$

implying the use of negative inductance, which can be looked upon as a capacity following an inductive law; x^2, therefore, becomes

$$\left(\omega L_m + \frac{1}{\omega C_m}\right)^2.$$

The square of the impedance with frequency for a mixed coupling of 2.6 microhenrys negative inductance and 0.05 mfd. common capacity is given as a curve in Fig. 4, and is seen to be practically parallel to the r^2 curve from 240 to 600 metres. This solves our problem.

A filter made up to the circuit of Fig. 3 (*e*) gives the desirable constant peak separation and constant selectivity referred to earlier. The winding of a coupling coil to give a small negative mutual induct-

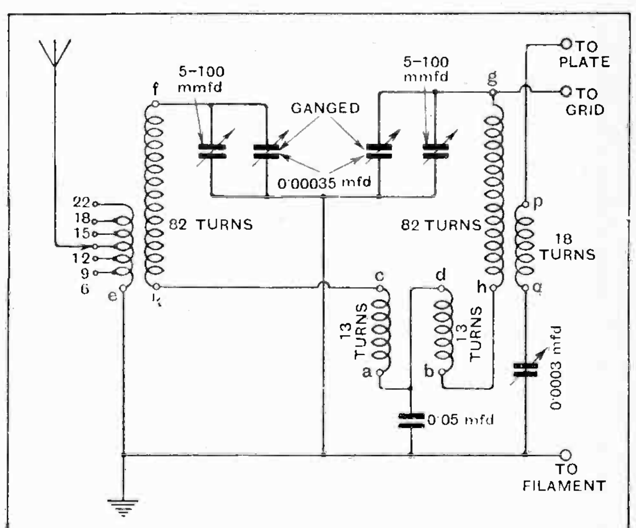


Fig. 6.—Circuit diagram of the filter unit with mixed coupling. The reaction winding is placed 5/16in. from the low-potential end of the secondary tuning coil. Note that the earthed screening boxes have been omitted in this diagram.

[1] See article entitled "Size *versus* Efficiency of Small Coils." Fig. 2. January 29th, 1930.

LIST OF PARTS.

- 2 Screening boxes, 6½ins. × 4½ins. × 6ins. (Magnum).
- 1 Variable condenser, 0.00035 mfd. twin-gang (Cyldon).
- 1 Variable condenser, 0.0003 mfd. (Utility "Mite").
- 2 Semi-variable condensers, 0.0001-0.000005 mfd. (Formo Type F).
- 2 Terminal mounts.
- 1 Ebonite former, 2⅝ins. dia. × 3¾ins. long, eight-ribbed (Redfern).
- 1 Ebonite former, 2⅝ins. dia. × 4½ins. long, eight-ribbed (Redfern).
- 1 Ebonite choke former, 1in. dia. × 3ins. long, six-ribbed (Becol No. 7).
- 4 Terminals.
- 1 Fixed condenser, 0.05 mfd., mica (Dubilier B.775).
- 1 Bakelised board, 12ins. × 7ins. × $\frac{3}{16}$in.
- 1 Baseboard, 12ins. × 10ins.
- Sleeving, wire, spacers and screws.

ance requires description. Use is made of a one-inch (overall) ribbed ebonite former around which is arranged a two-start winding. Two separate wires are laid on parallel to each other, as shown in Fig. 5. The end *c* is connected to the low-potential end of the primary tuning coil (see Fig. 6) and *b* to the end of the secondary coil; *d* and *a* are joined together and taken to the common coupling condenser. To obtain 2.6 microhenrys for the medium broadcast band when using 2½in. tuning coils, 13 turns are required for each winding on the one-inch former—that is, 26 turns in all. The wire used is No. 22 D.C.C., and the turns are wound touching.

Shorn of all theoretical considerations, the mixed coupler consists of a condenser of rather larger value than is usually employed in a capacity filter, together with a few turns of wire on a one-inch former costing but a few pence. No mathematical knowledge is required to construct a filter of this type to give 10 kc. peak separation on the medium band with tuning coils other than those of 2½in. discussed in this article. If, for instance, 2in. coils of 200 microhenrys inductance were used, the number of turns on the one-inch former would be about 11 plus 11. It is quite easy to start with 14+14 turns, and remove them gradually until a milliammeter in the anode circuit of the detector valve shows that the desired response has been obtained. There will be no need to deviate from the value of 0.05 mfd. coupling capacity—all fine adjustment being carried out in the negative inductance windings.

Little work has yet been done on the long waves, but for those wishing to experiment with 2,000-microhenry

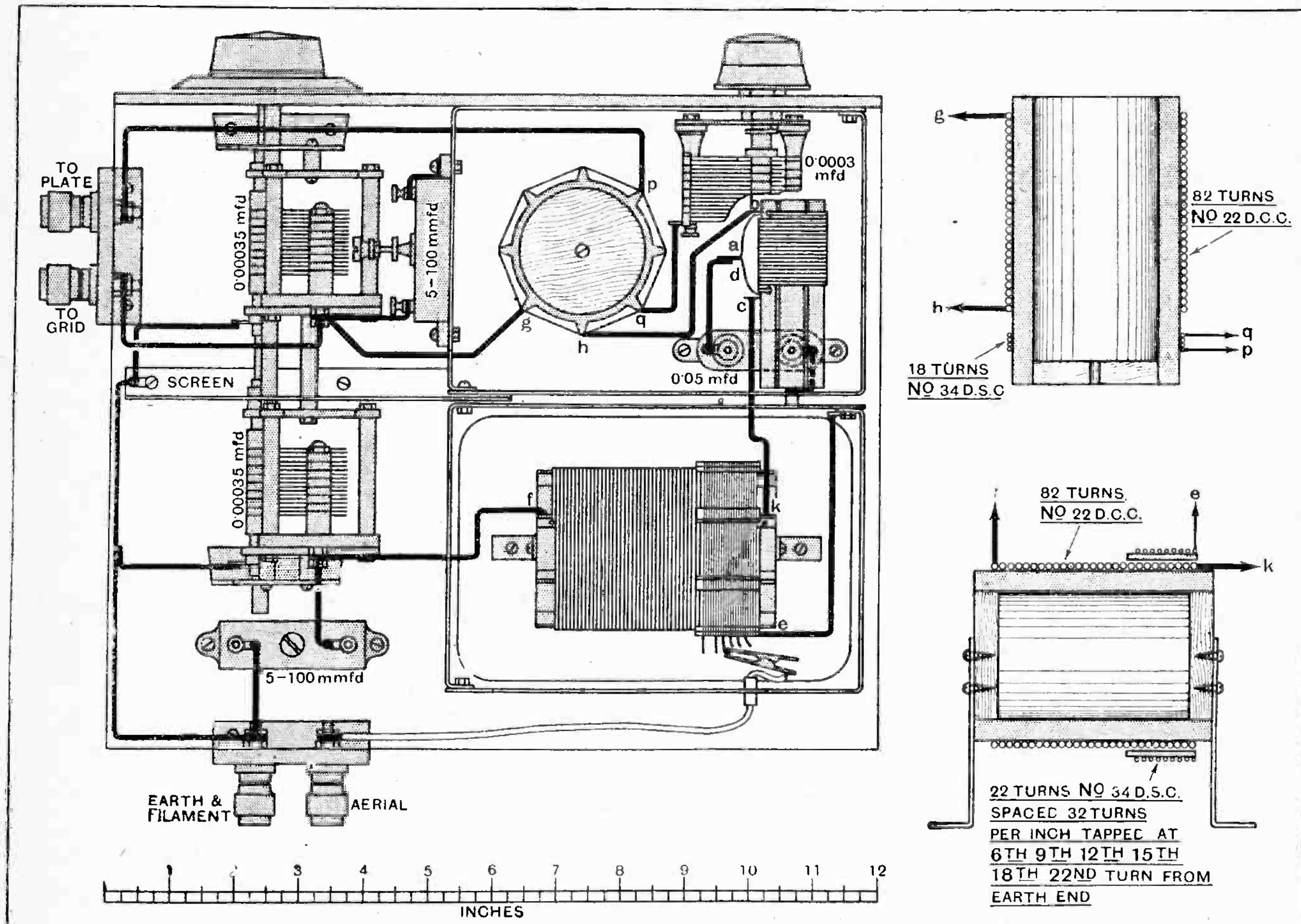


Fig. 7.—General layout and wiring plan of the unit. The separate aerial winding is wound on 3/32in. spacers—matches will do.

New Band-pass Filter.—

tuning coils, the following coupling values are suggested: 60+60 turns No. 36 D.S.C. on a one-inch ribbed former for the negative mutual inductance, and 0.02 mfd. for the common capacity.

Constructional Details.

Details for the construction of a mixed filter are given in Figs. 6 and 7 and in the photographs. The unit provides a highly satisfactory input circuit to a detector L.F. set, and can also form the basis of design for a pre-selector for H.F. sets, as the suitably shaped response curves should assist in preventing cross-modulation with the screen-grid valve. There is a separate input winding, as it has not been found advisable to couple the aerial through the negative inductance. Total screening of both tuning coils is essential, for even one microhenry direct coupling between them upsets the selectivity. The inductance of each coil *when screened* is about 230 microhenrys, which, in association with a 0.00035 mfd. tuning condenser, covers roughly the 200-550 metre band. Ganging is found to be simplified by the use of a 5 to 100 micro-microfarad trimming condenser across each circuit. Two response curves of the unit using an oscillator and measuring the volts developed by a valve voltmeter are given in Fig. 8; similar curves are obtained for any wavelength between 240 and 600 metres.

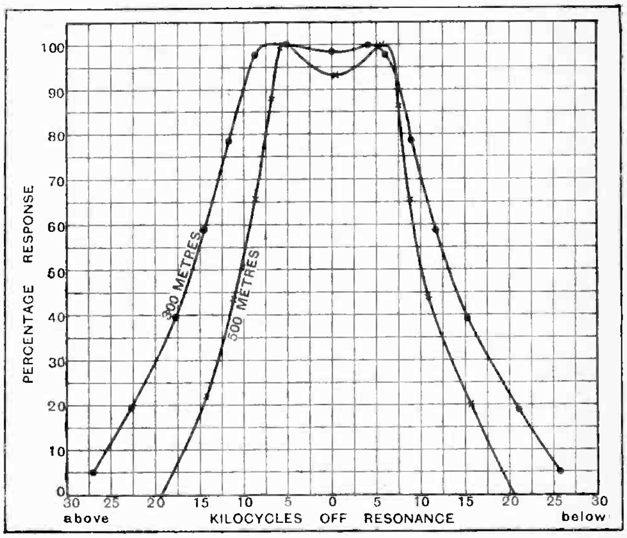


Fig. 8.—Using an oscillator, these two response curves of the unit were plotted. The readings were taken with a valve voltmeter. Similar curves to this are given at any wavelength between 240 and 600 metres. For comparison the curves are plotted to the same height.

Having completed the filter, tap the aerial to, say, the 12th turn and set the tuning condenser rotors carefully in line, having turned both trimmers to zero. Tune in a station of low wavelength and increase reaction to lower detector damping; alternately increase each trimming capacity until the signal is at a maximum. The ganging is correct when reducing or increasing either trimmer reduces signal strength.

CONVERTING A BATTERY SET FOR A.C. MAINS OPERATION.

It not infrequently happens that a set is primarily designed for use with battery valves, and that later on opportunity arrives for the use of A.C. mains, and it is consequently desired to convert the receiver to an all-mains instrument at a minimum of expense and trouble. The first thing which must be done is to rewire the filament circuits. The new filament wiring must be carried out in such a manner that there is no external field, for it must be remembered that the wires will be carrying A.C., and serious interference would result if this precaution were not observed. This end may be most conveniently achieved by merely twisting the filament wires together in the manner of ordinary electric lighting "flex," and if desired electric lighting "flex" may itself be employed. Alternatively, the pair of wires going to each valve-holder can be laid side by side in close proximity to each other, and yet a third method is to use lead-covered wire, not forgetting to earth the lead sheathing.

This having been done, it will possibly be found that there is a tendency to oscillate due to insufficient screening, for it must not be forgotten that owing to their greater efficiency the amount of screening which is sufficient to prevent oscillation with battery valves may not be nearly enough when "mains valves" are employed. If H.F. transformers are employed in the receiver it may be necessary in order to achieve complete stability to remove one or two turns from the primary, even though theory would dictate an addition owing to the higher A.C. resistance of the valve.

If the tuned anode system is employed it may be necessary in the case of certain sets to consider the advisability of changing over to H.F. transformer coupling, not so much in the interests of stability as of complete absence from mains hum, for it must not be forgotten that the properly designed H.F. transformer will not pass on the low-frequency impulses corresponding to mains hum owing to the low capacity between primary and secondary, whereas the grid condenser, which is a feature of the other system, will obviously do so. This must not, however, be taken to mean that the tuned-anode system is not advised in an "all-mains" receiver, for in a properly designed receiver it may give no more trouble than an H.F. transformer. The point which it is desired to emphasise is that they may be troublesome in a converted set which was not, of course, primarily designed for mains operation.

Dispensing with Intermediate L.F. Stage.

It may be possible to dispense with one stage of low-frequency amplification and to couple the detector direct to the output valve or valves.

Finally, the question of grid bias has to be considered and the necessary provision made for obtaining this from the mains. This may be done either by the so-called "automatic" method or by the use of a separate grid bias eliminator. Whichever arrangement is employed, however, it is always advisable to get the H.T. and L.T. portions of the main equipment going first, a battery being used temporarily for grid bias supply.

UNBIASED

BY FREE GRID

A Note of Hope.

I have been doing a great deal of set testing lately—commercial sets, I mean—and as a result of my labours I have been able to form some very definite opinions concerning them. The sets which I have tested have included most of the leading makes of both battery and mains sets. The sensitivity I have found is, in nearly all cases,

Filing my ebonite rather than my petition.

of a very high order. Two or three years ago there were comparatively few sets available which had any pronounced range-getting properties unless the reaction coil was skilfully used. Manufacturers have completely overcome this difficulty, and the great problem which they must now face is getting rid of unwanted stations. Almost without exception, all the sets which I have tested have had very poor selectivity, although quality is on the whole good. At any rate, their sharpness of tuning does not warrant keeping a first-aid outfit handy when manipulating these receivers. Hitherto it has, of course, been extremely difficult to make a set selective without marring quality, but with the coming of band-pass tuning and other methods of obtaining high selectivity without sacrificing quality this should be a thing of the past, and we may look forward this year to receivers which are first class in every respect. I hope, however, the prices will be a little more attractive. At present I find that the cost of complete sets makes it more profitable for me to continue filing my ebonite than to run the risk of filing my petition.

The Obsolescent Aerial.

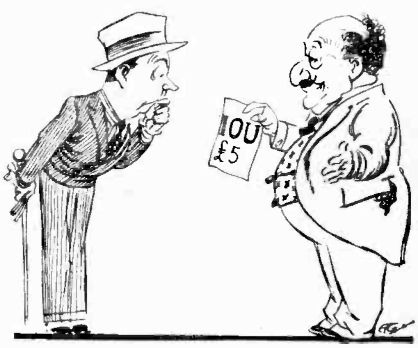
As time passes and receivers become more and more sensitive, outdoor aerials will no doubt entirely vanish, with considerable advantage to the appearance of the landscape; and, indeed, in many of this year's receivers a frame aerial is incorporated or provision is made for using the mains as an aerial. The chief disadvantage of the frame lies in the fact that it is necessary to rotate it at intervals, in order to obtain maximum signal strength, and, in addition, it is rather clumsy in appearance. In certain transportable receivers the question of appearance is got over by incorporating it in the cabinet of the set, together with the loud speaker; but even though the set is sufficiently sensitive to receive a large number of stations without the necessity of pointing the frame directionally, it often happens that, owing to the general cussedness of things, the distant station which one particularly desires to receive necessitates the turning of the set —and, therefore, the front of the loud speaker—away from the fireside.

Yet Another Knob?

In the case of some of the larger console - type receivers the frame is incorporated and provision is made for rotating it by a small knob. This is a perfectly satisfactory solution so far as I am concerned, but for the completely non-technical man it does mean, of course, that there is still one more knob to twiddle. Some manufacturers have attempted to solve the difficulty by making provision for using the mains as an aerial. It is my experience that while this method works quite well on the normal broadcasting band it gives relatively poor sensitivity on the long-wave band. I suppose the problem will be eventually solved by making the set so sensitive that an inch or two of aerial wire concealed in the lid will be all that is necessary.

"The Wireless."

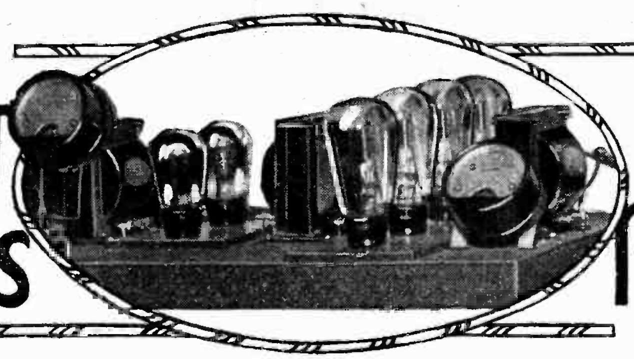
Certain combinations of letters, such as M.C. for moving coil, B.P. for band-pass, and *W.W.* for *Wireless World*, have literally passed into the language, and the same thing is true of certain words, such as triode and pentode. Unless something is done towards the evolution of a proper system of nomenclature by a responsible body, such as the R.M.A., or a special committee of etymologists, utter chaos will eventually arise. As has already been pointed out by a correspondent in *The Wireless World*, the word radiogram, which has for many years been a recognised abbreviation of the post-office word radiotelegram, is already being applied to radio-gramophones. This will eventually lead to confusion, and should be checked at once. I am afraid that the horrible expression "the wireless," meaning a wireless receiver, has taken root too firmly for it to be killed now. In my opinion, the word "radiophone" is far more euphonious—pardon the pun—and, although containing more syllables, is easier to say and is more comprehensive in its meaning than any of the expressions now in use.



Certain combinations of letters . . .

"Pick-up" is another cumbrous expression; one might as well speak of a loud speaker as a "put-down," although the expression loud speaker itself is ugly enough in all conscience, and badly needs the attention of a competent etymologist.

OUTPUT VALVES IN PARALLEL



Charts to Simplify Calculation of Output.

By W. A. BARCLAY, M.A.

THE practice of combining two or more output valves in parallel to secure a large power consumption in the loud speaker is one which is steadily increasing in vogue. A general review of modern receivers demonstrates—if demonstration were necessary—that the multiplication of L.F. stages is now a thing of the past, and that from the standpoint of quality the paralleling of power valves in quite small receivers has everything to commend it. For the energising of the larger phonic mechanisms of commercial use, banks of paralleled valves are, of course, standard practice.

The mathematical theory of parallel output valves has been dealt with by Baggally in *Experimental Wireless.*[1] The subject is, however, fairly complicated, and the writer believes that a simplified treatment on general lines will be useful to many readers who may wish to ascertain without much troublesome arithmetic the practical effect of paralleling their output valves. Here, as so often elsewhere in wireless theory, the principle of alignment will prove a useful aid, and the writer has accordingly designed an Alignment Chart from which the approximate performance of such combinations may be read off with the minimum of calculation.

The Limits of Distortionless Output.

Before describing this Chart we shall first recall the general conditions for the distortionless working of output valves. The mode of connecting such valves in parallel is illustrated in Fig. 1, from which it is seen that all the grids, as well as all the anodes, have a common connection. While the same signal e.m.f. is impressed on the grid of each valve, the anode current passing through the load will have N times the value of each individual valve current, N being the number of valves in the bank. We shall suppose in what follows that the load in the anode circuit is arranged as in Fig. 1, in which the loud speaker offers a resistance of *r* ohms to currents of speech frequency, all direct current through its windings being eliminated by the large condenser C, while the H.T. is supplied to the anode system of the bank through a resistanceless choke, L. When C and L are both very large, this is equivalent to the well-known "choke-feed" arrangement, the resistance *r* representing the dynamic resistance of the loud speaker windings. The modifications for other methods of connecting up the loud speaker will readily suggest themselves.

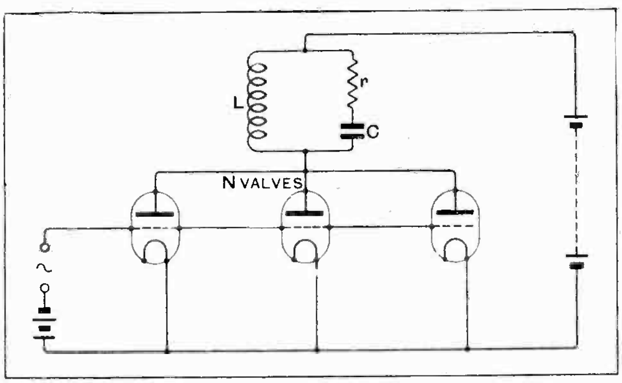


Fig. 1.—Schematic arrangement of N output valves in parallel, working with a dynamic resistance of r ohms.

It will be apparent that the conditions under which each individual valve of the system works without introducing distortion differ in no respect from those which must be fulfilled were the same valves working entirely "on their own." If, for simplicity, we exclude from our discussion all mention of the so-called "harmonic" forms of distortion arising from the unequal spacing of the resistance characteristics, we may set down briefly three main "limits" which must be set to the operating conditions of power valves:—

(A) The anode dissipation, or product of the supply voltage and mean value of anode current, must never exceed the safe wattage which is usually quoted by the makers.

(B) The anode current must never exceed a certain value, viz., the "saturation" point, in the region of which the resistance characteristics become curved. Nor should the anode current fall below a certain minimum, fixed by the position of the "lower-bend" curvature of the characteristics.

(C) The instantaneous potential of the grid should never be allowed to become positive, owing to the undesirability of the resulting grid current.

The nature of the limitations imposed by these three considerations upon the path of the working point under

[1] "On Banks of Paralleled Valves Feeding Resistance Loads Without Distorting the Wave Form." *Experimental Wireless*, June, 1928.

Output Valves in Parallel.—

given operating conditions may be illustrated by reference to Fig. 2a, which shows a set of resistance characteristics for a certain supposedly ideal power valve. The characteristics shown are equally spaced, and are assumed to be without "lower-bend" curvature. For most power valves the permissible minimum of anode

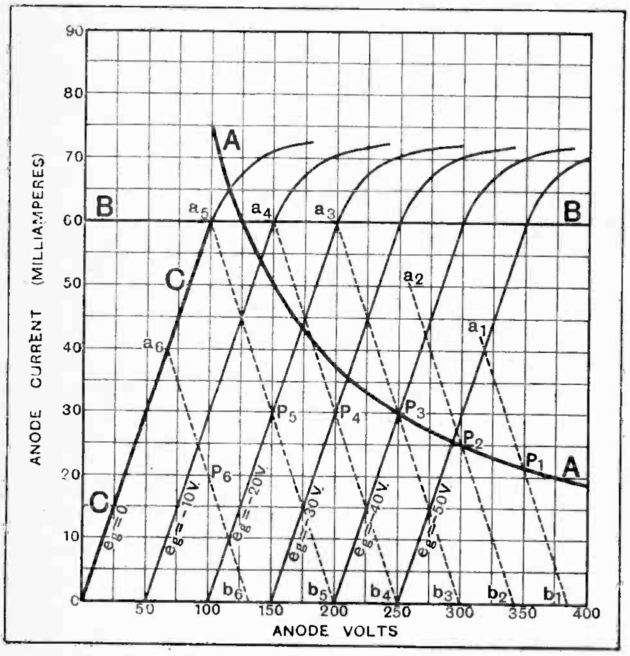


Fig. 2a.—Ideal characteristics of a power valve, illustrating the three limiting conditions which restrict output.

current is small relatively to the average value of this current, and can usually be neglected altogether in power calculations to the great simplification of the work. The anode dissipation is rated at 7.5 watts, and the curve corresponding to this value is shown at AA. The maximum permissible anode current is 60 mA., this value being shown by the horizontal line BB, while CC represents the straight portion of the characteristic for zero grid volts. Now, it is well known that for a given value of resistance load the working path on the diagram of Fig. 2a is a straight line of constant slope whose actual position depends on the values of grid bias and supply voltage in use. As an example, we shall assume a value of 6,667 ohms for our load resistance, and draw on our diagram a succession of lines of corresponding slope.

The High-tension Voltage.

It will be found that if a_1b_1, a_2b_2,...a_6b_6 be several such working lines, the total extent upon each which is available for the excursions of the working point is limited by one or other of the three considerations A, B or C previously noticed. For large values of the supply voltage, the total extent of the permissible "run" will be limited to such small lengths as a_1b_1 or a_2b_2, the governing consideration being that the centre point of the "run" must lie on the curve AA of maximum anode dissipation. Thus, when the supply H.T. is 300 volts, the necessary grid bias will be -52 volts, since this is the value of the characteristic at P_2, the intersection of AA with the 300 volts line. Since P_2 is the centre of the "run," the top half, a_2P_2, must equal the lower half, P_2b_2, and hence the total extent a_2b_2 representing the signal input may be set out. It will be seen that a_2b_2 is larger than a_1b_1, the corresponding "run" for a supply of 350 volts; nevertheless the 300-volt supply is uneconomical, for if a still lower value of H.T. were used, the working path could be still further extended. For 250 volts H.T. the total permissible working path is a_3b_3. Here, however, a fresh limit is imposed, namely, that set by the line BB, so that if the supply voltage be yet further reduced, say, to 200 volts, the resulting "run" will still be of the same length as before, e.g., a_4b_4. It will, of course, be most economical to obtain this maximum length of working path with the least possible value of H.T. supply. On reducing the H.T. below 150 volts, however, the third limiting condition comes into play, and the permissible "run" is curtailed by the line CC. Thus, for a supply of 100 volts, the total extent of the working path available with this load is restricted to a_6b_6. It will now be evident that the optimum position of the working line is that at a_5b_5, for which the greatest value of "run" (otherwise signal e.m.f.) is obtained with the minimum necessary voltage supply. Thus our object in designing a bank of parallel output valves will be to ensure as far as possible this ideal condition for each individual valve.

The above relative disposition of the limiting factors A, B, C, illustrated in Fig. 2a, is, however, very often modified by the fact that the maximum permissible value of anode current fixing the position of the line BB

Fig. 2b.—Ideal characteristics of power valve. In this case, only two of the limiting conditions are operative, the value of I_{max} being too great to have any restrictive effect on output.

Output Valves in Parallel.—

is so large that condition B does not come into operation at all. For most output valves, indeed, the characteristic-limiting scheme is similar to that shown in Fig. 2b. Here the maximum value of anode current is shown as 90 mA., the curve of anode dissipation being 7.5 watts, as in the previous case. The maximum extent and ideal position of the working path is here shown at a_4b_4, for which the supply voltage is 200, and the negative grid bias 24 volts. This path is situated at the junction of the

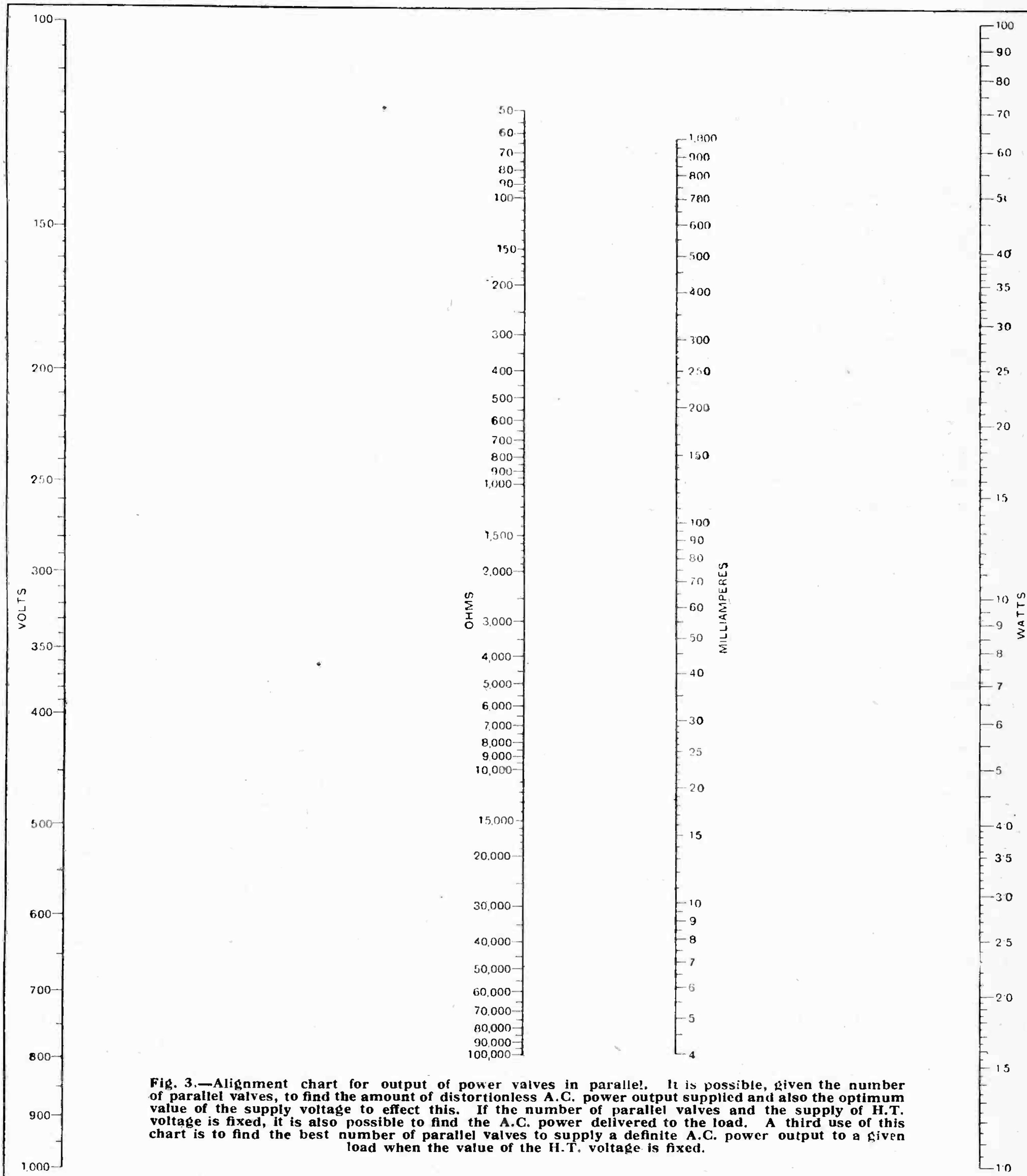


Fig. 3.—Alignment chart for output of power valves in parallel. It is possible, given the number of parallel valves, to find the amount of distortionless A.C. power output supplied and also the optimum value of the supply voltage to effect this. If the number of parallel valves and the supply of H.T. voltage is fixed, it is also possible to find the A.C. power delivered to the load. A third use of this chart is to find the best number of parallel valves to supply a definite A.C. power output to a given load when the value of the H.T. voltage is fixed.

Output Valves in Parallel.—

conditioning limits A and C, as shown graphically by the curve AA and line CC, the limiting condition shown by BB not being utilised at all. It is easy to see that all other positions of the working line for the same load are necessarily curtailed either by AA or by CC.

The Problem of the Bank of Parallel Valves.

Having considered, generally, the nature of the limitations imposed upon the working of the individual power valve, we come now to the questions arising from the performance of a number of such valves connected in parallel. We shall assume that all the valves concerned are of similar type, so that the characteristics of each are approximately the same. It will further be supposed that the resistance, r ohms, of the load is in all cases known. The points which arise are varied. If the supply H.T. voltage and the number of valves in the bank are both fixed to start with, it may be required to ascertain the amount of a.c. power which can be delivered to the load without distortion, together with the value of grid bias required to secure this. Conversely, if the amount of a.c. power required is specified, we may wish to determine either the number of valves in the bank or the optimum value of supply voltage. To such questions it is hoped that the Alignment Chart now to be described will supply a ready answer.

How to Use the Chart.

The Chart itself (Fig. 3) consists of four parallel axes, or scales, bearing respectively numerical values of voltage, resistance, current and power. From the data supplied for the individual valve, take the value of maximum permissible current, I_{max}, the anode dissipation D, and the anode a.c. resistance, R_a. We then find values of the following quantities:—

$$A = N \times \frac{D}{2} \text{ watts}$$
$$B = N \times \frac{I_{max}}{2} \text{ milliamps.} \qquad (1)$$
$$C = \frac{R_a}{N} + \frac{r}{2} \text{ ohms.}$$

r being, as usual, the load resistance and N the number of parallel valves. Further, let E represent the value of the supply H.T. voltage. In using the Chart, the points A, B, C, and E will always refer to the values of these quantities when taken on the appropriate scales of the Chart; thus, the point A refers to the value of $N \times \frac{D}{2}$ taken on the power axis. In addition, if P denote the value of a.c. power delivered to the load r by the bank of N valves, the point P on the Chart will refer to this value taken on the power scale. Lastly, the point $\frac{r}{2}$ will indicate the position of the value of $\frac{r}{2}$ upon the resistance scale.

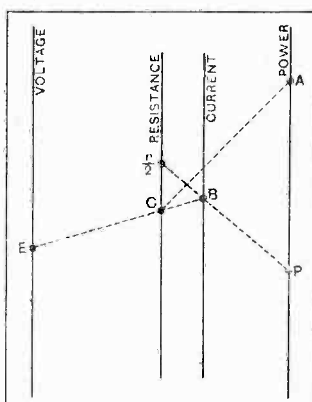


Fig. 4. (Left) Method of using Chart of Fig. 3 when B lies below AC. The dotted lines need not actually be drawn; their positions only need be indicated by a ruler or other straight-edge.

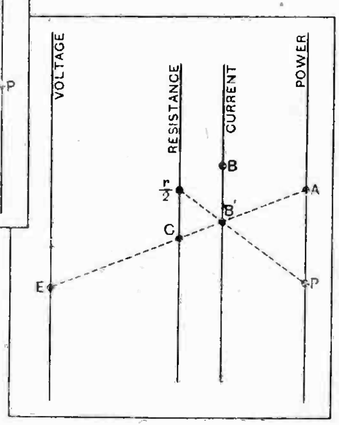


Fig. 5.—(Right) Method of using the chart when B lies above AC. An auxiliary point B' is found, which in turn is used to determine P.

Three general problems will now be discussed with the aid of this Chart. In all cases the value of the load resistance which is to be worked will be supposed known.

I. Given the number of parallel valves: to find the amount of distortionless a.c. power supplied by the bank, and also the optimum value of the supply voltage to effect this.

Our object here is to find the points E and P on the Chart. Join the known points A and C. There are now two possible cases, depending on whether the point B lies above or below AC.

Case (1).—If B lies below AC, the required point E is found in alignment with B and C. The power P is found in alignment with $\frac{r}{2}$ and B (see Fig. 4).

Case (2).—If B lies above AC, let B′ be the point in which AC meets the current axis. Then E is in alignment with A and C, while P is in alignment with $\frac{r}{2}$ and B′ (see Fig. 5).

Example.—We shall illustrate this procedure by considering a bank of five parallel valves each having the following constants: D = 10 watts; I_{max} = 100 mA.; R_a = 2,000 ohms. Suppose it required to find the approximate a.c. power which could be delivered by this bank to a load of 500 ohms, and further to ascertain the H.T. supply necessary. From equations (1) above, the following values are easily obtained: A = 25 watts; B = 250 mA.; C = 650 ohms. An inspection of the Chart shows that B lies above AC; hence *Case (2)* applies. Using the diagram as in Fig. 5 we find the necessary H.T. to be 255 volts, the a.c. power in the load being 9.7 watts. The necessary grid bias with which to operate will, of course, be read from the valve characteristics as usual.

II. Given the number of parallel valves and a fixed supply of H.T. voltage: to find the maximum distortionless a.c. power delivered to the load.

We here suppose that, owing to exigencies of supply, the actual H.T. voltage on the anodes is not the optimum value ascertained immediately above, but is of some definite fixed amount. We have already seen (Figs. 2*a* and 2*b*) that a variation from the optimum value of H.T. supply will usually necessitate a restric-

Output Valves in Parallel.—

tion of the extent of working "run" if distortion is to be avoided; consequently, the a.c. power now to be delivered will be the same or less (but never more) than with the optimum H.T. voltage. The procedure is now as follows:—

Join E to A, B and C, and note the point B′ in which the *lowest* of these lines meets the current axis. (If EB is the lowest line, B′ will be the point B.) Then P is found in alignment with $\frac{r}{2}$ and B′ (see Fig. 6). It is to be remarked that the limiting condition governing the extent of the working "run" will be (A), (B) or (C), referred to at the commencement of this article, according as EA, EB or EC is the lowest on the Chart.

Example.—With the same five valves as were used above, let the fixed H.T. supply be 200 volts. The point E now referring to this value, the points A, B, C being as before, the line EC is found to be the lowest of the three. Having found the position of B′, the value of P is read off as in Fig. 6 to be 6 watts, showing a considerable reduction on the former case. The limiting condition is here (C) that due to the zero grid volts line, which precludes signals of any greater magnitude being obtained. The remedy is, of course, to increase the H.T. value to that found in the first example, viz., to 255 volts.

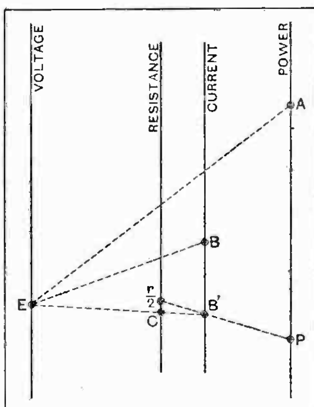


Fig. 6.—(Left) In this case EC is shown as the lowest of the three lines through E. It therefore fixes the position of the auxiliary point B′, which in turn is used to find the point P.

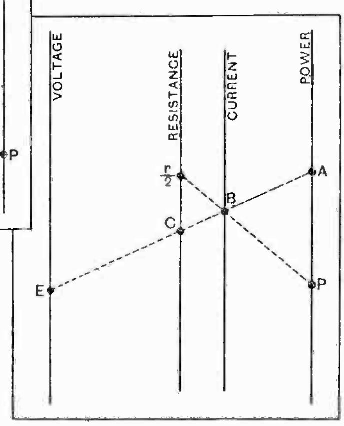


Fig. 7.—(Right) Illustrating the inverse method of using the Chart. When $\frac{r}{2}$, P and E are given, A, B and C, and hence N, may be derived.

III. Given the value of the available H.T. supply: to find the best number of parallel output valves in order to supply a definite a.c. power output to a given load.

In this case the value of N itself is unknown, and so none of the points, A, B, C, is available directly. We must, therefore, proceed to work inversely.

The point B will be found on the current axis in alignment with the known points $\frac{r}{2}$ and P. (See Fig. 7.)

The points A and C will be found in alignment with E and B, A being on the power axis and C on the resistance axis.

We have now obtained values for A, B and C, and can substitute these values in the equations (1) above, which thus give us three equations for N. Solving for N in each case, the greatest value obtained is the one required.

Example.—How many valves of the same constants as before would be necessary to supply an a.c. power of 20 watts to a load of dynamic resistance 2,000 ohms, using 450 volts H.T.? Here we join 1,000 ohms to 20 watts, and note the point B on the current axis. Joining 450 volts to B, we obtain A and C. The values are, A=31.8 watts; B=142 mA.; C=1,580 ohms. But from equations (1),

$$A = N \times \frac{D}{2} = N \times 5$$

$$B = N \times \frac{I_{max}}{2} = N \times 50$$

$$C = \frac{R_a}{N} + \frac{r}{2} = \frac{2000}{N} + 1000$$

We thus have three equations for N, yielding respectively the results

$$5N = 31.8, \text{ or } N = 6.4$$
$$50N = 142, \text{ or } N = 2.8$$
$$\frac{2000}{N} + 1000 = 1580, \text{ or } N = 3.4$$

We therefore select the value 6.4, i.e., the required number of parallel valves will be 7, taking the next greatest integer to be on the safe side.

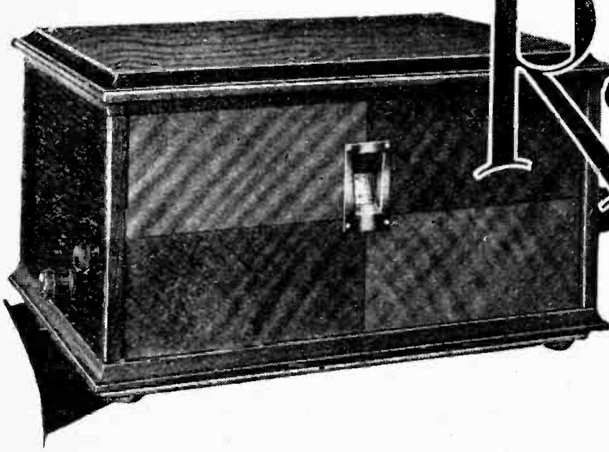
Anode Dissipation Limit.

The reason why the largest indicated number of valves will be that required will appear if a lesser number be chosen, and the a.c. power computed under the same conditions. Should we decide to use only 5 valves instead of the 7 found necessary, we could find the a.c. power supplied by applying the procedure of II above. It would now be found that

$$A = 5 \times 5 = 25 \text{ watts}$$
$$B = 5 \times 50 = 250 \text{ mA.}$$
$$C = 400 + 1000 = 1400 \text{ ohms}$$

Joining E=450 volts to each of these, we find that EA is the lowest of the three lines, and note the position of B′. The resulting a.c. power is easily read off as only 12.5 watts, whereas it was stated that 20 watts were required. Moreover, each valve is working at its extreme limit of anode dissipation. This is otherwise shown by the fact that EA was the lowest line of the three, showing, as we should expect, that anode dissipation is here the limiting factor. The load imposed on the five valves is thus seen to be excessive.

In conclusion, it should be said that the results obtained by this diagram are approximate only, this being necessarily due to the simplifying assumptions which were referred to in the text. It is believed, however, that the loss of accuracy thus entailed is sufficiently small to justify a fair measure of confidence in results only otherwise obtainable with a disproportionate amount of arithmetical labour.



Regentone A.C. FOUR

A Compact, Effective, and Easily Operated Receiver with Two H.F. Stages.

ONE could wish that there was a wider choice of commercial broadcast receivers with multi-stage high-frequency amplifiers. The better H.F.-det.-L.F. sets are capable of making a wonderfully fine showing, even for long-distance work; they fully deserve the wide popularity that has been accorded to them, but an extra H.F. valve is well worth having. A receiver with two H.F. amplifiers should be capable of doing its work without effort and with certainty, even in unskilled hands; further, it almost follows that there will be sufficient reserve of amplification to mask the ill-effects of irregular valve characteristics or operating voltages that differ widely from those intended by the designer.

With regard to selectivity, there is also an important advantage. When a superabundance of H.F. amplification is available, it becomes possible to work with an extremely loose aerial coupling, thus largely avoiding the particular type of interference to which the screen grid valve is liable, and at the same time retaining sufficient overall sensitivity to satisfy all reasonable needs as to range of reception.

This principle has been put into practice in the Regentone A.C. mains-operated four-valve receiver, which made its first appearance last autumn at Olympia, where its compact and workmanlike design attracted considerable attention.

As shown in the accompanying diagram, the basic circuit arrangement embodies two H.F. stages, a grid detector and a triode output valve. The aerial may be connected at will to the input coil, either through a single fixed condenser or through two condensers in series. As each of these capacities is rated at 40 mmfds. only, it will be appreciated that aerial coupling will be extremely loose in either case, and, further, that the capacity existing across the input circuit will not be affected by changes of aerial capacity.

Tuned anode couplings are used in the H.F. amplifier, and matters are so arranged that the variable condenser rotors may be earthed, thus avoiding constructional complications. Waveband switching is effected by the simple expedient of short-circuiting the long-wave sections of the tuning coils.

The detector grid circuit constants have obviously been chosen to ensure the avoidance of high-note loss, and to give sensibly linear rectification. Transformer coupling is adopted as the link between the rectifier and the L.F. valve, which is of the directly heated variety, with a heavy filament consuming one ampere at four volts. A choke filter output for the loud speaker is provided.

SPECIFICATION.

CIRCUIT: Two screen-grid H.F. valves with tuned anode couplings; grid detector, transformer-coupled to triode output valve. Filter feed to loud speaker. Westinghouse metal rectifier in voltage-doubling circuit.

CONTROLS: (1) Single-dial control of three tuning condensers. (2) Ganged wave-range switch (3) pre-detection volume control.

GENERAL: Provision for gramophone pick-up. For operation on A.C. mains and with inside or outside open aerial.

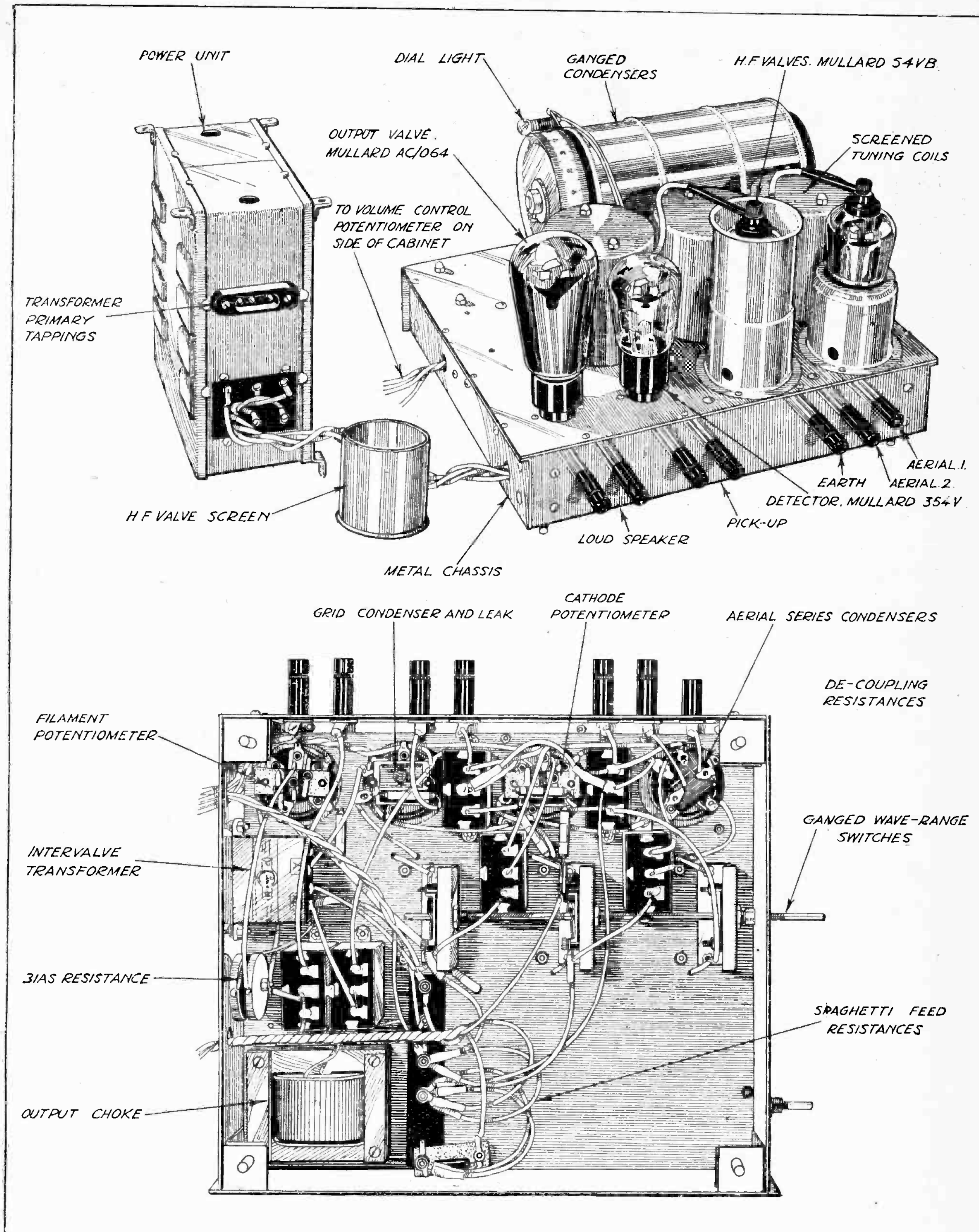
PRICE: £31 10 0 complete with valves.

MAKERS: Regentone, Ltd., Regentone House, 21, Bartlett's Buildings, London, E.C.1.

There is no reaction in the usual sense, but the pre-detection volume control takes the form of a grid potentiometer for the H.F. valves. Matters are so arranged that, by making the grids operate at zero or at a slightly negative potential with respect to their cathodes, self-oscillation can actually be brought about over the majority of the tuning range.

Decoupling resistances and condensers are fitted where necessary in grid, screening grid, and anode circuits. Automatic grid bias for the output valve is provided in the conventional manner.

Constructionally, a somewhat unusual plan has been followed, in that the receiver proper and the power supply units are entirely separate though housed in the same cabinet. The latter unit includes a power transformer with outputs for H.T. supply and filament heating, a Westinghouse rectifier, and also the usual smoothing equipment. The receiver proper is built as a chassis assembly; valves, screened tuning coils, and a triple "Polar" tuning condenser, are mounted on the top of a shallow aluminium box, in which are mounted the remaining components. Although there is no overcrowding—indeed, there is space to spare everywhere—the receiver is exceptionally compact, the chassis measuring a bare 12in. wide



Receiver and power supply chassis. Below is shown the underside of the base compartment.

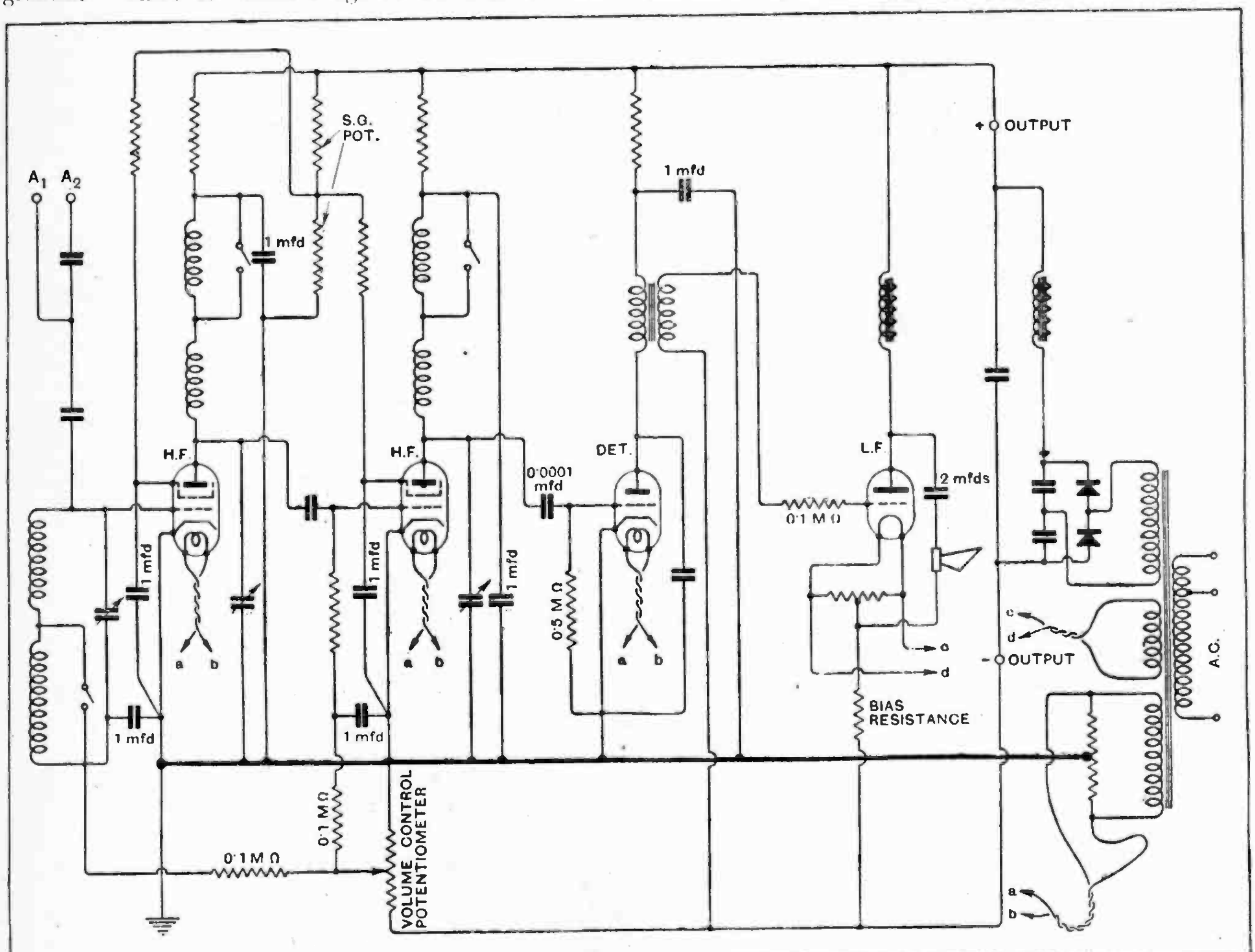
Regentone A.C. Four.—
by about 10½in. in depth. Both receiver and power supply units are readily removable from the cabinet.

About 100 volts is applied to the detector anode, and this valve passes a current of nearly 5 milliamps.

Although overall H.F. magnification is not exceptionally high, it is much greater than would be obtainable from a single stage, even of the "laboratory" type; it is no exaggeration to say that, under average conditions, any transmission with the slightest "programme" value is within range of the set. On the medium waves its behaviour is particularly pleasing, and an almost unlimited choice of stations was found to be available when a practical test was made in circumstances that were by no means ideal. The long-wave performance was perhaps slightly less striking, but almost all the high-power stations operating in this band were well received.

Selectivity is surprisingly good. The adjective is used advisedly as it is rather difficult to account for such a satisfactory showing in this respect in the case of a receiver with but three single-tuned circuits. Without any special operating artifices, it was possible to tune in transmissions intermediate between the local twin stations when testing the set in North London.

As far as quality of reproduction is concerned, the capabilities of a good modern receiver are largely determined by the characteristics of the loud speaker with which it is operated. The Regentone receiver leaves no grounds for unfavourable criticism on this score; although its bass cut-off is perhaps a shade higher than in some cases, the upper register is very well maintained. The special directly heated output triode, as used in this receiver, is entirely satisfactory, and one rather wonders why this particular type of valve is not more widely used. It is operated under optimum conditions and gives an output of 750 milliwatts—adequate for all ordinary needs.



Theoretical circuit diagram. Gramophone pick-up sockets (not indicated) are joined across the detector grid circuit

Volume regulation is effected entirely by operation of the 500-ohm. potentiometer which controls the grid potentials of the H.F. valves. This was proved to be a very satisfactory device; by its use even a strong signal can be reduced to inaudibility.

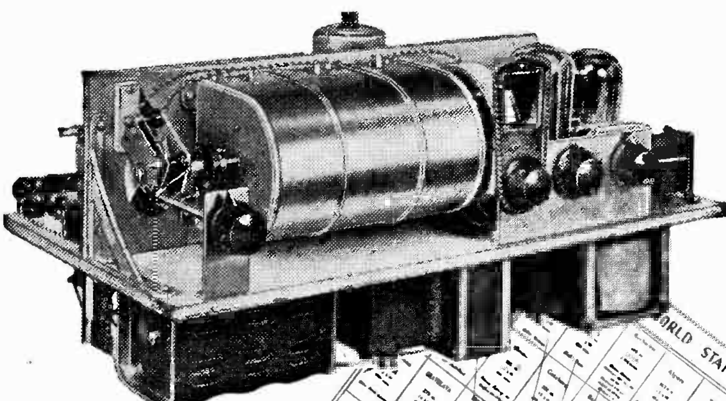
There is an almost complete absence of hum, and, indeed, the receiver is exceptionally free from background noises of every kind.

NEW READERS' NUMBER

Next week's issue will be, by "Special request," devoted principally to the interests of the new reader. Introduce *The Wireless World* to your friends with this issue. The following are some of the special features to be included :—

PRE-SELECTION A.C. THREE

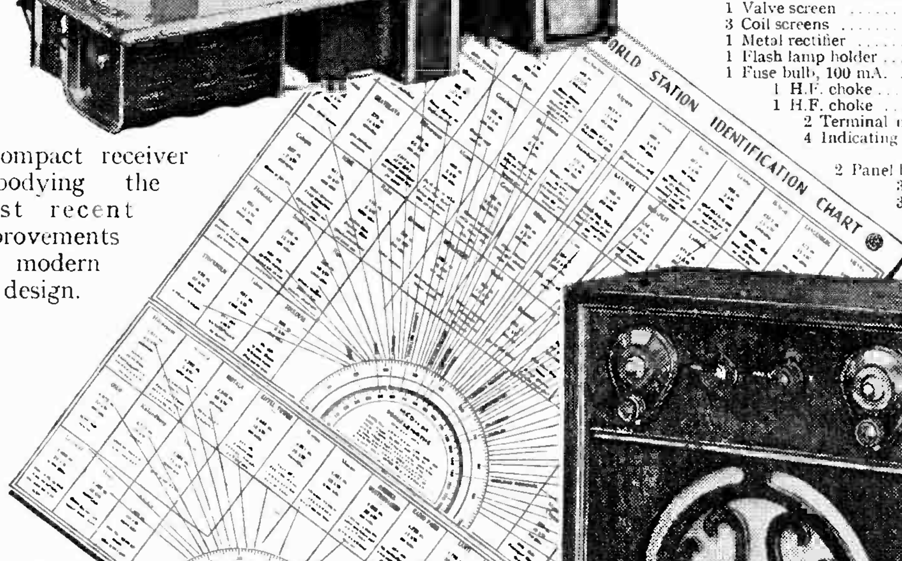
How to build the New Band-pass Set



A compact receiver embodying the most recent improvements in modern set design.

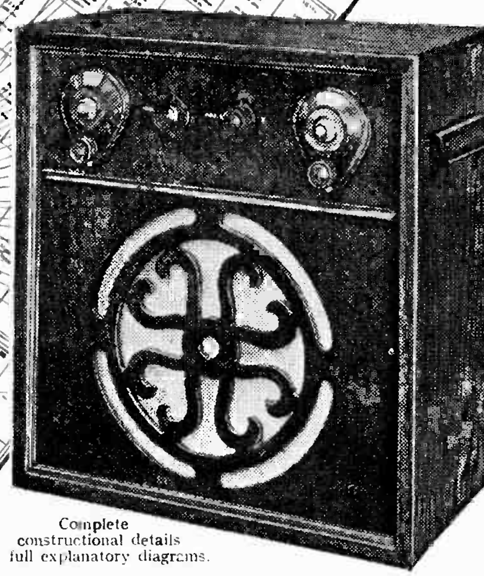
Parts used in the A.C. Three:

1 Triple variable condenser, 0.0005 mfd., with drum drive .... (Polar Tub)
1 Variable condenser, 0.0003 mfd., with knob (Utility, W.218)
1 Variable condenser, 0.0002 mfd., with knob (Utility, W.219)
1 Variable condenser, 40 mmfds. .... (J.B. Midget)
1 Differential condenser, 0.0003 mfd. .... (Utility, W.211)
1 Condenser coupler .... (Ormond)
3 Condensers, 1 mfd. (200 volts working) ... (T.C.C., No. 50)
3 Condensers, 4 mfd. (400 volts working) ... (T.C.C., No. 80)
4 Condensers, 2 mfd. (200 volts working) ... (T.C.C., No. 50)
1 Condenser, 2 mfd. (400 volts working) ... (T.C.C., No. 80)
3 Condensers, 0.0003 mfd. .... (Dubilier, No. 610)
1 Condenser, 0.0001 mfd. .... (Dubilier, No. 610)
1 Condenser, 0.05 mfd. .... (Dubilier, No. B.775)
1 Semi-variable condenser, 0.00002–0.0002 mfd. .... (Lewcos)
1 Semi-variable condenser, 0.00015–0.002 mfd. .... (Lewcos)
1 Resistance, wire-wound, 30,000 ohms, and holder.. (Varley)
1 Resistance, wire-wound, 50,000 ohms, and holder.. (Varley)
2 Resistances, wire-wound, 10,000 ohms, and holder.. (Varley)
1 Resistance, 400 ohms (Clarostat, Type F.W., Claude Lyons)
1 Resistance, 100 ohms (Clarostat, Type F.W., Claude Lyons)
1 Resistance, 100,000 ohms .... (Ediswan)
2 Resistances, 250,000 ohms .... (Ediswan)
2 Grid leak holders .... (Bulgin, Porcelain)
2 L.F. chokes, 40 henrys .... (Bayliss)
1 L.F. choke, 300 henrys .... (R.I.)
1 L.F. choke .... (R.I., Pentomite)
1 Power transformer .... (Bayliss, Type W.W.3)
1 Valve screen .... (Colvern)
3 Coil screens .... (H. & B.)
1 Metal rectifier .... (Westinghouse, H.T.7)
1 Flash lamp holder .... —
1 Fuse bulb, 100 mA. .... (Bulgin, Type B)
1 H.F. choke .... (Lewcos)
1 H.F. choke .... (McMichael, Binocular Junior)
2 Terminal mounts .... (Belling-Lee)
4 Indicating terminals, aerial, earth, 2 output (Belling-Lee)
2 Panel brackets, 4in. .... (Magnum)
3 Tuning coils (Type WWTG, Tangent)
3 Valve holders, 5-pin .... (Lotus)
Wire, screws, sleeving, sheet tin, sheet aluminium for brackets, etc., etc.



Large Coloured Supplement

STATION IDENTIFICATION CHART



Complete constructional details and full explanatory diagrams.

THE EVERYMAN TWO

An easily constructed, self-contained, transportable receiver for use with either indoor or outdoor aerial.

Components used in the Everyman Two:

1 Variable condenser, 0.0005 mfd. .... (Polar, No. 3)
1 Variable condenser, 0.0003 mfd. (Ready Radio, "Brookmans")
2 Vernier dials .... (Formo)
1 Differential reaction condenser, 0.0003 mfd... (J.B.)
1 Condenser, 0.0003 mfd., and clips ..... (Sovereign)
1 Condenser, 2 mfd. .... (Dubilier)
1 Tuning coil, base mounting, tapped 20% and 60% .... (Tunewell, Dual X)
1 H.F. choke .... (Ready Radio, "Hilo")
2 Valve holders .... (W.B., "Universal")
1 "Spaghetti" resistance, 30,000 ohms .. (Magnum)
1 Grid leak, 2 megohms .... (Sovereign)
1 Switch, three-pole double-throw .... (Eureka)
1 L.F. transformer .... (Ferranti, A.F.8)
3 Solid plugs .... (Clix, No. 25)
4 Sockets, insulated with bush heads .. (Clix, No. 24)
2 Hook terminals .... (Clix, No. 4)
6 Wander plugs, 2 H.T.+, 2 H.T.–, G.B.+, G.B.– .... (Belling-Lee, "Midget")
1 Piece of ebonite, $2 \times 1 \times \frac{3}{16}$ in. .... —
1 H.T. battery, 120-volt .... (Pertrix)
2 Grid bias batteries, 9-volt .... (Pertrix)
1 L.T. accumulator, 2-volt .... (Exide, D.F.G.)
1 Loud speaker unit .... (Ormond, R.450)
1 Small chassis and cone .... (Ormond, R.451)
1 Cabinet .... (Camco)
2 Valves .... (Mullard, PM1HL, and PM2A)
1 Pkt. insulated links.... (Ready Radio, "Jiffilinx")
Wood screws, flex, etc.,

CURRENT TOPICS

News of the Week in Brief Review.

MORE POWER FROM PARIS.

The new *Radio Paris* will shortly begin experimenting on 80 kilowatts. Tests will follow with *Petit Parisien* on 60 kilowatts.

oooo

A 500-KILOWATTER.

Europe's most powerful broadcasting station, now under construction at Noghinsk, a Moscow suburb, will have a power of 500 kilowatts.

In accordance with the famous Five Years' Plan, the Soviet Republic hopes to commission eleven new broadcasting stations of 100 kilowatts each and twenty-eight of 10 kilowatts before the end of 1933.

The new Kolpino station, which will relay the Leningrad programmes, will shortly begin transmission with a power of 75 kilowatts.

oooo

RADIO AMATEURS IN N.Z. EARTHQUAKE.

For the story of how New Zealand wireless amateurs rendered invaluable public service during the earthquake we are indebted to Mr. F. A. Mayer (G2LZ), of Wickford, Essex, who has been constantly in touch by wireless with Station ZL-2BE, operated by Mr. Mills, of Hastings, in the devastated area.

As soon as the main shock subsided Mr. Mills collected the remains of his transmitter and re-erected it on packing cases in the open. He was working under difficult conditions with fires raging all around him. His station proved the only means of communication between Hastings and the outer world for several days until the land lines were restored.

Communication with the stricken district was organised by the New Zealand Amateur Radio Transmitters' League, ZL2GK at Wellington being appointed official station under the control of Messrs. Taylor and Perkins. In Napier, where conditions were exceedingly bad, Station ZL2GE did good work. In spite of difficulties the little chain of stations handled large numbers of messages at an average speed of 35 words per minute. Ultimately they were taken over by the Government for official traffic.

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WHAT WAC STANDS FOR.

The letters WAC mean "WPorked All Continents."—*South African Wireless Weekly.*

This explains the term "ether hog."

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BROADCAST JOKE SERVICE.

A startling report comes from a Madrid correspondent to the effect that the famous Spanish humorist, Ramon Gomez, has been permitted to install a permanent microphone at his home linked up by land line to the nearest broadcasting station. The innovation has been arranged "so that he can intervene at pleasure during the transmissions for the purpose of throwing in a joke."

There is no truth in the rumour that the B.B.C. is installing a line to the residence of Tommy Handley with the object of brightening the Sunday programmes.

TELEGRAMS FROM TRAINS.

Radio enterprise on the French State Railways has not stopped short at the installation of broadcast receivers on trains. Preparations are now being made for the inauguration of a radio-telegraph service for the convenience of passengers to and from Paris on the Brest, Havre, Dieppe and Strassburg lines.

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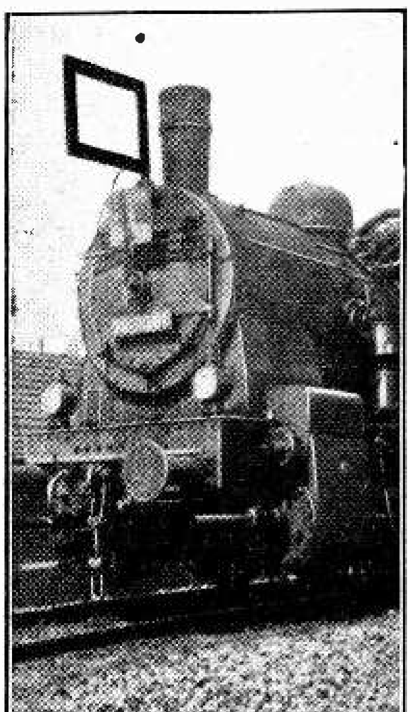
THE VATICAN WIRELESS STATION.

The short-wave broadcasting and wireless telephone and telegraph duplex station which has been supplied by Marconi's Wireless Telegraph Company to the Vatican City, and which was formally inaugurated by His Holiness the Pope on Thursday last, has a world-wide range. Illustrations will be found on pages 183 and 184 in this issue.



RAILWAY SIGNALS. A German locomotive fitted with a frame aerial used for reception of shunting instructions. Signals are transmitted from an "aerial" alongside the track.

The Pope's address, in Latin, took about a quarter of an hour to deliver and was heard in practically all countries of the world. The relay from the B.B.C. transmitters was entirely successful, but it was found that better results were obtained by picking up the transmission from W2XAD on 19.5 metres than receiving direct from the Vatican Station.

The transmitter, which in its main features follows the design of the high-speed British beam transmitters, consists of four main panels, and is designed for telephony and high-speed telegraphy on either 19.84 or 50.26 metres.

On telephony the transmitter is rated to deliver from 8 to 10 kW. of unmodulated carrier wave energy to the aerial feeder system, the output depending slightly on the wavelength used. The normal degree of modulation is 80 per cent. The rating on continuous wave telegraphy is 13-15 kW. to the aerial feeder.

The energy from the transmitter building is conveyed to the two aerials by two separate concentric copper tube feeders. The transmitting building itself is situated near the railway terminus. Every effort has been made to harmonise, as far as possible, the transmitting buildings and aerial towers with the graceful surroundings of the Vatican City. The transmitting building is of sober but pleasing architectural design.

A special receiver, partly made of standard parts of the normal telephone and high-speed Marconi receiver and telephone-terminal four-wire two-wire equipment, will secure good telephone and telegraph duplex communication between the Vatican City and any part of the world.

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TELEVISING MARKET PRICES.

W9XAP, Chicago, transmits the New York and Chicago Stock Exchange quotations by television. As it emerges from the machine the tape is carried past the scanning apparatus. The reproduction on television receivers is stated to be quite readable.

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DUTCH AMATEURS WARNED.

The Supervisory Committee of Radio Transmission in Holland has issued a special notice to Dutch amateurs forbidding them to transmit anything in the nature of a criticism of the Government's policy in broadcasting matters.

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BIGGER PROFITS FOR N.B.C.

The gross revenue of the American National Broadcasting Company in 1930 was in excess of £4,500,000, according to the annual report of its President, Mr. Merlin Aylesworth. The gross revenue in 1929 was £2,862,000.

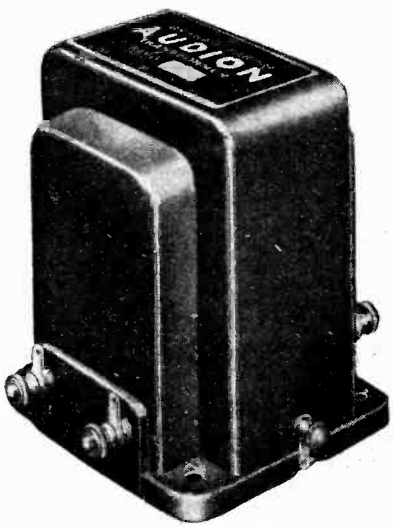
With the addition of six new transmitters to the N.B.C. system in 1930 the permanent wire network now totals 34,500 miles, linking seventy-four broadcasting stations, two of which are in Canada.

The synchronisation of stations, i.e., linking them together by short-wave channels or by wire so that a group can operate simultaneously on a single wave, is soon to be put to practical use.

Wireless World Laboratory Tests on New Apparatus

AUDION L.F. TRANSFORMER.

Made by Graham Farish, Ltd., Masons Hill, Bromley, Kent, the Audion L.F. transformer is available in two ratios—3 : 1 and 5 : 1, the price being 12s. 6d. and 15s. 6d. respectively. The 3 : 1 model has been tested and measurement made of its primary inductance at 50 cycles when passing various values of D.C. With no D.C. flowing, an inductance of 24.5 henrys was obtained; this falls to 23.5 henrys with 2 mA of D.C.



Graham Farish Audion L.F. transformer in moulded bakelite case.

and to 19 henrys with 4 mA. On passing 6 mA of D.C. through the primary, the inductance recorded was 16 henrys, and with 8 mA 14.5 henrys.

A practical test using a valve of some 15.000 ohms. A.C. resistance and passing a steady anode current of approximately 2.5 mA revealed a noticeable falling off in amplification below 300 cycles and above 6.000 cycles. Between these two limits the amplification was good and, judged aurally, appeared to be reasonably constant.

There was no improvement in the lower register by changing to a valve of 8.000 ohms. impedance, since the inevitable increase in anode current reduced the primary inductance to a level where the ratio of primary impedance to A.C. resistance of the valve was of about the same order as in the previous case.

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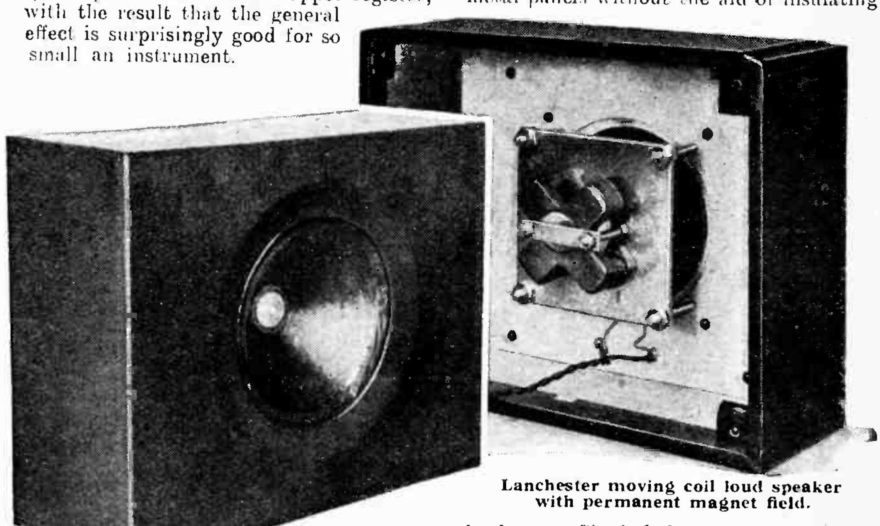
LANCHESTER MOVING COIL LOUD SPEAKER.

This neat little instrument is contained in a rexine covered cabinet measuring only 13in. × 10½in. × 5¼in. In spite of the small dimensions of the 35 per cent. cobalt steel permanent magnet, the sensitivity is of a high order and quite equal to the average moving coil loud speaker with mains-energised field.

The moving coil is of the low impedance type and a 25 : 1 transformer is required for normal low-impedance power valves. Models fitted with internal transformers suitable for either medium impedance triode valves or pentodes are available.

The response is characterised by crispness and brilliance in the upper register, the reproduction of speech being quite exceptionally good. From 50 to 150 cycles the output rises rapidly to a value slightly below the average for the whole characteristic. This output is maintained without any sign of resonance up to 750 cycles, after which there is a rise to the average value at 1,000 cycles. The curve continues at this new level up to 2,500 cycles and rises above the average between 3,000 and 6,000 cycles, the highest output being located between 4,000 and 5,000 cycles. Below 100 cycles the amplitude developed by the diaphragm is adequate, but the acoustic output appears to be limited by the small diameter of the diaphragm (5 in.). Nevertheless, this slight deficiency is more than compensated for by the performance in the upper register, with the result that the general effect is surprisingly good for so small an instrument.



Lanchester moving coil loud speaker with permanent magnet field.

The price is 4 guineas, and models now in production are fitted with fret of simple design in keeping with the lines of the cabinet. The makers are Messrs. Lanchester Laboratories, Ltd., Spring Road, Tyseley, Birmingham.

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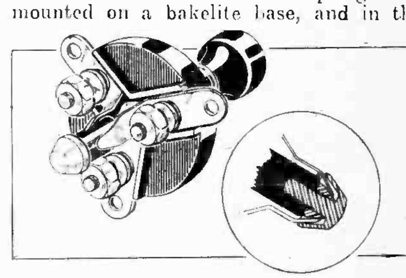
NEW W.B. SWITCHES.

The new push-pull switches introduced recently by the Whiteley Electric Radio Co., Ltd., Nottingham Road, Mansfield, Notts, make use of a method of contact not hitherto met with in switches of this type. Two samples have been sent in for review, the one a simple make-and-break switch, and the other a three-point switch. Stout nickel-silver springs are mounted on a bakelite base, and in the

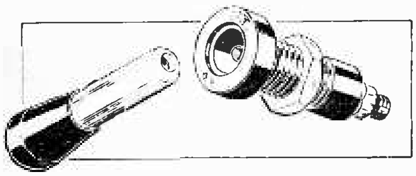


New W.B. three-point switch and, inset, enlarged view of double-cone contact

"on" position the tips of these springs snap into a re-entrant cone carried on the end of the plunger. This affords a larger area of contact than possible with the orthodox arrangement, since the springs are gripped by the double cone making contact on both sides of the leaves. All contacts are insulated from the plunger so that the switches may be mounted on metal panels without the aid of insulating bushes. Single-hole fixing bushes are fitted, and all metal parts are nickel-plated. Soldering tags, in addition to terminals, are provided, and the prices are: 1s. 6d. for the three-point model, and 1s. 3d. for the two-spring type.

CLIX NEW "ALL-IN" TERMINAL.

Since the introduction of the resilient socket to replace the split pin and plain socket for plug-in type connectors, Clix have remodelled many of their standard lines to enable the new arrangement to



Clix new "All-In" insulated terminal with solid plug and terminal socket.

be adopted. The insulated "All-In" terminal is now fitted with a solid pin mounted in the fixed position of the connector and the removable part, to which the flex lead is attached, has a helically slotted resilient socket.

All metal parts are fully insulated and the terminals are designed to safeguard the valves, since the various flex portions are not interchangeable.

The complete terminal costs 8d., engraved or plain. The flex portion and the panel fitment can be purchased separately at 4d. each.

The makers are Lectro Linx, Ltd., 254, Vauxhall Bridge Rd., London, S.W.1.

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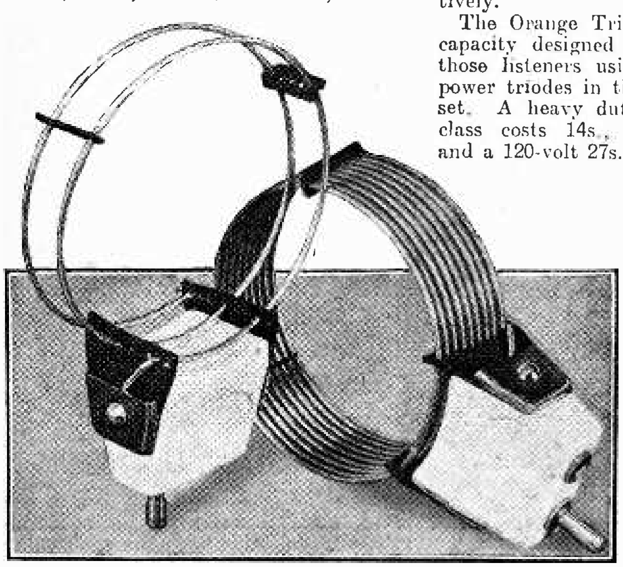
ATLAS SHORT-WAVE COILS.

These coils are made in four sizes, and enable a wave range of from 15 to 100 metres to be covered with a 0.0003 mfd. tuning condenser. The coils are wound with stout gauge tinned copper wire and mounted on porcelain, the plugs, sockets, clamping screws, and other metal parts, being nickel-plated. The set consists of a two-turn coil, a four-turn coil, a six-turn coil and a nine-turn coil, the price being 10s. the complete set. The prices of the separate coils are, No. 2, 2s. 6d.; No. 4, 2s. 7d.; No. 6, 2s. 8d.; and No. 9, 2s. 9d.



Clarke's Atlas No. 2 and No. 9 short-wave coils.

The makers are H. Clarke & Co. (Manchester), Ltd., Atlas Works, Old Trafford, Manchester.

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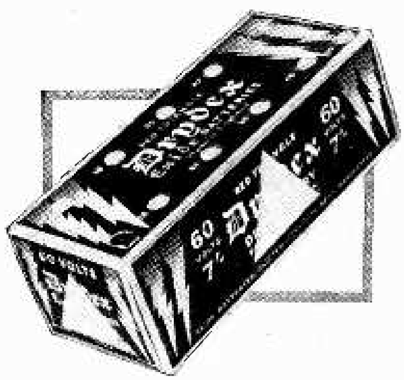
EXIDE INTRODUCE DRY BATTERIES.

Reliable figures relating to the percentage of broadcast listeners who use dry-cell H.T. batteries are exceedingly difficult to compile, but the evidence collected by the makers of Exide batteries is apparently sufficiently weighty to induce this firm to enter the dry-cell market.

The batteries are officially known as Drydex batteries, and include H.T., grid bias and sundry sizes of torch and pocket lamp batteries.

The H.T. range, with which we are particularly concerned, consists of four types—the Red Triangle, Green Triangle, Orange Triangle, and Blue Triangle. The first two mentioned are standard capacity size, but the Green Triangle class is of superior quality. The prices of the Red Triangle series range from 7s. for a 60-volt size to 14s. for the 120-volt unit,



New Drydex battery just introduced by Exide.

while the corresponding types in the superior class cost 9s. and 18s. 6d. respectively.

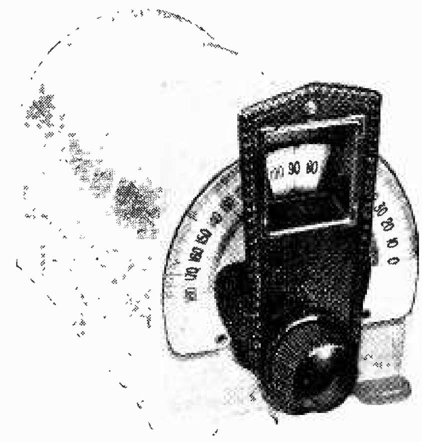
The Orange Triangle series are triple capacity designed to meet the needs of those listeners using power pentodes or power triodes in the output stage of the set. A heavy duty 60-volt unit in this class costs 14s., a 105-volt 24s. 6d., and a 120-volt 27s.

The Blue Triangle series have been designed especially for portable sets, and are made in three sizes, viz., 63 volts, 99 volts, and 108 volts, the prices being 9s., 14s., and 15s. 6d. respectively.

At the time of writing a sample Red Triangle battery is undergoing a life test, and when this is completed we shall be in a position to give some first-hand information concerning these new batteries.

POLAR "DISC" DRIVE.

Below is illustrated the Polar "Disc" drive fitted to their "Tub" three-gang



The Polar "Disc" drive.

condenser which was inadvertently omitted from the illustration accompanying our test report on this condenser, which we published on page 711 in our issue of December 24th last. The price of the drive is 5s. and the makers are Wingrove and Rogers, Ltd., Arundel Chambers, 188-189, Strand, London, W.C.2.

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Catalogues Received.

Rialton Radio, 14, Golden Square, London, W.1.—Illustrated folder dealing with their range of portables, transportables, and radio-gramophones.

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The M.L. Magneto Syndicate, Ltd., Victoria Works, Coventry.—"The Book of the M.L. Rotary Transformer," describing and explaining the uses of the various machines made by this firm.

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Celestion, Ltd., London Road, Kingston-on-Thames.—Illustrated folder in colour dealing with the new season's range of loud speakers, the Celestion-"Woodroffe" pick-up and the Tiltatone.

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Asea Electrical, Ltd., 5, Chancery Lane, London, W.C.2.—Illustrated price list, A.C.7, dealing with single, two and three phase induction type motors, ranging from ¼ h.p. to 120 h.p., also starter equipment for same.

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Snap Switches, Ltd., controlled by Graham Farish, Ltd., Bromley, Kent.—15-page illustrated catalogue describing the new range of Sinlas, Nilos, Litlos, and Ton-A-Kap condensers recently introduced by this firm.

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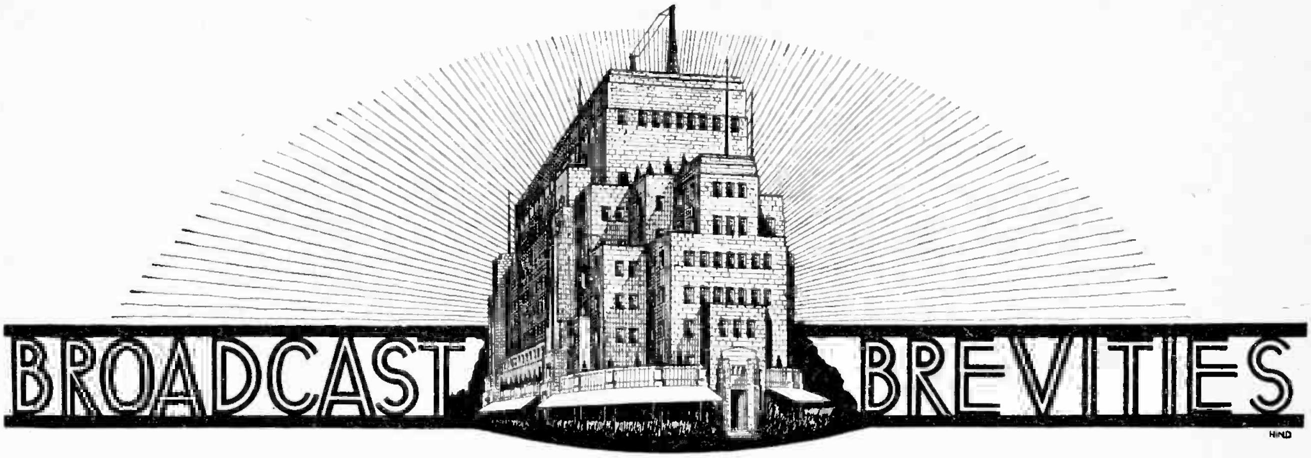
The Edison Swan Electric Co., Ltd., 123-5, Queen Victoria Street, London, E.C.4.—Publications R583 dealing with the full range of Mazda valves, and R594 describing the Ediswan Sound Reproducing Installations designed to distribute broadcast matter throughout hospitals, hotels, and residential flats.



By Our Special Correspondent.

More Money for the B.B.C.—Talk of "Sponsored" Programmes.—Mystery of Northern Regional.—Acoustic Tests at "Broadcasting House."—Is an Organ Needed ?

New B.B.C. Licence.

A new licence for the B.B.C. is being drafted by the Postmaster-General, Mr. Lees-Smith, but it will be a considerable time, I understand, before its terms are arrived at by the Treasury, mainly because its chief clauses will concern the amount of money to be paid over to the Corporation.

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A Treasury Grant.

The present percentages of the licence receipts allowed to the B.B.C. are, it will be recalled, 90 for the first million, 80 for the second, 70 for the third, and 60 for each of the succeeding millions.

The new licence will provide for an additional grant to the B.B.C. of £200,000, which should considerably ease the strain in regard to the regional scheme.

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The B.B.C.'s Assets.

It was always unlikely, of course, that a loan could be floated. Capitalists who might have been inclined to part with their money would have looked for assets as security, and it is surprising how few of these the Corporation possesses.

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More Money from Licences?

The only alternative that the P.M.G. has recognised is the grant of additional funds from the licence receipts, and these will certainly be needed before much headway can be made with the Scottish regional transmitters.

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Salaries at Savoy Hill.

In the meantime, strict economy is the order of the day at Savoy Hill. Considerable savings are being effected in lighting, heating, and a hundred and one little details about which the staff formerly never bothered themselves.

The annual period for the revision of staff salaries is now approaching, but I hear that suggestions for increases are being subjected to the closest scrutiny.

The "Sponsored" Programme.

While on the subject of B.B.C. finance, it is interesting to note the merest hint of a change of view at Savoy Hill in regard to the question of sponsored programmes. I believe that the attitude of more than one person in authority has recently changed from the adamantine to the slightly plastic.

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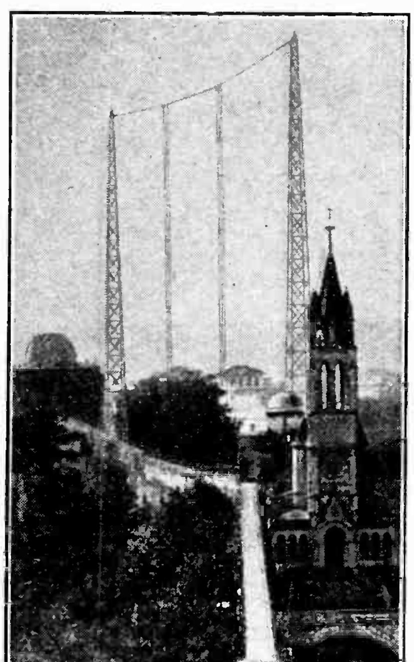
A Way Out?

The B.B.C. Charter specifically states, of course, that the Corporation must not accept any monetary consideration for its programmes, but there are probably ways of introducing the commercial element without transgressing the printed rules.



HYJ CALLING. A picturesque view of the new Marconi short-wave station at the Vatican City.

It is quite conceivable that a business house might supply the programmes for a whole day without paying a penny to the broadcasting organisation. But the said organisation would be saving the money which would otherwise have been required for that day's programme.

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Why Revenue Should Increase.

B.B.C. revenue should undoubtedly increase very considerably during the coming year with the inauguration of Northern Regional. This station opens up a vastly enlarged service area in the counties of Lancashire, Yorkshire, Cumberland, Westmorland, and Durham where the present proportion of listeners to the total population does not exceed 7 per cent.

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"This Year, Next Year, Sometime, Never."

In view of this fact it is all the more mystifying that there should be so much delay in starting up the new station. Week after week slips by and still we hear that "great progress" is being made, that radiation tests are being conducted, but that the public tests will not yet take place.

Already the station is nicknamed "The Four Cherry Stones."

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The "Patient" Northerner.

There is surely something disquieting in the fact that the northerners, who are generally vocal enough if they are kept waiting, are displaying very little sign of impatience over the regional delay.

Is this an indication that after all the regional scheme is not so tremendously popular as was once thought? Or is the North Country breeding a new race?

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Harry Tate.

Harry Tate will make his first appearance for many years in a studio on February 28th, when he is to broadcast in the vaudeville programme for National listeners. He has been heard only twice previously on the wireless.

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Exclusive to the "Radio Times."

How far the B.B.C. should go in advertising their journals by the aid of the microphone has for long been a subject of comment, but it must have come as a rude shock to many who were listening to the broadcast service the other Sunday evening to hear the announcement that the words of the second hymn were to be found "in this week's copy of the *Radio Times* only."

Coming "O.B.'s."

A large number of sporting events are entered in the Outside Broadcast Director's diary for running commentary arrangements on the coming months.

On February 28th National listeners will hear Captain Wakelam describe the Wales *v.* France Rugby International, and Regional listeners will have Mr. Allison's story of a match in the sixth round of the F.A. Cup.

The Oxford and Cambridge Boat Race on March 21st will be described in a running commentary by Mr. John Snagge, while the scenes on the course during the race will be described by Mr. Holt Marvell.

Other future arrangements include commentaries on the Grand National, the semi-final and the final of the F.A. Cup, the Derby, and the race for the Schneider Trophy.

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AT THE VATICAN CITY. Marchese Marconi and some of the officials inspecting the short-wave transmitter which was formally opened by the Pope on Thursday last in a Latin speech successfully re-broadcast by the B.B.C.

Acoustic Tests at "Broadcasting House."

Now that "Broadcasting House" has its lid on, arrangements are in hand for testing the studio acoustics, on which so much will depend.

According to the plans, the studios should yield perfect results, but architects have learnt from bitter experience that acoustic theories sometimes suffer very cruelly when put into practice.

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Is an Organ Necessary?

The results of the tests will greatly interest two rival factions at headquarters. One school of thought considers that the B.B.C. should possess its own concert organ and that an instrument of worthy proportions should be installed in the large studio at Portland Place. This opinion is opposed by those who feel that the B.B.C. has proved its ability to obtain all the necessary organ music from outside sources.

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A Severe Test.

I understand that there would be no objection to a studio concert organ if—and the if is a big one—it could be shown that no interference would be caused to other studios. But organ music, particularly in the lower register, is of a peculiarly penetrating kind, and it seems highly doubtful whether even the sound-insulating walls of Broadcasting House could withstand it.

Touring Scottish Churches.

The Scottish Region of the B.B.C. is, during the coming year, to make a tour of the churches all over Scotland, and on February 22nd one of the first of these outside broadcasts will be given from the Old High Church at Inverness. This tour of Scottish churches will take a long time, but it is to be hoped that when the end of it is reached the B.B.C. will, under the advice of the Religious Advisory Committee, have made a representative selection from the country religious life of Scotland as it is to-day.

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Theatre Releases Actor for Broadcasting.

Tom Walls, who is recovering from his recent accident in the hunting field, has written from his sick bed to Denis O'Neil, releasing him from his part in "Marry the Girl" on the nights of March 5th (Regional) and March 7th (National), to enable him to take part in the radio play, "Rich Girl, Poor Girl." This is the first occasion in the history of the B.B.C. that an artist has been released from his theatre contract to enable him to broadcast.

A few years ago Denis O'Neil's name was frequently in the broadcasting programmes, both for London and provincial stations. Before the Alhambra, Leicester Square, "went 'talkie,'" he was billed as "the great B.B.C. artist."

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Wanted: A Better Interval Signal.

Several bright suggestions have reached me for a better interval signal than the existing "tick tock," which one critic has described as "a death tick in goloshes."

The best, to my mind, is the notion that each B.B.C. station should have its distinctive interval signal, devised to reflect the traditions and sentiments of the locality.

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Intelligent Suggestion.

My correspondent suggests that Northern Regional might adopt a continuous clog-dance. Intervals at Aberdeen would echo with the sizzling of the haggis, while a Welsh station would offer the familiar "drip, drip," indicating a leek . . .

FUTURE FEATURES.

National (261 and 1,554 metres).

FEBRUARY 22ND.—"The Tempest" (Shakespeare).

FEBRUARY 23RD.—"Aida," Act 4, relayed from Halifax.

FEBRUARY 25TH.—B.B.C. Symphony Concert relayed from Queen's Hall.

FEBRUARY 26TH.—"Matinée," a play.

FEBRUARY 27TH.—"Requiem Mass," by Frederic d'Erlanger, first performance.

FEBRUARY 28TH.—Running commentary on Rugby match, Wales *v.* France (from Swansea).

National (1,554 metres).

FEBRUARY 22ND.—Religious service from St. George's Chapel, Windsor.

FEBRUARY 25TH.—Orchestral concert from Bournemouth.

London Regional.

FEBRUARY 22ND.—R.A.F. Band concert.

FEBRUARY 23RD.—Memorial concert to Peter Warlock, relayed from Wigmore Hall.

FEBRUARY 24TH.—Bach choir concert relayed from Queen's Hall.

FEBRUARY 25TH.—Vaudeville programme.

FEBRUARY 26TH.—"I Pagliacci," relayed from Halifax.

FEBRUARY 27TH.—A Grieg programme, vocal and instrumental.

FEBRUARY 28TH.—Running commentary on sixth round of F.A. Cup.

Midland Regional.

FEBRUARY 23RD.—The Prime Minister speaking at annual banquet of Birmingham Chamber of Commerce.

FEBRUARY 28TH.—"All the Fun of the Fair," cokernut cameos by F. Morton Howard.

West Regional (Cardiff).

FEBRUARY 27TH.—"Creditors," a play by Leonard J. Hines, relayed from Bristol's Little Theatre.

North Regional (Manchester and Leeds).

FEBRUARY 24TH.—Liverpool Philharmonic Society concert, from Liverpool.

FEBRUARY 26TH.—Hallé concert from Free Trade Hall, Manchester.

Glasgow.

FEBRUARY 28TH.—Mr. Alexander Malay: An eye-witness account of a tie in the fourth round of the Scottish Cup.

Belfast.

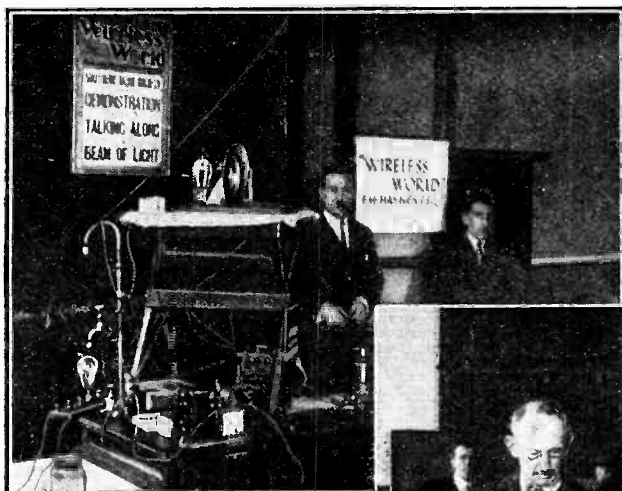
FEBRUARY 28TH.—Running commentary on International Rugby match, Ireland *v.* Scotland, relayed from Dublin.

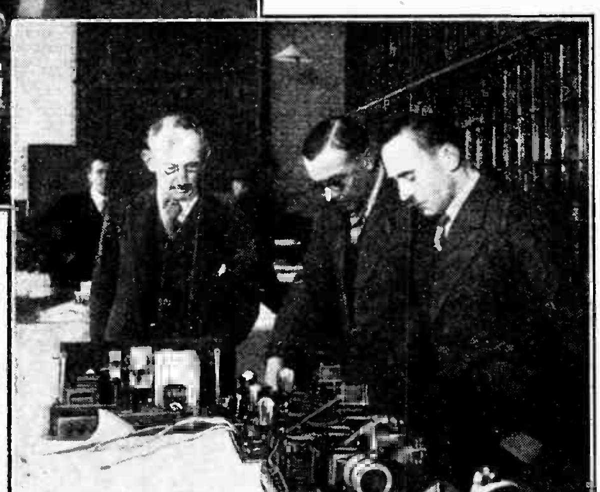
SOUTHEND'S RECORD RADIO SHOW.

Good Amateur Exhibits: Talking Along a Beam of Light.

IF public enthusiasm in the Southend-on-Sea district affords an index to the feelings of the country generally, the popularity of wireless is still steadily increasing. No fewer than 6,281 people visited the exhibition held at the Boys' High School, Victoria Circus, by the Southend Radio Society on Saturday, January 31st last, an advance of about 1,600 compared with the previous year.

The attractions were many and varied. They included a collection of receivers built by members in competition for the silver challenge cup, a vigorous display by the local radio trade, and a striking demonstration, conducted by Mr. F. H. Haynes, Assistant Editor of *The Wireless World*, in conjunction with the General Electric Company, of music and speech transmitted along a beam of light.





The upper photograph shows the apparatus used for a demonstration of transmission along a beam of light at the Southend Radio Society's Exhibition. The light beam was focused on a photo-electric cell fifteen yards distant. In the lower photograph the judges are seen inspecting home-built receivers.

The entire proceeds of the Exhibition, which was the seventh annual event of its kind, were devoted to charity, the main object being to install wireless equipment in the New General Hospital. In addition to the admission receipts, charitable objects also benefited from the proceeds of the "junk" stand, at which many members of the public displayed discrimination and judgment in the purchase of spare parts.

The silver championship cup for the exhibit of the most outstanding constructional merit was this year won by Mr. Britton for his radio-gramophone set incorporating a four-stage R.C.C. amplifier with paralleled pentode output. This instrument and another shown by Mr. S. Wilkins, using band-pass tuning and a diode detector, gave continuous demonstrations from 2 to 6 p.m. Other attractive exhibits included a small short-wave transmitter, made by Mr. Costin, of Billericay, and an all-mains set encased in glass which had been specially constructed by Mr. Knipe for the stand of Messrs. E. K. Cole, Ltd., at Olympia.

The judging was carried out by Mr. Frank Garon and by Mr. H. B. Dent of *The Wireless World*. Cabinets were judged by Mr. H. L. Lobb. The entries showed an increase over those of last year, the total being 53.

Many valuable prizes were presented by well-known radio firms. Messrs. Garnett, Whiteley and Co., gave one of their "Lotus" D.C. all-mains sets, valued at £19 10s., for the best entry by a High School boy, and this was won by C. J. Stockell. The General Electric Company gave an "Osram" Music Magnet Kit complete with valves.

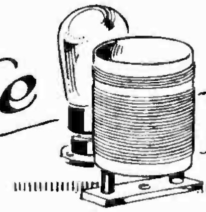
Great interest was shown in the modulated light beam demonstration. Gramophone music was transmitted by a beam of light traversing the hall and falling on a photo-electric cell followed by an amplifier. Visitors were able to convince themselves of the genuineness of the display by intercepting the ray of light, thus interrupting the music, to the amusement of the large audience.

Prize-winners.

The full list of prize-winners is as follows:—

Sets by High School boys: 1, C. J. Stockell; 2, E. R. Bessell; 3, A. Jenkinson. Transportable sets: consolation, F. C. James. Short-wave sets: 1, J. G. Ward. Two- or three-valve sets: Class A: 1, J. G. Ward; 2, G. Crabb; Class B: 1, Miss D. Burrows. Four-valve sets: 1, E. W. Lockhart. Sets with battery eliminator, Class A: 1, F. R. Ford; 2, E. T. Wiseman. Class B: 1, M. Keddie. Radio-gramophones: 1, G. P. Britton; consolation: S. R. Wilkins. Loud speakers: 1, W. McGeorge. Battery eliminators: 1, A. H. Gregson. Wave-meters: 1, B. Costin. Pick-up carrier arms: 1, T. Holbeche; consolation: F. C. James. Adaptor units: 1, E. W. Lockhart; special: H. H. Burrows. Various non-mechanical units: 1, L. Renall; special: H. A. Clinton.

THEORY of the H.F. TRANSFORMER



Interactions Between the Windings.

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

(*Concluded from page 126, February 4th issue.*)

HAVING found by numerical calculation the effects of the tuned secondary circuit[1] on the primary winding for a specified transformer, it is now expedient to develop a simple formula giving the apparent increase of primary resistance caused by the tuned secondary circuit magnetically coupled to it. This will show us upon what factors the effective increase of resistance depends. We already know that the voltage induced in the secondary circuit by the primary current I_1 is given by $E_2=\omega MI_1$ volts, where $\omega=2\pi\times$ frequency and M is the mutual inductance in henrys between the circuits. With the secondary circuit tuned to resonance the current in it is then $I_2=E_2/R_2$ amps., where R_2 is the effective series resistance of the circuit, and putting $E_2=\omega MI_1$ we get

$$I_2=\frac{\omega MI_1}{R_2}\text{ amps.} \quad .. \quad .. \quad (2)$$

Now, reversing the process, the voltage E_1' induced in the primary coil by the current I_2 in the tuned secondary is $E_1'=\omega MI_2$ volts, and, substituting for I_2 the value given by equation (2), we have $E_1'=\frac{\omega^2M^2I_1}{R_2}$ volts. It has already been shown that the primary current I_1 and the voltage E_1' produced in the primary coil by I_2 are in exactly opposite phase, so that the effect of the secondary current on the primary coil is to oppose the passage of I_1 at all times to an extent proportional to its magnitude. This means, as previously explained, that the *resistance* of the primary coil is apparently increased by an amount whose value is $R_1'=E_1'/I_1$ ohms. Therefore, substituting for E_1' the value given by the previous equation, we have for the apparent or effective increase of primary resistance:

$$R_1'=\frac{\omega^2M^2}{R_2}\text{ ohms} \quad .. \quad .. \quad (3)$$

where $\omega=2\pi\times$ frequency.

It should be borne in mind that this expression for the apparent increase of primary resistance is only true provided the secondary circuit is tuned to resonance and that R_2 is the effective H.F. resistance of the secondary circuit under these conditions.

Equation (3) shows that the resistance apparently added to the primary circuit is proportional to the *square* of the mutual inductance M between the coils and inversely proportional to the effective resistance of the tuned secondary circuit.

When we come to consider the high-frequency transformer as an intervalve coupling it will be seen that the value of R_1' plays a very important part. We must, therefore, have some means at our disposal of determining its magnitude in a moderately simple way. This might appear to have already been accomplished in the development of equation (3), but, unfortunately, a difficulty arises when we attempt to express the mutual inductance M numerically. The value of ω is known, being $2\pi\times$ frequency, and R_2 can be fairly closely estimated from the dimensions of the secondary winding of the transformer; but the mutual inductance depends not only on the geometrical properties and the number of turns of each winding, but also on the relative positions of the two coils. Theoretical calculation of the mutual inductance or the coupling coefficient between the windings is not an easy matter, and for a given transformer, actually having been constructed, the safest course is to find the value of M by practical measurement. This in itself requires special apparatus and a certain amount of skill.

Nevertheless, we have gleaned the information (*a*) that the tuned secondary circuit produces an apparent change of primary circuit resistance, (*b*) that there is no effect on the primary reactance, and (*c*) as to the factors determining the apparent change of primary resistance.

Power Losses in the Windings.

The fundamental effect of resistance in a circuit when a current flows is the generation of heat. We have repeatedly referred to the calculated increase of primary circuit resistance as being an *apparent* increase, the magnitude of which is given by equation (3). We shall now see why this is only an apparent increase. Its magnitude was obtained from Ohm's law as regards the ratio of voltage to current, and would therefore appear to be real enough. But *for a given current* in the primary winding the rate at which heat is generated there is exactly the same whether the secondary coil is carrying current or not, and so from this point of view there would appear to be no change of resistance whatever in the primary circuit.

The power represented by the generation of heat in the primary coil is equal to the product of the square of the primary current and the *actual* resistance under all conditions. Both methods of resistance calculation are perfectly sound, and yet they seem to render contradictory results. However, a little consideration will show that the conclusions are not really contradictory.

[1] See *The Wireless World*, February 4th, 1931.

The Theory of the H.F. Transformer.—Under working conditions heat is generated in both the primary and secondary circuits simultaneously, the total power represented being $I_1^2R_1 + I_2^2R_2$ watts, where R_1 and R_2 are the actual resistances of the respective circuits.

Now, suppose that the whole of this power could be made to occur in the primary circuit alone, the power in the secondary circuit being reduced to zero, and suppose, further, that the primary current remains unaltered. This feat of imagination means that the secondary circuit is removed altogether, and that, therefore, *extra* resistance is inserted in the primary circuit in order that the total power shall be the same. Then the extra power expended in the primary circuit must be just equal to the power originally in the secondary, namely, $I_2^2R_2$ watts. Let R_1' denote the extra primary resistance necessary to account for the additional power, the primary current remaining I_1 as before. Then $I_1^2R_1' = I_2^2R_2$ watts, or

$$R_1' = \left(\frac{I_2}{I_1}\right)^2 R_2 \text{ ohms} \quad .. \quad .. \quad (4)$$

Turning to equation (2), we find that $\frac{I_2}{I_1} = \frac{\omega M}{R_2}$, and, substituting this value of the current ratio in equation (4), we get $R_1' = \frac{\omega^2 M^2}{R_2}$ ohms, which is precisely the same result as given by the other method and shown as equation (3).

So, in spite of initial appearances, the two methods of treatment actually lead to the same result. The latter method, however, gives a more definite physical meaning to the apparent increase of primary resistance R_1'. It is equivalent to the extra resistance which would have to be included in the primary circuit to maintain the total power unchanged if the secondary coil were removed or open-circuited, the primary current thus being unaltered in magnitude or phase.

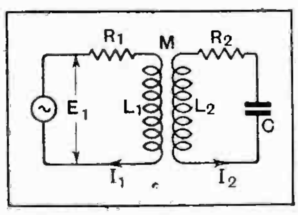


Fig. 1.—Circuit arrangement of a H.F. transformer with primary connected to a constant voltage source. The conditions obtaining when the secondary is tuned to resonance are discussed in the text.

Effect of Primary Impedance on the Secondary Circuit.

Since the secondary circuit has a definite effect on the primary, it is only reasonable to suppose that the reverse is also true. Let us refer for a moment to Fig. 1, in which a high-frequency transformer is connected to a source of alternating current. The primary and secondary resistance R_1 and R_2 are shown connected external to the windings for convenience.

Comparing the primary and secondary circuits, the main differences are (*a*) that the secondary is tuned to resonance whereas the primary is not, and (*b*) there are two E.M.F.s injected into the primary circuit, namely, the supply voltage E_1 and the induced voltage E_1' due to the secondary current, whilst in the secondary circuit the only injected voltage is that due to the current in the primary winding. Since the secondary circuit is tuned to resonance, the current is in phase with the voltage producing it, and we have seen that for this reason alone the secondary circuit only affects the resistance component of the primary impedance, the reactance being undisturbed.

On the other hand, the primary current will not be in phase with the resultant voltage determining its magnitude, and will therefore influence both the secondary resistance, as regards damping and selectivity, and the secondary reactance, as regards tuning.

The apparent increase of primary resistance arising as a result of the proximity of the tuned secondary is $R_1' = \frac{\omega^2 M^2}{R_2}$ ohms, and the apparent impedance of the primary circuit is therefore

$$Z_1' = \sqrt{(R_1 + R_1')^2 + (\omega L_1)^2} \text{ ohms} \quad .. \quad (5)$$

On the primary side the transformer behaves like a single circuit having this impedance. Knowing the applied voltage E_1, the primary current is therefore given by $I_1 = \frac{E_1}{Z_1'}$ amps. and lags by an angle ϕ where $\cos\phi = \frac{R_1 + R_1'}{Z_1'}$.

Apparent Increase of Secondary Resistance.

Referring again to Fig. 1, suppose that the supply voltage E_1 were to be suddenly reduced to zero, the circuit remaining closed. On account of the energy stored in the electrostatic and magnetic fields of the tuned secondary circuit, the current in the latter would not cease immediately, but would die away gradually in much the same way that the oscillations of a pendulum fall to zero when the driving impulses cease. The rate at which the current oscillations decay depends on the rate at which the stored energy is dissipated as heat *in both circuits*.

At the instant the voltage E_1 is cut off, the secondary current has its normal value I_2 amps., but immediately begins to decrease at a rate depending on the total power at that instant. Now we can apply the same argument as regards the apparent increase of secondary resistance as was applied in the case of the primary circuit, namely, the apparent gain of resistance in the secondary circuit is equal to that extra resistance which, when multiplied by the square of the secondary current, gives a dissipation of power equal to that in the primary circuit.

Immediately after the primary applied voltage E_1 has been cut off, the secondary current will be I_2 amps. This will generate a voltage $E_1' = \omega M I_2$ in the primary coil, and this, in turn, will drive a current $\frac{E_1'}{Z_1}$ amps. round the (closed) primary circuit, where Z_1 is the *actual* impedance of the latter. The power dissipated in the primary circuit will, therefore, be equal to the square of this current multiplied by the primary resistance, namely, $\left(\frac{E_1'}{Z_1}\right)^2 \times R_1$ watts.

The additional resistance R_2' in the secondary coil required to account for this extra power would have to be such that $I_2^2R_2' = \left(\frac{E_1'}{Z_1}\right)^2 R_1$ watts, and, putting

The Theory of the H.F. Transformer.—
$E_1' = \omega MI_2$, we get for the apparent increase of secondary resistance—

$$R_2' = \left(\frac{\omega M}{Z_1}\right)^2 R_1 \text{ ohms} \quad .. \quad .. \quad (6)$$

From this equation we obtain the important information that the apparent gain in secondary resistance is directly proportional to the primary resistance, and inversely proportional to the *square of the actual primary circuit impedance*. It is also proportional to the square of the mutual inductance, and therefore to the square of the coupling coefficient between the windings.

Effect on the Secondary Tuning.

By considering the power dissipation we have been able to develop equation (6) without recourse to elaborate deductions involving the phase differences between the various voltages and currents. But the equation could have been evolved by the vector method employed in the first instance in obtaining equation (3). However, in that case we should have found it necessary to split the primary current up into two imaginary components, one in phase with the votlage E_1' generated by the secondary current, and the other out of phase by 90°. It is the component of primary current in phase with E_1' that accounts for the apparent change R_2' of secondary resistance. The other component, out of step with respect to E_1' by a quarter of a cycle, generates in the secondary circuit a voltage which is just 90° out of phase with respect to the secondary current, and therefore represents an apparent change of *reactance* in the secondary coil.

In obtaining an equation for the change of secondary reactance, the only difference we have to contend with, compared with the determination of the apparent rise in resistance, is this 90° angle of phase difference. Therefore, the equation will be of exactly the same form as equation (6), but with the resistances involved in the latter replaced by reactances. Thus, the apparent change of secondary reactance due to the primary effects will be—

$$X_2' = \left(\frac{\omega M}{Z_1}\right)^2 X_1 \text{ ohms} \quad .. \quad .. \quad (7)$$

where X_1 is the primary reactance ωL_1 or $2\pi f L_1$ ohms.

But it is necessary to know whether this represents an increase or decrease of the inductive reactance of the coil. The current in the primary circuit lags behind the voltage, and by drawing the representative vector diagram it would be found that the reactive voltage set up in the secondary coil by the primary current is in opposition to the ordinary E.M.F. of self-induction in the secondary. The effect of inductive reactance in the primary circuit is, therefore, to produce an apparent *decrease* in the secondary inductive reactance. A preponderance of condensive reactance in the primary circuit would cause an apparent increase of secondary inductive reactance.

Since inductive reactance is given by $\omega \times$ inductance, if we divide each side of equation (7) by ω we obtain an expression for the apparent decrease of inductance of the secondary coil, namely—

$$L_2' = \left(\frac{\omega M}{Z_1}\right)^2 L_1 \text{ henrys} \quad .. \quad .. \quad (8)$$

The secondary inductance which is effective as regards tuning is, therefore, $L_2 - L_2'$ henrys, and for this reason rather more capacity will be required to tune the transformer to a given wavelength than for a single coil with the same inductance as the secondary of the transformer.

In an article to follow a complete numerical calculation will be given for a high-frequency transformer when used as an intervalve coupling, and the theoretical results obtained here will be utilised.

TRANSMITTERS' NOTES.

To Beginners and Advanced Transmitters.
In our issue of February 4th, under "Books Received," we drew attention to the seventh edition of "The Radio Amateur's Handbook," issued by the A.R.R.L., and containing much useful advice and information, both to experienced amateurs and to those who wish to qualify for a transmitting licence. The book, of course, deals mainly with American practice, which differs somewhat from that observed in Great Britain, but most of the valuable information is equally applicable to both countries.

Mr. F. T. Carter, Flat A, Gleneagle Mansions, Streatham, tells us that he keeps a supply of these handbooks, which he can sell at 4s. each, post free, and that he also has a few copies left of the sixth edition, which he can dispose of at half this price. Those interested will be glad to hear that copies are obtainable in this country, as thereby they avoid the delay consequent upon ordering direct from Hertford, Conn, and the trouble of remitting in foreign money.

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R.S.G.B. Tests.
The four Sundays in March will be devoted to tests on 2 megacycles (150 metres) for the purpose of investigating the possibilities of this wavelength for reliable long-distance communication with moderate power, and to note how much the reliability is affected by weather conditions, statics, fading, etc. The competition is open to all members of the R.S.G.B. in the British Isles, and the trophies at present held by G6ZH and G6YL will be presented to the winning transmitting and receiving station respectively. No contact will count for points unless the range exceeds 100 miles, and competitors should specially record the differences in signal strengths during periods of light and darkness. The power will be limited to 10 watts, and each competitor will be allotted four-letter codes, which will be changed for each of the four Sundays.

Mr. J. Hum, G5UM, 17, Eastwood Road, Muswell Hill, N.10, is in charge of the organisation of these tests and will allot the code letters to intending competitors and receive their reports on each Sunday's working. Transmitters intending to take part should send notice to G5UM not later than February 21st.

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International Short-wave Radio League.
We have received from Mr. Mander Barnett, the vice-president and European Manager of the League, the February issue of the "International Short-wave Radio News," from which we are glad to see that the membership is increasing. The current issue gives particulars of transmissions from the Westinghouse Electric and Manufacturing Company's station W1XIZ, which broadcasts programmes on 31.35 metres daily from Boston, Mass, as stated in our issue of February 4th, in "Current Topics."

The transmissions intended for Great Britain are sent from 1900 to 2100 and from 2300 to 0200 G.M.T., and reports of the reception of these signals, especially with regard to their strength, fading or other transmission phenomena, should be sent either to the headquarters of the League, Box 22, Jamaica Plain Station, Boston, Mass, or to Mr. Mander Barnett, 106, Lord Street, Southport, who will also receive applications for membership, for which the annual subscription is only 4s. 2d.

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.

Coupling Condenser Values.

I have some coils which I should like to use in the construction of a capacity coupled band-pass filter, although I believe that their H.F. resistance is rather lower than that of those ordinarily employed. Does this mean that I must use a smaller coupling condenser than usual?

No; as your coils are "better" than usual, the coupling condenser must have a somewhat higher value than is generally specified.

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Helping the Pigeon Fancier.

To avoid risk of injury to my neighbour's pigeons, I have threaded a number of corks on my aerial wire. Unfortunately, this has had the effect of impairing my reception; in fact, the transmissions from my favourite stations are now heard at less than half the normal strength. Is there anything I can do to avoid this loss of efficiency?

We would assure you that the fitting of corks to your aerial wire cannot in itself be responsible for any falling-off in efficiency of the aerial system. It must be assumed that your trouble is due to some other cause, or possibly that when the aerial was lowered a joint was disturbed, with the result that this resistance has increased, or that a partial short-circuit to earth has inadvertently been introduced.

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Non-uniform Coils.

A band-pass filter has just been added to my existing 1-v-1 receiver. Results are excellent as far as medium-wave reception is concerned, but on the long waves it is impossible to find an adjustment that will enable me to obtain single-knob control over more than a small part of the tuning range. This is not a matter of coupling, as various capacities have been tried. Will you please suggest what I should do in order to improve long-wave reception?

As your ganged-control system apparently works quite satisfactorily on the medium band, it seems certain that the inductance values of the long-wave coils are not properly matched; attention to this matter should overcome your difficulty.

Neutralised Filter Coupling.

If it is practicable, I should like to use a capacity-coupled band-pass filter as a coupling between a neutralised triode H.F. valve and a grid detector. Indirectly heated A.C. valves are used; there is to be no reaction, and, if possible, I should prefer to use ganged tuning condensers with earthed rotors. Will you please give me a circuit diagram of this arrangement?

The circuit diagram you require is given in Fig. 1. As the tuning controls are to be ganged and reaction is not to be used, it will be almost essential to "tap down" the detector grid connection in the manner indicated. Screening between the component circuits of the filter must, of course, be provided.

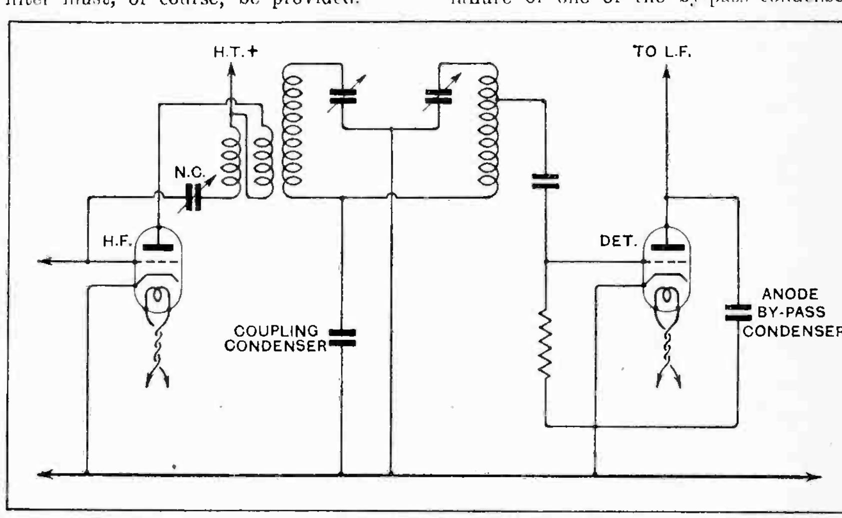

Fig. 1.—Intervalve filter circuit in conjunction with a neutralised triode H.F. valve.

"Live" Condenser Spindles.

In designing an "all-D.C." receiver is it possible to arrange matters so that the condenser rotors are "dead" as far as the mains are concerned?

The simplest way of attaining this object is to insert a large condenser (its actual value is not important, provided that it is many times that of the tuning condenser) between the rotor of the variable condenser and the low-potential end of the tuning coil with which it is associated. This plan is applicable when the tuning condenser is mounted on a metal panel or in a screening box, but, of course, the metal work must not be joined to the mains, except through a condenser; otherwise your object would be defeated.

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Motor-boating.

I have a four-valve A.C.-operated receiver which, after working satisfactorily for nearly a year, has developed uncontrollable L.F. oscillation or "motor-boating." Before attempting to trace the source of the trouble, I should like to know to what you think it might reasonably be ascribed.

The most obvious cause for this is the failure of one of the by-pass condensers forming part of the decoupling scheme; an internal or external disconnection may have developed. Similarly, a short-circuit may have developed across one of the decoupling resistances, but this is hardly probable.

Cases have come to our notice where L.F. oscillation has been due to decrease of emission in the output valve, with the result that the voltage applied to the earlier valves—and consequently their magnification and tendency towards self-oscillation—has increased.

An Unconsidered Resistance.

Will you please examine the circuit diagram of my output stage and say if there is any reason why the automatic bias arrangement as shown should not work properly. The valve seems to be over-biased, as anode current is rather less than it should be, according to the manufacturers' figures.

The bias resistance seems to be of the right value for the valve you are using, and assuming that the maximum permissible anode voltage is applied. We notice that you are using a 400-ohm. potentiometer which is connected across the valve filament, and we think you have ignored the fact that this introduces an extra 100 ohms into the circuit. Bias is thus increased by about 2.5 volts. This resistance, of course, is that of the two halves of the potentiometer in parallel. The matter will be made clear on reference to Fig. 2.

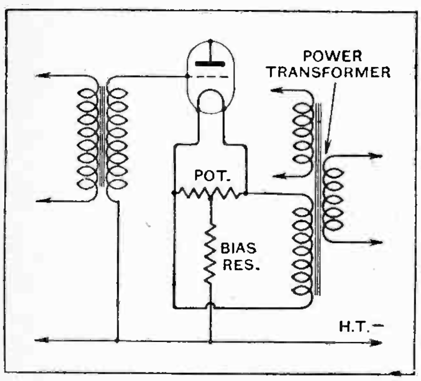

Fig. 2.—One-quarter of the filament potentiometer resistance must be added to the bias resistance value when calculating automatic bias voltage.

From every point of view it would be better to use a potentiometer of very much lower value.

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Overheated Resistance.

So far I have been unable to trace a fault in my "Band-Pass Four" receiver. The fact that the resistances R_{11} and R_6 become quite warm may possibly suggest to you where the trouble is likely to be found.

The resistance R_{11} will naturally become warm, as it carries about 40 milliamperes. R_6, however, should remain cool, and the fact that it heats up may be due either to the application of excessively high voltages or to the existence of a short circuit.

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Aerial Coupling.

Will you please tell me what is the best form of coupling for a two-circuit tuner which is to be operated in such a way that broad tuning—the band-pass effect, more or less—may be obtained without going to the length of providing ganged condensers? Any hints on the operation of the tuner would be welcomed.

From the electrical point of view there is very little to choose between the various methods of coupling between the aerial and secondary circuits, but possibly the method in which a very small variable condenser is joined between the high-potential ends of the two coils is slightly better for your particular purpose.

A tuner of this sort may best be operated by tuning-in signals to maximum strength with loose coupling—sufficiently loose to give no trace of the "double-humped" effect—and then, without touching the tuned controls, increasing the value of the coupling condenser till intensity is reduced to a slight extent. This procedure is hardly as simple as it would appear, and, if it can be managed, we would advise you to adopt single-knob tuning.

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Binocular Chokes.

When building a receiver with two H.F. stages one generally anticipates a certain amount of trouble through H.F. instability; in order to minimise the risk of uncontrollable H.F. oscillation, I propose, if you think it worth while, to obtain fieldless or binocular H.F. chokes, in place of those of the ordinary type.

Conditions sometimes arise where the use of chokes with a restricted external field is beneficial. This is particularly likely to be the case when dealing with self-contained frame aerial sets.

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Louder Signals.

At present my anode-bend detector feeds directly into the output stage through a resistance coupling. I am thinking of changing over to power-grid detection, and at the same time should like to obtain somewhat stronger signals. Accordingly, it is proposed to replace the coupling resistance by an L.F. transformer: will you please give me some idea as to the increase of magnification likely to be brought about by this change?

Provided that the conversion is properly made, it is reasonable to anticipate a gain in magnification approximately equal to the step-up ratio of the L.F. transformer chosen. Actually, it is to be anticipated that the actual gain will be slightly greater than this.

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H.F. or L.F. Amplification?

I am about to rebuild a somewhat out-of-date H.F.-det.-2 L.F. receiver, and intend to adopt a 2-stage H.F. amplifier; A.C. valves will be used throughout. As these valves are much more efficient than those originally used, do you consider that it would be as well to omit one of my present L.F. stages?

Yes; we strongly advise you to do so. Two L.F. stages in conjunction with modern A.C. valves will generally provide rather more L.F. magnification than can comfortably be dealt with. Unless one decides either to sacrifice a good deal of the available magnification, or else to adopt special precautions, there is a very real risk that instability will be produced. By adding an extra H.F. amplifying stage, losses in overall amplification, due to the omission of one of the L.F. valves, will be more than made good.

Earth Connections.

Is it not a fact that there should always be a direct connection between either the L.T. positive or negative bus-bars and the earth terminal of a receiver? I have just been examining a commercial three-valve battery-operated set of which the components are somewhat inaccessible, and find that there is no electrical continuity between either of the L.T. terminals and the earth terminal.

Almost invariably there is electrical continuity between these points, but very rarely an internal condenser is included in the earth lead, so that the set may be operated from a D.C. mains eliminator with safety. More rarely still, a double-wound, aerial-grid transformer without direct connection to the filament circuit is provided for the same reason.

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Battery Valves for Power Detection.

Although indirectly heated A.C. valves are generally used as power-grid detectors, I believe there is no reason why those of the battery-operated type should not serve this purpose. If so, will you please tell me what particular types are likely to be most suitable, and whether positive bias is needed as in an ordinary grid-detector circuit?

Battery-heated valves can be used for this system of detection; those of the "L" type with impedances in the order of 10,000 ohms are suitable. Positive grid bias will be required.

FOREIGN BROADCAST GUIDE.

POZNAN

(Poland).

Geographical position: 52° 25′ N.; 16° 55′ E.

Approximate air line from London: 728 miles.

Wavelength: 335 m. Frequency: 896 kc. Power: 1.9 kW.

Time: Central European Time (one hour in advance of G.M.T.).

Standard Daily Transmissions.

06.15, G.M.T. news; 08.00, concert (Sun.); 09.15, relays Wilno (Sun.); 12.00, time signal, fanfare from Town Hall; 16.45, concert; 19.00, main evening programme; 21.00, time signal, news, dance music (exc. Mon., Thurs.).

Woman announcer. Call: *Rhalo! Rhalo! Radio Poznanskie* and *Ici Radio Poznan* (phon.: *Paus-narn*).

Opening signal: as under; imitation of carillon.

Interval signal: Metronome.

Announcements as well as news bulletin are frequently given in both the Polish and French languages.

Closes down as Warsaw (*q.v.*).

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

New Readers' Number.

A "NEW Readers' Number" is an innovation for *The Wireless World*, so that we think a word of explanation might here be given as to why it has been introduced.

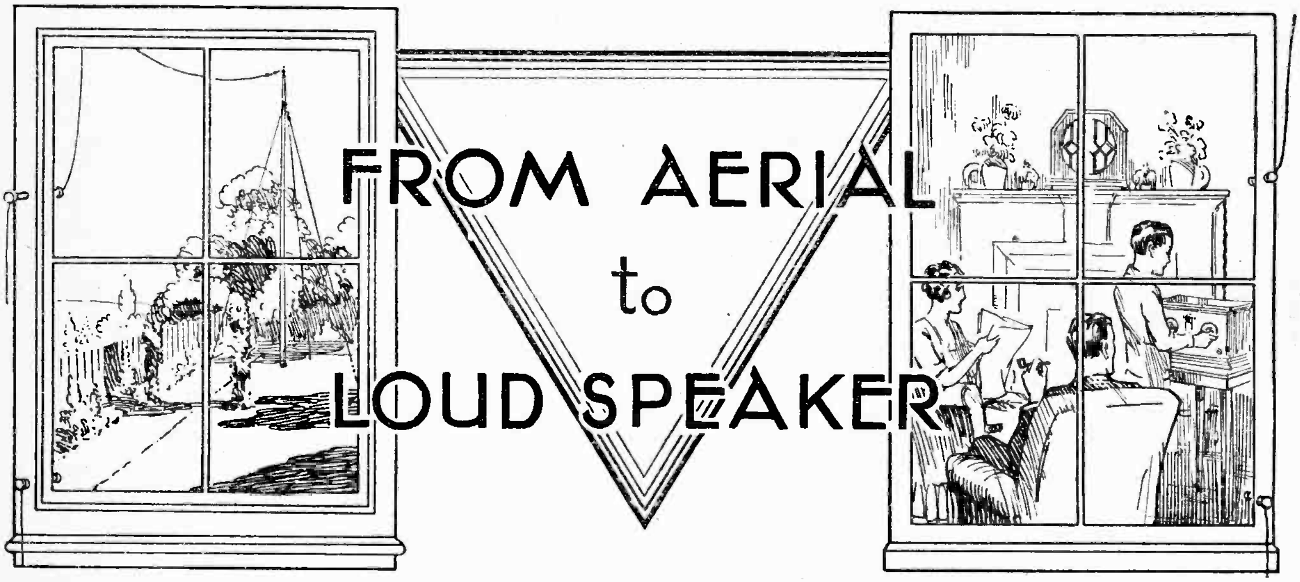
Very frequently, but more particularly about this time of the year, our correspondence with readers indicates that those who have become regular readers for the first time during the winter months, and a number besides who have been constant readers over a longer period, find that the pace set by *The Wireless World* is at times a little too hot for them. They have difficulty in keeping up to date, because new subject matter is frequently included, and, in their opinion, without as much explanation or simplification as they would like to see. It will be our endeavour, therefore, in this issue and in subsequent numbers, to maintain the same standard as in the past, but it will also be our aim to interpret more simply much of the subject matter with which we deal. We believe that this can be done without interfering with our policy of maintaining a high standard of accuracy and being right up to date in everything affecting the interests of our readers. No other wireless paper in this country has earned such a reputation for dependability, and, as our regular readers know, this position has been attained because the paper is one which can be trusted not to exaggerate claims for anything described, but to present all wireless topics, whether technical or general, in their proper perspective.

In this issue two constructional receivers are described—one a three-valve A.C. mains set, which makes use of the most up-to-date circuit for attaining selectivity with one high-frequency valve stage. An interesting refinement is introduced, to give constant selectivity over the tuning range. The second constructional set is not novel in itself, but is of a type which we believe will prove extremely popular with those of our readers who may not have attempted set construction before, or who want a stand-by receiver for general home use. The construction is reduced to the simplest possible limits, and the set is self-contained.

A feature which should be of very general interest is the Station Identification Chart, supplied as a supplement. This gives general information on most of the European stations, which can be satisfactorily received, and space is left for readers' additions, as required. The approximate tuning positions for various types of receiver are indicated.

The first of a new series of simple articles entitled "From Aerial to Loud Speaker" is included in this number. We believe that this series will supply a long-felt want amongst many of our readers. The aim has been to take a standard modern four-valve receiver and describe it section by section, explaining the purpose of every component. This method of treatment is new, and should, we think, prove extremely helpful. To emphasise the purpose which components serve in the set, the author discusses the effect of changing values above and below those chosen as correct, and in this way gives the reader a very complete explanation of circuit principles. The series will be continued through several issues concluding with the output stage

In This Issue



FROM AERIAL to LOUD SPEAKER

The Purpose of Every Component.

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

THE present article is the first of a short series in which the circuit of a modern four-valve receiver will be analysed in some detail. Each component used in the completed receiver will be separately examined, the reasons for its inclusion discussed, and the actual value that the component has in the set justified.

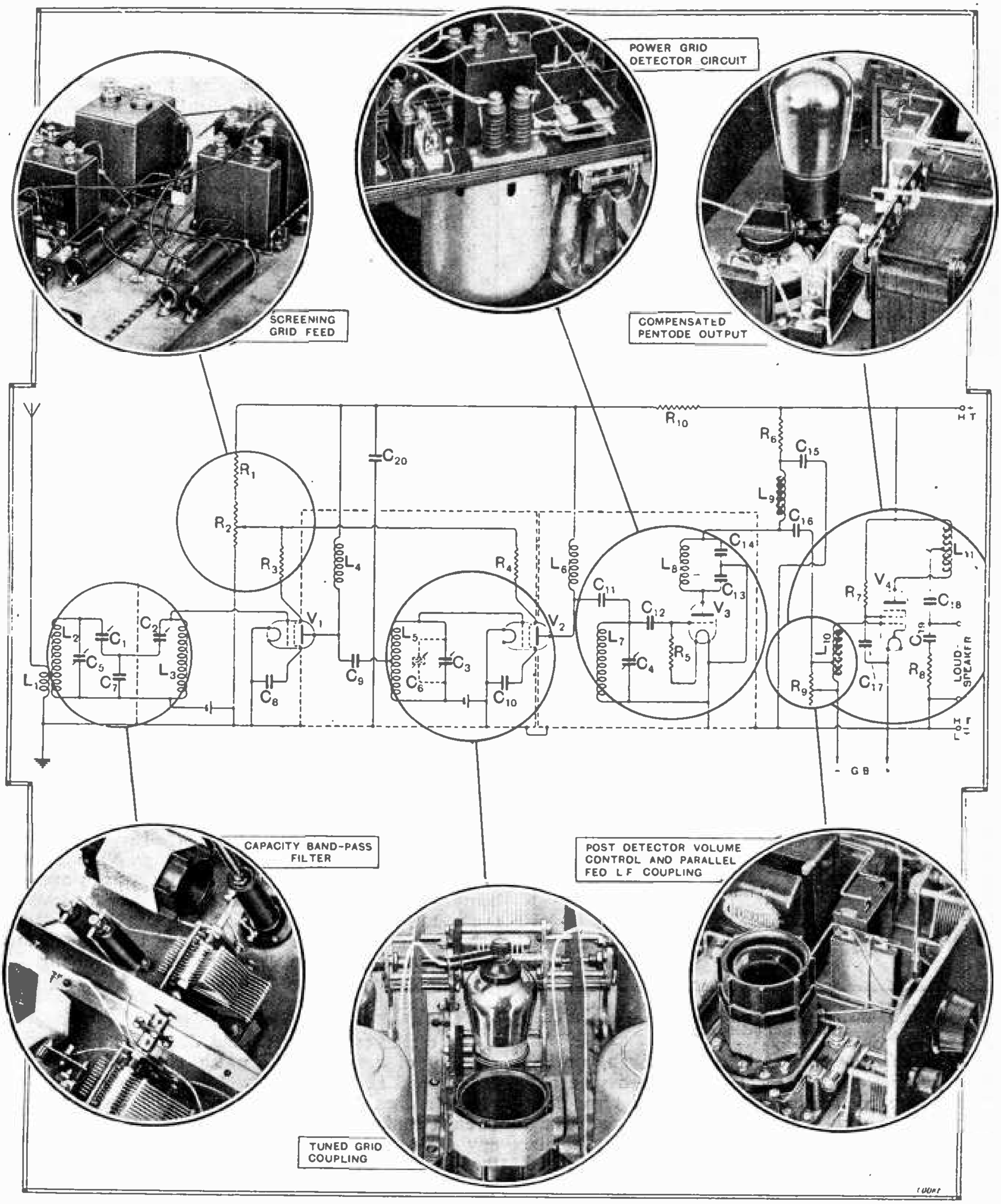
The series will almost amount to a short treatise on receiver-design, and readers are warned that however great the care taken to be strictly objective, the writer's favourite fads, fallacies, and prejudices will inevitably lie behind the whole. It is desirable, therefore, that every reader of these articles should consume them with the addition of as many grains of salt as his individual taste demands.

LET us make the arbitrary decision that the receiver of our discussions shall have four valves, but we have not yet settled what the functions of these four valves shall be. Modern practice is very definitely in favour of the set having two high-frequency stages and one low-frequency stage as against the other type of four-valve set with one high-frequency stage and two low-frequency stages. (These two types are referred to, shortly, as "2-v-1" and "1-v-2" respectively, the "v" standing for the valve detector, an abbreviation adopted by *The Wireless World*.) One of the reasons for preferring the 2-v-1 type is the fact the new high-ratio transformer and the pentode, used in combination, provide at least as much amplification as one needs to have after a detector of the modern "distortionless" type.

The fact that the detector has thus arbitrarily settled the point for us need not be regretted. It is not unfair to say that the most urgent need of the present day is selectivity, and it is self-evident that when there are two valves amplifying at high-frequency we shall be able to use more tuned circuits than when there is but one valve fulfilling this function; the 2-v-1 receiver is thus inherently more selective than its rival, the 1-v-2. It will not, however, be so very highly selective by nature as to absolve us from paying a very great deal of attention to selectivity in working out the details of the design. The only advantage, in fact, that the receiver with the single H.F. stage could possibly offer is a greater simplicity in use, due to the reduction in the number of the tuned circuits. The increased selectivity offered by the 2-v-1 set is more than adequate compensation for sacrificing this simplicity; the other gains, not the least of which is the distortionless detector, are all pure profit.

The circuit which the writer has chosen as being representative of all that is best in modern circuit design—including, of course, all his own pet fads—is reproduced, in slightly simplified form, in the accompanying full-page illustration. The simplifications made amount to no more than omitting wave-range switching and leaving the filament circuits incomplete.

Either battery-heated or mains valves can be used without alteration of the circuit; for the former, the L.T. *plus* leads must be added to the diagram, on which only L.T. *minus* leads are shown, while for indirectly heated valves the L.T. *minus* leads are to be connected to the cathodes, and complete heater-wiring has to be added. Whichever type of valve is adopted, the circuit as drawn may be used either with an H.T. battery or with any eliminator which will provide a smoothed current at the necessary voltage. As all decoupling and voltage-dropping resistances are included in the set itself (which, in the writer's opinion, is the proper place for them) there is no need to make any provision in the eliminator for voltages below the maximum which it will give. This simplifies the eliminator design.



PRESENT-DAY PRINCIPLES IN RECEIVER DESIGN. An analysis of a modern receiver circuit showing the essential features. They are, reading from left to right across the circuit (1) the capacity-coupled band-pass filter as used in the "Band-pass Unit." (2) The screen-grid feed circuits, (3) the tuned grid H.F. intervalve coupling and (4) the grid and anode circuits of the power grid detector as shown in "The Wireless World Four," (5) the parallel-fed L.F. circuit with its post-detector volume control and (6) the compensated pentode output as arranged in the "Power Pentode Two."

From Aerial to Loud Speaker.—

For purposes of illustration, it will be assumed that battery-heated valves are to be used, in conjunction with a mains unit giving 200 volts H.T.; such small alterations as are necessary for mains valves or other H.T. voltages can readily be made by those who are sufficiently interested to do so.

In going through the set in detail, one naturally begins with the aerial. This is necessary to pick up energy from the ether waves radiated by the transmitting station, from which it follows that a long aerial is likely to be more efficient than a short one. On the other hand, greater selectivity is usually obtained if the aerial is not too long. With the receiver shown, selectivity will be quite high even if a hundred-foot aerial is used, though in the immediate neighbourhood of a powerful transmitting station some sixty feet would be preferable in this respect.

Aerial and Earth.

Currents induced in the aerial pass through the coil L_1, which consists of some 20 turns of fine wire wound in close proximity to the earth end of the tuning coil L_2. The coupling between L_1 and L_2 is close enough to ensure that in passing through L_1 the aerial current sets up an induced current in L_2, thereby feeding the signals into the set. If L_1 were short-circuited practically no signals would be received, while if it were open-circuited by breakage of a connection the aerial currents could only pass to earth by way of stray capacities, so that signal strength would be very poor. With 10 turns in place of 20, signal strength would fall off very considerably, but the selectivity of the aerial circuit would be greatly enhanced; with 40 turns, on the other hand, selectivity would become extremely

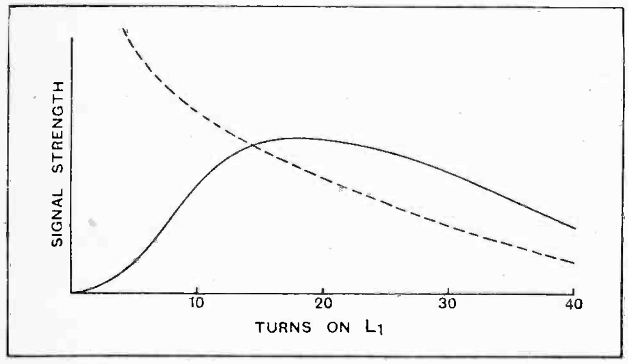


Fig. 1.—Variation of signal strength with primary turns, using average aerial. The dotted line gives some rough idea of the variation of selectivity.

poor, and volume would again suffer, though to a less extent (see Fig. 1). It is not unusual to have aerial-primaries tapped, so that the number of turns most suited to the particular aerial in use can be determined by experiment. In general, the smaller the aerial the more turns must be included in circuit between it and the earth connection.

Of the earth connection itself there is not much to be said, except to reiterate the well-known advice to use a thick, short wire running to a water-pipe that really goes to earth—and not, for example, to a cistern in the roof. The necessity for a low-resistance earth will be appreciated when it is remembered that the aerial and the ground beneath it form two plates of a condenser, and that the high-frequency currents resulting from the reception of signals have to pass from aerial to earth and back again in about a millionth part of a second. Even a small resistance, inserted in

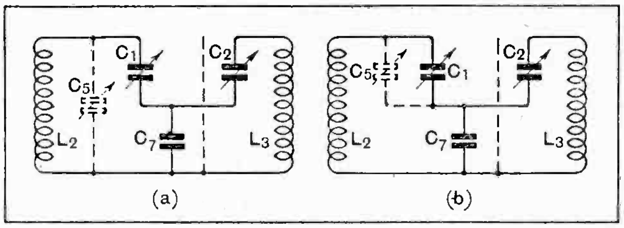


Fig. 2.—In (a) C_5 is in parallel with L_2; in (b) it is in parallel with C_1. The former position, in which the coupling is slightly loosened at low wavelengths owing to part only of the current flowing through C_7, is theoretically less perfect. In practice, the difference is too small to be detected with any certainty.

a path so frequently travelled as this, is to be avoided if possible.

The band-pass filter, built up from the two coils L_2 and L_3, the tuning condensers C_1 and C_2, and the coupling condenser C_7, may be regarded as one unit. Much has already been published in these pages on the design of filters; for present purposes it will be enough to say that such a filter gives both better selectivity and better quality than can be had from a single coil and condenser. The two coils L_2 and L_3 should be identical, and for such a set as that under discussion they should be as "low-loss" as is convenient. They should, therefore, be as large as space will permit, and should be wound on formers of good dielectric quality with wire of fairly heavy gauge. Sixty-eight turns of No. 24 D.S.C. wire wound on a 2½in former of ebonite or first-grade paxolin will be very suitable.

Each of these coils has a dual function; besides being tuned by its condenser to the required wavelength it gives a very considerable step-up of signals. If, therefore, either of them is short-circuited or disconnected, signals will vanish altogether. The windings suggested give an inductance of about 230 microhenrys, which can be tuned comfortably over the wave-range 200 to 550 metres. If the inductance were halved, the wave-range covered would become 140 to 390 metres, while if it were doubled the receiver would not tune much below 300 metres.

Wave-range Covered.

The tuning condensers C_1 and C_2 have a maximum capacity of 0.00035 mfd., which serves to take the coils L_2 and L_3 over the correct wave-range. If either of these should be disconnected, or short-circuited through contact between fixed and moving plates, or any other cause, the circuit concerned will cease to tune, and signals will vanish exactly as if the same fault had developed in the associated coil. Condensers of lower maximum capacity would restrict the waveband at the upper end, so that with the condensers "all in" the maximum wavelength would be below the 550 metres which we have taken as the highest wavelength

From Aerial to Loud Speaker.—

to which we are likely to wish to tune, while if larger condensers were used the waveband would be extended to well over 600 metres. This would be harmless enough were it not for the fact that the useful portion of the tuning range would then be restricted to part only of the dial, thus making accurate tuning more difficult than it need be. A change of condenser capacity in either direction would have but little effect at the lower end of the waveband.

Ganging the Band-pass Filter.

It is intended that C_1 and C_2 should be ganged together and operated by one knob; for ease in compensating for any slight difference in inductance between the coils L_2 and L_3, it is desirable that log-law condensers should be chosen, and that at least one of the two sets of moving plates should be movable on the shaft.

In addition to making allowance in this way for possible discrepancies between the inductances of the two coils it is necessary, if the two circuits are to tune accurately together over the whole wave-range, that the minimum capacity (that is, the capacity remaining in the circuit when the condensers are set to "o") should be the same in both circuits. For this purpose there is provided a small compensating, or "trimming," condenser C_5, which need have a maximum capacity no more than 0.00003 mfd. (*four* o's 3), and should have a very low minimum. An air-dielectric neutralising condenser, possibly with a few of the vanes stripped away, is ideal for the purpose. In the diagram C_5 is shown in parallel with the first tuning coil L_2; it depends very much on the details of the individual receiver whether it is required here or in parallel with the second tuning coil L_3. A filter which refuses to be ganged with the trimmer on the aerial side will usually behave at once if the trimmer is shifted to the secondary side and is put in parallel with L_3. There is, perhaps, a slight theoretical advantage to be gained by putting the trimmer across the tuning condenser rather than across the coil, as shown in Fig. 2, but in practice no difference can be detected in a normal case. The choice between these alternatives is largely a matter of convenience in wiring.

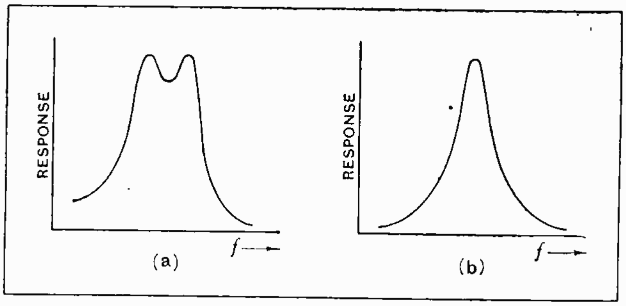


Fig. 3.—(a) shows a typical frequency-response curve of a band-pass filter, and (b) that of an amplifier without band-pass filter. If the two "humps" in (a) are high enough, the insertion of curve (b) into the central dip will give some approximation to the ideal flat-topped curve. The "humps" in (a) are raised by using low-resistance coils in the filter.

The condenser C_7, which is common to the two tuned circuits $L_2C_1C_7$ and $L_3C_2C_7$, provides the coupling between them. In theory it should be varied in capacity as the tuning is changed; in practice a fixed condenser is used, choosing a capacity which gives a satisfactory, if not quite perfect, compromise over the whole waveband. For the coils and condensers already described a capacity of about 0.01 mfd. will provide about the best possible compromise. A larger capacity than this would give too loose a coupling between the two tuned circuits, leading to over-sharp tuning and a considerable loss in signal strength, especially at the lower wavelengths. Too small a capacity, on the other hand, will broaden the tuning, especially at the higher wavelengths, to an unpleasant degree, and, in a bad case, would lead to the appearance of two separate points on the tuning dial, at either of which the same station could be heard, though at reduced strength. The advantage of using a capacity band-pass filter in the input of a receiver having tuned high-frequency stages is seen by referring to Fig. 3.

If C_7 is short-circuited, there will be no coupling whatever between the two tuned circuits, so that signals will only get through to the grid of the first valve by accident and in small amount. Disconnecting C_7 would open both tuned circuits, altogether preventing them from tuning.

Since C_7 has to provide the coupling between the two halves of the filter, and is given the right capacity to produce the exact degree of coupling required, it is essential that no source of accidental coupling shall exist. By setting L_2 and L_3 at right angles to one another, and putting between them a sheet of metal to form a capacity-screen (shown dotted on the diagram), stray couplings can be reduced to negligible proportions. It is to be noted that if C_1 and C_2, which are on opposite sides of the screen, are in metallic contact with it, C_7 will be short-circuited. The two tuning condensers should therefore be mounted on insulating bushes. In next week's issue consideration will be given to the choice of the screen-grid valve and the methods of feeding its screening grid and anode.

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OBTAINING SMOOTH REACTION WITH AN ANODE BEND RECTIFIER.

THE complaint is not infrequently heard that it is extremely difficult to obtain the same smooth reaction effects with an anode bend rectifier as with the conventional leaky-grid arrangement, and in some cases it is difficult to obtain reaction at all. The latter state of affairs usually exists in cases where the detector is followed by a stage of resistance coupling and the grid voltage has been adjusted to give maximum rectification efficiency. Under such conditions the power available in the anode circuit is small in comparison with that existing in the anode circuit of a leaky grid rectifier. It is necessary, therefore, if smooth reaction is desired, to compromise in the matter of grid voltage and use less negative bias than is necessary for best rectification conditions. A little experiment will speedily enable a value to be found at which reasonably good detection efficiency and also reaction control are both obtainable.

UNBIASED

BY FREE GRID

Shocking.

One frequently reads of various novel methods of ascertaining the nature of the electric light supply, ranging from the homely glass of water to the stroboscope, but, personally, I always think that the simplest and quickest method is to look at the meter, even though in some cases this involves crawling under the stairs and striking matches in the neighbourhood of the gas meter. Now, it so happens that I live in a district in part of which the supply is A.C. and in other parts D.C., although the voltage—240—is the same in each case. A friend of mine who is an electrical engineer recently moved into the district, and on the evening after his arrival we both sat in his den amid the havoc created by the "plain-van" men, discussing the details of a new receiver which he intended building. The question of mains operation cropped up, and I suddenly called to mind the fact that I was in a part of the district unfamiliar to me and did not know whether A.C. had yet displaced D.C., as it had done in my part of the town. The cellar door was still blocked by large packing-cases, and I commenced pushing them to one side in order to get at the meter.

With a muttered "Don't bother about that," my friend rose from his seat, removed a glowing lamp from its socket, and inserted his thumb. "A.C.," said he nonchalantly, and resumed his seat without more ado. "But how on earth——" I began, thoroughly mystified. "Elementary, my dear Watson," said he facetiously. "The fact has probably not penetrated to your somewhat adamantine cerebellum that in the case of A.C. the shock you get is due to the peak voltage, and not to the R.M.S. value." Now, obviously, if this were so, one would get the benefit of nearly an extra 100 volts when the mains were A.C., and my friend amplified his explanation by saying that experience had taught him this little trick. I was still unconvinced, and feebly protested that theory was all against this, as shock in the case of A.C. mains was due to an R.M.S. effect. However, on reaching home, my first job was to connect up 240 volts' worth of accumulators to a lamp socket and stick my thumb into this and then into one of the household lamp sockets. I was convinced. You are definitely *not* advised to try this unless you wish to bring grist to the mill of the mortician (see American dictionary), since a medical friend of mine tells me that this test, besides determining the nature of the supply, is also invaluable for detecting weak hearts and various other bodily ailments. Incidentally, the foregoing probably explains why A.C. and not D.C. is used at the electrical treatment centres maintained by various State Governments in the U.S.A.

"Elementary, my dear Watson."

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This Freedom.

So called "free" grid bias is being condemned in certain quarters on the grounds that nothing worth having is free, or, alternatively, as they say in law courts, that it is not free, as you have to pay for it in the form of lessened H.T. voltage and a greater tendency to instability. The advocates of it are putting forward equally foolish arguments against the retention of the grid battery. It seems to me that both parties are barking up the wrong tree. Surely both methods of obtaining grid bias have entirely separate spheres of usefulness. The case is analogous to that of the H.T. battery and H.T. eliminator. No serious amateur would think of conducting experimental work in receiver design using any form of battery eliminator as his source of H.T. supply, not only because he would have to be constantly changing the values of voltage dropping resistances, but because he would never know to what extent his experiments were influenced by stray coupling effects in the eliminator. It must be the bias battery every time for the experimenter, but in the case of a complete mains set built for the sole purpose of receiving broadcast programmes nothing is more absurd than the presence of a battery of any kind, even for the purpose of operating a remote control relay.

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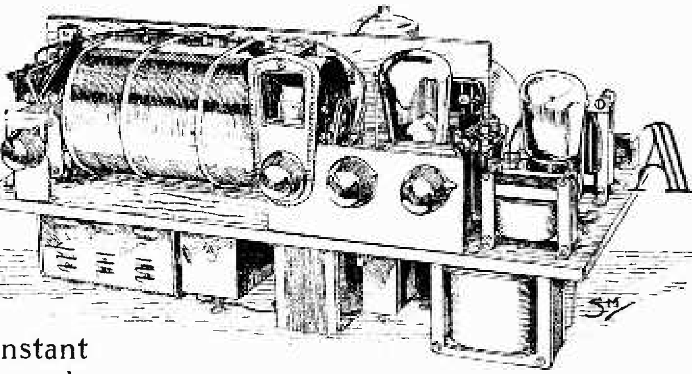
A Matter of Opinion.

This does not necessarily mean, however, that personally I entirely favour the particular method of mains bias which consists of putting resistances in the anode return lead —usually known as "automatic," by the way—although there is nothing whatever to be said against the system if you are prepared to change resistance values every time valves are changed for others of somewhat different characteristics. A far more satisfactory method from my point of view, however, is to employ an entirely separate grid bias eliminator, which consists of nothing more than an H.T. battery eliminator in miniature. A separate power transformer need not be used as you can now obtain transformers with an extra winding for this purpose.

Since only a very small current will be taken from the instrument in order to produce a fall in voltage across a potential divider, quite a small and inexpensive smoothing choke can be used. The method possesses the advantage that grid bias values can be changed as quickly and easily as when using a battery, and, moreover, the value of grid bias can be accurately determined, which is not always the case with the "automatic" method. It is, however, equally important to de-couple each grid circuit if motor boating is to be avoided.

Pre-Selection A.C. Three



A New Filter System Giving High and Constant Selectivity without Complications.

By H. F. SMITH.

SPECIFICATION.

GENERAL. A three-valve general-purpose receiver for A.C. mains operation with an open aerial.

CIRCUIT. Input filter. Screen-grid H.F. valve, coupled by tuned-grid method to power-grid detector. Choke L.F. coupling to pentode output valve. Auto-transformer feed to loud speaker. H.T. supply through Westinghouse metal rectifier.

CONTROLS. (1) Single-dial control of three tuning condensers. (2) Input volume control. (3) Reaction. (4) Trimmer for H.F. coupling. (5) Wave-range switch.

SOME eighteen months ago it was seriously debated whether the neutralised three-electrode H.F. valve should be granted a new lease of life. Selectivity was the trouble; everyone realised that the screen-grid valve gave much more real amplification—and with much simpler apparatus—than its forerunner, but to avoid cross-modulation and other drawbacks, while retaining simplicity of operation, it was found that so large a proportion of the available aerial input had to be thrown away that the average set of the period worked no better than a good "neutrodyne" of 1926 or 1927.

Fortunately, the drastic and retrograde step of abandoning the screen grid valve was proved to be quite unnecessary. Pre-selection, or the virtual elimination of interfering signals before they are allowed to reach the first valve of the receiver, was found to offer a practical solution of the problem. Admittedly, this principle had previously been applied by adopting two-circuit aerial tuners, but such devices appealed only to the skilled amateur, and the man in the street showed no inclination to master the art of operating them. The development of single-control band-pass filters entirely obviated the need for any special skill.

Now, any kind of input filter is probably better than none; but, as pointed out in last week's *Wireless World*, the conventional capacity- or inductively-coupled arrangements have definite shortcomings, as their selectivity changes seriously while passing from one end of the tuning scale to the other, if we assume that coupling is fixed. If provision is made for variation of coupling, the receiver will no longer be easy to operate.

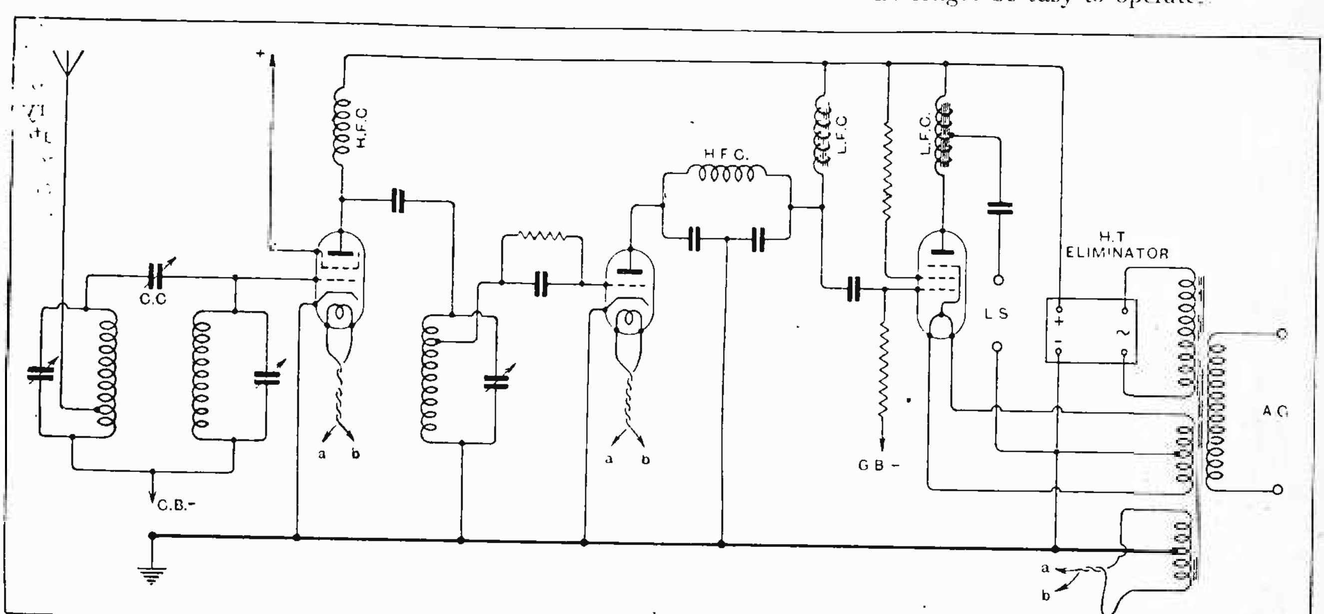


Fig. 1.—Simplified circuit diagram, omitting wave-range switching, feed resistances and by-pass condensers, reaction, automatic grid bias connections, etc.

LIST OF PARTS.

- 1 Triple variable condenser, 0.0005 mfd., with drum drive .... (Polar Tub)
- 1 Variable condenser, 0.0003 mfd., with knob .... (Utility, W.218)
- 1 Variable condenser, 0.0002 mfd., with knob .... (Utility, W.219)
- 1 Variable condenser, 40 mmfds. .... (J.B. Midget)
- 1 Differential condenser, 0.0003 mfd. .... (Utility, W.211)
- 1 Condenser coupler (flexible mechanical link) .... (Ormond)
- 3 Condensers, 1 mfd. (200 volts working) .... (T.C.C., No. 50)
- 3 Condensers, 4 mfd. (400 volts working) .... (T.C.C., No. 80)
- 4 Condensers, 2 mfd. (200 volts working) .... (T.C.C., No. 50)
- 1 Condenser, 2 mfd. (400 volts working) .... (T.C.C., No. 80)
- 3 Condensers, 0.0003 mfd. .... (Dubilier, No. 610)
- 1 Condenser, 0.0001 mfd. .... (Dubilier, No. 610)
- 1 Condenser, 0.05 mfd. .... (Dubilier, No. B.775)
- 1 Semi-variable condenser, 0.00002–0.0002 mfd .... (Lewcos)
- 1 Semi-variable condenser, 0.00015–0.002 mfd. .... (Lewcos)
- 1 Resistance, wire-wound, 30,000 ohms, with holder .... (Varley)
- 1 Resistance, wire-wound, 50,000 ohms, with holder .... (Varley)
- 2 Resistances, wire-wound, 10,000 ohms, with holder .... (Varley)
- 1 Resistance, wire-wound, 400 ohms ... (Clarostat, Type F.W., Claude Lyons)
- 1 Resistance, wire-wound, 100 ohms ... (Clarostat, Type F.W., Claude Lyons)
- 1 Resistance, 100,000 ohms .... (Ediswan)
- 2 Resistances, 250,000 ohms .... (Ediswan)
- 2 Grid leak holders .... (Bulgin, porcelain)
- 2 L.F. chokes, 40 henrys .... (Bayliss)
- 1 L.F. choke, 300 henrys .... (R.I.)
- 1 L.F. choke, centre tapped .... (R.I., Pentomite)
- 1 Power transformer .... (Bayliss, Type W.W.3)
- 1 Valve screen .... (Colvern)
- 3 Coil screens .... (H. & B.)
- 1 Metal rectifier .... (Westinghouse, H.T.7)
- 1 Flash lamp holder ....
- 1 Fuse bulb, 100 mA. .... (Bulgin, Type B.)
- 1 H.F. choke .... (Lewcos)
- 1 H.F. choke .... (McMichael, Binocular Junior)
- 2 Terminal mounts .... (Belling-Lee)
- 4 Indicating terminals, Aerial, Earth, Output, Output .... (Belling-Lee)
- 2 Panel brackets, 4in. .... (Magnum)
- 3 Tuning coils, with built-in switches .... (Type WWTG, Tangent)
- 3 Valve holders, 5-pin .... (Lotus)
- Wire, screws, sleeving, sheet tin, sheet aluminium for brackets, etc., etc.

What is needed is an arrangement whereby filter coupling may be automatically maintained at a value giving the desired band width, irrespective of wavelength. This can be done by electrical means, as described last week, or mechanically, as in the case of the receiver to be discussed in the present article.

Reference to the simplified circuit diagram, Fig. 1, shows that the two component circuits of the filter are coupled by a variable condenser (C.C.) joined between the high-potential ends of the tuning coils. In order that correct coupling may be maintained, this condenser, which must be very small, is mounted on an extension of the main tuning condenser spindle in such a way that coupling capacity and wavelength are increased or decreased together.

Although the theory of this method of coupling is involved, in practice it is simple and free from "snags." Further, it is flexible, and any desired peak separation may easily be obtained to suit individual needs.

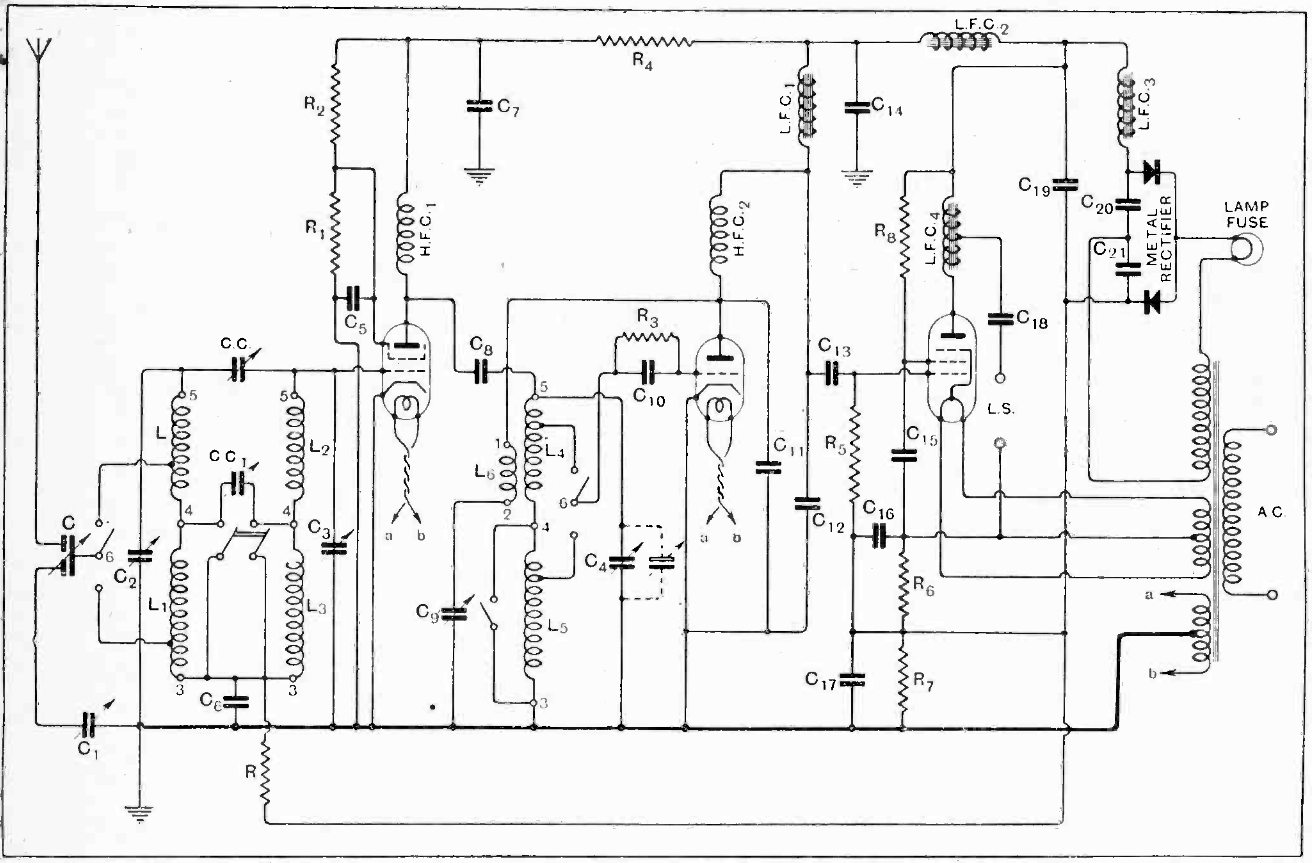


Fig. 2.—Complete circuit diagram. Numbers on coil terminals correspond with the coil base terminals. C.C., coupling condenser (see text); C.C_1, long-wave coupling condenser, semi-variable, 0.00002-0.0002 mfd.; C, differential volume control condenser, 0.0003 mfd.; C_1, balancing condenser, semi-variable, 0.00015-0.002 mfd.; C_2, C_3, 3_4, ganged tuning condensers, 0.0005 mfd.; C_5, C_6, C_7, 1 mfd.; C_8, C_9, 0.0003 mfd.; C_{10}, 0.0001 mfd.; C_{11}, C_{12}, 0.0003 mfd.; C_{13}, 0.05 mfd.; C_{14}, C_{15}, C_{16}, C_{17}, C_{18}, 2 mfds.; C_{19}, C_{20}, C_{21}, 4 mfds. R, 100,000 ohms; R_1, 30,000 ohms; R_2, 50,000 ohms; R_3, R_5, 250,000 ohms; R_4, 10,000 ohms; R_6, 400 ohms; R_7, 100 ohms; R_8, 10,000 ohms.

Pre-selection A.C. Three.—

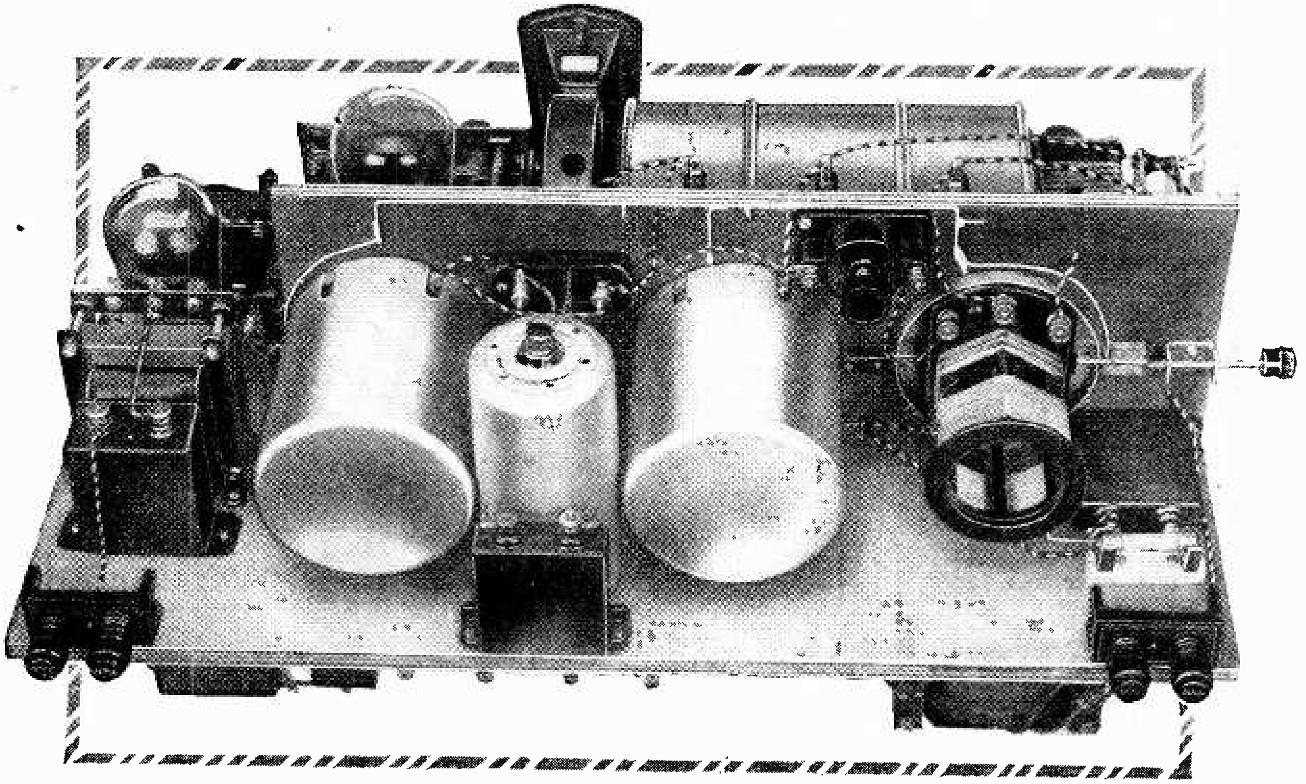
Before discussing the purpose and performance of the receiver, it seems advisable briefly to enumerate the basic features of its circuit. The filter output is applied to an indirectly heated screen-grid H.F. amplifying valve, which is coupled to a power grid detector (also indirectly heated) by a choke-fed tuned grid circuit. In order to reduce damping, and to avoid the transference of sufficient stray capacity to upset the ganged tuning system, the detector-grid connection is "tapped down" on the inductance. Reaction (not shown in the skeleton diagram) is applied between the detector anode and grid circuits.

An H.F. choke with two by-pass condensers is inserted in the detector anode circuit as an H.F. stopper, and this valve is linked to a pentode output valve through a simple L.F. choke coupling. To assist in matching valve and loud speaker an output choke with a centre tapping is fitted; it should be noted, in passing, that a simple tone-control device, consisting of a condenser and variable resistance, can easily be added in cases where reproduction is likely to be improved by such a refinement; this is largely a matter of one's personal taste and the loud speaker characteristics.

It has been the aim of the writer to produce a set possessing enough true selectivity to be operated under average conditions without any need for sacrificing signal strength. With regard to range, it was considered essential to have sufficient real sensitivity to ensure fairly consistent reception of foreign stations without relying to any great extent on reaction. Even if a satisfactory system of single-knob tuning is included, a set cannot fairly be called easy to operate if selectivity and sensitivity are attained, respectively, by constant manipulation of aerial coupling and reaction controls. It is hardly necessary to add that the reproduction of a modern set must be good enough to do justice to the best loud speakers available, and that when A.C. mains supply is used, there is little excuse for providing an undistorted output that is insufficient to fill a room of ordinary size, with at least a small margin of safety. The Marconi or Osram P.T.425 output valve which is recommended actually gives about 750 milliwatts.

As far as long-distance reception is concerned, the satisfactory performance of the receiver is almost entirely due to the input filter. Amplification conferred by the H.F. stage is but little above the average for an A.C. set; excessively "good" coils are out of place when ganging is employed. Similarly, the power-grid detector is sensitive enough, but not exceptionally so, and it may be taken that the loss of L.F. magnification due to choke coupling is about balanced out by the extra amplification of the pentode. The set provides a wider choice of programmes than the usual specimen of its class, mainly because full use can be made of everything that is picked up by the aerial.

Elaborations to the simplified circuit are shown in the complete diagram, Fig. 2. Starting at the aerial end, there is a differential volume control condenser; this, in conjunction with a semi-variable balancing condenser, enables regulation to be effected without appreciably changing the tuning.

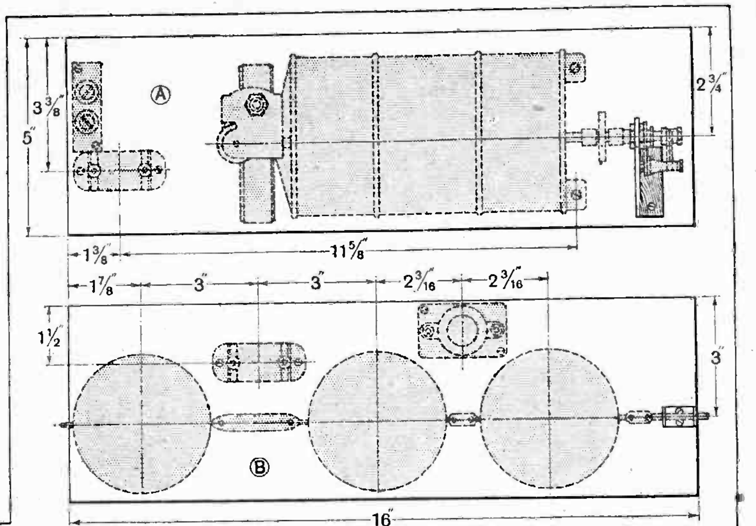


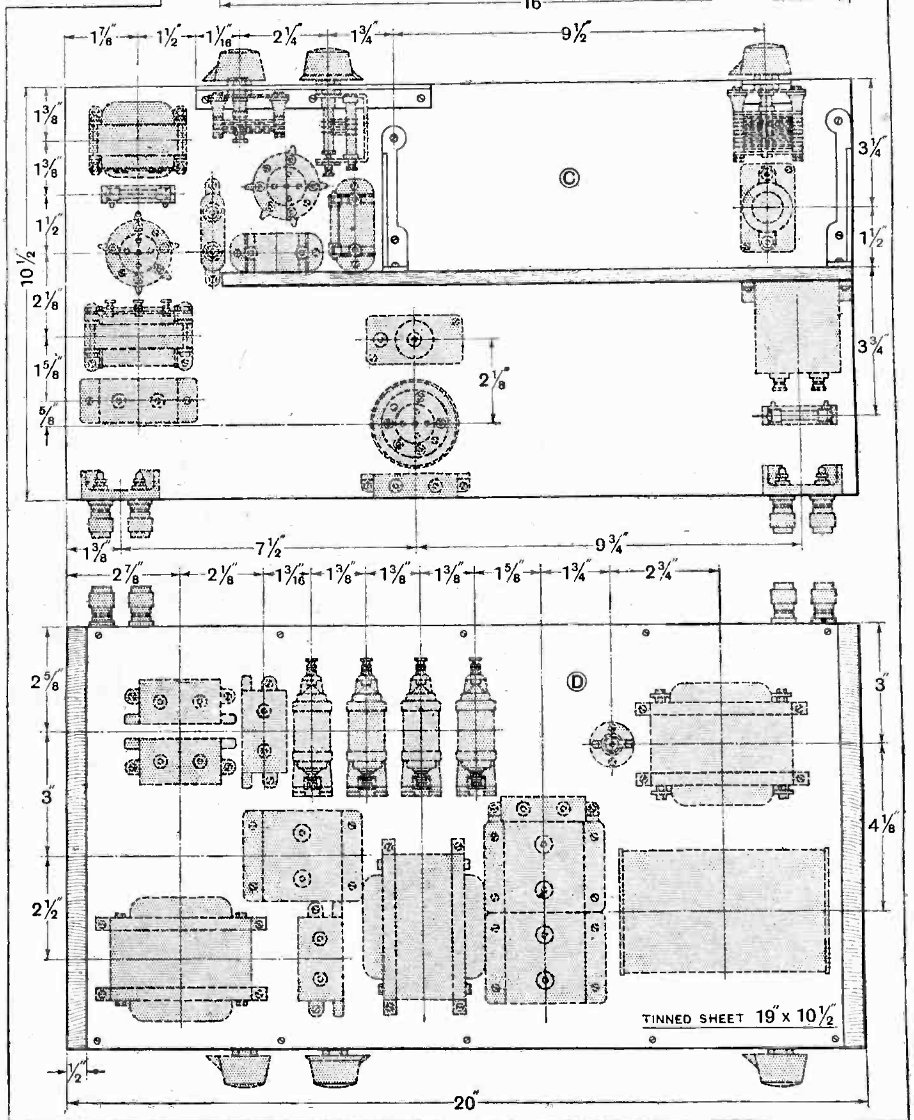
Rear view of the receiver, with input coil screening cover removed.

Pre-selection A.C. Three.—

Wave-range switching is effected by short-circuiting the loading coils, and, as the coupling condenser CC is inadequate for the long-wave band, its capacity is supplemented by a semi-variable condenser, CC_1, which automatically comes into effect when the switch is "opened." Clearly, it is not suggested that sensibly constant band width is provided on the long waves, as well as on the medium band; in order to do so, mechanical complications would ensue, and, in practice, results would not be noticeably better than those of the "compromise" arrangement as described.

Voltage supply for the H.F. valve screening is obtained through a potentiometer consisting of two resistances in series, and the anode circuit of this valve is fed through a decoupling resistance.





A, sub-panel, front; B, sub-panel, rear; C, baseboard, top; D, baseboard, under-side.

Fig. 3.—Layout of components on baseboard and sub-panel.

The tuned-grid coupling coils are tapped, and the detector-grid connection is transferred to the appropriate points for each waveband by a change-over switch. This plan is preferred to the simpler one of throwing the grid load across the whole inductance, as it restricts grid damping and prevents the transference of excessive stray capacity; further, it assists in the maintenance of accurate "ganging" when passing from one waveband to the other.

Balancing Capacities.

Each of the three tuning condensers, C_2, C_3, and C_9, are fitted with internal trimmers (not indicated in the diagram) and, in addition, there is a small external trimming condenser in parallel with the detector grid circuit. Actually, there is little need for this component, but on the rare occasions when it is necessary to apply considerable reaction, it is reassuring to know that this circuit may be tuned with extreme precision.

Constructional details will be discussed in next week's issue. Care has been taken to avoid the need for making special parts, and the only components needed that are not at present available commercially are three simple brackets for supporting the variable condensers.

CURRENT TOPICS

News of the Week

IN BRIEF REVIEW

AN ALL-PURPOSE TRANSMITTER.

Madagascar is to have a short-wave wireless station, which will operate the local telegraph service, and transmit news, besides broadcasting concerts and lectures when it is not required for official purposes.

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A POLYGLOT STATION?

It is rumoured that a German firm has obtained a contract for the construction of a 100-kilowatt station at Luxembourg which will broadcast in all European languages.

oooo

WINDMILLS FOR WIRELESS.

The Air Ministry has notified the Marconi Company that the Marconi-Newton constant-speed windmills, type 110, 140, 160, and 180, are approved for use on civil aircraft registered in Great Britain. These aero-generators, which develop output of from 100 to 500 watts, according to type, include important improvements, greater strength and efficiency being obtained by the use of solid blades and a new system of governing.

oooo

MONEY SHORTAGE AND WORLD'S BIGGEST RECEIVING STATION.

America's magnificent new "policeman of the air," the constant frequency radio monitoring station recently erected by the Radio Division of the Department of Commerce near Grand Island, Nebraska, is standing idle while traffic congestion grows more acute every day along the invisible roadways of the ether, writes our Washington correspondent.

Although the Federal Government has expended about £50,000 to build the station, which represents probably the most sensitive "radio ears" in the world, it has thus far failed to appropriate the £20,000 or so necessary to man the station with adequate radio engineering staff. Certain members of Congress are endeavouring to secure the much-needed money

Thirty-six trained engineers are required to enable radio's "super-traffic cop" to furnish instructions to radio stations in America and the rest of the world by standing continuous twenty-four-hour watches to measure their signals. Only six men are available, and they are finding little time away from their routine duties at the plant to attend the complicated apparatus of this receiving system.

The vast network of antennas, covering the better part of 50 acres in the midst of a sparsely inhabited prairie and located near the exact geographical centre of the United States, is capable of receiving radio signals over the whole range of useful frequencies between 10 and 60,000 kilocycles (30,000 to 5 metres). There is hardly a radio station in the world with substantial power, whether it is broadcasting by voice or telegraph code, that cannot be tuned in.

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PRESS WIRELESS NETWORK IN U.S.A.

Permits to erect 19 short-wave stations to form a network across the United States have been granted by the Federal Radio Commission to the Wireless Press Inc. Two of the stations, situated at Los Angeles and Chicago respectively, will be intended for trans-ocean news messages.

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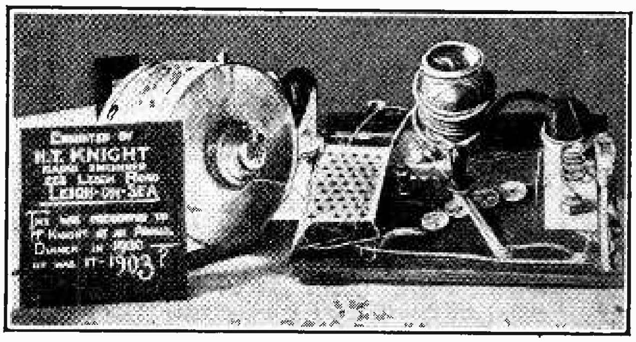
A DIFFERENCE.

An Italian correspondent deplores the fact that in the land of Marconi there are only 150,000 broadcast listeners, while in France, which possesses almost the same size of population as Italy, there are more than three million.

Our friend can console himself with the thought that, whereas the Italian listener pays a tax of 15s., his French counterpart gets his programmes free.



ALL-(RE)MAINS SET. An amusing exhibit at the Southend Radio Society's recent show. Although complicated in appearance, the set was quite cheap to construct, the most expensive item being the lump of coal needed as a detector.

TRANSLATORS AND WIRELESS.

Wireless is among those subjects which can play havoc with the reputation of an expert translator—if his knowledge of wireless is nil! To save distress in the future the Association of Special Libraries and Information Bureaux, 16, Russell Square, London, W.C.1, is considering a scheme whereby the Association should establish a panel of translators possessing the double qualifications of proficiency in one or more languages and expert knowledge of one or more subjects.

HAVE YOU HEARD BUCHAREST?

The Electrical Institute at Bucharest is now operating a 300-watt transmitter every Sunday evening on wavelengths of 21 and 50 metres.

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R.S.A. LECTURE ON TELEVISION.

Sir Ambrose Fleming, M.A., B.Sc., F.R.S., will preside at the meeting this evening (Wednesday) of the Royal Society of Arts, John Street, Adelphi, London, W.C.2, at which Mr. W. G. W. Mitchell, B.Sc., joint hon. secretary of the Television Society, will deliver a lecture entitled: "Developments in Television." The meeting opens at 8 o'clock.

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AMERICA'S 45 PER CENT.

Having completed its census of American radio receiving sets on April 1st, 1930, the U.S. Census Bureau hopes to have the total compiled by April 1st of this year. In the meantime it is issuing, as fast as they can be compiled, the "radio set populations" by States. The first State count shows that New Hampshire, with 119,660 families, has 53,111 with sets. In other words, 44.4 per cent. of the families of the State have radio sets. The second count released shows that Delaware, with 59,295 families, has 27,183 or 45.8 per cent. owning "radios."

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SWAN MEMORIAL APPEAL.

All valve users who are conscious of radio's debt to the inventor of the electric incandescent lamp will be interested in the Swan Memorial Appeal which is being organised to provide a sum of not less than £5,000 for the foundation of National Swan Memorial Scholarships in Electrical Engineering Science.

Sir Joseph Swan was born in Sunderland in 1828, and a committee representing the town of his birth and the Institution of Electrical Engineers, of which he was president in 1898, is responsible for the appeal. Subscriptions should be sent to Mr. P. F. Rowell, secretary, The Institution of Electrical Engineers, Savoy Place, London, W.C.2.

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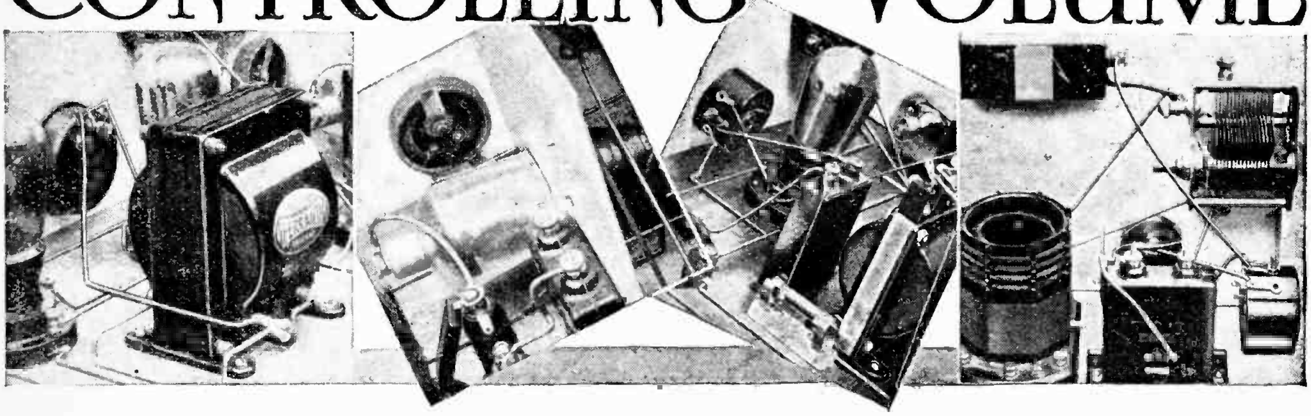
TRANSMITTING FROM A MOUNTAIN TOP.

A running commentary on a climb to the summit of Mount Brévent (8,100ft.), in the Franco-Swiss Alps, was carried out by M. Cheney, director of *Radio Lyons*, on the afternoon of January 31st M. Cheney started in the morning with four guides, who helped to carry the transmitter. In the afternoon, during the final stages of the climb, the guides each took a turn at the microphone. The commentators concluded their story while sitting on a snowdrift 6ft. deep.

CONTROLLING VOLUME



How to Change Signal Strength Without Affecting Tuning or Quality.

By W. T. COCKING.

THE amount of low-frequency amplification in most up-to-date sets is so chosen that when the loud speaker is working at normal strength the detector is working under its most favourable conditions. In order to maintain this correct operation on signals of varying strengths a pre-detector volume control is essential, while to control the sound output from the loud speaker a post-detector control is desirable. In practice, however, it is found that in most cases such a post-detector control is unnecessary, for the reason that the detector operating conditions are not very critical, and that quite a wide departure from the theoretical input of optimum value makes little, if any, audible difference to the results.

It will be seen, therefore, that every receiver should include a pre-detector volume control, while the use of a post-detector control in addition is often a matter of personal preference. It becomes of importance, therefore, to determine the best type of pre-detector control, and its best position in the receiver. This latter question is easily settled; high-frequency amplifying valves introduce amplitude distortion when they are overloaded, just as do low-frequency valves, although this distortion is not quite so evident. The volume control, therefore, should precede the first H.F. valve in the set, when the possibility of distortion through overloading becomes small.

THE volume control is an essential part of the modern receiver, not only to allow of the desired degree of loudness being obtained, but also to prevent a strong signal from overloading the valves and so causing distortion. Means can be found for controlling the amplification in almost any part of the set, but it is obvious that the best position is before the first valve, since overloading can then be eliminated on even the strongest signal. Many methods of volume control are described and practical hints given as to the best way of introducing them into a receiver.

It is worthy of note that this question of amplitude distortion rules out all those forms of volume control which depend for their action upon a variation in the D.C. voltages applied to the valves. Any increase in the grid bias, or a reduction in the anode voltage, the screen-grid voltage, or the filament current inevitably introduces distortion of the H.F. wave-form, and also produces rectification, which is a prolific cause of that form of interference known as cross-modulation.

Apart from not introducing distortion, the volume control must not reduce the selectivity to any great extent; a small reduction, however, is not of great importance, since the amount of selectivity needed in most circumstances depends upon the amplification employed. In addition, the control must be smooth and noiseless in action, and give an adequate variation of volume.

The H.F. Potentiometer.

One of the most satisfactory controls of this type is the H.F. potentiometer shown in Fig. 1, which has been used in a number of receivers described in the pages of this journal.[1] The tuned circuit is shunted by a high-resistance potentiometer, and, by the adjustment of the slider, a varying proportion of the voltage developed across the tuned circuit is applied to the grid of the valve. If the resistance of the potentiometer be high, some 500,000 ohms or so, it damps the input circuit but lightly, and so has little effect upon either the selectivity or the sensitivity.

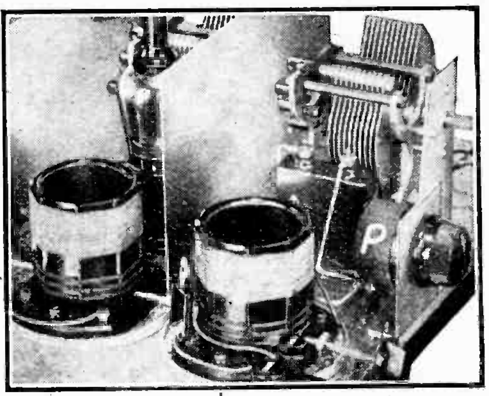
In practice, there are certain objections to the control, but these are not always serious. In the first place, it will be obvious that when the control is set at maximum the input capacity of the valve is thrown directly across the tuning condenser in the normal manner. When the control is set for low volume, however, this capacity becomes effectively disconnected from the

[1] The Megavox Three, by N. W. McLachlan, September 12, 1928. The Band-Pass Four, by W. T. Cocking, June 25, 1930. "The Wireless World" Four, by F. H. Haynes, October 15, 1930.

Controlling Volume.—
variable condenser, and the tuning of the circuit is altered. The importance of this in a ganged receiver depends upon the number of tuned circuits in the set; if there be many circuits. it is only of slight importance; if there be but few, however, then it becomes a serious objection to this form of control.

There is, however, an advantage to be gained, which is due to this same fact. When the control is set for reduced volume, the first tuned circuits are partially disconnected from the succeeding ones, and any tendency towards instability is usually eliminated. This results in an improvement in quality on the stronger stations, for which the control need not be set at maximum; at the same time, the receiver may be so adjusted that it oscillates with the control at maximum, which may then be used as a regeneration control as well as in its normal capacity as a volume control.

Unless care be taken, however,



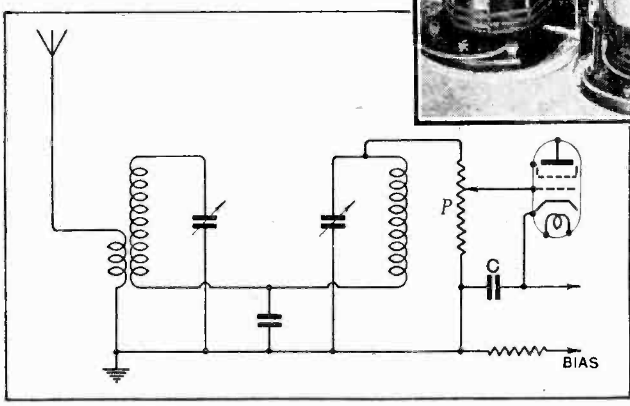


Fig. 1.—The H.F. potentiometer method of volume control, which also makes an extremely good regeneration control. At low volume settings the first tuned circuits become partially disconnected from the succeeding circuits, with a great reduction in feed-back effects. This type of control was embodied in "The Wireless World" Four receiver, the input end of which is illustrated.

some curious effects may be observed in practice; for it is often found that minimum volume does not occur when the slider is at the earthed end of the potentiometer, but at some higher setting. Indeed, instability sometimes occurs when the volume is supposed to be at minimum. This is due to the valve cathode, or filament, not being at earth potential, and the cure is to increase the capacity of the condenser C in Fig. 1; in some cases the writer has found that it is necessary to use a capacity of 4 mfd. in this position.

The Aerial Control.

The fact that it produces an alteration in the receiver characteristics with its adjustment, although often extremely useful, may, in certain circumstances, render its use undesirable. There is then no alternative but to control the actual voltage transferred from the aerial to the first tuned circuit, and one method of accomplishing this is shown in Fig. 2. It will be seen that the potentiometer, which can have a resistance of some 15,000 to 30,000 ohms, is connected across the aerial winding, and that the aerial is taken to the slider. With this form of control it is very important that all the tuning coils should be completely screened, and it is desirable that the valves, variable condensers, and wiring should be also. It has been the writer's experience that unless these precautions be taken the control is quite useless on the local station, owing to direct pick-up in the coils and wiring following it. It is a satisfactory control, however, where care is taken to avoid direct pick-up.

It will be found that, just as in the case of the H.F. potentiometer control, its adjustment upsets the tuning of the first circuit, due to the alteration in the amount of aerial capacity thrown on to the tuned circuit. This can be reduced to a negligible amount by using only a small aerial winding, and this is the method usually adopted in the U.S.A. where this type of control is very popular; but as it reduces the sensitivity considerably it is not of universal application.

The Aerial Capacity Control.

Another method which has been used in several recent receivers[2] is very similar. This is shown in Fig. 3*a*, and it will be seen that, like the method just discussed, it controls the voltage transfer between the aerial and the tuned circuit, and, furthermore, that the method of control is still by means of a potentiometer; the potentiometer arms, however, are variable condensers instead of variable resistances. This offers several important advantages; in the first place, it is possible, by the careful proportioning of the relative values of capacity, to eliminate the change of tune of the tuned circuit, and, secondly, the control is smoother and more noiseless than any of the resistance methods. This is simply because a

[2] The Band-Pass Three, September 17, 1930.

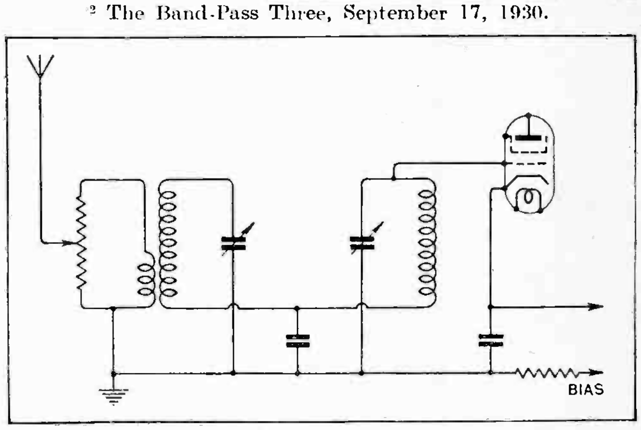
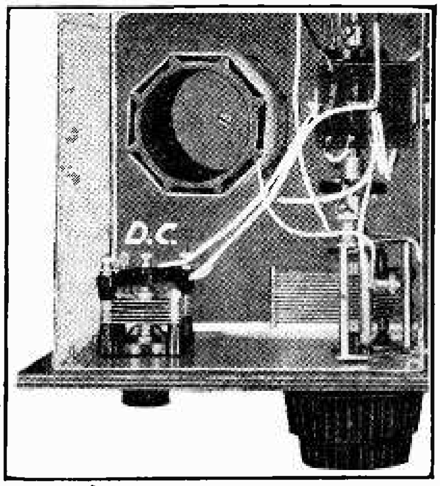


Fig. 2.—The potentiometer control of the aerial input is very satisfactory, provided that all the tuning coils are well screened to eliminate direct pick-up from the local station. The potentiometer should have a resistance between 15,000 ohms and 30,000 ohms.

Controlling Volume.—
perfect variable resistance of high value is extremely difficult to manufacture, while a variable condenser is comparatively simple.

At the present time there is no condenser available with characteristics designed to eliminate the change of tune of the secondary; but it is possible to make a fairly close approximation to this by adopting the particular circuit shown in Fig. 3*b* and using an ordinary differential condenser.



tap and the earthed end. By suitably positioning this tap, the effective amplification of the first H.F. valve can be reduced to about unity, and the normal volume control still serves to adjust the strength to exactly the desired value. It is suggested that as a start in arriving at the correct position for the tap, which will, naturally, vary in individual cases, some five to ten turns only should be included between the anode connection and earth.

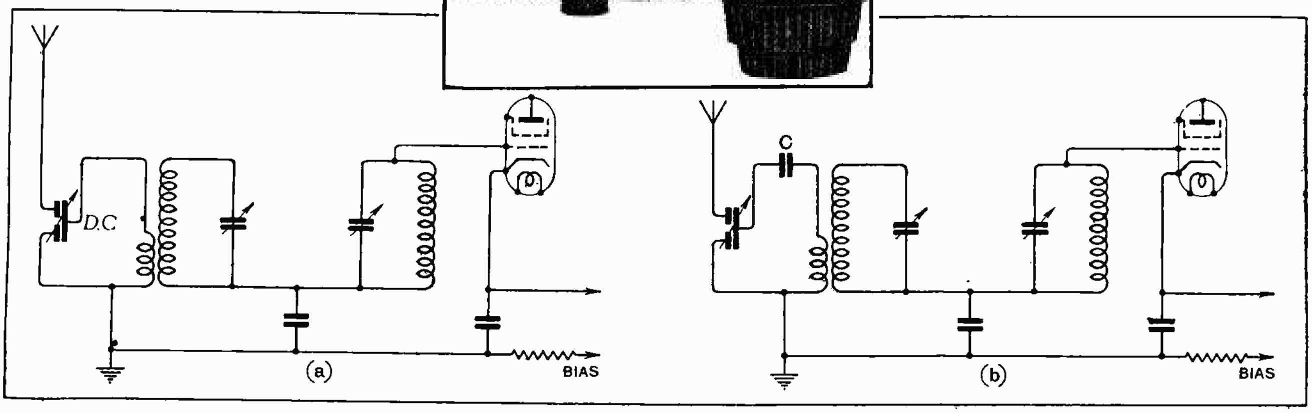


Fig. 3.—The control of the aerial input by means of a differential condenser is shown in (a) and a modification in (b) which to a large extent prevents the tuning of the first circuit changing with different settings of the volume control. Such a volume control was used in the Band-Pass Three receiver here illustrated.

The extra condenser C, which can be of the compression type, is so adjusted that the tuning of the secondary circuit is unchanged whether the control is set at maximum or minimum; at intermediate settings the tuning is changed, but the amount of this change need only be small.

Now, it will usually be found that any one of these three methods will give an adequate control of volume with even the most sensitive set, except on the local station. The control will be satisfactory, even on a strong local station, with only a single H.F. stage, but it fails completely when two stages are used. In a sensitive set, therefore, it is essential to provide some additional means of controlling the volume for use on the local station only.

In many cases this can take the form of some alteration external to the set, such as disconnecting the aerial or short-circuiting the aerial and earth terminals. It is usually desirable, however, to reduce the actual amplification in the receiver itself, for the reason that all valves introduce a certain amount of noise into the set, and this may take the form of an objectionable hiss on the local station.

Considerations of efficiency and stability usually prohibit the switching of one of the valves out of circuit, but there can be no such objection to the adoption of the arrangement shown in Fig. 4. It will be seen that the anode tapping on the tuned intervalve coupling is transferred to a tapping position at the bottom of the coil, so that only a few turns are included between the

In conclusion, therefore, it may be said that for radio purposes a post-detector volume control is often unnecessary, and that the most satisfactory pre-detector control is probably the variation of the aerial input by means of a differential condenser, accompanied by some method of reducing the H.F. amplification for local-station reception. The resistance methods are usually quite satisfactory, and if in use there is little point in changing to the condenser method.

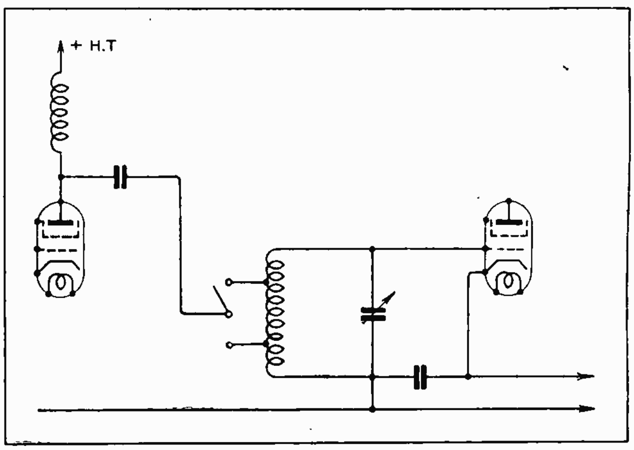
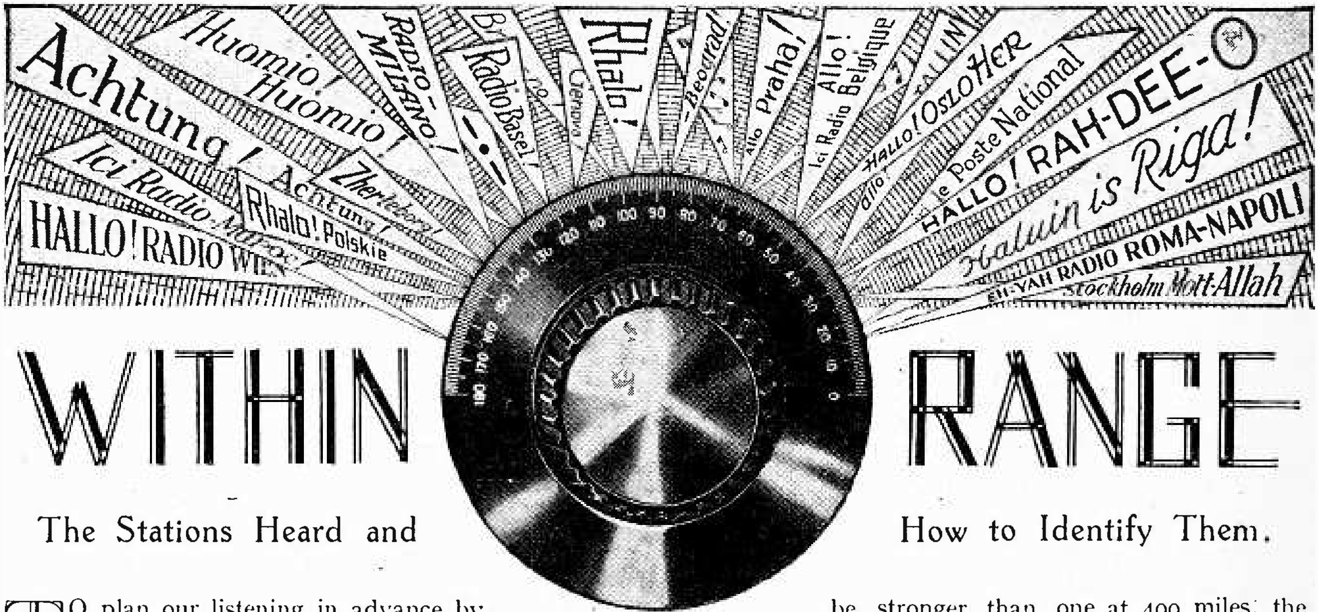


Fig. 4.—A suggested method for reducing the amplification on the local station. When the switch is in the upper position normal results are obtained, but when it is placed in the lower position the amplification of the first valve can be reduced to any desired extent. It is used in addition to the normal control and has the advantage of eliminating valve hiss on the local station.



WITHIN RANGE

The Stations Heard and How to Identify Them.

Round the Dial.

TO plan our listening in advance by reference to the published programmes, using the foreign transmissions as a refreshing relief to dinner-time talks and such like, is the only way of obtaining full benefit from a radio receiver. Now, when we turn to the foreign stations it is safe to say that few of us have any idea as to the identity of the stations to which we tune. We should not search for alternative programmes at random, as it is preferable to select particular stations by appreciation of their programmes. Many sets of to-day unquestionably give good foreign-station reception, and no longer is the absurd plea advanced that the transmissions from abroad have no programme value and are to be jammed out of existence by high-power stations situated in areas of dense population.

As a rule, the user of the long-range set merely rotates the dial until he hits off an item pleasing to his taste. He has no knowledge of the precise identity of the station and, in fact, to determine the origin of the transmission is often a matter of difficulty. The better the set the greater the number of stations received and the more difficult does identification become.

In making a guess as to the name of the station transmitting we are guided first by the programme itself, such as the language spoken, characteristics of the music or the interval signals, next by the loudness of reception, and, thirdly, by the tuning position as compared with stations already known. Reference to a list of foreign stations and their wavelengths affords some assistance, yet in only a few instances can stations be recognised with any certainty. Stated power of transmission may be misleading as, for instance, a 1.5 kW. transmitter may be louder than one of 6 kW. situated at approximately the same distance off. Distance, moreover, is but a poor guide, and a station 800 miles away may be stronger than one at 400 miles, the stated power in each case being about equal.

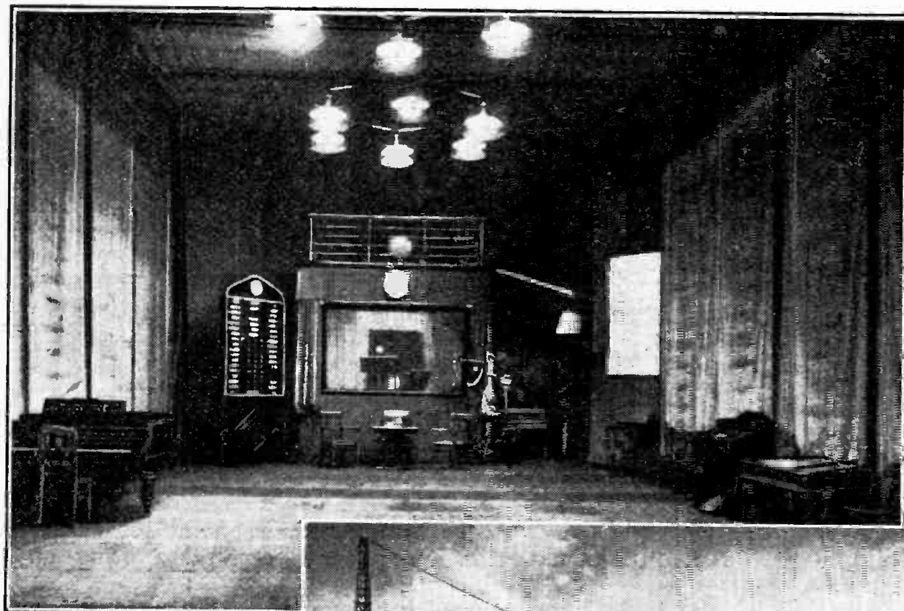
Accompanying this issue is a station identification folder which has been compiled partly by reference to international lists of wavelengths and the programmes given in foreign radio journals, but the main factor as to the inclusion and classification of the stations has been based entirely upon listening. The conditions of reception were a four-valve, two H.F., set, with single-dial control and input band-pass filter ("The Wireless World Four"), a 50ft. aerial, and located $5\frac{1}{2}$ miles from the Brookmans Park transmitter. Stations were principally identified, in the first instance, by their wavelength, with the aid of a wavemeter. In this way the confusion arising out of relayed transmissions was avoided.

See Coloured Supplement.

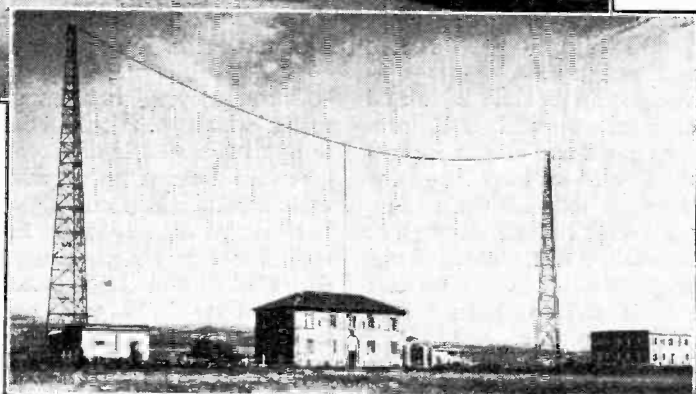
STATION IDENTIFICATION CHART.

Three styles of type are used in the chart when denoting the stations, revealing the comparative facility with which they are received. Capital letters are used for the more powerful, or key, stations, from which others may be identified by their relative tuning positions. Smaller type is used for the less powerful stations, light type representing those not usually received satisfactorily on sets with less than two H.F. stages. Many other stations than those shown can be heard, but reception from them does not possess a programme value, hence they are omitted. Instead of relying entirely upon the ear as a means of estimating the loudness of reception a wattmeter was used on the output, in addition to a milliammeter in the anode circuit of the detector. The classifications given above were represented by outputs of (1) over 1,300, (2) over 500, and (3) over 150 milliwatts when receiving a programme of music and using a pentode output valve, the P.M.24A.

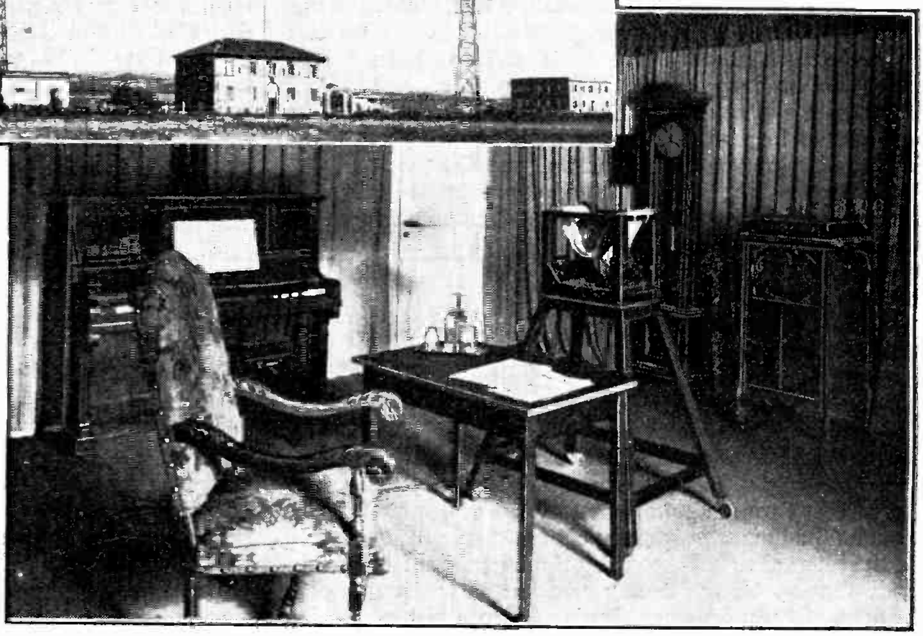
In each station panel appear observations noted in the course of reception, giving some detail typical and peculiar to the station. Phonetic spelling is adopted in these notes in respect of languages other than French or German. Interval signals are given where they occur, and form a valuable guide. It is to be regretted that well-defined interval signals are not used by every station to-day. Although the London transmitters are now coming into line in this respect, the feeble sound emitted, resembling that of the clanking of a distant shipyard, so lacks brilliance that it may be passed unnoticed, or may be confused with the metronome signals now used by many other stations.



"Hallo! Rah-dee-o Booda-Pescht Ungar." The studio of the well received Budapest station.



"Eh-yah Radio Roma-Napoli," the familiar call of the Rome station, the aerial system and station buildings of which are shown.

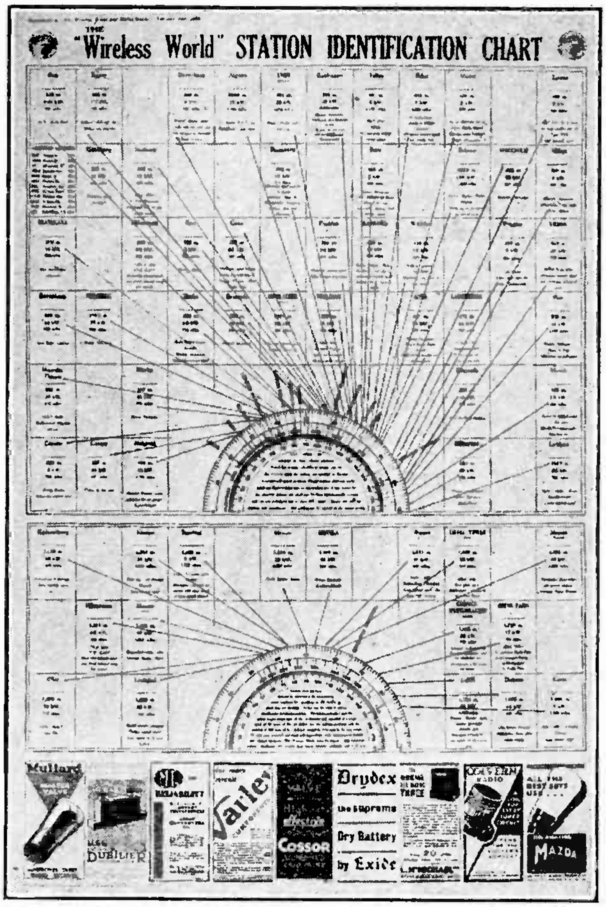


"Hallo! Hallo! Oslo her." The talks studio of the long wave Scandinavian station.

Spaces are left on the station panels for entering the precise dial setting; the actual figure obtained will probably not widely differ from that shown on the 100- or 180-division scales. The difference between the figures given and those obtained will not be uniform across the scale; it will steadily increase or decrease, but the change will be progressive and can be estimated. Should the receiver be of an older type with more than one tuning dial, or be fitted with reaction or volume controls which change the tuning positions, the settings for these auxiliary adjustments might be noted in the spaces provided.

The best plan is to identify and note the settings of those key stations shown on the chart in large type. Thus, as the dial is rotated, the high-power station at Heilsburg, in East Prussia, is readily identified at a few divisions below the National transmitter. Almost within a degree of this station, and immediately above it, is Bratislava, a station located in Czecho-Slovakia, which, with a power of only 14 kW., is counted among the best-heard stations in this country. Passing on, between the two London transmitters a number of stati... of medium power are encountered, and the next high-power foreign station is Mühlacker, almost overlapping the London Regional, which is usually heard in the intervals of the foreign programme. Rotating farther, we hear the new transmitter of Lvov.

Within Range.—This Polish station has only recently increased its power, and its identity is revealed by the frequent announcement "Ler Woof." Farther on, and almost overlapping, is Toulouse, an unmistakable station. After an interval of several divisions, Katowise is heard, with its hollow-sounding metronome and its frequent announcement "Polski Raadjo Kat-owe-vee-tsee." Stockholm, found a little farther on, is one of the most powerful of European transmitters as regards initial energy, yet it is often overlooked by British listeners, its signals being slightly weaker than, say, the modest Radio Toulouse. Rome, almost adjoining, needs no introduction, with its lady announcer and her frequent "Eh-yah Raadio Roma Napoli." Just before reaching the Midland Regional is Langenberg, recognised by its distinctive chime of five bells. Beyond, but well clear of the Midland Regional, is Brussels, which, owing to a recent increase of power, comes in well. Towards the end of the scale are the two well-defined stations, Vienna and Budapest. The former is recognised by its frequent announcement, "Radio Wein," and the continuous ticking of its interval signal, while the musical interval signal of the latter, and the fact that it is clear of other stations, makes its identity obvious. It might be mentioned that the tuning range of certain receivers fitted with large trimming condensers will not go high enough for the reception of Budapest.



THE SUPPLEMENT.

Stations are classified according to the facility with which they are received. Having identified the more powerful transmitters, other stations are recognised by their relative tuning positions.

Between these key stations those of less power can be readily fitted in. It is best to go definitely after a particular station, having carefully estimated its tuning position, hanging on to the transmission until some clue to its identity is heard. The lot of the English listener is a little unfortunate in that the stations best received mostly fall bunched closely together between 50 and 75 divisions on the scale. Stations crop up clearly at almost half-degree intervals, so that errors are easily made in identification. There are very few powerful transmitters operating below the National, and while this was at first thought to be due to the falling sensitiveness of the capacity-coupled band-pass filter the evidence of stations was confirmed by listening on a modern long-range single-dial superheterodyne.

Listening on the long-wave range, we find the stations well defined. Most sets give better amplification on the long wavelengths, and when, during the hours of daylight, the medium wave band may be found nearly deserted nine stations can invariably be brought in on the long waves. Taken in order round the dial we hear Oslo, Kalundborg, Motala, Eiffel Tower, Daventry National, Kœnigswusterhausen, Radio Paris, Lahti and Huizen, the last mentioned being well received in spite of its modest power. Careful estimation of dial setting assists in the picking up of the other stations shown.

At this time of the year at least five American broadcasting stations can be heard on the medium broadcasting band on favourable occasions after midnight. Details of these stations have been included on the chart. They are readily recognised by their frequent announcements.

As changes are frequent, spaces have been left on the chart for additions and amendments. With the knowledge that the stations shown are those normally received one can go ahead and methodically fill in their tuning positions. The chart thus completed and available for reference adds considerably to the utility of the radio receiver, particularly in unskilled hands.

Using the chart with several different receivers it was found that the actual readings given did not differ widely from the tuning positions obtained. The difference being progressive, it is worth while entering on the scales the increasing or decreasing difference between dial setting and scale reading. Thus, with a particular set the dial reading for Cork was two divisions on a 180° scale in advance of that shown. Toulouse was three divisions in advance, the Midland Regional four, and Budapest four-and-a-half. Taking into account this steady change, precise dial readings for other stations were readily predicted. Another useful hint for the enthusiast is that of projecting a wavelength calibration on to the centre red semi-circle using station wavelengths as a guide and coinciding with the particular dial reading to wavelength scale of his receiver.

WHAT is the effect of using an unsuitable value of grid bias in a receiver? Why is it possible for a mains valve to become temporarily paralysed if the supply transformer is badly designed? These questions and many others are dealt with in simple terms and rule-of-thumb methods helpful to the newcomer to radio are introduced.

No. 1.—The Triode and its Working Voltages.

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

IT is probably safe to hazard the guess that one of the most common faults contributing to unsatisfactory reception in a receiver is the application of wrong voltages to one or more of the valves. Although the number of different valves available to the user grows greater with the passage of time, it can be said with confidence that the modern valve, in conjunction with appropriate components, may be relied upon to give admirable results when its filament, anode and grid are fed as their makers meant them to be.

In these notes it is proposed briefly to take the case of the three-electrode valve and to make a simple study of the effect of increasing and decreasing the voltages beyond their correct values in the hope that where sets are not giving of their best the fault may be traced to its source. It will be assumed that the couplings between the valves have been chosen with due care, and that at some time or other reception has been beyond reproach. Let us take Fig. 1, where there is a schematic diagram of an imaginary low impedance four-volt valve which the maker's pamphlet tells us should have 8 volts negative bias, with 150 volts on the anode when used as an amplifier —the arrows pointing to these conditions.

Examining the filament circuit first, we will assume that the L.T. accumulator is faulty, and that its voltage has dropped to the value marked C—just under 3 volts; what will be the effect? The impedance of the valve will rise considerably, less current will pass through it, and the volume of sound from the loud speaker shown as "Power" will drop, say, from the arbitrary figure of 8 to point C. But as the speaker will have most certainly been matched to the valve for quality in the first instance, the new conditions will bring about distortion—low notes being absent. Better reception will be obtained by bringing the bias down to C, as high-impedance valves only require small values of grid potential, but this must be considered as a temporary expedient.

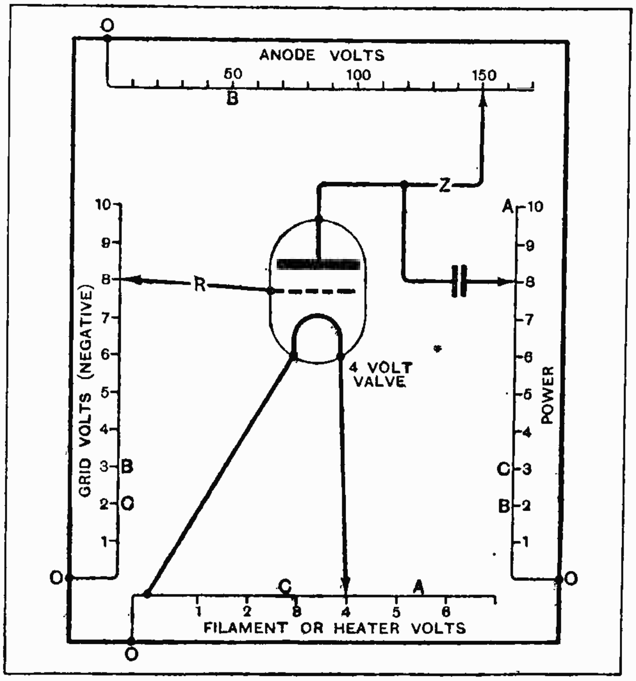


Fig. 1.—Schematic diagram showing how the voltages applied to the various electrodes of a valve interconnect with one another. A 4-volt valve is taken, but the considerations apply equally to the 2-volt or 6-volt type. When a valve is given a considerable negative bias a resistance R, as shown, does not affect the grid voltage.

Had the valve been suitable for H.F. amplification the drop in filament voltage, which can be imitated by putting a rheostat in one of the filament leads, would be accompanied by a decrease in volume and by better selectivity, because the higher impedance of the valve would act as a smaller load across the tuned circuit.

With large battery or mains output valves a considerable drop in filament or heater voltage is likely to reduce their life, as they will be working near "saturation." Valves in this condition will be particularly sensitive to fluctuation of mains voltage—the volume from the speaker changing audibly as the lighting supply varies.

Next we shall consider a rise of heater volts to point A—about 5.5 volts. The word heater rather than filament is used advisedly, as it is not likely that the potential of a four-volt accumulator will increase above 4.5 volts, but there are, unfortunately, mains transformers existing, deficient in iron and copper, which if under-loaded may make possible this state of affairs. The only gain — doubtful in its nature—is an increase in power output to point A.

Besides a considerably curtailed life, there is often another effect of overrunning the heater of an A.C. valve. Owing to excessive heat the grid, which is close

The Valve at its Best.—

by, begins to rise to a sufficient temperature to emit electrons like an ordinary filament, and grid current flows in the external grid circuit, damping the input to such a degree that signals drop to a low level. Readers may have come across a mains receiver in which the volume decreases almost to vanishing point after, say, an hour, and only returns to normal when the set is switched on again after a period of rest. This may be the result of grid emission. Gradually the cathode deteriorates, the chances of recuperation grow less and less, and signal strength is permanently lost. The remedy is the choice of a transformer of reputable make.

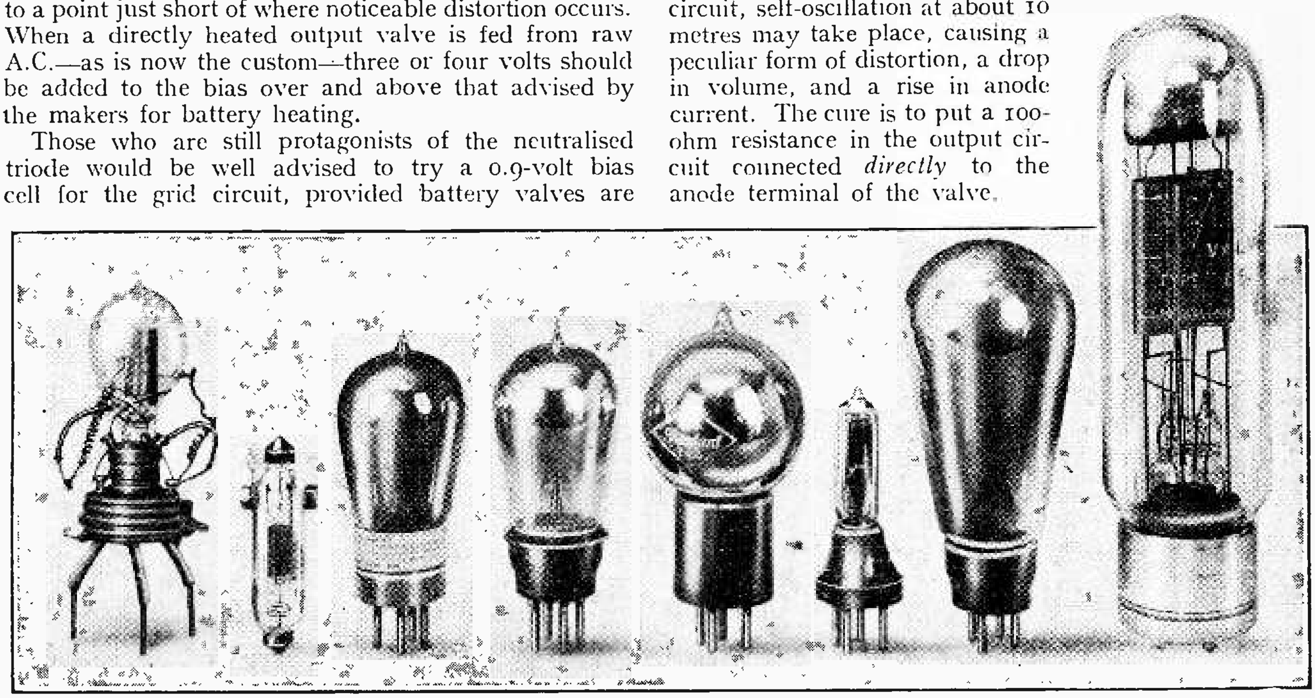
Turning our attention now to the grid of the valve, we can formulate a rough rule for negative bias under amplifying conditions: divide the anode voltage by the amplification factor and multiply this by two-thirds. As an example, the amplification factor of the Mullard PM.254 is 4.2, and the maximum anode voltage 150; by dividing the latter by the former and taking two-thirds of the result we get 23, which is the official bias figure. Should a milliameter be available, it is rather better to set the working conditions by the correct anode current, which is now given by most manufacturers, making the necessary alteration to the bias to effect this. A word of warning, however, is necessary here—never break the bias circuit unless the H.T. has been switched off first, otherwise excessive anode current may flow, damaging the coating of the filament. Under-biasing or the use of an exhausted bias battery with an output valve will cause a big drain on the H.T. battery, whereas over-biasing will cause distortion and reduction in volume. If a milliammeter for measuring anode current cannot be pressed into service, it is best to increase negative bias to a point just short of where noticeable distortion occurs. When a directly heated output valve is fed from raw A.C.—as is now the custom—three or four volts should be added to the bias over and above that advised by the makers for battery heating.

Those who are still protagonists of the neutralised triode would be well advised to try a 0.9-volt bias cell for the grid circuit, provided battery valves are being used. With an indirectly heated valve in this position a minimum bias of 1.5 volts is necessary. It is generally safe to double the normal bias where the grid potential of an anode bend detector is concerned and to give zero bias—that is, connect the grid return lead direct to filament or cathode—in the case of the power grid detector, the new form of distortionless rectifier developed by *The Wireless World*.

Lost Anode Volts.

And now to the anode circuit and back to Fig. 1. We will suppose that the high-tension battery is getting old and that the anode volts have dropped to the point B—i.e., to 50 volts. The output power will drop to B, or about a quarter of its normal value, and as in the case of reduced filament voltage the bias must be decreased to about the point B to obtain better reception which in no circumstances will be distortionless with such a low anode voltage. It must be remembered that a loud speaker or choke at Z will cause a loss of volts between the battery and the actual anode of the valve; this loss is calculated by multiplying the resistance of Z by the milliamperes passing, and dividing the result by a thousand. If, for instance, the battery voltage is 180, the resistance of the loud speaker wired directly in the anode circuit 2,000 ohms and the current 24 milliamps, the volts lost will be $48,000 \div 1,000 = 48$ volts.

There are many amateurs who find themselves called upon to design amplifiers for small dance halls and make use of power valves of the DO/20 type, having a comparatively high amplification factor and low impedance (high mutual conductance). Owing to the tuned circuit formed by the small condenser consisting of the grid and anode of the valve and the inductance in the external circuit, self-oscillation at about 10 metres may take place, causing a peculiar form of distortion, a drop in volume, and a rise in anode current. The cure is to put a 100-ohm resistance in the output circuit connected *directly* to the anode terminal of the valve.



TWENTY YEARS OF VALVE PROGRESS. On the left is the early Fleming valve next to the V.24. The two following valves are the R and the DER, on the right of which are a B.S.A. power valve and a WECO valve. More recent additions are the Marconi and Osram P.625, and the Ediswan ES.75 on the right.

MARCONIPHONE Model 560

FOUR VALVE AC SET

SPECIFICATION.

Two H.F. stages with tuned grid coupling and S.G. H.F. valves.
Power grid detection.
Single dial control.
Compensated transformer L.F. coupling.
Power pentode output.
Valve rectification.
Permanent magnet moving coil loud speaker.
Walnut console cabinet.
Price 38 guineas.

THERE is no outstanding radio set which might earn for itself the title—"The Rolls-Royce of Radio Receivers." This statement assumes that the set earning such a title is the best that could be produced *regardless of cost.* Price and performance in radio do not go hand in hand, but it is safe to say that the best-built sets to-day from a production and assembly standpoint are the best performers. It is after an examination of the Marconiphone Model 560 receiver that these remarks are made. Here we have a set which is a thoroughly first-class production representing the bringing together of everything that is right in radio-receiver design with skilful manufacture, sparing nothing in the making of patterns and press tools.

Circuit Details.

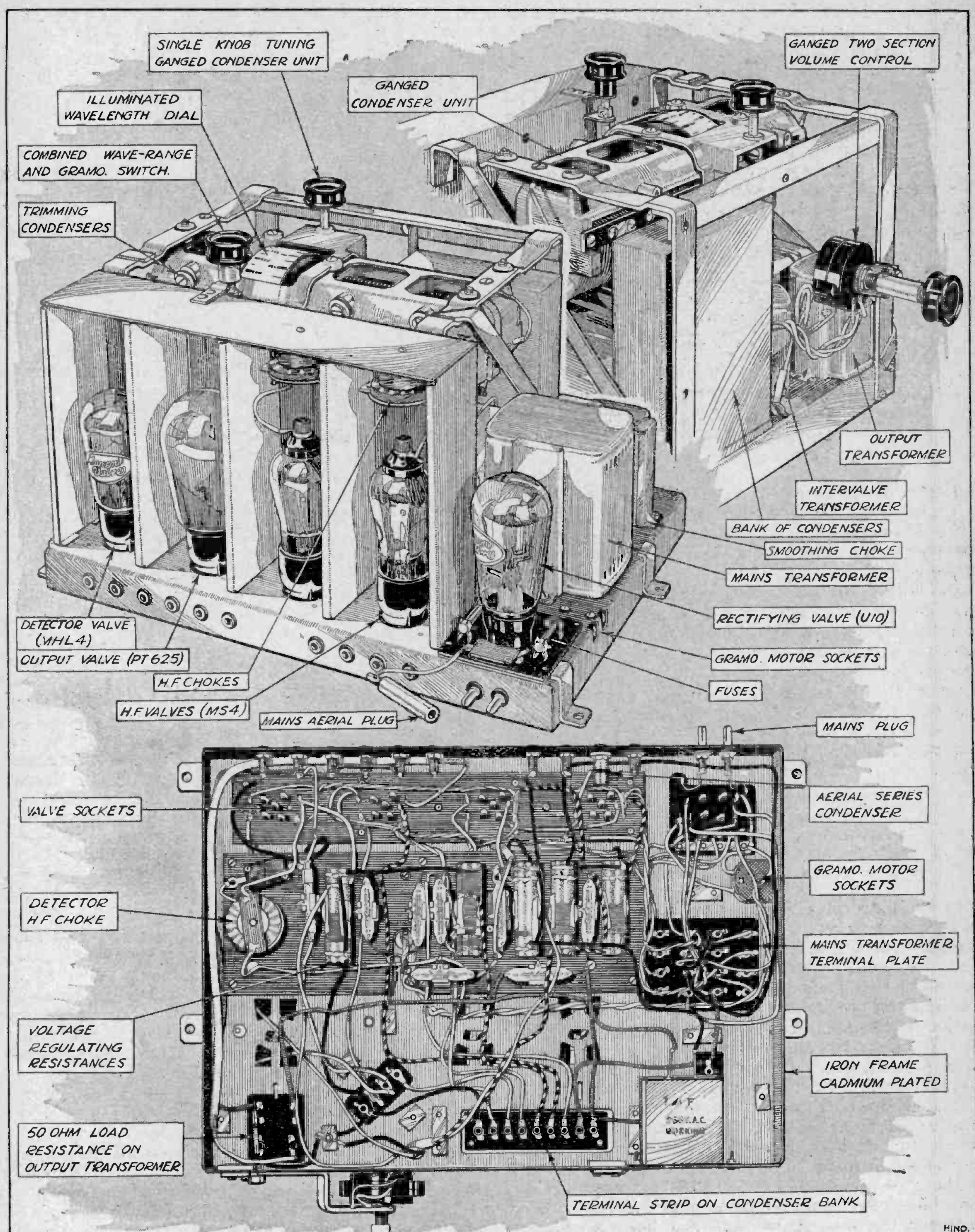
Conforming to a recent tendency, this receiver makes use of a four-valve circuit, so that reliable local-station reception is possible with a small aerial under the most adverse conditions, while, with an average aerial, a choice of thirty reliable programmes results. Two H.F. stages are employed, followed by a leaky grid detector, capable of handling a generous signal voltage without distortion, followed by a power-pentode output valve. Anode current is obtained from a U.10 valve rectifier from A.C. supply, while the first three valves, which are of the Marconi M.S.4 and M.H.L. types, are indirectly heated, and the output pentode directly heated with A.C., as is customary. Single-dial control, the essential of all modern receivers, results from the use of a triple-sectioned ganged condenser tuning choke-fed circuits, the aerial being brought into the first tuned circuit through a small condenser coupling. Generous decoupling is found in the anode and screen circuits of the S.G. valves, and the detection which occurs in the H.F. stages is prevented from giving rise to L.F. oscillation by the use of high-value feed resistances. Both anode and screen voltages are derived from potentiometers, though the former may be regarded almost as a simple resistance feed circuit owing to the high value of resistance included on the earth side.

Regulation of screen voltage constitutes the volume control, although the spindle of the variable resistance used to control screen potential simultaneously operates the potential divider connected across the gramophone pick-up. The inclusion of an additional resistance in series with the pick-up control prevents the maximum pick-up potential being applied to the detector valve. It is interesting to note that the value of these resistances, both the fixed and the variable, across the pick-up is only 10,000 ohms, and, while this is much lower than the values normally used, experience shows that a low value is desirable.

Ingenious Tone Corrector.

In the detector stage we find values of condenser and grid leak indicating "power" grid detection, while the voltage on the anode of the M.H.L. valve is in the order of 70. Bias is introduced into the detector circuit when switched over to gramophone pick-up. The biasing potential, as in the case of the H.F. valves, results from the inclusion of resistance in the cathode lead. In the anode circuit of the detector is the usual H.F. choke, and in order to provide a filter feed to the high-ratio intervalve transformer there are both feed and decoupling resistances.

It is important to note, however, that the decoupling condenser in the anode circuit returns to earth through part of the pentode biasing resistance. The explanation for this is that the biasing resistance, being shunted by a condenser, has the bass frequencies developed across it to a larger extent than frequencies in the

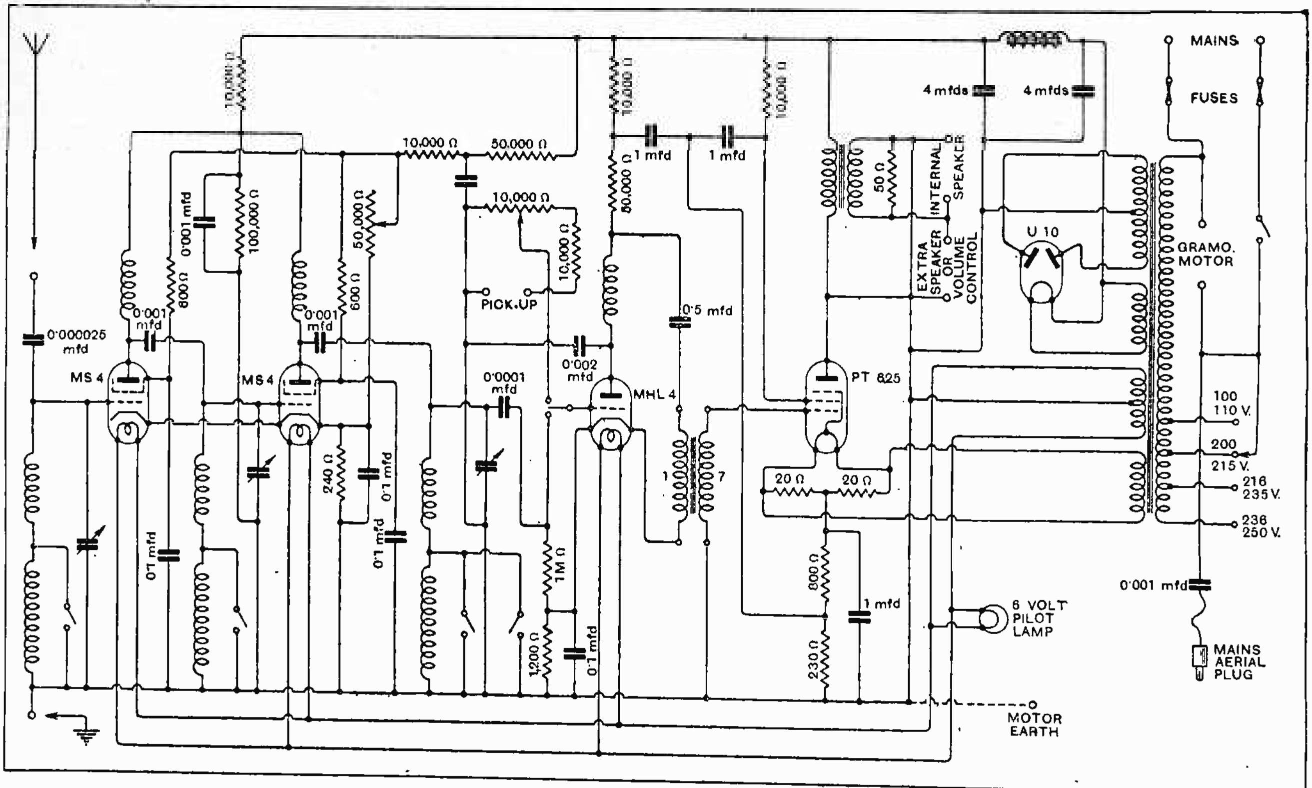


Constructional features of the Marconiphone, Model 560.

Marconiphone Model 560.—
upper register. Thus, part of the amplified potential representing the lower frequencies is fed back into the anode circuit of the detector, so that when passed on again through the transformer to the grid of the pentode a boosting up of the bass results. This ingenious method of introducing tone control corrects the normal characteristic of the pentode with its tendency to attenuate the bass frequencies in its anode circuit. A step-down output transformer is fitted, and one notes the wise precaution of permanently connecting a resistance across the loud speaker terminals in order to avoid the chance of damage to the pentode should

A solid-walnut cabinet houses the set, al. offending controls being hidden in a recess at the top, to which access is gained through sliding doors. The dial is illuminated, and carries a wavelength calibration. A moving-coil loud speaker, making use of a large permanent magnet of quite recent design, ensures the best possible loud speaker performance, free from hum which might arise were a rectifier employed for field excitation.

On performance, it was noted that this receiver covered as wide a range of audio frequencies as any set we have tested. Reproduction possessed the characteristic brilliance due to the pentode combined with a



Tone correction and loaded output are interesting details found in the circuit of the Marconiphone, Model 560, A.C. operated receiver.

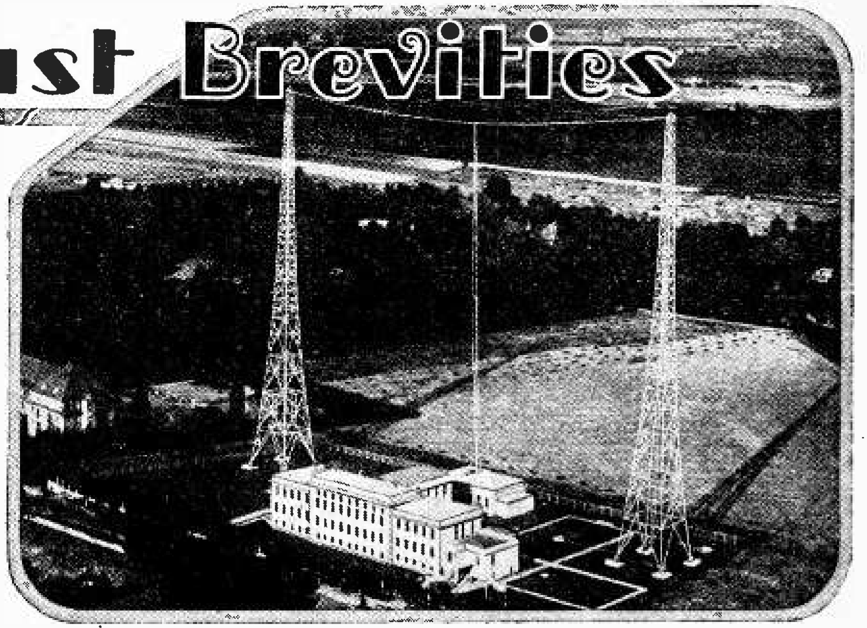
signals be tuned in with one of the loud speaker leads disconnected. Circuit refinements such as these, which, strangely enough, are rarely found in present-day receivers, give confidence in the skill of the designers.

Likewise, on the production side, we find a die-cast mounted variable condenser operated through worm-driven cords, positive and free from backlash, and a clever rotation stop device. Single-knob control, with four positions, actuates the entire mechanism of "on" and "off," wave-change switching and change-over to gramophone pick-up. All components are screened, and the housing is of pressed metal, while the voltage-regulating and feed resistances are carried in the ideal position, a recess under the base, so that all wiring is hidden. All the framing is of iron, which is stiffer and, incidentally, cheaper than the aluminium customarily used, and, being dull cadmium-plated, it is rustless and of good appearance.

well-defined bass devoid of boom. Used on a 30ft. aerial at a distance of 5½ miles from Brookmans Park one finds that the nearby transmissions are only equal in their programme value to, say, Brussels or Budapest. Dial readings start just above 200 metres, and as one turns the control Cologne and Helsinki are almost at once encountered. These stations are free from the National transmitter, and before reaching the London Regional there are seven well-defined programmes. Above the Regional are about ten stations, Katowice, Rome, Stockholm, Lagenberg, Brussels, Vienna and Budapest being particularly good. The little station of Rabat, in Northern Africa, almost overlapping on Dublin, came in well.

At a price of 38 guineas this set does not qualify for the title mentioned at the commencement of this article, though we would call for no change in its design, construction or performance.

Broadcast Brevities



An air view of the Breslau broadcasting station which can be heard on 325 metres.

By Our Special Correspondent.

New Waves for Broadcasting?—The Power Problem.—Welshmen's Grievance.—Four Million Licences.—Northern "Patience."—Tackling Electrical Interference.

Secrets from Semmering.

Several secrets of vital interest to ordinary listeners have been brought back from Semmering, where the Union Internationale de Radiodiffusion have just held their little meeting to ruminate on such unpleasant topics as mutual interference and incompatibility of temperament among broadcasting stations. One outstanding concession has been gained.

oooo

Bigger Waveband for Broadcasting?

On excellent authority I learn that the organisers of the World Wireless Conference at Madrid next year have already been persuaded to include on the agenda the discussion of a considerable extension of the existing broadcast waveband. The possibility of an expansion of 100 metres both above and below the existing medium waveband is mentioned.

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Only a Temporary Solution.

If the world governments prove far-sighted and generous enough to assent to this change there is some hope that the ether of Europe may be reasonably commodious for another two or three years. Assuming that the existing band covers roughly 300 metres, the increase to a 500-metre width would permit of a station separation of approximately 15 kilocycles as compared with the present separation of 9 kilocycles. On the face of it we have a solution to most of our interference troubles.

oooo

The Power Ogre.

It has been repeatedly urged in these columns, however, that no amount of dazzling jugglery with the wavelengths can serve much purpose while the ogre of unrestricted power output still struts about the stage. And all the indications are pointing to an all-round power increase in the near future.

oooo

What Madrid Must Do.

It lies within the scope of the Madrid Conference to limit every broadcasting station to a power not exceeding the reasonable maximum necessary to provide listeners with a suitable service. Unless Madrid exerts this authority we can hope for little more than an interminable series of trifling conferences all actuated by the one motive, viz., the putting of a quart into a pint pot.

"Hope Springs Eternal . . ."

In the meantime the members of the Union in fifteen European countries have undertaken to measure the field strength at which some thirty of the principal stations are received in their countries. It is hoped (I am told) that the knowledge gained will lead to a solution of the interference difficulty.

"Man never is but always to be blest!"

oooo

Wails from Wales.

"We demand the inclusion on the B.B.C. staff of a Welshman who will attend to the interests of Welsh listeners."

This from an energetic Welsh Society with whose aspirations on this point I am entirely in sympathy.

oooo

Welsh Rare Bit.

"Yes, I think we have a Welshman—somewhere," said a B.B.C. official in answer to my enquiry. He ran his finger down the Savoy Hill automatic telephone directory. But nearly everybody on the list was either Scots or half-Scots. Sir John Reith, Mr. Gladstone Murray, Mr. Lockhead. . . . Two or three lonely Englishmen were found in company with an Irishman or two. As for the rumoured Welshman, he was non-existent.

The Welsh have a genuine grievance. Savoy Hill must find a Welshman immediately.

oooo

Charlie Chaplin.

Where the "talkies" have failed it seems unlikely that the B.B.C. will succeed, and I shall be more than surprised if Charlie Chaplin can be induced to approach the microphone even to voice a charity appeal.

After all, the great little man has made his reputation through his appearance; any impression he could convey over the ether, however good, would be quite foreign to the personality we associate with the screen.

oooo

Michael Faraday.

Sir William Bragg, one of the greatest chemists of the day, will broadcast a National Lecture on March 4th. His subject will be the life and work of Michael Faraday. Sir William holds two of the scientific posts which were once filled by Faraday.

oooo

What Odds?

The fact that the receiving-licence figure touched 3,501,000 on January 31st, makes it a sporting chance that the four million mark will be reached by the end of the year. Here is an opportunity for the sportsman!

But the wily punter who has studied preceding licence figures will probably have noted that the increase during the previous 12 months was only 456,000. He will, therefore, bet against the attainment of four million by December 31st next.

oooo

Four Million Licences by December 31st?

Honest but observant onlookers, however, will "take him on," nourishing only in their private bosoms the reflection that the opening of Northern Regional is about to bring another vast army of new listeners into the fold.

Yorkshire and Lancashire are among the most "radio conscious" among English counties, but at present they are not adequately served.

oooo

An Anxious Month.

Bearing in mind this increase, it seems that a figure of 3,950,000 may be comfortably reached by the end of November.

With only a month to go the nation should become white-hot with excitement. I like to think of those anxious little groups of people gathered round the post offices at the eleventh hour on December 31st nudging each other into the purchase of extra licences. . . .

oooo

Making Our Mouths Water.

The really expert chef commands the salary of a Cabinet Minister and his work is one of the great arts. In far too many homes of Great Britain food is ruined in the cooking. The new series of broadcasts on Gastronomy, which starts next month, will treat seriously this question of making an attractive job of cooking. Mr. Wickham Steed opens the series on March 6th with a talk entitled "Is Cooking an Art?" Mr. Evelyn Wrench will be a later contributor to the series, also M. Boulestin, famed equally as a poet of gastronomy and restaurateur.

oooo

Are Northerners Patient?

A Manchester man stepped into my office with a fiery light in his eyes and a copy of last week's *Wireless World* in his hand.

"Is the North Country breeding a new race?" he quoted, tapping page 183 and smiling sardonically. "Are we growing patient?"

He drew himself up. "No, Sir!"

oooo

Homely Muhlacker

He then explained. He put it very clearly. There was nothing disquieting, he said, in the fact that northerners were showing no impatience over the delay in opening Northern Regional.

"Up North," he said, "we don't listen to British stations. Our programmes come from Germany. Muhlacker is our local station; we enjoy every minute of the transmissions, especially the operas, which come through splendidly with just that extra touch of modulation that makes all the difference."

"But Northern Regional ——," I began.

"Northern Regional?" he said. "I tell you, we listen to German stations——"

A moment later he had gone.

oooo

Radio Drama by Celebrities.

The dearth of original radio plays is responsible for the increasing trend towards the adaptation of stage plays and novels to the microphone. Three important events in radio drama are already scheduled.

"Will Shakespeare," the play by Clemence Dane, is to be broadcast during the third week in April. Soon afterwards we shall hear Galsworthy's "The Forest," and this will be followed by G. K. Chesterton's "The Napoleon of Notting Hill."

oooo

Manufacturers and Broadcast Interference.

It is a healthy sign that the manufacturers o. those types of electrical apparatus which have been known to interfere with broadcast reception are seeking to modify their designs. I am told that two important manufacturers have separately approached the B.B.C. for the views of the Corporation on the electrical silencing of traction plant.

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Post Office and B.B.C. Tests.

An admirable report on interference caused by electric trams and trolley 'buses was issued by the General Post Office eighteen months ago, as a result of tests carried out jointly by the B.B.C. and G.P.O. at Blackpool.

It was found that clicks were induced in nearby receivers when the collector-shoe of the experimental car jumped over a suspension ear. The noise was considerably reduced, however, by the use of the Fischer plate—a 4ft. long collector running transversely to the "live" wire and held against it by spring tension.

The Dudgeon shoe was also successfully tested. This consists of a trailing shoe behind the ordinary trolley wheel, and is intended to bridge the gaps in the collector-wire.

FUTURE FEATURES.

National (261 and 1,554 metres).

MARCH 1ST.—Orchestral concert from Hastings.
MARCH 2ND.—"The Ridgeway Parade," a song and dance show.
MARCH 5TH.—Hallé concert, relayed from the Free Trade Hall, Manchester.
MARCH 6TH.—Military Band concert.
MARCH 7TH.—"Rich Girl, Poor Girl," a modern musical comedy.

London Regional.

MARCH 1ST.—Sunday Orchestral Concert.
MARCH 3RD.—"The Ridgeway Parade."
MARCH 4TH.—Military Band concert.
MARCH 5TH.—"Rich Girl, Poor Girl."
MARCH 6TH.—Concert of Contemporary Music—3.
MARCH 7TH.—Brass Band Concert.

Midland Regional.

MARCH 3RD.—"The Dream of Gerontius" (Elgar), from Worcester Cathedral.
MARCH 5TH.—Two short sketches—"Mademoiselle," by Elizabeth Illingworth; and "Full Tide," by Jack Heming.
MARCH 6TH.—Rugby Male Voice Choir Concert, relayed from the Co-operative Hall, Rugby.
MARCH 7TH.—The Leicester Brass Band Festival, relayed from the de Montfort Hall, Leicester.

West Regional (Cardiff).

MARCH 1ST.—A St. David's Day Programme of Welsh music.
MARCH 3RD.—Second Concert (Season 1930-31) of the Swansea Orpheus Choral Society, from the Patti Pavilion, Swansea.
MARCH 5TH.—"Second Childhood," a comedy in one act by R. G. Berry.

North Regional (Manchester and Leeds).

MARCH 1ST.—The Manchester Municipal Chamber Concert, relayed from Platt Hall, Manchester.
MARCH 6TH.—"Thirty Thousand Pounds," a play by W. P. Crozier.

Glasgow.

MARCH 7TH.—Excerpt from the Annual Concert of the Glasgow Caledonian Strathspey and Reel Society, relayed from the St. Andrew's Hall.

Belfast.

MARCH 2ND.—"The Far-Off Hills," a comedy in three acts by Lennox Robinson.

Consolation.

Transport authorities have still a long way to go before they quit the ranks of the "man-made static" brigade, but it is comforting for the defenceless listener to know that his troubles are appreciated and that efforts are being made to overcome them.

As regards tramway interference, the best remedy would be to abolish the trams.

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The Grand National.

Running commentaries on the Grand National on March 27th and on the Scotland *v.* England Association Football Match on March 28th will be broadcast on the National wavelength.

The Grand National will be described in two parts, one by Mr. R. C. Lyle for that part of the course on the Grandstand side of Becher's and Valentine's Brooks, and the other by Mr. W. Hobbiss for the remainder of the course, including Becher's Brook, the Canal Turn, and Valentine's Brook. General descriptive scenes will be given by Mr. Alan Howland.

oooo

The Microphone Manner.

Seekers after the ideal microphone talker, who is neither too "announcerial" nor too casual, should tune in on Monday evenings for Dr. T. R. Glover's talks on "Virgil and his Times." We may not all be interested in Virgil, but few of us, I think, could switch off in a hurry after hearing a few sentences from Dr. Glover.

He seems to address the microphone as he would talk to a friend sitting at the other side of a cosy hearth in a study lined with books. Perhaps Dr. Glover's art is explained by the fact that he is Public Orator at Cambridge.

oooo

Still Waiting for the Stille.

The B.B.C. seems to be in no hurry to begin rehearsal tests with the Stille machine, about which so much was said a few weeks ago. The machine has not yet been delivered.

Although the reproduction given by this magnetised-steel recording instrument is stated to be definitely inferior to that of a gramophone, an interesting "stunt" broadcast could easily be arranged, but Savoy Hill apparently fears copyright complications, and will give no promise of such a test in the near future.

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Bedtime Story.

"Sorry, but we can't cut him out," said the engineer. "The 'fade out' switch has jammed."

The announcer looked grave and glanced at his wrist watch.

"Ghastly shame, but what can a man do?" he muttered as he took up the revolver specially provided for such emergencies and levelled it at the violinist. A moment later a shot rang out and the music ceased.

"Ladies and Gentlemen," said the announcer, addressing the microphone, "we must apologise for being two seconds late with the Epilogue."

Laboratory Tests on New Apparatus.

CLIX VERTICAL ANODE CONNECTOR.

In a large number of modern receivers the screen-grid valves are encased in metal containers with a small hole in the top to pass the anode lead. To afford perfect insulation for this lead, Clix have introduced a new vertical type insulated connector. This consists of two separate parts; a spade terminal carrying a plug and an insulated pillar fitted with one of the Clix resilient sockets and a flex connector.

Clix S.G. anode connector for use where the valve is encased in a metal screen.

Perfect insulation is assured so that the H.T. supply is protected against accidental short circuit. The makers are Lectro Linx, Ltd., 254, Vauxhall Bridge Road, London, S.W.1, and the price is 3d.

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MATLOCK TWIN STATION CRYSTAL SET.

Although designed primarily to meet the needs of those residing within a few miles of Brookmans Park, this crystal set should prove equally effective under similar conditions elsewhere.

In brief, the arrangement consists of two separately tuned circuits exceedingly well screened and coupled at the high potential ends by a small variable condenser; this, and a wave-change switch, being the only controls on the panel. The function of the condenser is to adjust the selectivity to cope with local conditions.

"Formodensers" are used to tune the circuits, four being mounted in line on a metal sub-panel with the wave-change switch disposed centrally between them. Access to these condensers is obtained through an opening at the back normally closed by a hinged trap.

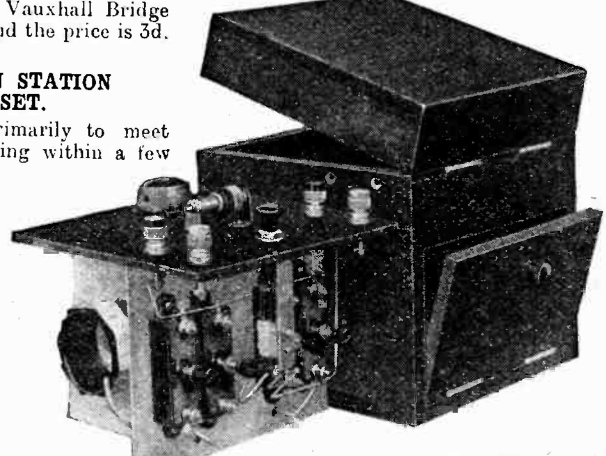
A test was made in North London about 10 miles from the Brookmans Park transmitters using an outdoor aerial of average size. The set functioned admirably, no difficulty whatsoever being experienced in separating the two programmes. Indeed, it was not even necessary to set the selectivity control at minimum, consequently the receiver can be used much nearer the transmitting site and still give satisfactory reception.

The following procedure was adopted to adjust the set, although in all probability this will be done before delivery. First depress the wave-change switch, set the variable condenser at maximum, and tune in the National programme, using the two end "Formodensers." Now pull up the switch knob and tune in the London Regional programme, this time using the two condensers mounted on either side of the switch.

The selectivity control can then be adjusted so that each programme is free from interference and, if necessary, final adjustment made to the semi-fixed condensers.

The perikon type crystal detector fitted is a good feature, since normal jolts, such as it might receive in the ordinary course of use, will not displace it or call for readjustment.

One point we feel requires a little attention is the aerial circuit. Used on an aerial about 70 feet long—including down lead and earth wire—the National programme on 261.3 metres could not be tuned in exactly. Either a small aerial shortening condenser or, possibly better still, the introduction of a tapping on the aerial coil for the aerial, would make a worth-while improvement.



Neat layout, accessibility and good screening are the distinctive features of the Matlock crystal set. Note the semi-fixed condensers and the wave-change switch on the sub-panel.

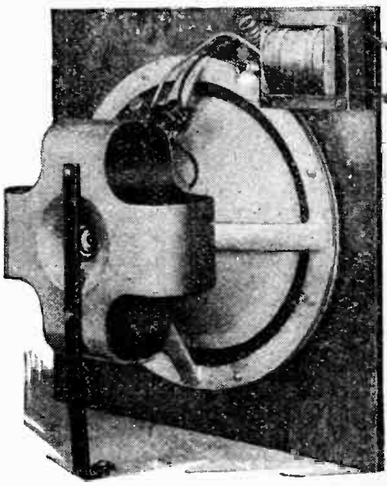
The makers are the Matlock Radio Manufacturers, Matlock House, North Finchley, London, N.12, and the price is 39s. 6d.

oooo

W.B. MOVING COIL LOUD SPEAKER UNIT.

This unit is notable for the massive proportions of its permanent magnet which weighs no less than 10½ lb. It is attached to a rigid cast aluminium cone chassis which also supports a 12¼in. square plywood baffle. The diaphragm is 7½in. in diameter, and carries a low impedance speech coil. A step-down transformer was incorporated in the model tested.

The response between 1,000 and 6,000 cycles is good, and reaches its maximum between 2,500 and 3,000 cycles. Between 1,000 and 50 cycles the output falls off slightly, and as there is no resonance in



W.B. moving coil loud speaker unit in which the permanent magnet is of unusually generous proportions.

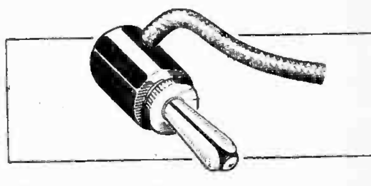
the lower register, the reproduction is free from any tendency to boom. As might be expected with so large a field magnet, the sensitivity is good, and not inferior to mains-excited moving coil instruments.

The price is 6 guineas, and the makers are Messrs Whiteley Electrical Radio Co., Ltd., Nottingham Road, Mansfield.

oooo

BELLING-LEE MIDGET WANDER PLUG.

This new Belling-Lee plug has been designed especially for use where the H.T. and the grid-bias batteries have only a very small head room for the accommodation of the wander plugs. The lead is inserted through a hole in the side of the plug cap and fixed in position by screwing up the metal inset carrying the prongs. The prongs are not formed by longitudinal saw cuts but consist of three segmental pieces of hard drawn brass wire riveted

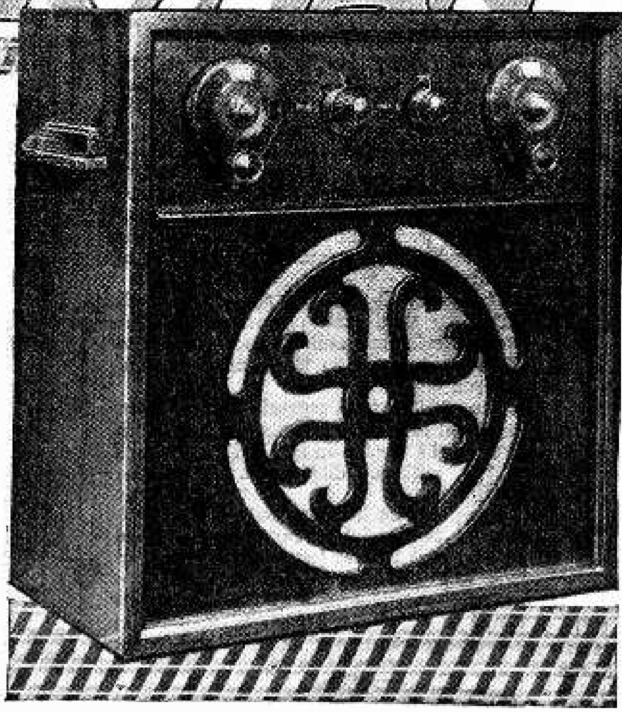


Belling-Lee midget three-prong wander plug with side entry for lead.

into the metal inset. This gives good self-alignment, and in addition provides three separate points of contact.

The price of these midget plugs is 2d. each including engraving, which is available in 12 different styles. The makers are Belling and Lee, Ltd., Queensway Works, Ponders End, Middlesex.

EVERYMAN TWO



A Chassis-built Transportable Set.

By N. P. VINCER-MINTER.

NO apology is needed for describing a plain two-valve regenerative receiver in 1931, for such an instrument still has a very great sphere of usefulness, although it cannot be used to roam the ether at will, as was the case in the earliest days of broadcasting when high-powered stations were quite unknown. In spite of all that has been said to the contrary, it is still possible for a man living within half a dozen miles of a Regional station such as Brookmans Park to be able completely to separate the two programmes and listen to either without interference from the other. At considerably less than double that distance from Brookmans Park he can count upon eliminating both London transmitters, and adding not only the Midland Regional station but also a few foreign stations to his bag without calling in the aid of an H.F. stage or the complication of a separately tuned aerial circuit.

Before giving the actual constructional details we will briefly consider the circuit used. In the first place the variable condenser in series with the aerial circuit is solely for the purpose of regulating selectivity. This can be connected up to the top of the coil or to a tapping on it. The question of which connection to use depends solely upon the electrical characteristics of the aerial and upon the locality in which the receiver is to be used. This optional connection is arranged for by means of a plug and two sockets. Speaking broadly, the connection to the top of the coil is for use only with very short indoor aerials. Now, it will be seen that the combined wave change on-and-off switch is arranged so that it will short-circuit the long-wave portion of the tuning coil when medium-wave reception is desired. It will be observed, however, that when this is done the aerial is still tapped on to No. 4 connection on the long-wave coil. This connection is tapped at a point on L_2 at which one-fifth of the total number of turns on this coil are included in the aerial circuit. Now L_2 itself is linked into the medium-wave inductance (L_1+L_3) at a point which causes one-fifth of the total number of turns of this coil also to be included in the aerial circuit; it follows, therefore, that on both wavebands a 20 per cent. coupling is obtained. Connection No. 3 is tapped into L_2 at a point which gives 60 per cent. coupling on long wavelengths, this particular tapping being only intended for use by readers in certain localities, as will be discussed later.

Constructional Details.

We can now turn to constructional details. The cabinet is supplied with the whole of the panel—which is of wood and is in one piece with the loud-speaker fret—screwed to its front. Our first task is to remove this so that we may fasten on to it the shelf which is provided with the cabinet. The shelf is already fitted with two side pieces, as shown in the photograph. It is necessary, however, for us to cut into it a slot 6in. long and $\frac{3}{8}$in. deep, as shown in Fig. 2. This slot is merely to avoid fouling the rim of the loud speaker chassis, as the diameter of the latter is just too large to permit of it being placed completely under the shelf. It will be noticed from the photograph that the loud speaker is not mounted centrally, but as far to the right as it will go. This is done in order to enable a 120-volt battery to be used in place of the 99- or 108-volt type usually employed in transportable receivers.

The fact that the loud speaker is not mounted centrally does not impair quality in the slightest degree. The shelf is fixed at a distance of $4\frac{3}{16}$in. from the top of the front panel by means of wood screws passing through from the front of the panel into its two side pieces;

THIS receiver is completely self-contained, and since all components, including the loud speaker, are mounted on a removable chassis, the constructional work is very simple. It is suitable for use with either an indoor or outdoor aerial. The H.T. battery may be replaced if desired by a portable type H.T. eliminator and trickle charger, for which there is ample space in the cabinet. By comparatively slight alterations the receiver may be converted to all-mains operation using indirectly heated valves and for use as a gramophone amplifier only small modifications are required.

Everyman Two.—
additional support is given by the fact that the bottom of both slow-motion dials is on a level with the shelf and, therefore, the two wood screws which are necessary to fix the dials in position pass right through the front panel into the edge of the shelf. The whole arrangement is quite firm and strong. All components can now be mounted in accordance with Fig. 2.

Care should be taken when mounting the tuning coil to see that it is placed with its numbered terminals in the position shown in Fig. 3. The actual numbers of the terminals will be found on the ebonite moulding underneath the coil. The fact that they cannot be seen once the coil is screwed in position is no disadvantage, if care is taken to position the coil correctly before screwing it down. Before finally screwing the coil down it is necessary to identify the three terminals A, B and C, shown in the practical wiring diagram, because these are not marked by the makers of the coil. We do not want to make any connection to C, which does not go to a separate connection on the coil as is the case of A and B, but is merely a repetition of one of the terminals at the base, it being provided to facilitate wiring when the coil is used in certain circuits other than the one under discussion. This terminal may, therefore, be ruled out. It can be readily identified by the fact that the wire which passes down the middle of the coil former to connect to one of the base terminals, is covered by yellow sleeving, it being the only one that is so covered. With regard to the remaining two terminals A and B, which, of course, go to the switch as indicated in Fig. 1 and in Fig. 3, it is pointed out that it is immaterial which terminal goes to which switch contact. The combined decoupling and voltage dropping resistance, R_2, actually consists of a "spaghetti" resistance which connects from the H.T. terminal on the inter-valve transformer to the positive terminal on the loud speaker unit.

The aerial and earth connections are taken to two sockets mounted on a piece of ebonite 2in. × 1in. × $\frac{3}{16}$in., which is screwed on to the edge of the horizontal shelf of the chassis, as shown in Fig. 2. This can be clearly seen in the photograph. These sockets come opposite to the two holes which are already drilled in the back of the cabinet. The connections marked K and H also consist of sockets into which a plug is inserted. This is easily understood by reference to Figs. 1 and 3.

Small battens, which are clearly shown in the photograph, are screwed on to the bottom of the cabinet in order to help to steady the H.T. and L.T. batteries, which are held quite securely when the back of the cabinet is put on. The two 9-volt grid batteries are mounted by screwing their lids on to the base of the cabinet. The batteries are then stood in these lids, this method of mounting being specially provided for by the particular make of grid battery used. If the valves which are specified are actually employed, the second bias battery will not be required. It was, however, put in to permit the use, if desired, of other output valves which require a greater value of bias than can be supplied by one battery. If using other valves, however, remember that the total plate current consumption should not exceed 12 mA., which is the maximum economical discharge rate of the H.T. battery employed.

Avoiding Interference on Long Waves.

Before finally putting the chassis into the cabinet it is necessary to make up our minds whether we are going to connect to No. 3 tapping or No. 4; or, in other words, whether we are going to use 60 per cent. or 20 per cent. coupling on long waves. The locality in which the set is used will definitely decide the point once and for all, and so no trouble has been taken to make this connection readily accessible after the chassis is once put into the cabinet. The 60 per cent. coupling connection

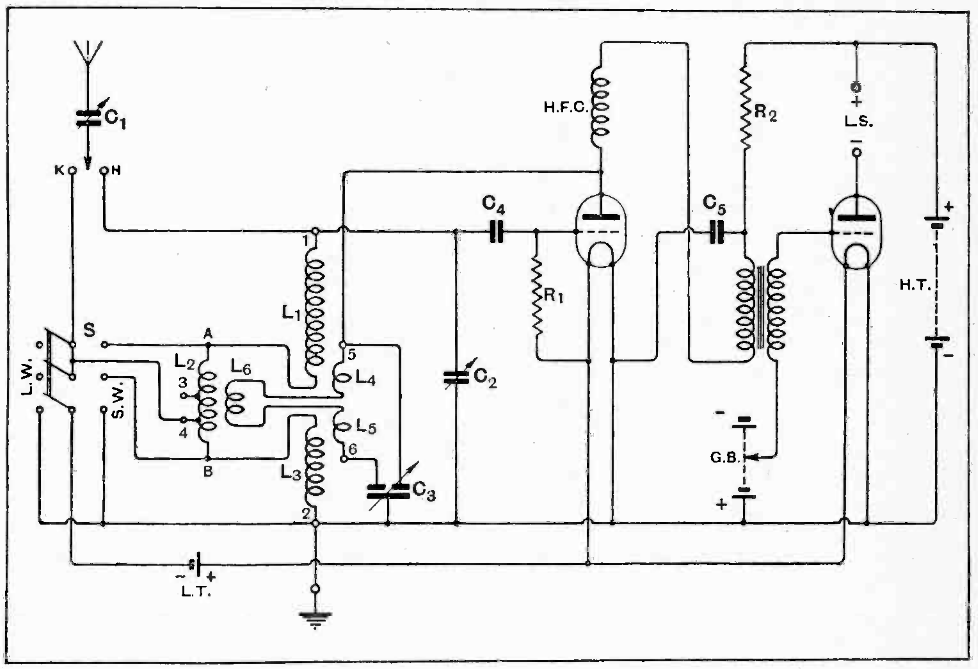


Fig. 1.—The theoretical circuit diagram. Values are as follows: C_1, 0.0003 mfd.; C_2, 0.0005 mfd.; C_3, 0.0003 mfd. differential; C_1, 0.0003 mfd.; C_5, 2 mfd.; R_1, 2 megohms; R_2, 30,000 ohms.

at No. 3 will be of little use, for instance, to people dwelling on the South Coast, as tuning is so broad that 5XX and Radio Paris will be heard simultaneously. The chassis can now be put into the cabinet. It is held in position by the screws which attach the wooden handles to the sides of the cabinet. These wood screws

Everyman Two.—pass completely through the side of the cabinet into the two upright members of the shelf. No other support is really necessary, although, if desired, the fixing screws which will be found attaching the front panel to the remainder of the cabinet when it is purchased may be restored to their place. The batteries are, of course, inserted after the chassis is put in.

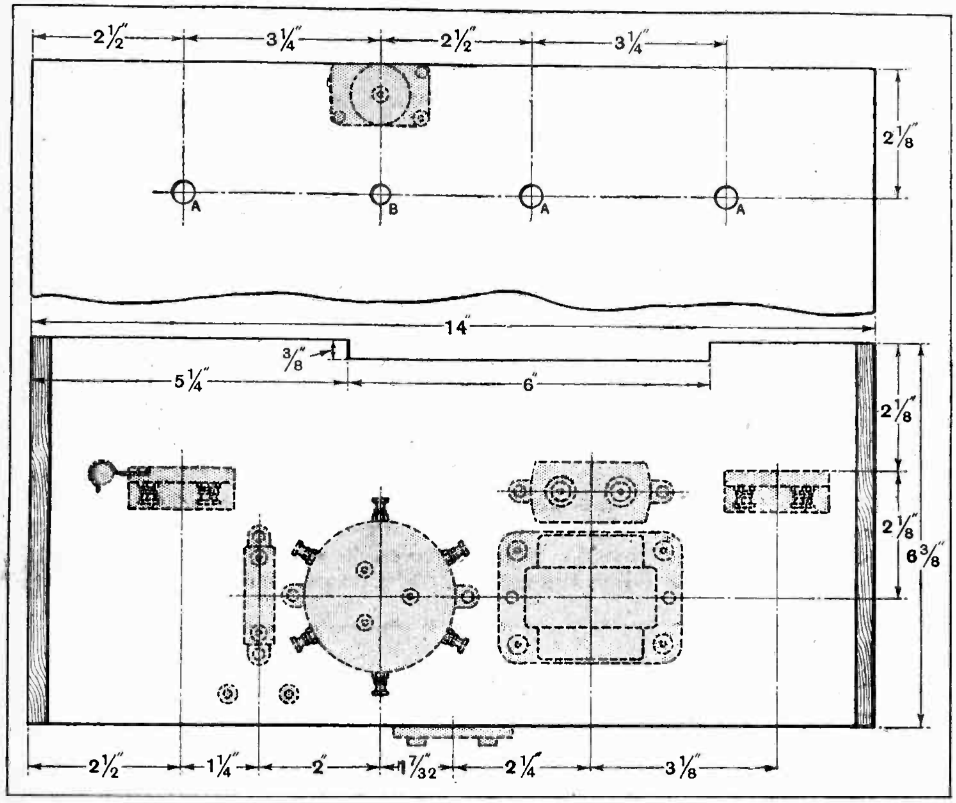


Fig. 2.—The layout of the panel and baseboard. Drilling sizes are as follows: A, ⅜in. dia.; B, 5/16in. dia.

If desired, a simple H.T. eliminator, either D.C. or A.C., may be inserted in place of the H.T. battery. There is, in fact, ample space for one of the combined H.T. eliminator and trickle chargers which are now upon the market. For those who desire it, the conversion of this set to all mains working, using indirectly heated valves, is not a very difficult matter.

With regard to tuning it is necessary to conduct our first experiments with the back of the cabinet off. First connect up aerial and earth and put the wave-change switch to SW (see Fig. 1). If the aerial is an outdoor or a large indoor one, insert the plug which comes from C_1 into the socket K (see Fig. 3); C_1 should be set at maximum, and C_3 should be set at about 5 or 6 degrees on the scale, C_2 being rotated until a station is tuned in. More probably than not two stations will be heard simultaneously, and recourse must be had to C_1 and its capacity lessened by turning the knob in an anti-clockwise direction. It will be convenient when referring to the pointer on the control knob of this condenser to consider it as being the hour hand of a clock, the maximum position being at 3 o'clock and the minimum at 9 o'clock. If interference is bad, put the pointer at 12 o'clock and retune with C_2, not forgetting to use the reaction control to assist in obtaining selectivity. The movement of C_1 will naturally affect the setting of C_2 somewhat, but C_1 must in no sense be considered as a tuning control, and, indeed, it would be impossible to employ it as such because hand-capacity effects are naturally prevalent when using it towards its minimum position. If it is not wrongfully used as a tuning control these are quite immaterial.

If selectivity is insufficient at the 12 o'clock setting move it to 10 o'clock; and in the case of a good outdoor aerial move it to absolute minimum, since under such conditions the capacity of the condenser is not zero, and there is quite a useful degree of coupling remaining. If using a small indoor aerial the plug associated with C_1 should be inserted into the socket H (see Fig. 3), and under such conditions it will be found that signal strength is very much greater. It may be found, however, that C_1 has to be set almost to its minimum position, and that C_3 has to be adjusted down to about 8 degrees on the scale to receive a station at the bottom

LIST OF PARTS.

- 1 Variable condenser, 0.0005 mfd. (Polar, No. 3)
- 1 Variable condenser, 0.0003 mfd. (Ready Radio, Brookmans)
- 2 Vernier dials, brown (Formo)
- 1 Differential reaction condenser, 0.0003 mfd. (J.B.)
- 1 Fixed condenser, 0.0003 mfd., and grid leak clips (Sovereign)
- 1 Fixed condenser, 2 mfd. (Dubilier)
- 1 Tuning coil unit, base mounting, tapped 20% and 60% (Tunewell, Dual X)
- 1 H.F. choke (Ready Radio, "Hilo")
- 2 Valve holders (W.B., "Universal")
- 1 "Spaghetti" resistance, 30,000 ohms (Magnum)
- 1 Grid leak, 2 megohms (Sovereign)
- 1 Switch, three-pole, double-throw (Eureka)
- 1 L.F. transformer (Ferranti, A.F.8)
- 3 Solid plugs (Clix, No. 25)
- 4 Sockets, insulated with bush heads (Clix, No. 24)
- 2 Hook terminals (Clix, No. 4)
- 6 Wander plugs, H.T.+, H.T.−, 2 G.B.+, 2 G.B.− (Belling-Lee, "Midget")
- 1 Piece of ebonite, 2 × 1 × 3/16 in. —
- 1 H.T. battery, 120-volt (Pertrix)
- 2 Grid bias batteries, 9-volt (Pertrix)
- 1 L.T. accumulator, 2-volt (Exide, D.F.G.)
- 1 Loud speaker unit (Ormond, R.450)
- 1 Small chassis and cone (Ormond, R.451)
- 1 Cabinet (Camco)
- 2 Valves (Mullard PM1 HL and PM2A)
- 1 Pkt. insulated connecting links (Ready Radio, "Jiffilinx")
- Wood, screws, flex, etc.

Everyman Two.—
of the normal broadcasting band. At first this might be thought to indicate that there are too many turns on the coil.

It must not be forgotten, however, that the coil is not designed for use with a connection at its high-potential end, and this feature has only been put in by the writer because he has found it very convenient under certain conditions, and thinks that others may find the same thing. It will not take long to decide which socket to put the plug in, and the back of the set can then be locked up. With a little practice with the delicate adjustment of reaction necessary to get the utmost selectivity, it is surprising what a lot can be done with a set of this kind, although one must remember that results cannot possibly come up to those obtainable with a receiver having a stage of high frequency or a band-pass tuner. This receiver will be found to give much better results on the medium band, from the point of view of selectivity, and the writer would frankly point out that on long waves 5XX will be the only satisfactory transmission except for those dwelling in localities which are fortunately situated for the reception of long-wave Continental stations. On the medium band, stations *between* the two London transmitters will not be receivable. In fact, at half a

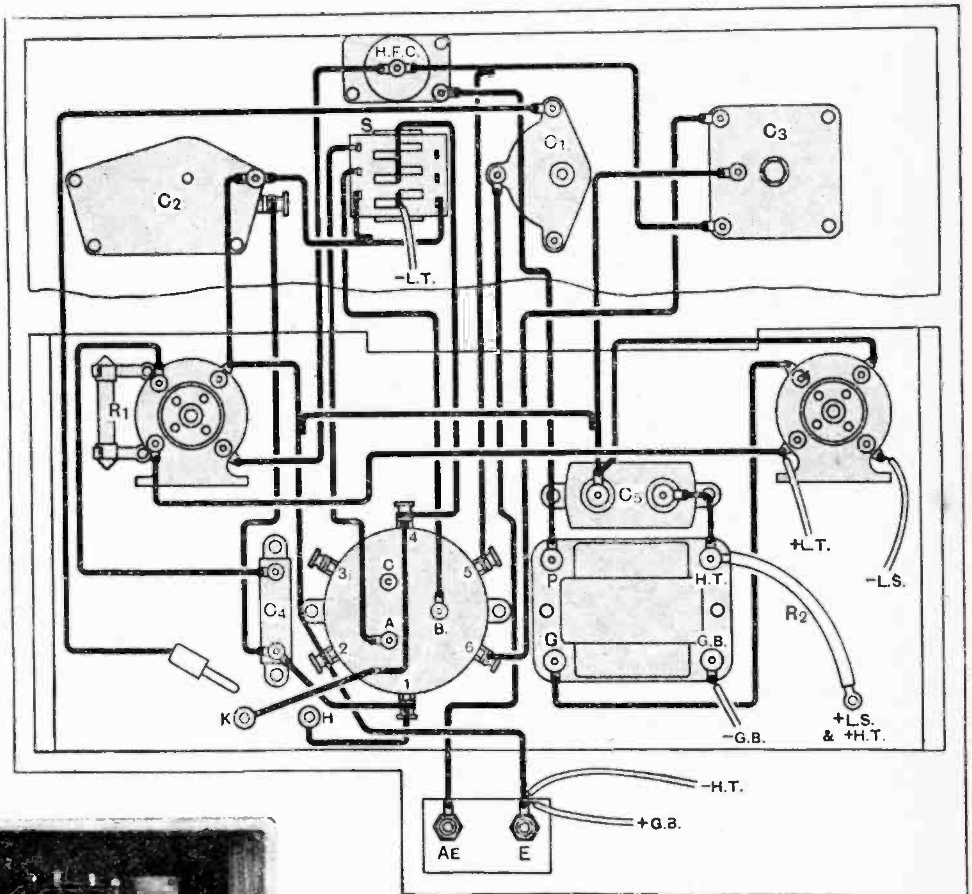
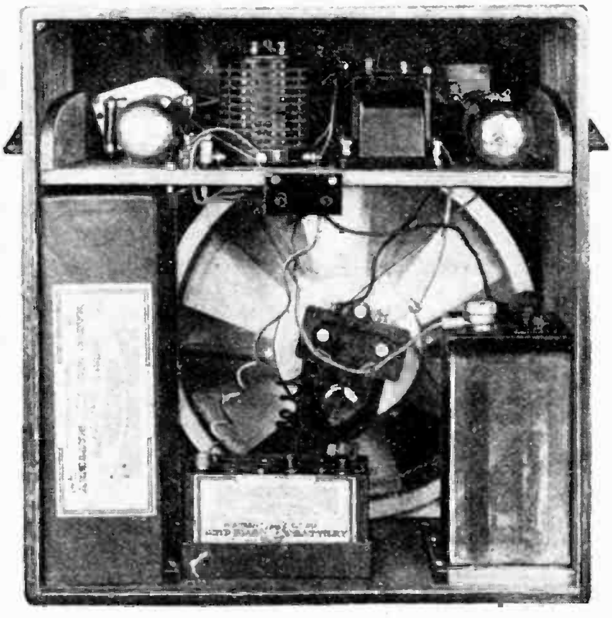


Fig. 3.—The practical wiring plan.



The receiver viewed from the back. Ample space is provided for the housing of the batteries or a portable eliminator and trickle charger.

dozen miles from Brookmans Park there will be no silent space on the tuning dial between the two transmitters, and both will be heard simultaneously. This does not matter, however, but what does matter is that when the set is fully tuned to the London Regional there should be no sound of the London National.

In the writer's opinion the leading feature of this receiver is the excellent quality it gives on the two Londons and the two Daventrys. This is largely accounted for by the good qualities of the intervalve transformer, the loud speaker and the valves. There appears to be negligible box resonance but obviously anybody can test this for himself by trying the set with the back removed, and if in any particular case better results are obtained, a large circular hole may be bored through the back of the cabinet, although in his own case the writer has not found this necessary.

This receiver is available for inspection at the offices of "The Wireless World," 116, Fleet Street, London, E.C.4.

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.

RADIO SOCIETIES AND SERVICE.

Sir,—I was very much interested in the letter of Mr. J. Baggs in the February 11th issue of *The Wireless World*. Personally, I think that the reason for the falling off in membership of the various radio societies is due to the introduction by the radio dealers of the "Kit set." The 20 wires and no solder idea has taken the interest away, and until the set goes wrong the "Kit set" owner requires no knowledge at all. More interest would be stimulated if the manufacturers gave technical details of their products, i.e., response curves for speakers, pick-ups, transformers, the grid swing power valves would handle, etc. An increase in membership of radio societies would also have a big effect on the radio trade. ROBERT REID JONES.

Liverpool.

Sir,—The suggestion put forward by Mr. Baggs in your correspondence columns is, in my opinion, an excellent one.

As a long-standing member of one of the oldest radio societies in the country, it has always appeared surprising to me that local dealers and their staffs do not take advantage of the excellent opportunities for the acquiring or furthering of technical knowledge, and the interchange of experiences and opinions relating to current developments afforded by membership of a radio society.

To give a signal illustration, it is the practice of my society, before proceeding with the lecture of the evening, for the members to be asked "Any questions?" Someone present will, in most cases, be able to answer the troubled ones. Knotty or debatable matters that cannot be dealt with at once are held over to be dealt with at an early date, when a whole evening is devoted to fully threshing out the matter.

I hold that by following these "questions and answers" dealers whose pride it is to advertise service can in course of time glean more practical information of actual difficulties experienced with every type of apparatus than they can hope to acquire by attending the short, intensive "service courses" arranged by set manufacturers. Other advantages must be apparent to the dealer who is prepared to give the matter a few minutes' consideration.

Mr. Baggs is right when he says the membership of the societies has dropped to the "really hard-boiled enthusiasts." All the people who wanted to know how to wind a variometer have been shown—and who wants to, anyway, in these days of cheap components and blue prints? Those that remain represent the "intelligentsia" of the radio fraternity, many of whom, although outside the industry, possess a fund of knowledge that would surprise (and embarrass) many "technical engineers."

The dealer cannot fail to benefit by their acquaintance.

The radio societies are not supported by the technical Press with one notable exception, and for this reason my society is distributing a leaflet in the hope of reaching enthusiasts who may not have heard of its activities.

South Hackney, E.9. G. W. HEATH,
Assistant Hon. Secretary,
Hackney Radio and Physical Society.

AVOIDABLE INTERFERENCE.

Sir—Your Editorial Comments in the February 11th issue of *The Wireless World* raise an issue of the utmost importance to the whole wireless universe—listener, dealer and manufacturer.

Unfortunately, there is no statutory power by which interference, however bad, may be dealt with in the Courts.

As a manufacturer of specialised apparatus, I have investigated scores of complaints of interference caused by electrical machinery, and quite agree with your statement that the only satisfactory way of dealing with it is to tackle it at the source. There it is the most easily and cheaply eradicated.

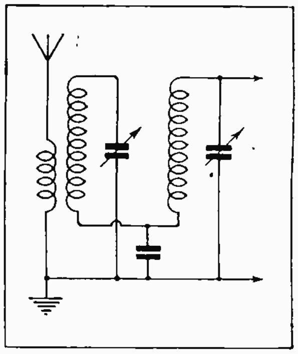
I feel that a great service could be done to radio if legislation could be passed to compel the users of interfering apparatus to provide the necessary filter device; but nothing will be done while sufferers continue to put up with the present state of affairs as being inevitable.

It should be urged upon everyone whose entertainment is spoiled in any way by this form of nuisance to report its existence to the B.B.C., marking the letter "Interference." The Post Office officials who deal with these complaints are anxious to help in the matter—I have found them most courteous and obliging—and the more evidence they can accumulate the sooner will there be a hope of the necessary legislation being passed. F. E. GODFREY.

Hampstead, N.W.3.

HUM IN A.C. SETS.

Sir,—There is one cause of modulation hum which does not appear to be mentioned in the article on "Tracing Hum in Mains Sets." The leads connecting the set to the mains may be in such a position as to cause induction in the aerial lead-in; this will cause trouble if there is no path of low audio-frequency impedance between aerial and earth. A case in point is the filter circuit with the aerial connected to a tapping on the coil and the coupling condenser in the coil leads; the remedy, of course, is to use a separate aerial coupling coil.



D. A. BELL.

Magdalen College,
Oxford.

THE STENODE.

Sir,—Unlike Mr. Yates-Fish, I lack the boldness to criticise or comment on Dr. Robinson's paper until I have had an opportunity of reading it. Though I am thus prevented from entering into technical arguments, I can give the results of practical experiences with a Stenode Radiostat receiving set. Some weeks ago I had a seven-valve experimental model made up, and this has been in constant use ever since.

At a range of 15 miles from Brookmans Park this set will bring in either Stuttgart or Graz quite free from interference from the London Regional; it is equally successful with the "next-door neighbours" of the London National. On both medium- and long-wave bands it enables one to obtain excellent reception from stations which, with any other set that I have tried (and their number is legion!), are hopelessly jammed or heterodyned.

As regards Mr. Yates-Fish's "analysis of the behaviour of the set," may I say that the Stenode eliminates both of the audible effects of interference that he mentions. Both the interference due to audio-frequency modulation and that due to heterodyne tones are definitely cut out.

With all its selectivity the Stenode provides reproduction of the very highest quality, the moving-coil loud speaker used with it bringing out the lowest notes of the double-bass or the highest of the violin E-string equally well.

Why does Mr. Yates-Fish suggest that the Stenode may prove to be a useful alternative to the band-pass filter? Surely by simplifying receiving circuits and providing *real* selectivity in combination with the highest quality in reproduction, it is a step far beyond the band-pass filter, and offers an entirely new and much-improved method of designing wireless receiving sets.

Berkhamsted. R. W. HALLOWS.

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.

Why Coils are "Potted."

Will any improvement be effected by mounting the tuning coils of my receiver (of which I am sending you a circuit diagram) under screening covers, as used in the construction of most modern receivers?

Your receiver apparently includes a simple vertical screen, and, as its H.F. amplifier is presumably stable, extra screening will not confer any benefit. The point about screening is that it enables one to obtain much more H.F. amplification—with stability—than would otherwise be attainable.

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Easy Pick-up Adaption.

Due to the fact that a very small condenser—0.0001 mfd.—is used in conjunction with a power grid detector, would it be permissible to connect a pick-up directly across the grid circuit in the manner shown in the accompanying diagram?

A consideration of your diagram (reproduced in Fig. 1) shows that the pick-up is in effect shunted by the grid condenser and leak. As the reactance of the condenser over the whole range of

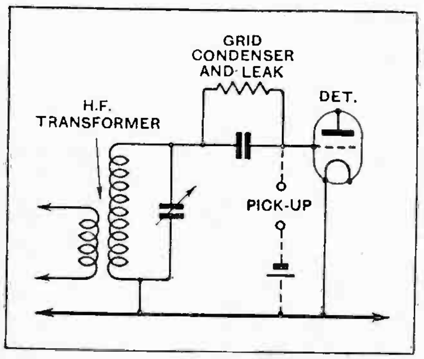

Fig. 1.—Simple, but generally effective, method of connecting a pick-up to a power grid detector.

audible frequencies is high, it will not impair the output characteristics of the average pick-up. Similarly, the grid leak, if of about 0.25 megohm, as is usual, will have no appreciable effect.

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Inductive Filters.

Do you consider that the input band-pass filter of the "D.C. Band-Pass Five" would be suitable for inclusion in a simple detector-L.F. set without any H.F. amplification?

This system of coupling will be quite satisfactory, except that it is particularly susceptible to the disturbing effect of reaction.

Interaction.

I have just noticed that my 2-v-1 receiver can be made to oscillate when the loud speaker is brought into proximity with the aerial lead-in wire. Must this be taken as an indication that there is something wrong with the receiver?

This would suggest that the H.F. filtering arrangements in the anode circuit of your detector are not entirely satisfactory, but it must be admitted that it is virtually impossible to keep all traces of H.F. energy out of the L.F. amplifier, particularly when dealing with "2-H.F." sets. We do not think that you need be concerned, provided that there is no trace of instability when the aerial and loud speaker leads are in their normal positions.

oooo

Heterodyne Wavemeter.

When a heterodyne wavemeter is operated by the absorption method, a "flicker" is produced in the anode milliammeter as the external circuit is tuned through resonance. I have observed that this change of current is sometimes in an upward and sometimes in a downward position, depending on the wavelength being dealt with. As energy is being taken out of the oscillating circuit, should not the deflection always be in a downward direction?

Everything depends on the extent of coupling between the grid and plate circuits of the oscillating valve in the wavemeter. As the effective coupling changes considerably from one end of the tuning scale to the other, it is quite usual that the effect you have noticed should be produced.

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Dry Battery Limitations.

In your opinion, what is the greatest current that can be taken with economy from H.T. dry batteries of the "super-capacity" type?

We can hardly be dogmatic on this matter, and in any case everything depends on one's definition of "economy." The maintenance of a dry battery becomes somewhat expensive if current consumption is allowed to exceed some 15 milliamperes.

"Local-distance" Switch.

Some time ago you published a circuit diagram showing how aerial coupling could be reduced, by operation of a throw-over switch, to a value giving adequate signal strength for local-station reception without introducing any change in tuning. I should like to fit a device of this kind to my own set, if possible, without making any internal alterations. The receiver includes a double-wound aerial-grid transformer with medium- and long-wave windings in series; there is also a variable aerial series condenser. Tuning condensers are ganged; hence my desire to avoid change of tuning.

Can you suggest a suitable scheme?

The arrangement shown in Fig. 2 will be found to work satisfactorily. The extra series condenser, which should have a maximum capacity of about 0.0001 mfd.

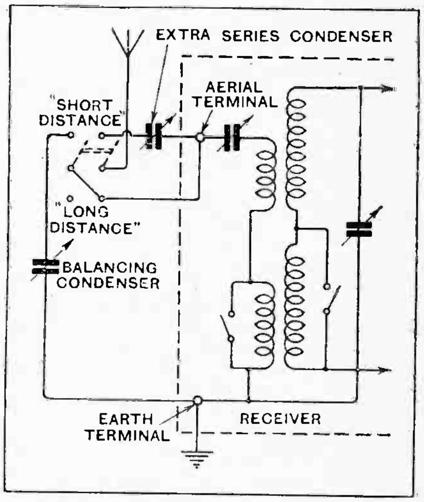

Fig. 2. — Changing sensitivity without affecting tuning; a useful arrangement when local signals are overpoweringly strong.

and a low minimum, is placed in circuit when the switch is thrown to the "short-distance" position; at the same time compensation for the removal of a part of the aerial capacity is made by introducing the balancing condenser, which may be of the semi-variable variety, with a maximum capacity of 0.0003 mfd.

Having set the extra series condenser to give the desired reduction of input, the balancing capacity should be adjusted (without touching any other control) so that signal strength is at maximum, thus indicating that the input circuit is again accurately tuned.

Economy in Anode Current.

As I have to depend on dry batteries for H.T. supply, it is necessary for me to exercise care in the choice of valves. If I replace my neutralised triode H.F. valve by a screen-grid valve, is any appreciable increase in current consumption to be anticipated?

A three-electrode valve, of the type normally used for amplification, will consume not far short of 2 milliamperes. A suitably chosen S.G. valve of high impedance will pass about the same current in its anode circuit, and, in addition, from 0.5 to 0.75 milliamp. will be required for the screening grid. It will thus be seen that the extra consumption is quite negligible, particularly when the current drawn by the output valve is taken into consideration.

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Reaction Adjustments.

There is a good deal of "overlap" in the reaction condenser control of my H.F.-det.-L.F. set. Will you please enumerate briefly the alterations that can be made in an attempt to improve matters in this respect? I have tried various values of detector anode voltage.

We advise you to try the effect of removing a number of turns from the reaction coil, and also of moving the physical position of this winding in relation to the tuned coil. An H.F. choke of different characteristics from that at present used might be beneficial, and it would also be worth while to alter the anode circuit load by joining a small fixed condenser between detector anode and earth.

Detector grid operating conditions are important, and it is often found that an appreciable reduction in positive grid voltage can be made without noticeably impairing rectification efficiency, but with a decided improvement from the point of view of smoothness of reaction control.

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Simplified Coil Switching.

I am engaged in planning a "2-H.F." A.C. mains set, intended to give a particularly good performance on the long waves, and cannot quite see how the desired results are to be achieved without undue complication of the wave-range switching.

Ganged tuning is to be employed, and my aim is to ensure that the proportion of the valve capacities transferred to the tuned circuits shall be practically identical on both wavebands. The position is complicated by the fact that it will be necessary to "tap down" the anode connection on the tuned grid coils, which are to be used as couplings.

Any suggestions, and, if possible, a circuit diagram would be appreciated.

We suggest that you should work on the lines indicated in Fig. 3. Medium- and long-wave coils are joined in series, and short-circuiting switches are connected in the usual way. A single-pole switch is arranged to transfer the anode connection to appropriate points on the first coupling coil L_1. With regard to the coupling between the second H.F. valve and the detector, matters will be greatly simplified by joining both plate and grid to the same tapping points, as shown, and thus avoiding the need for changing over a second connection. We have not completed the aerial input circuit, as you do not say if you intend to use a filter or two-circuit tuner. In any case, this part of the receiver should present no special difficulties.

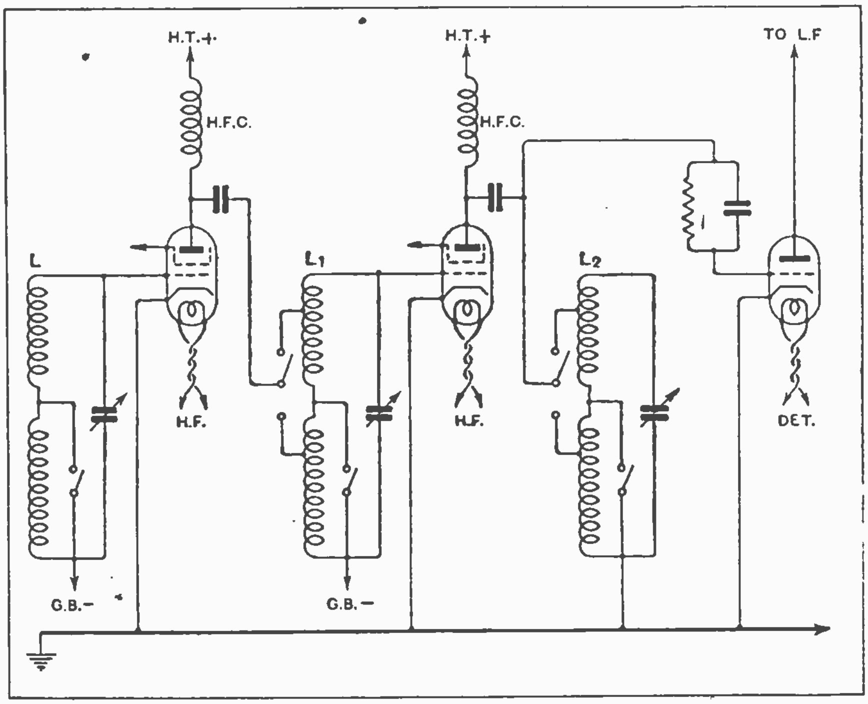


Fig. 3.—Maintaining a balance on both medium and long waves; how excessively complicated switching may be avoided.

FOREIGN BROADCAST GUIDE.

NAPLES (INA)

(Italy).

Geographical position: 40° 49′ 58″ N.; 14° 16′ 25″ E.

Approximate air line from London: 1,003 miles.

Wavelength: 331.4 m. Frequency: 905 kc. Power: 1.7 kW.

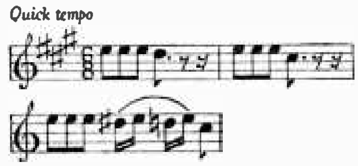
Time: Central European (one hour in advance of G.M.T.).

Standard Daily Transmissions.

(The majority of the programmes are S.B. with Rome.)

Woman announcer. Opening Call: *EIAR* (phon.: *Eh-yar) Signori Buon giorno-Radio Napoli*: if with Rome, *Radio Roma-Napoli* (phon.: *Nar-polly*).

Opening signal: melody played in several keys (Pipes of Pan).



Closes down with the words: *Fine della trasmissione; Buona notte a tutti*, followed by the Fascist hymn, "Giovinezza," and the National Anthem, "Marcia Reale."

oooo

Litz Wire.

I have some Litz wire, comprising thirty strands of No. 42 wire, and, if you approve, would like to use it for winding tuning coils for the "Band Pass Three" receiver.

This cannot be real Litz wire, of which the total number of strands must always be to the power of 3, i.e., 3×3=9; 3×3×3=27, etc. In the circumstances we can hardly advise you to use it; even though it were effective, a complete redesign of the coils would be necessary, as the diameter will differ considerably from that of the wire specified.

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Better Valves for a Portable.

Is there any risk of producing instability by replacing the existing H.F. valves in a ——— portable (two aperiodic H.F. stages) by fitting modern valves of appreciably the same impedance but with greatly improved mutual conductance?

We have not had an opportunity of testing this set (which is now obsolete) with modern valves. By fitting better valves than those provided for in the original design, uncontrollable self-oscillation may certainly be provoked.