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We Ought to be Told.

THE United States of America cover a vast area geographically, but the whole country is under one Government, and regulations controlling the development of broadcasting there are, generally speaking, applicable throughout the States, and broadcasting, within the terms of those regulations, can proceed unhampered in its development.

In Europe we are facing an entirely different proposition. Every separate country has its own internal regulations as regards the establishment of broadcasting services, and the only way in which it has been possible, up to the present, to maintain a reasonable degree of freedom from mutual interference between stations has been through the good offices of the International Broadcasting Union. The International Broadcasting Union, however, cannot be regarded as a body officially recognised by the respective governments. It is rather a kind of working agreement between the broadcasting authorities for their mutual convenience. Nothing, as far as we are aware, which is agreed to between the various members of the periodic conferences of the Union, is legally binding to the governments, who, in turn, control broadcasting in the individual countries.

More than ever before, public interest throughout Europe is attracted by the facilities which broadcasting offers for listening-in to stations abroad in addition to the home transmitters. Distant reception is growing in popularity and importance, and a very large amount of capital, too, is invested in the development of various aspects of long-distance reception.

But a disturbing element has arisen in the midst of these endeavours because of the international distinctions and varied political opinions in the individual countries of which Europe is composed. Not all the matter broadcast in one country is considered in another country to be wholesome for the consumption of the inhabitants. Broadcasting is, in certain instances, being employed for political or international propaganda unsavoury to the governments of adjoining states. If such a state of affairs develops, individual governments will be forced to resort to what weapons they can employ to counteract it.

To-day rumours are spreading to the effect that, whilst the International Broadcasting Union is exerting every effort to keep free the channels for the stations of Europe, other and more powerful influences, in the shape of the foreign offices of European countries, are at work to encourage the increase of power of European stations and the overlapping of broadcasting channels, having in view the deliberate creation of such chaos and mutual interference on the broadcast wavelengths of Europe as shall permit only the powerful local transmitters of each individual country to be received by the inhabitants.

If there is any basis for these rumours, and if such influences are actually at work, then the listeners of Europe should be informed.

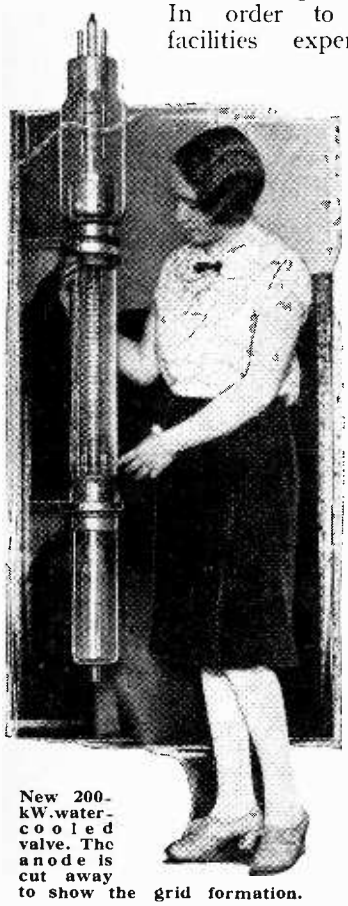
In This Issue

KDKA's New 400 kW Transmitter

Experimental Station with Unconventional High-power Equipment.

By A. DINSDALE.

DURING the World War the Westinghouse Electric and Manufacturing Co. did a great deal of wireless work for Britain and her allies. Thus it is not surprising that at the conclusion of hostilities the company should find itself with a considerable amount of material and a large staff of men on hand. In order to make use of these facilities experimental radio-telephone stations 2WE and 2WM were set up, one at the East Pittsburg plant of the company and the other in a room over the private garage, attached to his home, of Dr. Frank Conrad, Assistant Chief Engineer. Experimental work continued until Dr. Conrad found it possible to transmit entertainment programmes regularly every Saturday night. These programmes became so popular with local wireless amateurs that eventually one of the Pittsburg department stores advertised receiving sets which would pick up Dr. Conrad's programmes.



New 200-kW. water-cooled valve. The anode is cut away to show the grid formation.

When Mr. H. P. Davis, vice-president of the company, saw this advertisement he began to realise the value of the radio-telephone as a mass disseminator of information, as well as a means for conducting private conversations. Plans were therefore made to broadcast programmes regularly from the main Westinghouse plant, instead of from Dr. Conrad's home. A 100-watt transmitter was installed, and commenced service on November 2nd, 1920, by broadcasting the results of the Harding Presidential Election. Thus born, KDKA has not since missed a single day of broadcasting.

In the decade of broadcasting, which has followed, innumerable changes have been made in the equipment of the station, and always KDKA has been one of the leaders of the movement towards higher and still higher power until to-day it is licensed to broadcast regularly on 980 kc., with a power of 50 kW., and uses similar power on several much higher frequencies.

Spray-type Aerial and Field Strength.

With the advent of 1931, the eleventh year of broadcasting, KDKA opened fire with two experimental transmitters of 400 kW. each, one operating on the normal broadcast frequency and the other on the higher frequencies. Both transmitters are close copies of each other and designed to be, so far as possible, interchangeable. Full power is only utilised between the hours of 1 a.m. and 6 a.m., E.S.T. (8 p.m. to 1 a.m., G.M.T.), for experimental purposes.

The aerial system of the new transmitter is of the spray type, designed to attenuate the field strength in the immediate vicinity of the station so that nearby listeners shall not be blanketed and augment signals at a distance. Greater efficiency is claimed for this scheme in that it allows the broadcaster to utilise the radiated energy to greater advantage in reaching distant points with greater regularity, since less energy is absorbed by objects in the immediate vicinity of the station.

The site of the new transmitter is at Saxonburg, Pa.,

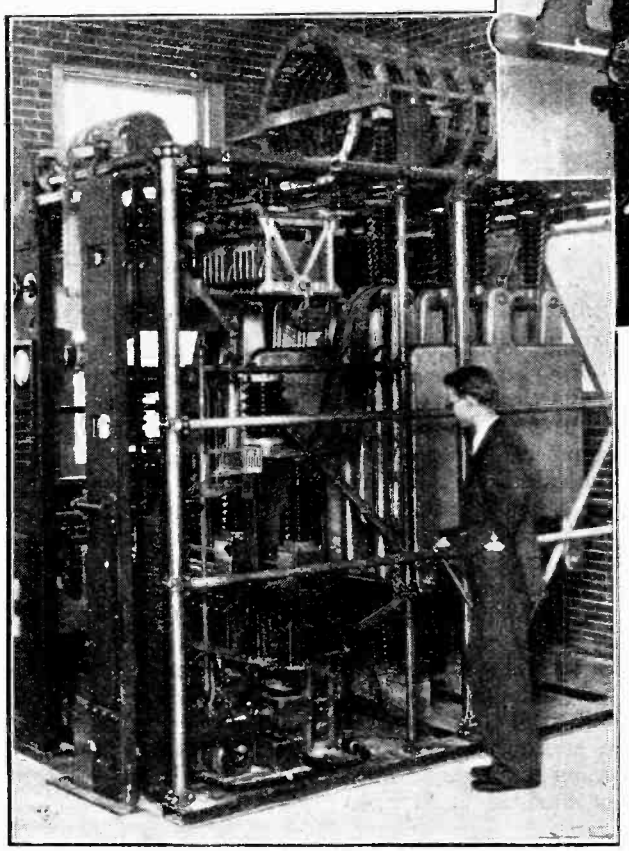
KDKA's New 400-kW. Transmitter.—

and covers about 130 acres, and the long-wave KDKA aerial consists of a circular arrangement of poles enclosing about 8 acres. These poles are 100ft. high and painted yellow and black, according to U.S. laws, for the protection of aircraft. A much smaller area is enclosed by the W8XK short-wave aerial.

Controlling the Angle of Elevation of Waves.

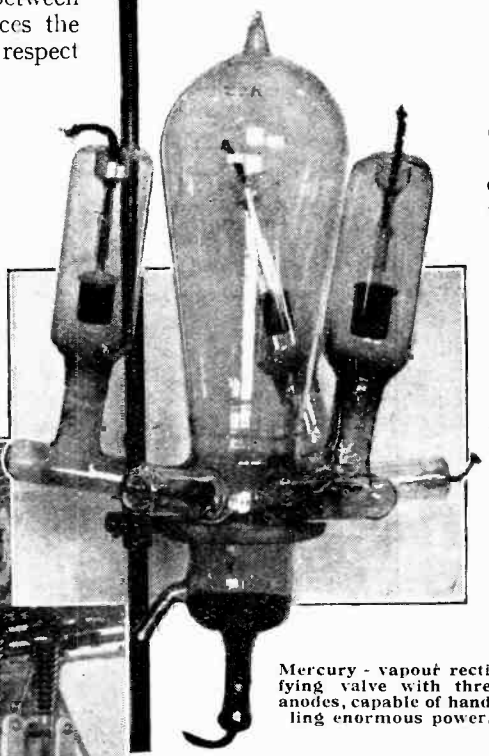
The increased ratio of space to ground-wave radiation is secured by using vertical aerials supplied with currents in differing phases through horizontal feeder lines which radiate from the centre of the circle of poles. Thus, interference between outgoing waves from different aerials reduces the horizontal component of the wave with respect to the vertical component.

Eight poles, spaced round a circle 700ft. in diameter, are used to support the aerial, which has a vertical down-lead at each pole. A cage top links up each pole to form a complete circle. By varying the phase relation of the currents in the feeder lines the radiated energy can be directed at any angle of elevation found most desirable. In this way varying conditions due to day and night, season of the year, etc., can be counteracted. That, at least, is the avowed object of the scheme; much still remains to be found out before the desired ideals can be attained.



Power-stage equipment of the new KDKA station.

Two 200-kW. water-cooled transmitting valves are used in each of the new transmitters. These valves, known as type AW-220, are also a new development. They measure 6ft. in height, 8in. in diameter, and weight 60 lb. apiece. In designing these high-power valves the greatest difficulty encountered by the engineers was the adequate cooling of the grid. The final design, claimed to be of great mechanical strength and sturdiness, embodies a double-ended construction, i.e., filament leads come out at one end and the grid lead at the other. This is in contrast to the older 100-kW. valves[1] wherein all three leads came out at the same end. While the new valves are in operation five tons of cooling water must pass through each water jacket per hour.



Mercury-vapour rectifying valve with three anodes, capable of handling enormous power.

To supply each 400-kW. transmitter a power plant of 900-kW. capacity is installed. Power from this equipment is obtained from 3-phase, 60-cycle, 25,000-volt power lines. At the sub-station, 700ft. from the main building, three 500-kva. single-phase transformers step the current down to 2,500 volts, which power is then carried over two three-phase 2,500-volt armoured cables laid directly in the ground without special duct. The main 30,000-volt transformers which supply the plate voltage for the high-power valves are placed just outside the main building, in the open. Inside the building further transformers supply motor-generators which supply 3,000 amperes D.C. at 40 volts for filament lighting and grid voltage at 3,000 volts D.C. In addition, a moderate amount of power at 10,000 to 15,000 volts, and still smaller amounts at 3,000 and 400 volts, are needed for the various intermediate amplifiers and the master oscillator.

Mercury-vapour Rectifiers.

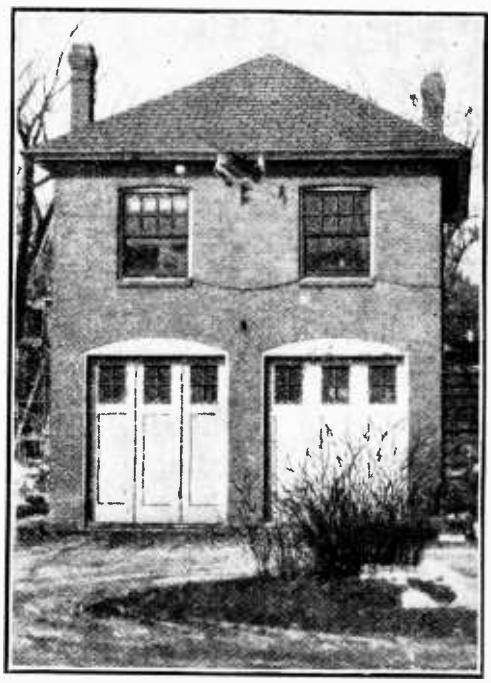
The main 900-kW. rectifier, the largest unit of its kind ever built for broadcast purposes, employs six 190-kva. single-phase transformers to provide the proper voltage and phase relations for rectification into the desired direct-current energy. The rectifier is further remarkable for its use of the recently developed mercury vapour rectifier tubes—ridiculously small glass

[1] See *The Wireless World* for June 15th, 1927.

KDKA's New 400-kW. Transmitter.—

tubes which are capable of handling enormous powers. One of these tubes is illustrated here and, as can be seen, it has three main anodes. Two small sustaining arc anodes and one starting mercury anode are also provided in each tube.

In operation, the tubes are fully immersed in oil, each mounted in a separate oil tank in a cradle by means of which it can be readily removed from the oil. All necessary connections are made when the cradle slides into place, thus permitting tube changes to be conveniently made with minimum effort.



Garage of Frank Conrad from which first broadcasts were made.

Induction Regulators.

Automatic tilting mechanisms for starting the sustaining arcs are provided. This permits the rectifier to be placed in operation from a remote push-button control station with no more attention from the operator than the switching on of the filament-heating circuit of hot cathode valves. The starting mechanism functions in from one to two seconds, after which it is immediately possible to apply full operating plate potential if desired. The sustaining arcs, once established, maintain the tubes in readiness for operation when desired without further use of the starting mechanism unless the power supply circuit is interrupted. Very little energy, about 120 watts per tube, is required to operate the sustaining arcs. This is low compared with filament-type rectifier valves, since the mercury cathode automatically provides emission as needed at the hot spot in the mercury pool, and therefore the power for the sustaining arc does not need to maintain the maximum emission at all times.

Mercury pool rectifier tubes such as these, while not commonly employed heretofore for radio power apparatus, appear to have a number of desirable characteristics, particularly in installations of such size that the use of filament valves would require a great number of them, both in series and in parallel, to furnish the equivalent amount of high-voltage direct-current energy.

To smooth the rectifier output into pure continuous current untuned filter circuits made up of large iron-cored chokes and banks of high-voltage condensers are connected between the rectifier tubes and the radio equipment. The rectifier plate transformers and filter chokes constitute quite a percentage of the total bulk of power equipment, and are mounted out of doors in the rear of the building, thereby saving considerably in its size and cost.

In order to control the direct-current voltage output developed by the rectifier, three-phase induction regulators, water-cooled to conserve space and cost, are employed, with which it is possible to vary the applied alternating current voltage from 0 to 4,600, the regulators being designed to give 100 per cent. range both above and below the line potential. Such a great range was considered desirable in an experimental equipment such as this.

In view of the filament requirements of both low- and high-frequency transmitters, a total of six 40-volt, 1,000-ampere generator sets were installed, three being normally assigned to the low-frequency set and two to the high-frequency equipment, leaving one in reserve. A line-start type 75 h.p. motor drives each generator and operates directly from the 2,300-volt three-phase station supply with only a simple magnetic coil contactor for control.

Filament Supply.

The distribution of filament current is accomplished over a heavy copper bus structure, over two tons of copper being used in its construction. A master field rheostat furnishes the main filament voltage control with individual rheostats on each machine to make slight adjustments for equal distribution of load. A special starting step of field resistance is also interlocked with the filament excitation control so that a damaging current rush does not take place when excitation is applied to cold filaments, which possess only about 10 per cent. of normal operating resistance.

Data Available to Electrical Science as a Whole.

While commercial broadcasting stations do not as yet require equipment as large as that installed in KDKA's new plant, nevertheless it is only by actual construction and use of such apparatus that the development of commercial stations to give safe and economical operation can well be carried out. It is also hoped that data can be obtained from this experimental equipment which will be of value not only in the specialised field of radio engineering, but also to electrical science as a whole.

In Europe to-day broadcasting stations are conducting a war of power. Fifty and one hundred kilowatts are becoming common. The 100-kW. transmitter dates back to the pioneer transmitter of that power, which was built at WGY, Schenectady, in 1927.[2] It remains to be seen whether the new KDKA plant will provide further ammunition for further hostilities in the ether—not confined to Europe.

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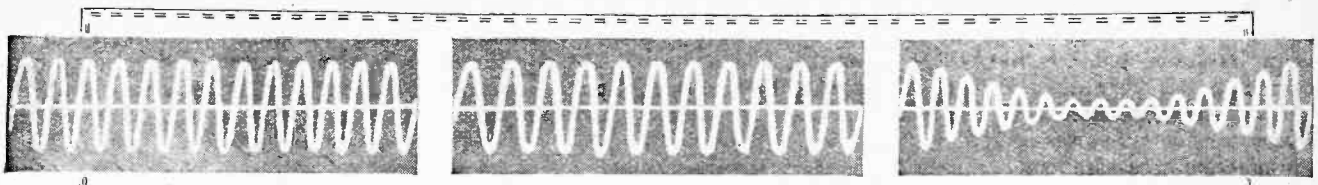
[2] "WGY's New 100-kW. Transmitter," *The Wireless World*, October 5th, 1927.



Frequency Changers

The Effect of Different Methods on Selectivity and Quality.

By W. T. COCKING.

IT is not too much to say that the frequency changer spells the success or failure of the superheterodyne, and that upon it depends not only the efficiency but also the ease of operation of the receiver. Frequency changers are of many and varied types, but they all depend upon the same fundamental principles for their operation. Perhaps the most commonly used circuit of all is that shown in Fig. 1, and it is also the easiest to understand. The circuit LC is tuned to the frequency of the desired station, and as a result the signal voltage is impressed upon the grid of the detector V_1, which is adjusted for anode bend rectification. The oscillator V_2 generates oscillations whose frequency is determined by the tuned circuit L_1C_1; and in practice this circuit is so adjusted that its resonance frequency is different from that of the desired signal by an amount equal to the intermediate frequency. That is to say, if the desired station be working with a frequency of 1,000 kc., and the intermediate frequency be 100 kc., then the oscillator circuit is tuned to either 1,100 kc. or 900 kc.

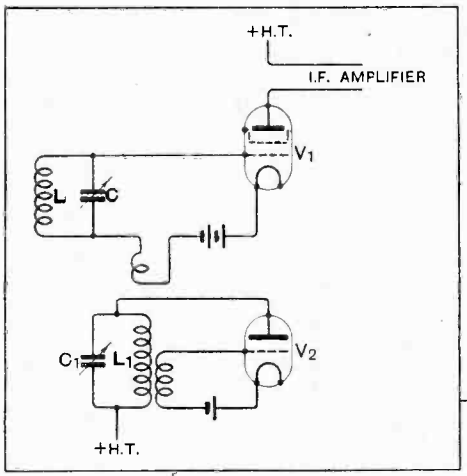


Fig. 1.—The most commonly used frequency changer. Owing to its radiating propensities it cannot be employed with an outdoor aerial without a preliminary stage of H.F. amplification.

These oscillations are applied to the grid of the detector as well as the desired signal, and after rectification it is found that there is present in the output of the valve a frequency of 100 kc., the intermediate frequency, in addition to the two original frequencies, and a number of others which are due to imperfect rectification. The action is really the same as that of the ordinary oscillating detector, except that the well-known heterodyne whistle produced when a carrier wave is tuned in, is above audibility and is the intermediate frequency.

The Single-valve Circuit.

The fact that the oscillator itself contributes nothing towards the amplification has led to many attempts to utilise a single valve acting both as an oscillator and a detector, and one of the earliest of these circuits is shown in Fig. 2. The circuit LC is tuned to the frequency of the incoming signal, but the circuit L_1C_1 is tuned, not to the frequency which gives the desired beat, but to one-half of this frequency. The valve has a high negative grid bias, and so it generates strong harmonics, and the second harmonic of the frequency at which the valve is oscillating beats with the signal to give the desired intermediate frequency.

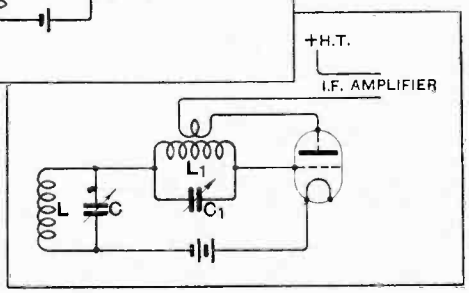


Fig. 2.—An early single-valve frequency changer. The second harmonic of the oscillating frequency is used for beating with the incoming signal.

In practice, the circuit is not very successful, for two reasons; in the first place, there is a large amount of interaction between the two tuning controls, and an adjustment to one necessitates a readjustment of the other; and secondly, the large number of harmonics generated by the valve means that a station can be tuned in at many different settings of the tuning dial. It is often difficult to arrange matters so that the local station can be received at less than twenty different dial settings! It is well known that even with the ordinary circuit of Fig. 1 harmonics of the oscillator are at times troublesome, but the harmonic generation with the circuit of Fig. 2 is of necessity so strong that it renders it useless for present-day reception.

Another single-valve circuit which enjoyed some measure of popularity under the name of the "Tropadyne" is shown in Fig. 3. In this circuit the valve oscillates at the desired frequency, and so there is no necessity for the generation of harmonics. In practice, however, the fact that the valve must be so biased that it rectifies means that harmonics will be strong, and so many of the disadvantages of the previous circuit still apply.

Frequency Changers.—

In theory, interaction between the two tuned circuits can be prevented by the bridge connections, but in practice it is very difficult to obtain a perfect balance. It will be seen, therefore, that there is likely to be a very considerable amount of interaction between them.

IT is generally stated that the intermediate frequency amplifier is the heart of the supersonic receiver. While the selectivity, sensitivity and quality must to a very large extent depend upon this highly important piece of apparatus, it may truly be said that the frequency changer is of even greater importance, for without it even the best intermediate frequency amplifier is useless. There are a number of methods of changing frequency and their relative advantages are discussed at some length in this article.

The Tetrode Frequency Changer.

Since a single triode valve does not make a good frequency changer the four-electrode valve has often been pressed into service, as in Fig. 4, and such circuits are very common on the Continent. The desired signals are applied to the inner grid of the valve, while the outer grid is connected to the tuned oscillator coil. The valve, therefore, oscillates and rectifies at the same time, and, since the tuned circuits are only connected together by the valve interelectrode capacity, interaction between them should be small. The circuit is distinctly better than either of the two triode circuits just discussed, but this is not to say that it is very good.

In the first place, in order to work at all the valve must be adjusted so that it rectifies, but it will then generate harmonics when oscillating, and so we are up against the old problem of the local station coming in all over the dial. It seems impossible at the present time to devise a single-valve frequency changer which is free from harmonic trouble, and, indeed, even the best of the two-valve circuits are not quite perfect in this respect.

Now, the only object in using a single-valve frequency changer is to reduce the cost of the receiver by eliminating a valve; but it can be shown that this reduction in cost is more apparent than real. The screen-grid valve is unsuitable for use in the circuit of Fig. 4, and it is necessary to use one of the special four-electrode types which have been developed on the Continent; the efficiency of the frequency changer, therefore, will be no greater than that of the two-valve circuit of Fig. 1 when a triode is used for the detector. In this latter circuit, however, we are at liberty to use a screen-grid valve as the detector, with a very considerable gain in efficiency, and so we find that the two-valve circuit is more efficient than any of the single-valve type. This means, in practice, that more amplification must be used with a single-valve frequency changer than with a two-valve, and there is then little advantage to be derived from its use.

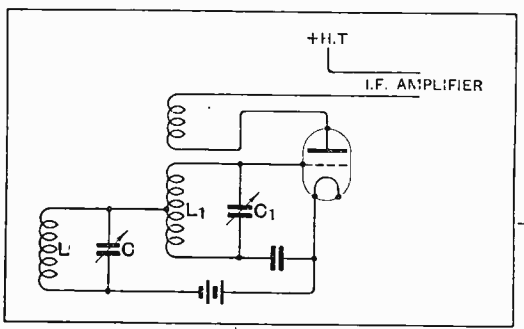


Fig. 3.—The "Tropadyne" circuit is non-radiating when a perfect balance is obtained, but in practice the circuit is rather unsatisfactory.

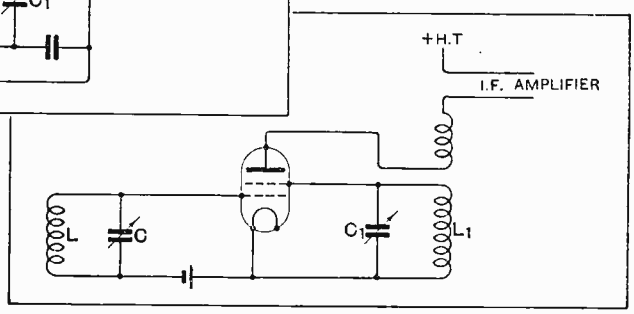
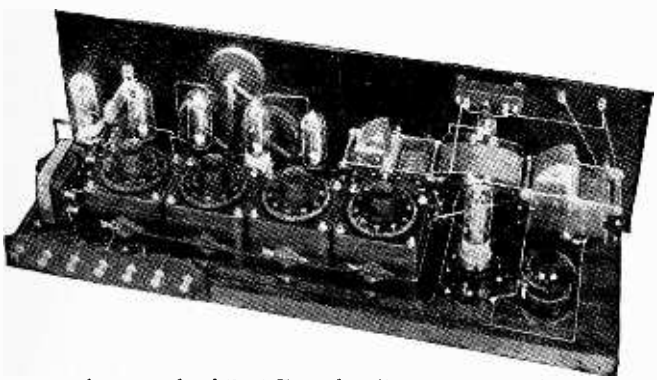


Fig. 4.—A four-electrode valve frequency changer is commonly employed on the Continent. Although more satisfactory than the single valve triode circuits, harmonic trouble is considerable. The valve is known as a *bi-grille* or *bi-grid* frequency changer.



An example of the "Tropadyne"—a superheterodyne receiver which was popular a few years ago.

The Aerial System.

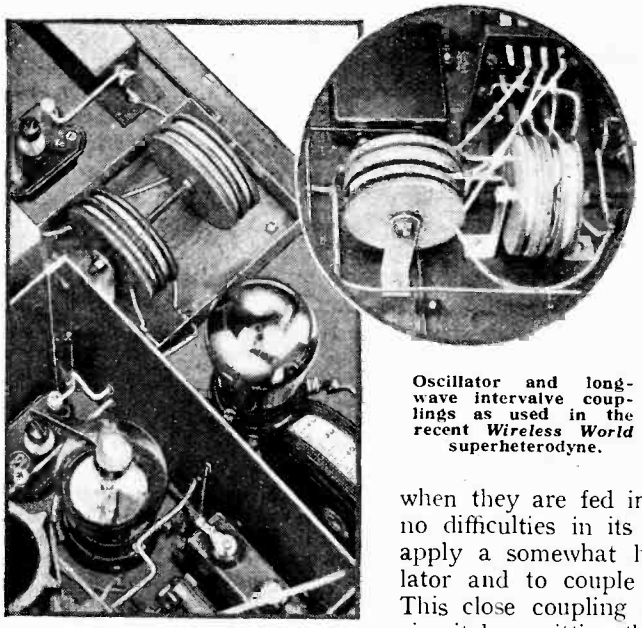
We may take it as axiomatic, therefore, that the two distinct functions of rectification and oscillation should not be combined into a single valve, and that a two-valve frequency changer should always be used. There is no doubt, however, that the usual superheterodyne employs too many valves, and so we must investigate the circuit in some detail to see whether we can reduce the number of amplifying valves without reducing the volume from the loud speaker.

A receiver such as the "Band-Pass Superheterodyne," which employs a single H.F. stage, a single L.F. stage, a two-valve frequency changer, and a triode second detector with a pentode output valve, will give quite sufficient amplification for most ordinary purposes when used with a frame aerial. Now, a frame aerial is very inefficient when compared with a good outdoor aerial, and it is, moreover, rather inconvenient, since it is awkward to dispose of in a room and it does not lend itself nicely to ganging. What results should we get, therefore, if we eliminate the first H.F. stage and connect an outdoor aerial directly to the tuned input circuit of the frequency changer? We should find that the sensitivity of the receiver is not greatly

Frequency Changers.—

altered, that the selectivity is approximately the same, except that the directional properties of the frame are missing, and that second-channel and long-wave interference are both somewhat greater, but can be reduced to the same degree by careful attention to design.

It would appear, then, to be highly desirable in the interests of efficiency and economy to use an outdoor aerial with the superheterodyne and to dispense with the usual preliminary H.F. stage. There is one point, however, which has not so far been considered, and that is the question of radiation. If any of the ordinary frequency changers be used with an outdoor aerial and without a preliminary stage of H.F. amplification, the oscillator will cause a current to flow in the aerial circuit which will be radiated and cause interference with other listeners. We thus find the reason for the use of a frame aerial with the supersonic receiver. When an outdoor aerial is used with the ordinary frequency changers a preliminary H.F. stage is essential in order to avoid radiation; but with this extra H.F. stage the amplification is excessive for an outdoor aerial and gives a noisy background, and so a frame aerial is employed.



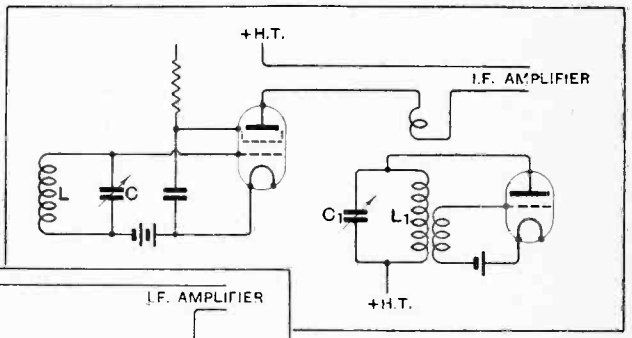
Oscillator and long-wave intervalve couplings as used in the recent *Wireless World* superheterodyne.

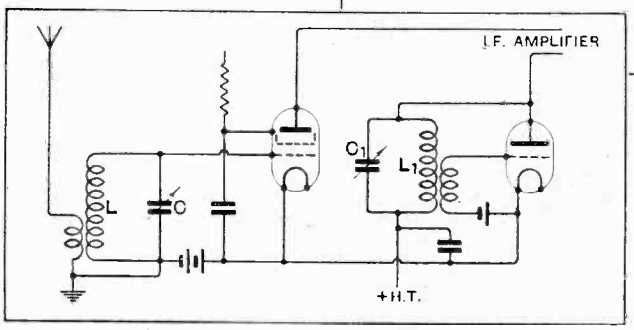
A Non-radiating Frequency Changer.

It will be seen, therefore, that if the receiver is to be really economical it is essential to employ an outdoor aerial and to dispense with the preliminary H.F. stage. This means that the frequency changer itself must be so designed that it is non-radiating, while, of course, it must be efficient. None of the ordinary circuits is satisfactory, and so the writer has devised the scheme outlined in Fig. 5. It will be seen that the oscillator is coupled to the *anode* circuit of the detector, which *must* be a screen-grid valve. If this valve be correctly chosen to have a small grid-anode inter-electrode capacity and it be properly screened, there is no appreciable feed-back from the anode to the grid of the detector. The oscillator is isolated from the aerial circuit, therefore, and as a result the circuit is free from radiation and can be used with an outdoor aerial with impunity.

At first glance it might appear that coupling the oscillator to the detector anode circuit would not give good results; actually, however, it is more direct and logical than coupling it to the grid circuit, and it is capable of quite as satisfactory operation. It must be remembered that with anode-bend detection rectification takes place in the anode circuit, and that the action of the valve can be considered as that of an H.F. amplifier followed by a diode rectifier. With the circuit of Fig. 1, therefore, the oscillations are introduced before the H.F. amplifying action takes place, but with the circuit of Fig. 5 they are introduced after this amplifying action and immediately before the rectifying action.

Since the local oscillations are not amplified by the detector they must be stronger than is necessary when they are fed into the grid circuit. This brings no difficulties in its train, as it is only necessary to apply a somewhat higher H.T. voltage to the oscillator and to couple it more closely to the detector. This close coupling allows of a simplification of the circuit by omitting the coupling coil, and including the tuned-anode coil of the oscillator directly in the detector anode circuit as in Fig. 6. In this manner the wave-





(Above) Fig. 5.—A new non-radiating circuit employing a screen-grid first detector with the oscillator coupled to the anode circuit. An outdoor aerial can be used without a preliminary H.F. stage.

(Left) Fig. 6.—A modification of Fig. 5 which dispenses with the coupling coil, thus simplifying waveband switching. The number of decoupling components is also reduced, since only a single H.T. feed is required.

band switching is very considerably simplified, while the coil construction becomes no different from that of the ordinary reacting detector.

Independent Tuning Controls.

The superheterodyne is rarely quite free from inter-

Frequency Changers.—

action between the oscillator tuning control and the detector grid circuit tuning control. It is usually found that a small adjustment to one variable condenser necessitates a readjustment of the other, and this makes tuning more difficult than it need be and the receiver incapable of accurate calibration. The circuits of Figs. 2 and 3 are probably the worst in this respect, but the usual circuit of Fig. 1 is by no means immune, particularly if the coupling to the oscillator be at all tight. There will only be interaction between the tuning controls with the circuit of Fig. 4 if the valve capacity is large; this is usually large enough to allow the circuit to radiate if connected to an aerial, however, and so interaction cannot be entirely absent. With the circuits of Figs. 5 and 6 the coupling between the tuned circuits is only that afforded by the extremely small grid-anode capacity of a screen-grid valve, and so interaction between the tuning controls is, practically speaking, non-existent.

It will be seen, therefore, that this new frequency changer offers very decided advantages over the older methods. Interaction between the tuning controls is absent, and a simplified circuit is possible. Because of its non-radiating properties, an outdoor aerial can be employed without a preliminary H.F. stage, and one valve can thus be omitted without reducing the range of the receiver below that obtainable with a frame aerial and an H.F. stage. It is no less efficient than the usual two-valve frequency changer, and it is more efficient than any of the single-valve circuits, and it has none of the disadvantages attendant upon the latter.

In view of this formidable list of advantages there would appear to be no object in using any of the single-valve frequency changers, which give endless trouble from harmonics and are all capable of radiating. Even the old and well-tried circuit of Fig. 1 is inferior, except perhaps when a preliminary stage of H.F. amplification is used, and even then it offers no definite advantage.

Two-way Working with Japan.

With reference to our note on April 22nd, Mr. J. Clarricoats, G6CL, tells us that he was in two-way communication with Yokohama on April 20th, 1929, with an input of only 5.8 watts, and again on April 7th of this year he worked with J3DE, Wakayama-si, using an input of 6.2 watts.

G6CL has now worked with well over 100 American stations, and holds the W.A.C. certificate issued to members of the I.A.R.U. who have worked with stations in six continents, and the W.B.E. certificate, issued by the R.S.G.B. to B.E.R.U. members who have been in two-way communication with some part of the British Empire in each of the five continents. He has also successfully worked Europe, Asia and Africa in 24 hours on telephony, using an input of only 6 watts.

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Busy Days.

Another amateur, Mr. George Edwards, has recently worked all continents on two occasions in 12 hours or less from his station, G2UX, at Walworth, using an input of about 10 watts from 300-volt dry batteries to a Hartley transmitter with two 6-volt receiving valves in parallel. The first occasion was on March 15th, when the following stations were worked on the 21-metre waveband :— ZL4AP, New Zealand; PY2AZ, Brazil; XYI6KR, Kurdistan, Iraq; AU1AI, Tomsk, Siberia; SU1AA, Cairo, Egypt; and W2QF, New York, all between 07.15 and 18.00 G.M.T. The second occasion was on April 19th, when the following stations were worked within the 12 hours between 07.50 and 19.50 G.M.T. :—PY2BO, Brazil; ZL2BC, New Zealand; VK2JZ, Australia; XYI6KR, Kurdistan; FM8IH, Algeria; W2QF, U.S.A.; and PY2BA, Brazil, after which he found time to work two more Brazilian stations.

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The R.S.G.B. Groups.

We are frequently asked, especially by new transmitters, to put the enquirer into

TRANSMITTERS' NOTES.

touch with other experimenters who are working on lines similar to those he intends following, and, for the benefit of those who wish to specialise, we would draw attention to the organisation of the Contact Bureau of the R.S.G.B., under the guidance of Mr. H. C. Page (G6PA).

The society encourages its members to pursue various paths of investigation, and for this purpose the Contact Bureau is divided into several sections or groups, each with its own group manager; and, to simplify the working and expedite the circulation of the budgets, each main group is subdivided into secondary groups of not more than six members. The reports of the working of each group of six are collected and published monthly by the respective group managers, and in this way a mass of valuable information is gained about each aspect of amateur transmission.

The main sections and their respective group managers are :—

56 megacycle (5-metre) work, Mr. S. W. Cutler (G2OL), Ealing.

28 megacycle (10-metre) work, Mr. A. Smith (G6VP), West Drayton.

3.5 megacycle (85-metre) work, Mr. R. A. Bartlett (G6RB), Bristol.

2 megacycle (150-metre) work, Mr. J. H. Hum (G5UM), London.

Fading skip distance, etc., Mr. A. M. Houston-Fergus (G2ZÇ), Jersey.

Low-power working, Mr. J. N. Roe (G2VV), Farnham.

Television, Mr. P. D. Walters (G5CV), Chiswick.

Aerial systems, Capt. G. Courtenay Price (G2OP), Cheltenham.

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International Short-wave Radio League.

The membership of this League continues rapidly to increase, according to the April issue of the *International Short Wave Radio News*. It is interesting to note that the Editor states : "For every reader we have in the United States we have twenty in Europe, Africa, and the Orient." The European manager and vice-president of the League is Mr. Mander Barnett, who will welcome applications for membership addressed to 106, Lord Street, Southport. He evidently shares the writer's detestation of the misuse of "radiese" in written correspondence, as he particularly says to applicants : "Don't address your letters in some fancy ham language."

The annual subscription is $1, or 4s. 2d. The current number of the League's official organ gives an interesting account of the services performed by Mr. Gerald Marcuse's station, G2NM, and contains, as usual, a list of the principal short-wave broadcasting and telephony stations which are likely to be heard by listeners in both hemispheres.

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83-metre Calibration Service.

Mr. Gerald Marcuse will transmit calibration services from his station, G2NM, on the 3.5 megacycle band every Sunday at 11.00 telephone and every Sunday and Thursday at 23.00 morse. The times are G.M.T. or B.S.T. as in force. The exact frequency is 3,583.13 kc., which has been checked and approved by the Post Office.

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NEW CALL-SIGNS AND CHANGES OF ADDRESS.

G2MI	A. O. Milne, 79, Victoria Ave., Broadstairs, Kent. (Change of address), working on 1.7, 3.5, 7 and 14mC. at week-ends.
G2ZQ	(ex **2ABS**) J. Hunter, 63, Hervey Rd., S.E.3.
G2ZX	A. N. Porter, 32, Tyndales Park Rd., Bristol.
G5CV	P. D. Walters, 45, Fairfax Rd., W.4.
G5UF	A. A. Barrett, Sydcote, Cabball Rd., Cromer. (Change of address.)
G5WB	C. A. Webb, 1a, Crescent Gardens, Swanley, Kent. (Change of address.)
G6JG	C. W. Jennings, 150, Longmead Ave., Bishopston, Bristol.
G6QH	G. Tamblyn, Barkla Shop, St. Agnes, Cornwall
G6XB	G. E. Jones, 33, Atlas Rd., Canton, Cardiff. (Change of address.)
2AHK	G. R. Scott Farnie, The Grange, Cefn Coed, Merthyr.
2AHR	D. G. Rumary, Pineholm, Upper Station Rd., Heathfield, Sussex.
2AUT	R. H. Farrington, 15, West St., Sittingbourne, Kent.
2AXD	W. H. Peters, Stone Lodge, Stoneleigh Rd., Gibbet Hill, Coventry.

Sponsored Programmes

An Appreciation—and a Challenge

RECENTLY I had the pleasure of hearing one of the sponsored programmes with which the Dublin Station has been experimenting, but, having missed the opening announcement, I was unaware of its nature and sponsors. It was soon evident, however, that the underlying *motif* was the sea—obviously a subject of wide appeal to British listeners, apart from the possible novelty of sponsored programmes as such. Orchestra, chorus, and vocalists combined to provide a well-rendered and pleasing variety of songs, rollicking sea chanties, selections from Gilbert and Sullivan, and other popular favourites, and although the announcer's American twang may have irritated some of us, the absence of any advertising matter was calculated to soften the heart of the stoutest antagonist to programmes of this kind. So far, so good. Nothing jarring—nothing irrelevant; just an hour's uninterrupted entertainment in which memories and traditions of the sea blended with a growing curiosity as to the name of the promoters of so excellent a programme.

BROADCASTING has probably produced no subject more controversial than that of sponsored programmes introducing advertising matter. In this article our contributor, who wishes to remain anonymous, takes a generally broad view of the subject, but, whilst indicating that sponsored programmes in good taste and reserve can be a blessing, warns us that the ultimate effect of sponsored programmes must, in all probability, be disastrous, and that it is foolish to suppose it would be possible to stem the tide of commercialisation if once the principle of sponsored programmes were to be accepted.

Consequently it was with a feeling of pride and satisfaction that we heard the final announcement take the form of a short statement of facts concerning the successful activities of one of Britain's oldest and biggest industrial groups, whose name is a household word and whose achievements have gained them fame throughout the world. Such a fitting conclusion—neither too long nor too obtrusive—was a proud reminder of our world position in shipbuilding and aviation, and as long as sponsored programmes follow this model of good taste and elegant reserve they cannot fail to attract a large percentage of listeners.

But what of the future? Business is business, and none grasps this fact more thoroughly than those who purchase the right to call the tune. Any discrimination as to the advertiser's rights is next to impossible, and if one section of industry is permitted this form of advertising, then all sections must have the same right in proportion to their ability to pay. But all manufacturers and industries do not lend themselves to the same treatment as one which is inherently bound up with our national pride and inheritance.

America is a long way off, but there are doubtless many who listen to the more easily received French stations. How many listeners, however, understand the short announcements with which these otherwise good programmes are so freely interwoven? How many dance enthusiasts would care to hear between each item that indigestion and bad breath may be relieved by chewing someone's aromatic india-rubber; or that a postcard to such and such a concern will bring you their profusely illustrated catalogue of 220 pages, free, gratis, and for nothing? When that catalogue has been metaphorically rammed down your throat several times a night for months on end you may, in time, be reduced to the condition of the nervous man who waited up half the night because he didn't hear the lodger upstairs throw his other boot across the floor. Your interest in the programme diminishes in proportion as you become grotesquely fearful of what will turn up next. Unfortunately, there is no escape except to dispense with listening altogether, and in time you will come to hate that advertiser and everything associated with him, wireless included.

We in England are accustomed to having our news bulletins treated with respect. We tune in to the news because we want to hear the news. Moreover, those responsible for its preparation are careful to marshal their items according to a general plan that has unconsciously familiarised us with what to expect. In consequence we may be reasonably sure of switching off at the appropriate moment without much fear of missing anything material. Contrast this with one of our Continental neighbours, and we find two voices alternating at the microphone. The first crisply informs us of some breathless event in the world of human achievement, followed

Sponsored Programmes.—

by his colleague's oily admonition to your wife to wear a specific make of corset, or risk the loss of her beautiful figure and possibly the affection of her loved ones. No. 1 now takes over with a solitary item of sports news, whereupon the other butts in to the effect that no wife can be proud of her husband's pyjamas unless they come from the "Factory-to-consumer-direct-sales-service" of the Pyjam Silk Corporation, whose name and address will be repeated to you as many times as human ingenuity can embody it in each and every announcement.

"But," you may say, "you cannot do this to us, because we get all the news we want from the papers, and, besides, we do not like dance music." Forgive me, but this is a mistake. When the payer calls the tune, he will have no scruples as to your æsthetic attitude towards the arts. Let me cite a case of a few weeks ago. The opera "I Pagliacci" was being given from a certain Continental studio, and Nedda had just concluded her love duet with Sylvio, promising to meet him at midnight. Hard by, the treacherous Tonio was leading Canio to the secret meeting-place of the lovers, and one was all agog for the clash of music that was to herald the betrayal of a rival, the fruitless chase, and the climax of the "Motley." But no! At the crucial moment the opera was switched off, and a crude announcement substituted by an advertiser whose monotonous repetitions are becoming a threat to one's peace of mind. And what, after all, is wireless entertainment but a convenient means of securing a temporary release from the bustle and business of the outside world? Once open the doors of broadcasting to the tender mercies of the modern advertiser and you not only sacrifice the sanctity of the home, but point the way to the prostitution of good taste and decency. Imagine the parallel in English. It is Sunday evening in the quiet seclusion of your drawing-room. From the loud speaker comes the mellow rhythm of Gray's immortal words:

"Beneath those rugged elms, that yew tree's shade,
Where heaves the turf in many a mould'ring heap. . . ."

Here a new voice fades in to tell you that the advent of Tomsons' Patent Tombstones have made the "mould'ring heap" a thing of the past, and an unsightly object of pity in any well-managed graveyard. Loving and discriminating listeners should write for the "T.P.T." catalogue illustrating scores of varieties of Tomsons' Patent Tombstones—the heritage of the dead.

If you doubt these things, you have only to tune in to some of the Continental stations to learn the ugly truth of what is already an accomplished fact. Further instances might be cited *ad nauseam*, but may I conclude by saying that if you can associate the Hungarian Rhapsodies with crustless cheese, or the Unfinished Symphony with an alleged cure for perspiring feet, then by all means have your sponsored programmes—you will get your fill; but take heed, a real danger is upon us.

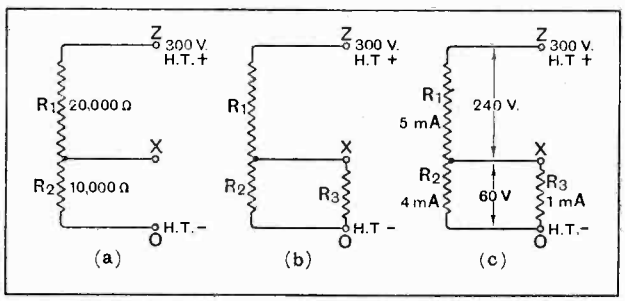
SCREENING GRID VOLTAGE CONTROL.

Simpler Calculations for Ascertaining Potentiometer Values.

OWING to the extremely small current taken by the screening grid of a modern S.G. valve it has become common practice to feed this electrode by means of a potentiometer so that, in spite of small current variations, the applied voltage does not change substantially. The screen potential in a receiver is somewhat critical, and it is usually unsafe to employ a series resistance feed, with which the change of potential may be large.

The working principles of a potentiometer as shown at (a) are simple enough. Assuming the H.T. voltage to be 300, R_1 20,000 ohms and R_2 10,000 ohms (so that R_1 and R_2 together equal 30,000 ohms), the voltage between X and O will be $10{,}000/30{,}000 \times 300 = \frac{1}{3} \times 300 = 100$ volts, while obviously that between X and Z will be $\frac{20{,}000}{30{,}000} \times 300 = \frac{2}{3} \times 300 = 200$ volts. The current passed by the potentiometer is that due to a potential of 300 volts across a total resistance of 30,000 ohms. By Ohms Law $I_{amps} = \frac{E_{volts}}{R_{ohms}}$ which in our case becomes $\frac{300}{30{,}000} = 0.01$ amperes or 10 milliamperes. It must always be remembered that in applying Ohms Law, current as represented by I must be measured in amperes; one milliampere (mA.) being 0.001 amp., 10 mA, 0.01 amp., 100 mA, 0.1 amp., and 1,000 mA. 1.0 amp.

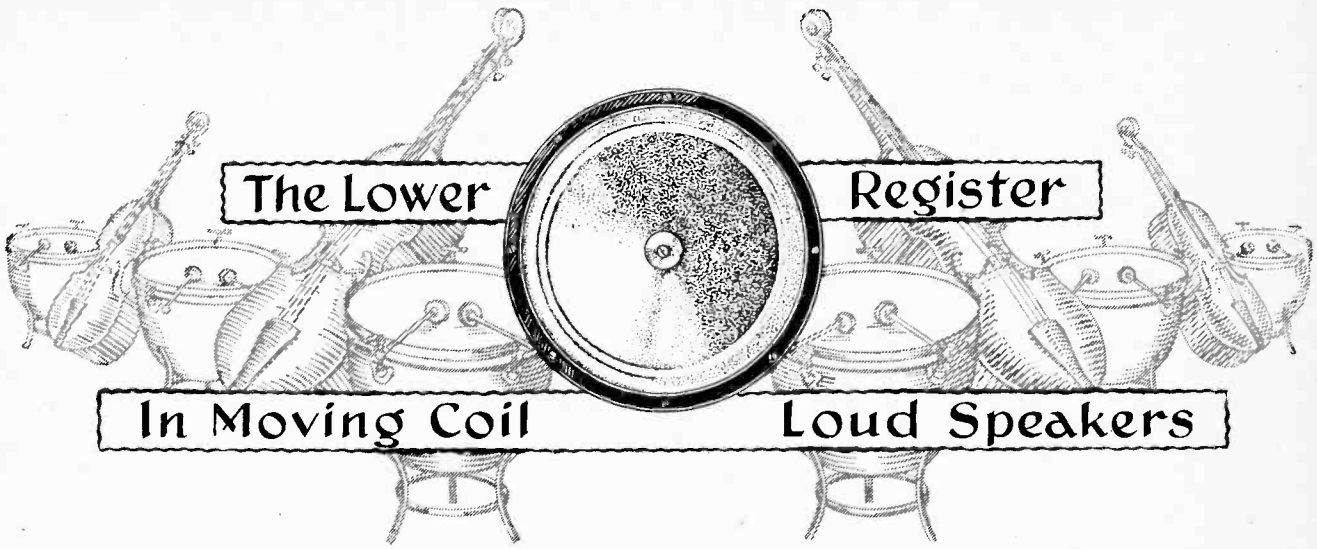
There would be little more to say about potentiometer feed were it not for the fact that when the screen of the valve takes current there is a load put across R_2—the lower limb of the potentiometer. This has the effect of reducing its value, for a load can be looked upon as a resistance, and the combined resistance of two resistances in parallel is always less than either component part taken alone. In Fig. (b) the screen circuit is shown as R_3.



Showing how a simple potentiometer is modified when a valve circuit is connected across one limb.

From the makers' curves we must now find out the best working potential for the screen and the current that it passes. Let us assume that these are 60 volts and 1.0 mA. respectively. Now, in order that a potentiometer shall fulfil properly its function of supplying a steady voltage in spite of small current changes, it is important that the current continuously passing through its two limbs (R_1 and R_2) shall be considerably greater than the current taken by the device which it is feeding. It is generally accepted that a current ratio of four times gives satisfactory "regulation." By this we mean that the potentiometer must take four times the current passed by the screen circuit. We now have sufficient knowledge to fill in the voltages and currents required (see Fig. (c)). The resistance R_3—representing the screen of the valve—is to pass 1 mA. with 60 volts across it; R_2 should pass four times this current, i.e., 4 mA. at 60 volts, while R_1 must also pass 4 mA., plus the screen current of 1 mA.—that is 5 mA. Thus, after passing through R_1 the current divides into R_2 and R_3. As 60 volts are to be dropped across R_2, there are left, out of a total of 300 volts, 240 to be lost across R_1. We must again make use of Ohms Law, for since $I = E/R$, $R = E/C$ and both R_1 and R_2 can be calculated by dividing the volts to be absorbed by the current to be passed. The value of R_1 required is $240/0.005 = 48{,}000$ ohms (50,000 ohms will be near enough), whilst R_2 is $60/0.004 = 15{,}000$ ohms.

W. I. G. P.



Locating and Measuring the Resonances.

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

SINCE the publication of my article entitled "Modern Views of the Moving Coil Loud Speaker" (*The Wireless World*, January 21st and 28th, 1931), it is rather surprising to find that no one has written to tell me the whole thing was quite wrong. Rather to my surprise I have had a number of letters asking for more details and further information regarding any other peculiarities possessed by the moving coil loud speaker which have as yet not been treated. Of course, at this stage of the proceedings, it must be realised that loud speakers are being used by a much larger and ever-increasing percentage of readers of *The Wireless World* than was the case in 1926 when the moving coil loud speaker made its debut. Many readers are therefore very familiar with the intestines of their loud speakers, since they are the proud creators of these organs which conspire to produce sounds of varying veracity and vitality. But there are others who have bought loud speakers, or who have only recently become the Editor's parishioners, and, moreover, are, unfortunately, less familiar with the inner organs of the animal.

IN this article an explanation is given of the peculiar properties of the loud speaker diaphragm at the lower speech frequencies. Our contributor, Dr. McLachlan, who has carried out extensive investigations on the design of moving coil speakers, is well known to readers of this journal, being a leading authority on loud speaker technique. The conclusions arrived at are the outcome of considerable research work.

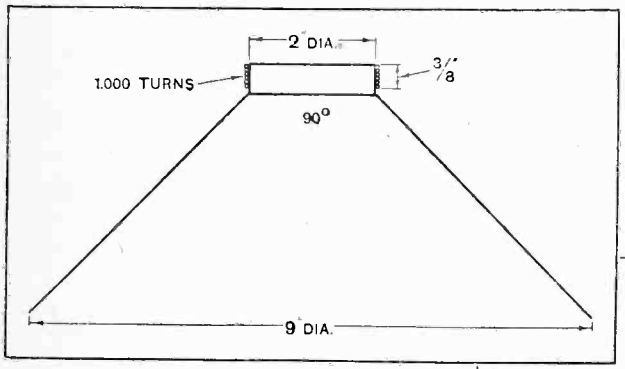
To the first-mentioned, the descriptions of the researches and results given during the past five years will be followed with comparative ease, even though at times one is compelled to introduce certain technicalities. To the other class of reader difficulties may crop up, but reference to former articles on the subject will pave the way to a better understanding of the action of these devices. Undoubtedly, the modern loud speaker, whose external appearance is the symbol of architectural simplicity, is one of the most complicated electro-mechanical systems from the viewpoint of accurate scientific analysis. I would ask those new readers who consume these pages not to lose patience because the concepts and terminologies appear unfamiliar. After all, nothing of value in this world can be understood in five minutes, for if it could its value would, *ipso facto*, immediately disappear. I think it was Euclid who said, "There is no royal road to learning." Doubtless, if I have got the wrong author, it will provide someone with an excuse to write to the Editor, giving the correct quotation.

I propose in this article to deal chiefly with the lower register in moving coil loud speakers, explaining in greater detail the general argument stated in the issues of January 21st and 28th, 1931. It was stated there that the lower register could be obtained in two ways: (1) By using a rubber or other adequately flexible surround to mount the diaphragm at its periphery the resonance of the diaphragm as a whole on the surround being below 20 cycles per second; (2) by using a surround of leather or similar material and of such tautness that the diaphragm (moving as a whole) resonates upon it at some frequency between 50 and 100 cycles. We now proceed to an examination of the experimental results upon which these statements are based.

The dimensions of the diaphragm upon which the experiments were made are given in Fig. 1. First of all, we start off with a diaphragm whose edge is quite free. This is suspended by four elastic threads, as shown in Fig. 2, so that the natural frequency axially is about three cycles per second. A baffle six feet square is arranged to fit nicely round the diaphragm. What we have to do is to measure the total sound output from the diaphragm at various frequencies. This

The Lower Register in Moving Coil Loud Speakers.—

is a good deal more difficult than might be imagined at first sight, but the variation in output corresponding to different mechanical conditions of the edge of the diaphragm are so large that it is immaterial for the purpose of illustration whether the output is measured very



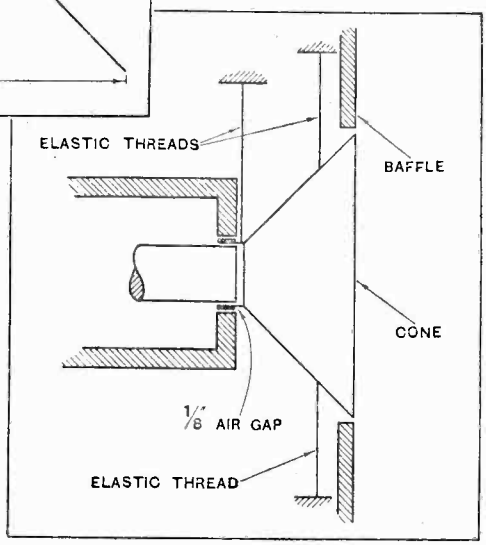


Fig. 1.—(Above) Showing the dimensions of the diaphragm upon which experiments were made. Fig. 2.—(On the right) The edge of the diaphragm is quite free. It is suspended on four elastic threads and has a natural axial frequency of three cycles per second.

accurately or not. What has been done is to find the difference in resistance of the moving coil when it is free to move and when fixed. This gives an approximate indication of the output from the speaker, although it includes diaphragm losses of different kinds and variations in the resistance due to the iron of the magnet.

There is a difference between the resistance due to the iron when the coil moves and when it is fixed. Fortunately, it was found that the coil fixed condition could be simulated with adequate accuracy *for our purpose* by short-circuiting the magnet on itself (no battery). This was due to the large air gap ($\frac{1}{8}$in.) used and the very low remanent magnetisation of the magnet steel. In this way the readings of resistance for the coil fixed and free conditions could be taken immediately after each other, thus ensuring that the temperature and the position of the coil in the magnet was the same in both cases. The temperature is rather important for the following reason: Suppose first thing on Monday morning a series of readings is taken when the coil is free. As the morning wears on the magnet and, therefore, the moving coil become warmer. In fact, in some experiments the field current decreased 10 per cent., which corresponds to a temperature rise of 25° C.

Taking a Resonance Curve.

This, however, is not an unduly large rise, since the field current was only 0.8 of its normal value. Consequently, about 12.30 p.m. on Monday, if some of the readings taken earlier are checked, they will be appreciably different, due to (1) temperature rise, (2) decrease in magnetic field strength. Item (1) generally preponderates, so that the measured resistance at a given frequency will be greater at 12.30 p.m. than at 10 a.m. If towards the end of the afternoon readings of the coil fixed are taken, they will obviously be too large. Moreover, the difference between the two, which is what we require, will be reduced, and might in some cases vanish or become negative. It is advisable, therefore, to let the magnet assume its normal working temperature before commencing operations.

Now we are in a position to discuss resistance measurements on our free-edge diaphragm—which, of course, ought to be in an adjacent room away from draughts and noises, so that it cannot act as a microphone. Also, in measuring the resistance with the coil free at telephonic frequencies, it is imperative that the output from the instrument should not reach the experimenter's ears.

Starting about 45 cycles, we soon find that things happen in a fast and furious manner—provided we are cute. If we are not, then nothing abnormal occurs at all. But working up the frequency scale, cycle by cycle, we soon come to a point where resonance is indicated. Now we retrace our steps 0.1 cycle at a time until, finally, we have a very sharp resonance curve, as shown in Fig. 3. To find the actual resonance frequency accurately requires considerable patience, because each reading takes ten minutes or so. However, after doing one diaphragm, the game becomes quite exciting, because one begins to anticipate which frequency has the greatest hump—or whether that of the experimenter is even greater!

A complete curve in which all the points are not shown—they might look like the constellation known as the milky way—by any means is plotted in Fig. 4. The shape of the diaphragm corresponding to the fundamental resonance frequency is sketched in Fig. 5, and

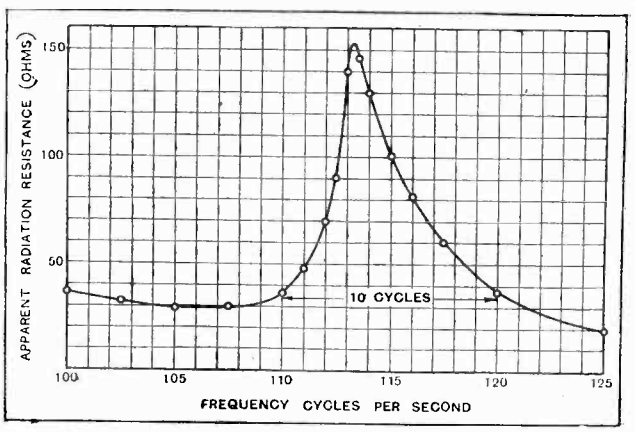


Fig. 3.—A resonance of the diaphragm at 113 cycles per second due to a radial mode of vibration.

The Lower Register in Moving Coil Loud Speakers.—

was obtained by the neon lamp treatment described in the former article. Incidentally, I may mention that, if it is at all possible, the reader will find it a fascinating experience to see his diaphragm (free edge) vibrating in slow motion.

Owing to the seam of the cone, the various diaphragm shapes corresponding to the resonances (modes)

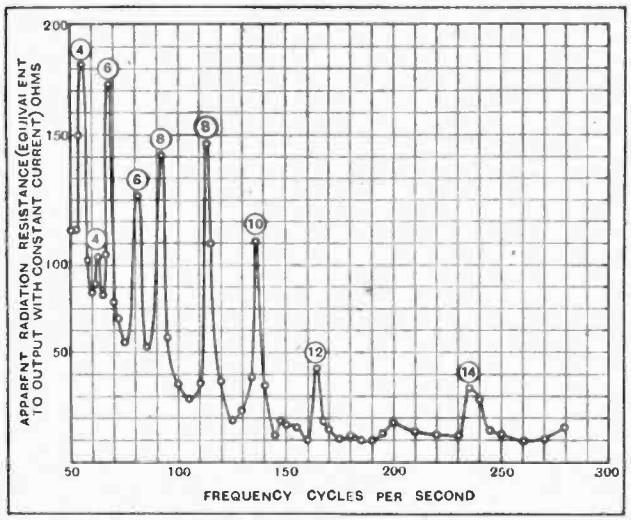


Fig. 4.—Showing the large number of resonances in the bass register due to the radial modes of a free-edge diaphragm.

sometimes occur at two frequencies, and this is illustrated by the data given in Fig. 4 and Table 1. It often happens at the lowest frequencies that the shape is not regular, and this again is due to the seam. In fact, the pattern becomes more regular as the frequency increases.

From Fig. 5 we see that the first, or fundamental, resonance pattern is characterised by the mouth of the diaphragm becoming oval in shape. There are four points where the oval cuts the original dotted circle which represents the mouth when the diaphragm is at rest. Each of these points is called a radial node because there is no motion along the radial lines drawn in the diaphragm. In other words, the diaphragm does not move radially inwards and outwards at such points, hence the term *node*. It should be observed, however, that the diaphragm is not absolutely at rest at these points, since the surface moves tangentially. The points are, thus, only nodes in the sense that there is absence of radial motion, whilst the points of maximum radial displacement (antinodes) are tangential nodes (no tangential motion). The reader must understand, of course, that Fig. 5 shows only an instantaneous position of the deformed diaphragm, as would be visualised by the aid of a neon lamp. Actually, the diaphragm moves inwards and outwards, as indicated by the arrows.

The points of maximum inward and outward motion are known as anti-nodes. The second mode of vibration of the diaphragm—provided it were quite symmetrical and the seam did not introduce irregularities—is characterised by six nodes, the next by eight, and so on *ad infinitum*.

Table 1 gives the resonance frequencies and the corresponding modes of vibration of the diaphragm:

TABLE 1.

GIVING MODES OF VIBRATION OF FREE-EDGE DIAPHRAGM AT DIFFERENT FREQUENCIES.

Frequency (Cycles per second).	Mode of Vibration of Diaphragm.	Frequency (Cycles per second).	Mode of Vibration of Diaphragm.
54.8	4 Radial Nodes	113.3	8 Radial Nodes
62.6	4 ,, ,,	136	10 ,, ,,
68	6 ,, ,,	164	12 ,, ,,
81	6 ,, ,,	235	14 ,, ,,
92.6	8 ,, ,,		

By the time the middle register is reached, say, 250 cycles, the magnitude of the resonances has died down

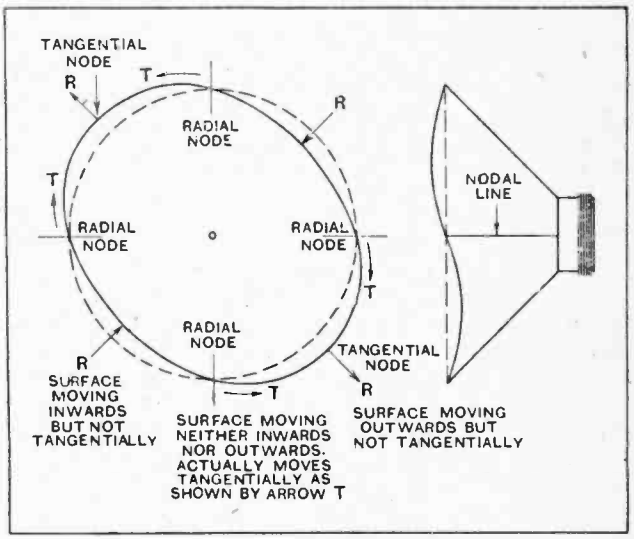
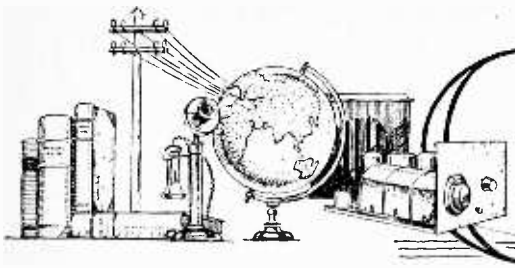


Fig. 5.—The instantaneous position of the deformed diaphragm visualised by the aid of a neon lamp.

considerably. This is illustrated in Fig. 4, where the peaks are seen to subside gradually. In fact, the curve resembles a diaphragm of the Alps or the Rocky Mountains drawn to a large vertical and a small horizontal scale.

(*To be concluded.*)

THE QUALITY UNIT. Next week's issue will include constructional details of an easily built set intended not for distant reception, but arranged to give the best possible quality from the local alternative programmes. Pre-set tuning on two wave-ranges is provided and provision is made for the playing of gramophone records, while avoidance of the need for special components is a feature of the design.



Current Topics

Events of the Week in Brief Review.

SOFT SPEAKERS.

The municipality of Casablanca forbids the use of public loud speakers which can be heard at a distance of over 100 feet.

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THE PLAIN VAN.

A strange reversal of Post Office policy is revealed in the announcement that the newly projected "pirate" detector van is to be made "less recognisable." Hitherto it has been common knowledge among the technically informed that the detector vans have owed their success to psychological rather than radio factors.

One can only suppose that "pirate detection" has now reached a stage of scientific advancement which justifies the use of a "plain van."

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TELEVISION DISCLOSURES ?

Illumination on the subject of television may be expected at the meeting to-night (Wednesday) of the Wireless Section of Electrical Engineers. The topic of the informal discussion is "Technical Problems in Connection with Television," and the introducer will be Mr. C. O. Browne, B.Sc. The meeting will be held at the Institution, Savoy Place, W.C.2, at 6 p.m.

ABERDEEN LISTENERS, PLEASE NOTE.

Letters addressed to Russian broadcasting stations need not be stamped, says a Soviet order.

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NEW SHORT WAVER STARTS TO-DAY.

To-day (Wednesday) is scheduled as the opening date for the new French Colonial short-wave broadcasting station in Paris. The call-sign is FYA, and we understand that testing will begin on 40.73 metres.

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BENCH WISDOM.

"He who oscillates is lost," said the Tower Bridge magistrate in fining an unlicensed listener detected as the result of an oscillation complaint.

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THE VATICAN MYSTERY.

"Will the new Vatican station catch us on the hop?" Wireless amateurs are asking each other this rather natural question in consequence of the uncanny silence of the Papal short-wave station, which was opened with such éclat only two months ago. One of the first requirements of a station which has been "opened" is that it shall transmit, but amateurs will declare that, unless HYJ makes a practice of agitating the ether between, say, 3 and 6 a.m., it is rarely operating at all. However, for the sake of those who do not want to be "caught on the hop," we append the alleged schedule :—

9 a.m.-9.30 a.m.—Telephony. Wavelength 19.84 metres.

9.30 a.m.-10 a.m.—Telegraphy. Wavelength 19.84 metres.

6 p.m.-6.30 p.m.—Telephony. Wavelength 50.26 metres.

6.30 p.m.-7 p.m.—Telegraphy. Wavelength 50.26 metres.

All times are Greenwich mean time.

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TRANSPORTABLE SETS REVIEWED.

The next of our series of reviews dealing with commercial receivers will be devoted to the "Enemains" A.C. and D.C. transportable models. The review will appear next week.

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£144,000 FOR SCHOOL WIRELESS.

One wonders what would have been said if Mr. Snowden's Budget had included an appropriation of £144,000 for the provision of wireless sets in schools. Yet this is the amount that is being asked for by the Czecho-Slovakian Minister of Education, who seems anxious to introduce a broadcast system of teaching throughout the country.

A wireless census just taken shows that 17 per cent. of schools in Czecho-Slovakia are already fully equipped with radio, while 13 per cent. are prepared to install it at their own expense. The remaining 70 per cent. will require the sum mentioned if reliable apparatus is to be installed. Whether the Education Minister will obtain the grant remains to be seen, for Czecho-Slovakia, like certain other countries, is pretty well acquainted with the tax-gatherer.

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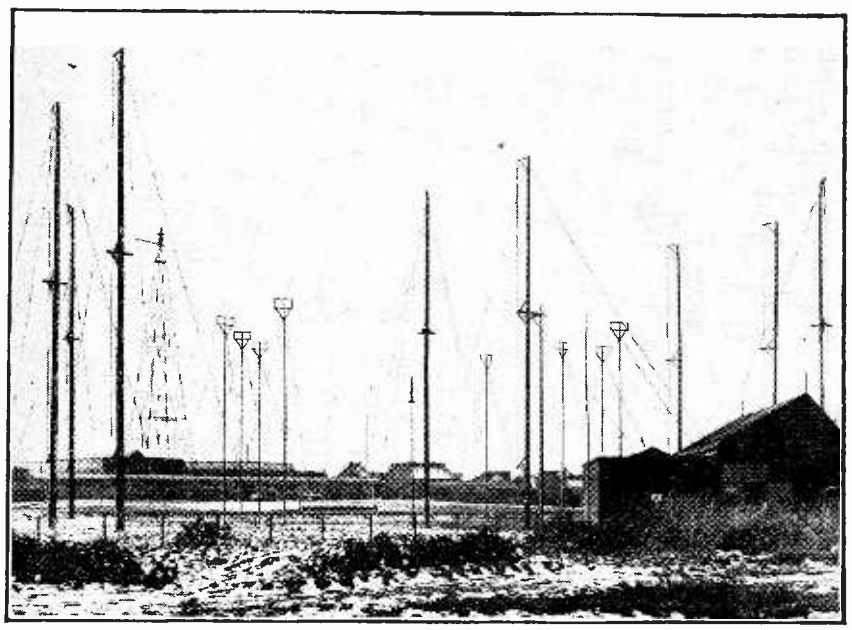
AN INDIAN BIRTHDAY.

We take a peculiar pleasure in offering our congratulations to the Indian State Broadcasting Service on the completion of its first year of operations. If any broadcasting organisation deserved recognition after only twelve months of broadcasting it is the Indian. When, early in 1930, the former Indian Broadcasting Company went into liquidation, the country was threatened with a stoppage which might easily have put back the clock for ten, or even twenty, years. Fortunately, the Government of India came to the rescue, and, in spite of a storm of destructive criticism, broadcasting was somehow "kept going" until a measure of stability was secured. Criticism of the programmes is still rife, but this in itself we



AN AERIAL FOREST. A new photograph of PCJ, the famous short-wave station of the Philips Company at Hilversum. The three aerial systems are as follows: (1) non-directional, (2) east-west directional for Dutch East Indies service and (3) directional to South America. In the background can be seen the lattice mast of the Hilversum broadcasting station.

regard as a healthy symptom of public interest. The I.S.B.S. deserves well of Indian listeners.

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NEW USE FOR PHOTO-CELL.

Although cigarettes are now toasted, given health-ray treatment, sun-dried, aged in the wood, and what not, it is pleasant to find that the wit of man is not yet exhausted. Comes the photo-electric cell, which, according to the Philips' Press Service, is now used for testing cigarette paper. In a certain factory the paper is passed before the cell and any hole or imperfection is revealed by the operation of a warning device.

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A NIGHT IN RABAT.

The Press in Morocco evidently has strong broadcasting sympathies, for the newspapers are uniting in a campaign against the loud speaker tax initiated by the Rabat municipal council. According to *Radio Magazine* (Paris), a café proprietor operating a loud speaker during the normal hours of human activity must pay 25 francs per diem. After 8 p.m., however, the rate rises volcanically to 100 francs per hour, thus preparing the café owner for a further eruption to 225 francs per hour at 10 p.m. Fortunately for him, the Rabat transmitter closes down at midnight, otherwise the municipality would probably collect all his profits.

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OPTIMISTIC FINANCE.

In facing a loss of £4,896 for the financial year ended June 28th, 1930, the Australian broadcasting authorities are consoling themselves with the reflection that a sum of £10,470 was paid for theatre broadcasting rights, and £4,641 for directors' fees. Says "Wireless Weekly" (Australia): "So that if the loss of £4,896 is deducted from the total of these two sums, viz., £15,111, a profit of £10,215 is shown for the period."

To us this seems rather optimistic finance, but with the prospect of a good year to come no doubt our Australian cousins are entitled to put the telescope to the blind eye.

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"PIRATES" CONTRIBUTE £1,110

The Postmaster-General announced in the House of Commons last week that the number of prosecutions undertaken during the twelve months ended March 31st, 1931, for the use of unlicensed wireless sets was 1,433, and the total amount of the fines imposed was £1,110.

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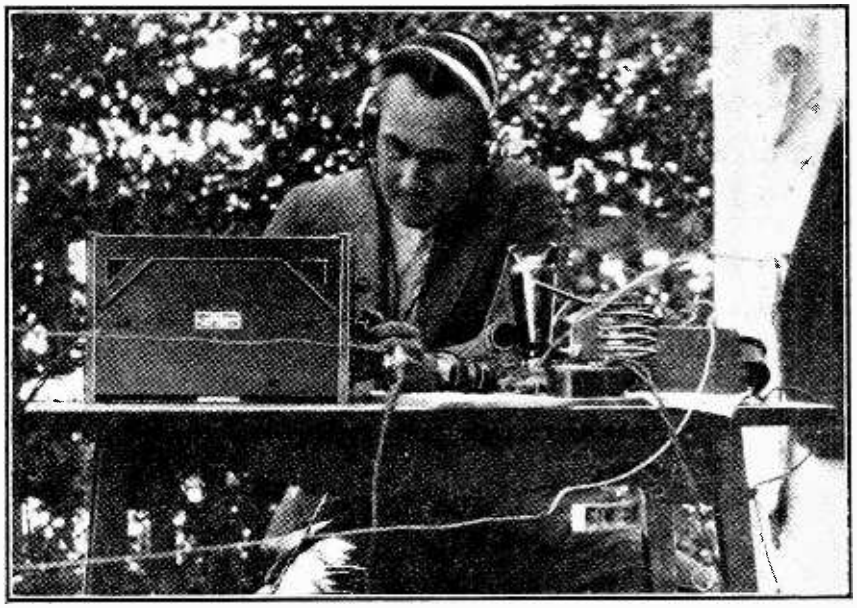
GERMANY AND POLAND IN RADIO DISPUTE.

So much has been said about the ability of broadcasting to forge bonds of international brotherhood—a notion splendidly fostered by the B.B.C. motto—that one is inclined to overlook those disturbing little indications that the broadcasting ploughshare can be very easily beaten into a sword. The Soviet radio propaganda, in whatever light it is viewed, pours no oil on troubled waters; and now comes the news of "diplomatic exchanges" between Berlin and Warsaw arising out of certain remarks at the Katowice microphone anent Germany's communications with the League of Nations on the frontier question.

Fortunately, according to our correspondent, an agreement has been reached in which it is declared that the Reichrundfunk and the Polish Broadcasting Company shall "narrowly survey their transmissions in future in order to prevent their political, religious, economic, intellectual or artistic contents from prejudicing the fulfilment of Radio's duty in the domain of international conciliation."

NO HUMBUG IN HOLLAND.

A tendency to introduce unsavoury political items into the Dutch broadcasts has led to the issue of unusually severe regulations by the Dutch Government, writes a correspondent. The Wireless Control Commission, which has exercised an indulgent authority over all broadcasting in Holland, is now required to stiffen its attitude to the extent of forbidding all criticism of the Government. Talks manuscripts must undergo a rigid censorship, and the law now provides a scale of punishments for any violation of this principle. In extreme cases the power supply may be cut off without notice.



A NEW ZEALAND EMERGENCY STATION.—Mr. W. M. Dawson, ZL 2XP, transmitting press and other messages from a temporary station at Wellington, New Zealand, to Christchurch after the disastrous earthquake in February. Mr. Dawson was transmitting practically continuously from early on Wednesday morning until late on Thursday evening.

MORE LADIES, PLEASE.

Mr. L. A. Corridon, of the U.S. Department of Commerce, has prepared a separate list of the women transmitters in U.S.A. These number 84 out of a total of about 19,000 amateur transmitters, and most of them are stated to be "darn good operators." They seem to be fairly equally distributed over the various districts.

In Great Britain we can at present only boast of two, G2IA in Lanarkshire, and G6YL in Northumberland, but it is to be hoped that the useful activity of these accomplished representatives of their sex will encourage others to join the ranks of amateur experimenters.

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KING ALFONSO.

Considerable interest has been aroused in regard to the suggestion that King Alfonso should broadcast. The fact appears to be that the proposal originated in the United States. After discussion by American broadcasting authorities, however, it was decided not to proceed with the idea partly because of the feeling that it would be distasteful to the ex-King of Spain and partly because of delicate international implications. The B.B.C. were not involved.

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BRITISH ARCTIC EXPEDITION.

As we go to press news is still awaited from the British Arctic Air Route Expedition concerning the whereabouts of a member of the party, Mr. Augustine Courtauld. Earlier in the week rumours were spread that the young man had transmitted a wireless message from a lonely spot in Greenland explaining that he was without food. It was afterwards stated that Mr. Courtauld had no wireless apparatus.

The meteorological section has radio equipment with the call sign GKN.

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A WORLD WIRELESS GUIDE.

For the touring and globe-trotting wireless user few booklets could have a more practical value than the newly issued "Guide to Exide Service Stations at Home and Abroad." Its 46 pages comprise a directory of Exide agents from China to Peru. Copies can be obtained, post free, on application to the Chloride Electrical Storage Co., Ltd., Clifton Junction, Manchester.

ERP Screen-Grid 4 Portable

Type P264.

Inexpensive Suit-case Receiver with Screen-grid Amplifier.

AS one by one the new high-power Regional stations are inaugurated, the door is kept open for the continued use of the battery-driven portable. The set under review, which belongs to this type, aims at a happy compromise between economy in material and cost. The general layout is neat, there being three separate compartments in the case proper; one contains the three batteries, next there is a narrow channel for the four valves, and screened from this the inter-valve couplings are supported on two paxolin strips.

It was found by judicious use of the directional properties of the frame and the two geared tuning controls that selectivity was adequate. Tested some eighteen miles south of London, the two Brookmans Park transmissions were, of course, easily separated, and the Midland Regional was received well enough, together with about five European stations on the medium waveband. On the long waves the set gave a good account of itself, bringing in four stations at sufficient signal strength to be of entertainment value.

The control of volume is smooth, and, though quite effective, is not linear, as judged by the ear. As with all reaction schemes, the signal strength grows very rapidly when the oscillating point is approached. The quality of reproduction is pleasing, and there are no objectionable resonances, provided that the volume is not taken beyond the signal-handling capacity of the last valve.

The circuit is quite conventional, and follows well-tried practice. The frame aerial is wound in the lid whence six leads emerge; four of these are connected to the waveband switching arrangement, and two to the loud speaker. Across the input is a 100,000-ohm resistance, which acts as a stabiliser; and, although there must be some reduction of dynamic resistance due to its presence, the stability of the H.F. amplifier would seem to justify the addition.

Passing next to the screening-grid feed of the single S.G. amplifier, there is a scheme which is to be found in a number of receivers to-day. A potentiometer with an upper limb containing a 15,000-ohm resistance and a lower limb consisting of the detector valve ensures that voltage regulation is satisfactory when small current changes take place. The inter-valve coupling consists of the tuned anode arrangement having 1¼in. coil windings carried in a slotted former. A single reaction inductance coupled to these serves for regeneration on both wave ranges.

The condenser tuning the frame aerial has a capacity of 0.0005 mfd., whilst that for the tuned anode is 0.0003 mfd., both having their rotors tied down to earth. Decoupling is to be found in the anode circuits of the H.F. and detector valves, which are the danger points in a circuit of this nature. No signs of L.F. oscillation were apparent until the voltage of the high-tension battery had dropped to about half its normal value, when a slight whistle was noticed. This hardly calls for criticism, as the H.T. battery would probably have to be discarded before there was any evidence of feed-back.

Detection is carried out by the leaky grid method—the grid-leak and condenser having the conventional values of 2 megohms and 0.0003 mfd. To assist in by-passing H.F. energy, and to enhance rectification efficiency, a 0.0001 mfd. condenser is joined between the detector anode and L.T. negative. Stray high-frequency potentials which find their way through the L.F. amplifier and into the loud speaker circuit often cause considerable feed-back trouble in portable sets. To guard against such an occurrence in this set, it will be seen from the circuit diagram that there is an 0.005 mfd. condenser shunted across the output of the last valve. "Six-sixty" valves were to be found in the set under review, their filament consumption accounting for a total of about 0.55 amp., so that the eighteen ampere-hour unspillable accumulator will give some thirty hours listening before recharging is necessary.

SPECIFICATION.

CIRCUIT: Four valves. Frame aerial coupled to screen-grid H.F. amplifier. Tuned anode coupling to regenerative leaky grid detector. Two transformer-coupled L.F. stages.

CONTROLS: Two dial tuning. Reaction volume control. Switch providing on-and-off and change of waveband.

GENERAL FEATURES: Unspillable two-volt accumulator of 18 ampere hours' capacity. 108-volt H.T. battery. Decoupling in anode circuits of the H.F. amplifier and detector.

Price £10 . 0 . 0. Dimensions 15 × 9½ × 12¾in. Weight 25 lb.

Makers: Electrical and Radio Products, Ltd., 90, Regent Street, London, W.1.

A self-contained receiver selling at such a modest price should appeal to those who cannot erect an outside aerial and to whom untidiness is intolerable. The wooden containing case, covered in rexine, is substantially made, and the domed top, which provides ample room for the cone speaker, gives a pleasing finish to the receiver.

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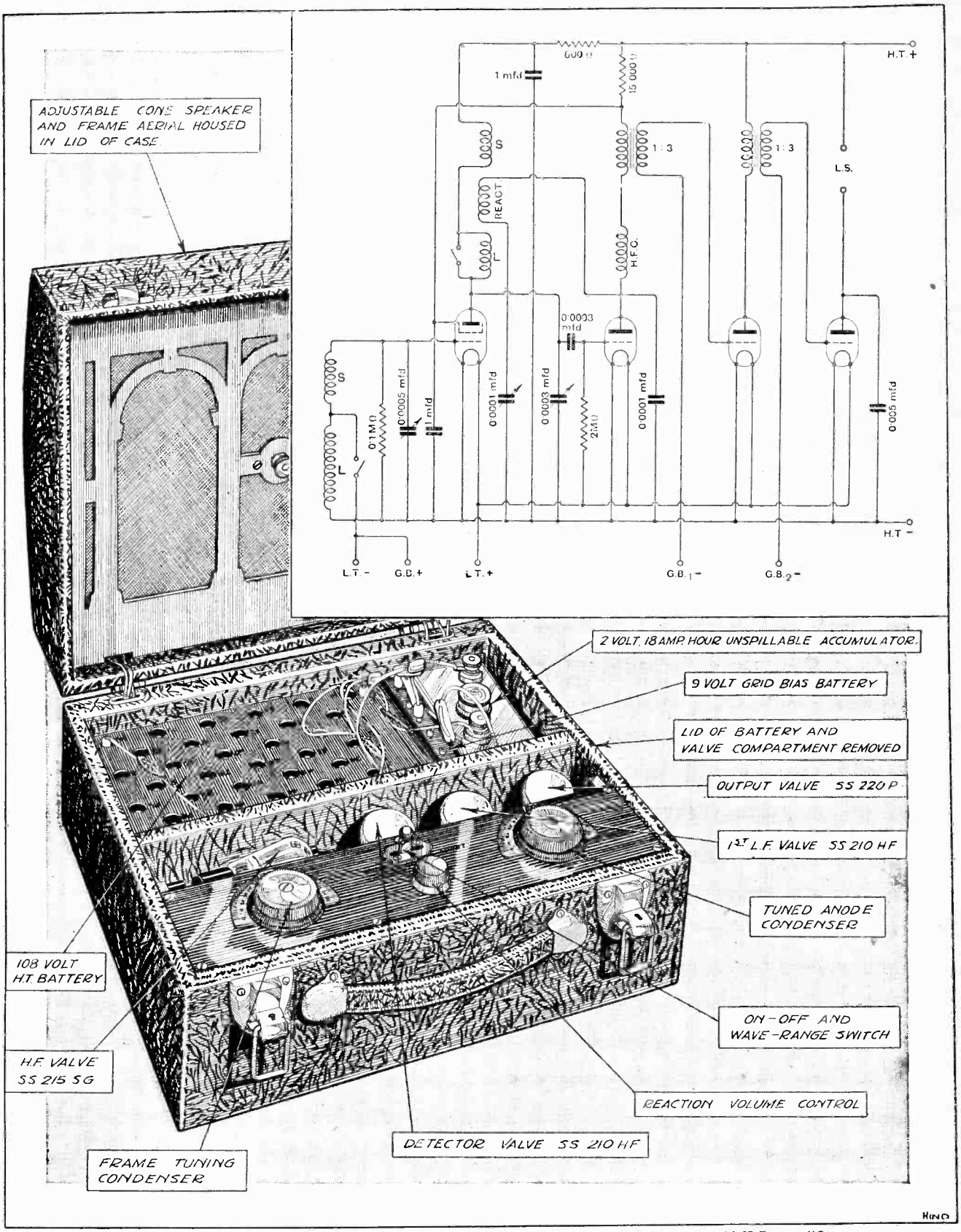

The E.R.P. suitcase portable. The circuit contains 4 valves, including a single screen-grid H.F. amplifier.

BROADCAST BREVITIES.

By Our Special Correspondent.

The "D.G." in U.S.—Rebuilding 5XX.—Belfast's Future.—The New Tatsfield Mast.—A Relay Discovery.

Sir John Reith's American Mission.

Despite rumours, I believe that Sir John Reith's forthcoming visit to America will be primarily for the purpose announced. The "D.G." goes to attend the first general assembly in New York of that weightily named body, the United States National Advisory Council on Radio in Education, and will give an account of British aims and methods in broadcast teaching.

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Seeing How the Wind Blows.

Suggestions that Sir John will be implicated in any grandiose schemes for co-operation between the American and British broadcasting authorities can be discounted at once, although, very naturally, he will make profitable use of the visit to study which way the winds are blowing in God's Own Country. The said winds will not, I think, cause him any discomfort.

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Wartime Memories.

Sir John will renew many friendships first formed when he was in America during the War. He was then recuperating after being severely wounded at Loos; and to fill up the time he took over the management of a large staff dealing with munitions.

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Seeing the Sights.

Mr. Merlin Aylesworth, the President of the National Broadcasting Company, who was warmly welcomed at Savoy Hill two years ago, will no doubt display a legitimate pride in explaining to the British Director-General the plans for New York's "Radio City," and in conducting him over WEAF, the new transmitter which in many ways represents the last word in American radio practice.

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Oh Yeah?

And talking of last words, we must not be scandalised if on his return the "D.G." clothes the Epilogue in an American accent.

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Daventry and Belfast Surprise.

It is difficult to realise that Daventry 5XX is six years old and already obsolescent. At the same time, there is a paradox in the fact that the long-wave station possesses a permanent building while its modern neighbour, 5GB, still sleeps in a doss-house.

We have been told that 5XX and the Belfast station are both to be rebuilt, and I am now informed that the work will be started *before* the completion of the Regional Scheme.

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More Power for Belfast.

If present plans materialise the Regional Scheme should be an accomplished fact before the end of next year, which means that the Daventry and Belfast alterations may be carried out in the very near future.

The new Belfast transmitter will have a power of between 12 and 15 kilowatts (Geneva rating), and will be erected on a site, not yet chosen, outside the city.

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A Rival to Athlone?

When visiting Belfast recently I was struck by the magnificent broadcasting possibilities of the Divis Hill, 1,500ft. high, some three miles inland. The only possible objection to such a site would probably be launched by the Free State authorities, who might see a potential rival in field strength to their long-projected transmitter at Athlone.

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"Let Us Know the Worst!"

I admire that Northern aggressiveness which has leapt out in the demand for Sunday afternoon transmissions from Slaithwaite. "Let us know the worst!" seems to be the slogan, and obedient to the demand, the B.B.C. is giving it. And apparently, the worst is not so overwhelming after all.

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A Rational Attitude.

Quite 25 per cent. of the letters received are unadulterated praise. Other correspondents admit that the "cutting out" business is troublesome, but there is a rational acceptance of the fact that the station is there for the benefit of listeners as a whole.

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Why Indeed?

Two or three listeners, who can hardly have troubled to acquaint themselves with the Regional idea, have written asking why the "local" transmitter is so much stronger when working outside the normal weekday broadcasting hours.

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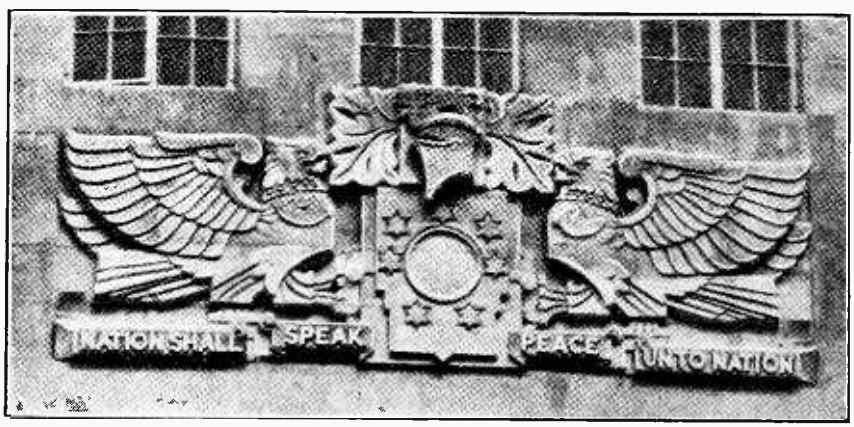
Anxiety in Aberdeen.

Writes Mr. Angus McHaggis, of Aberdeen: "I am given to understand that when the Northern National transmitter



RAMPANT. This *Wireless World* photograph, taken last week with a telephoto lens, shows the B.B.C. crest which now adorns the western façade of "Broadcasting House." Viewed from Portland Place the building already appears complete. Internal decoration work will be started within six weeks.

FUTURE FEATURES.

National (261 and 1,554 metres).

MAY 10TH.—String orchestral concert.
MAY 11TH.—Variety Artists' Benevolent Fund Command Performance, from the London Palladium.
MAY 13TH.—Congregational Union of England and Wales Centenary Celebration Service, at the City Temple.
MAY 14TH.—The Ridgeway Parade.
MAY 15TH.—"The Forest," a play by John Galsworthy.
MAY 16TH.—Mr. George Bernard Shaw: "Libraries and the English Language," relayed from Icknield Hall, Letchworth.

London Regional.

MAY 10TH.—Brass band concert (from Manchester).
MAY 11TH.—"Chinese Moon Party," a Landscape in Lacquer, composed by M. H. Allen, from the translations of Arthur Waley.
MAY 13TH.—The Ridgeway Parade.
MAY 14TH.—"Tristan and Isolde," Act 2, relayed from the Royal Opera House, Covent Garden.
MAY 16TH.—"The Forest."

Midland Regional.

MAY 13TH.—"Memories of Ireland," orchestral programme.
MAY 15TH.—"This Spring Business," feature programme.

West Regional (Cardiff).

MAY 12TH.—Three Valleys Festival: First Festival Concert—"The Messiah" (Handel), relayed from The Pavilion, Mountain Ash.

North Regional (Manchester and Leeds).

MAY 12TH.—"Fooils an' their Brass," a Yorkshire comedy in two scenes, by F. A. Carter (from Leeds).

Glasgow.

MAY 14TH.—"Our Heritage of Highland Song," arranged in collaboration with An Comunn Gaidhealach.

Belfast.

MAY 11TH.—"The Pagan," an Ulster comedy, by Lewis Purcell.

begins to operate on 301.5 metres, the Aberdeen wavelength will drop from 301 to 288.5 metres. (Quite correct, Mr. McHaggis.) What I want to know is whether, in view of this sacrifice of 12.5 metres, Aberdeen listeners are to be given an increase of power?"

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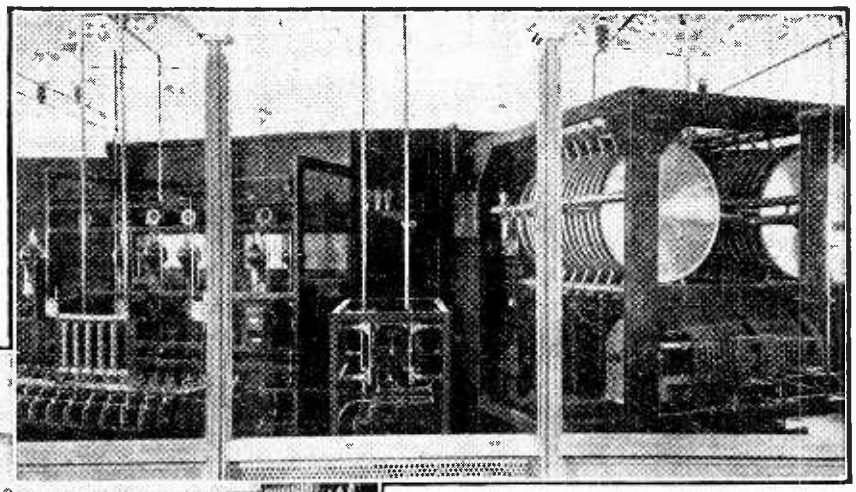
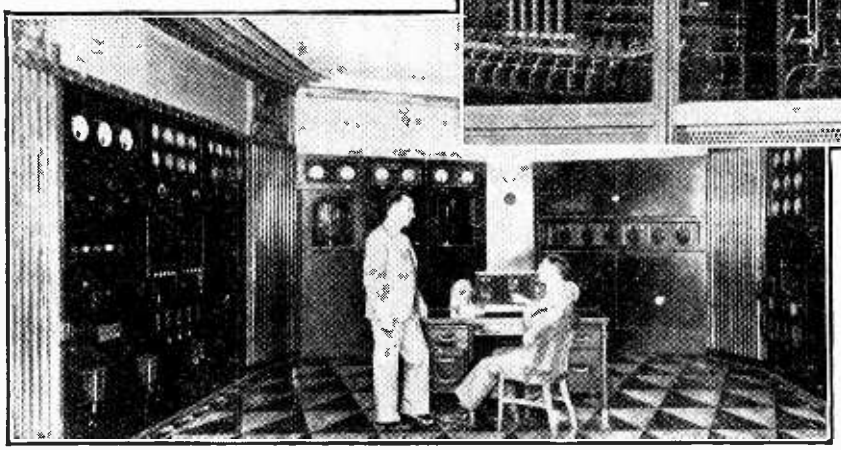
The Only Promise.

No such provision has been allowed for, Mr. McH.; the only satisfaction I can promise is that a quartz oscillator will be conveyed to the Granite City to secure absolute synchronisation with the other relays, which will then not be out of step with Aberdeen.





AMERICA'S LATEST. Views of WEAF the newly constructed "headquarters" broadcasting station of the U.S. National Broadcasting Company in New York City. The upper picture gives a glimpse of the transmitter as seen by visitors through an inspection window. On the right are the tuning condensers and, on the left, the rectifier system. The lower photograph, taken in the main transmitter room, shows the control desk and the modulator and frequency control panels.

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The Tatsfield Lamp.

In odd moments the B.B.C. engineers at the Tatsfield receiving station have a splendid plaything in the lamp suspension equipment fitted on the new 140ft. mast. Being on a recognised air route, the Tatsfield aerial at night is as much a menace to a 'plane pilot as a nicely pitched spider's web to a fly; hence the necessity for a beacon light.

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A Ticklish Problem.

The problem with an aerial lamp attached to a stayed mast of the unclimbable type is to secure a means of lowering the lamp for cleaning and maintenance purposes without fouling the stay wires. It must also have the necessary steadying lines and guides to prevent the lamp from swaying in the wind while being lowered.

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The Handle.

These requirements have been met by a device in which the lamp is held rigid at a distance from the mast on two struts attached to the runner, which works up and down the guide rope.

At the foot there is an inviting little winch handle. . . .

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Unguarded Masts at Slaithwaite.

The only other B.B.C. masts which carry beacon lights are those at Daventry and Brookmans Park. In spite of their immense height, the Slaithwaite masts are unilluminated, apparently because no aeroplane has ever been seen near the place. But one night, it seems to me, a plane will wander over those moors, and people in Wigan will grumble because the vaudeville is interrupted.

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What the Relay Reveals.

A man who must accept some responsibility for the spread of the relay system in this country has put forward what seems to me one of the very few arguments in favour of "programmes down the pipe." He says, and I agree with him, that a relay system is the only existing method of broadcasting that provides an indication of the number of listeners at any given moment.

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The Man at the Master Set.

Sitting at his master receiver, which feeds numbers of houses in the locality, this gentleman can tell from the load on the circuit approximately how many subscribers are listening to the news bulletin, how many switch on for the vaudeville, and how many switch off for the chamber music.

What he is unable to discover, however, is how many drop off to sleep during a talk.

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Broadcasters on the Platform.

It is not often that the ordinary listener has an opportunity of seeing in the flesh so many broadcast artistes as those assembled for the "Roosters" Commemoration Concert at the Northern Polytechnic, London, on April 24th. The concert had been organised to inaugurate a fund in aid of the widow of the late Mr. Albert H. Howe, a member of the "Roosters" party, and it speaks volumes for the comradeship among professional broadcasters that so many were ready to offer their services. They included Norman Long, Leonard Henry, Essie Ackland, Elsie and Doris Waters, De Groot, and the Roosters themselves. The sum raised was well over £100.

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Cortot To-night.

Cortot, one of the world's greatest pianists, is making his first appearance before the microphone to-night (Wednesday) at the last of the B.B.C.'s present season of Symphony Concerts in the Queen's Hall.

To-morrow evening, May 7th, he will broadcast the twenty-four Preludes of Chopin from a studio at Savoy Hill.

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One Letter from a Hundred and Twenty.

The appreciations of musical broadcasts which swell the B.B.C.'s postbag to the largest extent concern Joseph Lewis's "Memories" programmes.

Among several hundred congratulatory letters on one such programme recently given, three letters alone represented thirty-five, seventy-two and one hundred and twenty listeners respectively.

The B.B.C. must often wish that those who grumble about other programmes would display the same passion for economy in stationery.

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Distressing.

From a B.B.C. engineer's Sunday log entry:—

"Church broadcast. 8.45 p.m.: Minister blasting heavily, congregation faint."

Unbiased

by Free Grid

Through a Salesman's Spectacles.

Some months ago I was taken to task in the Correspondence columns of *The Wireless World* for some complaints I had made concerning the lack of courtesy and general spirit of helpfulness met with in a large number of wireless shops, and it was suggested that a week behind the counter would soon "larn me" to pity the poor shop assistant. I was far too busy to take up the challenge at that time, but when I was chatting the other day with the manager of the radio section of a large departmental store he happened to bemoan the waste of time caused by people coming in to talk technicalities with his assistants without having any intention of buying anything. He referred to such people by the forceful, though descriptive, title of "Brain Suckers." My curiosity was piqued and I said that I should be glad of a day behind the counter to see what the life was like. He instantly suggested that I take my place as an assistant on some convenient day. Nothing loth I complied, and three mornings later I duly presented myself for duty at an hour which I fear was somewhat later than that at which the ordinary assistants commenced their day's labours.

I had previously observed that plus-fours were not encouraged among the assistants and that horn-rimmed glasses appeared to be *de rigeur*, and so, on the appointed day, I arrived suitably clad and equipped with the necessary horn-rims fitted with plain glass. The manager assigned one of his best assistants to me as a sort of dogsbody, and I promptly took my place behind the counter and prepared to show the others the compleat art of radio retailing. I am afraid that the Editor will not allow me sufficient space to give a full account of my day's experience as he needs it—the space I mean—for his wretched Editorial Views.[1] I hope later on to persuade him to grant me "hospitality of his columns" as "Pro Bono Publico" and "Indignant Ratepayer" usually put it. I can only say that my experience did not greatly modify the views I expressed last September. Meanwhile, I eagerly await a similar invitation from the proprietor of one of the numerous small wireless shops employing one or two assistants, if he thinks that he can make me eat my words.

The "Brain Sucker" at work.

Those American Sets.

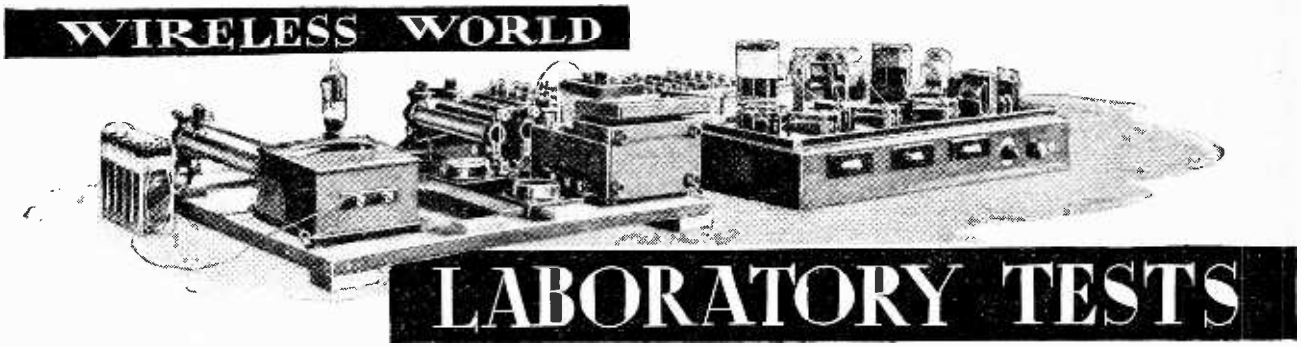
During the past few months there has been an influx of American radio goods into this country which bids fair to rival the great invasion which occurred after the lifting of the ban on the use of foreign receivers at the end of 1924. The great difference to my mind, however, is that while the 1925 invasion consisted for the most part of worthless kits of parts badly designed and shoddily made, the present one consists of thoroughly well-designed and up-to-date all-mains receivers complete with built-in loud speakers. Apart from the fact that most of them do not cater for long-wave reception nor for the connection of a gramophone pick-up, I have one very grave fault to find with them, and that is their relatively poor quality of reproduction.

I am perfectly well aware that this statement will call forth expostulations not only from people who claim to have a musical ear, but also from radio technicians. The former will bid me listen to drums and to the bass generally, while the latter will tell me that bad quality is impossible because these receivers employ band-pass tuning, power-grid rectification, push-pull output, and every other device intended to combat it, and, therefore, it cannot occur; they will, furthermore, state that I am prejudiced against American receivers because of the atrocious quality which was inevitably associated with those produced several years ago.

A Mellow Bellow.

Nevertheless the fact remains, and one has only to listen to the news bulletin to notice the rich and fruity nature of the announcer's voice. I pointed this out to a large importer of these receivers the other day when he was demonstrating one of his latest acquisitions to me. "But," he expostulated, pointing to the "book of words" which accompanied it, "quality could not be better, because as you see by the book, it possesses a 'coloratura' loud speaker." Now, as I explained to him, that was precisely what the trouble was, for I have always found that whenever an American loud speaker designer tacks that unfortunate word on to his products the result is always the same, namely, poor reproduction of speech and an overall tone which loud speaker manufacturers in this country used at one time to describe as "mellow." That the fault lies with the loud speaker and not with the set can be quickly proved by connecting up an external loud speaker of good make. The view held by some people that a loud speaker and receiver combination capable of giving first-class results in the matter of musical reproduction is incapable of giving clear-cut speech and vice versa is as mistaken as the attempts at self-deception made by others who delude themselves into a belief that hollowness of speech is "natural," the aforesaid naturalness presumably being first cousin to the Oxford accent.

[1] Nearly time "Free Grid" was "earthed."—ED.



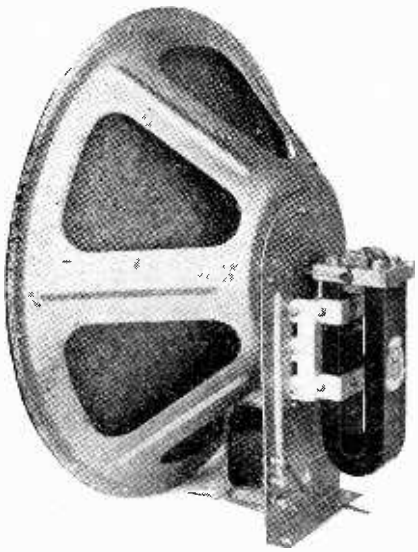
A Review of Manufacturers' Recent Products.

UNDY SUPER DYNAMIC "8."

The movement of this loud speaker is of the balanced armature type and can be visualised as having eight poles, four of these being grouped round the armature pivot and the remaining four disposed in pairs on opposite sides of each extremity of the armature. A massive permanent magnet is provided, and in spite of the comparatively wide air gaps the sensitivity is extraordinarily good.

The provision of a filter feed unit in the base of the instrument is an unusual feature in a moving iron type loud speaker. The choke is tapped and three terminals permit the adjustment of the input impedance to suit output valves of low, medium or high impedance, including pentodes.

Comparative tests showed the sensitivity to be very much above the average. The bulk of the output is obtained between 100 and 2,000 cycles, and there are rather prominent resonances in the vicinity of 150 and 1,750 cycles. The response above 2,500 cycles falls to a low level, but is relieved by a resonance at 3,400 cycles. The reproduction of music is, on the whole, better than that of speech, which has a somewhat nasal quality, due, no doubt, to the prominence of the 1,500-2,000 band of frequencies. There is, however, no tendency to boom as a result of the bass resonance at 150 cycles.



A new "Undy" loud speaker chassis—the Super Dynamic "8."

The price of the new model is 70s., and supplies are obtainable in this country from Messrs. J. Hemelik, 8, Collinwood Road, London, N.W.10.

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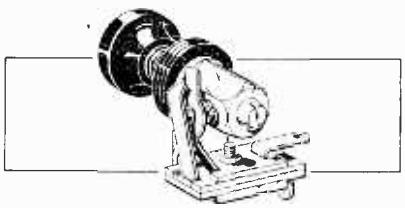
"EUREKA" SINGLE-POLE SWITCH.

This is a single-pole make-and-break switch operating with a push-pull action



"Eureka" single-pole push-pull switch with single-hole fixing.

and fitted with self-cleaning contacts. The spring leaves are made of nickel silver and both are fully insulated from the frame. A single hole fixing bush is fitted. The plunger is so fashioned that when in the out position it presses a steel ball against an insulated washer, and this in turn closes the contacts; these have a wiping action.

The makers are L. Person and Son, 53, Shaftesbury Street, London, N.1, and the price is 1s.

o o o o

POLAR "TUB" TWO-GANG CONDENSERS.

This is a companion model to the Polar "Tub" Three-Gang condenser reviewed in our issue of December 24th last. The method of construction is identical, and the principal reason this model has been developed is to enable these condensers to be employed where two, three, four, five or even six ganged condensers, each individually screened, are required. A single-drum dial will drive the complete assembly.

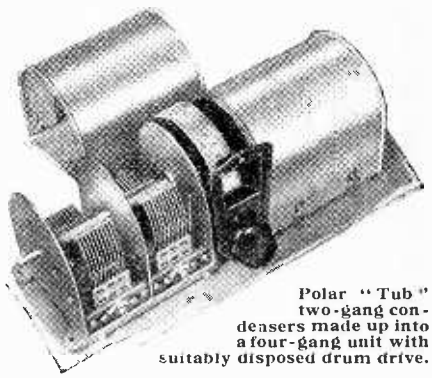
As in the case of the earlier model, each condenser in a unit is guaranteed matched to within 1 micro-mfd., up to 0.0001 mfd. of the capacity and thence to within 1 per cent. over the remainder of the scale. A small trimmer is incorporated in each compartment which, in the later models of both the three- and two gang units, is now operated by a star-shaped wheel.

The capacity of each condenser in a sample unit was measured at various positions of the 180° scale, after first adjusting the trimmers to give the same minimum value in each case. As can be seen from the tabulated matter, the matching is exceedingly good throughout the scale, and at all parts the relative accuracy is well within the limits set by the makers.

Polar "Tub" Two-Gang Condenser.

Scale Reading.	No. 1. Condenser (Capacity in micro-mfds.).	No. 2. Condenser (Capacity in micro-mfds.).	Difference.	
			Micro-mfds.	Per cent.
Zero	24	24	—	—
20	50.8	50.6	0.2	—
40	94.6	95.3	0.7	—
60	147.3	148.4	1.1	0.75
80	195.0	196.9	1.9	0.97
100	248.0	249.6	1.6	0.65
120	307.7	307.3	0.4	0.13
140	366.7	368.3	1.6	0.44
160	422.5	424.0	1.5	0.36
Max.	512.6	509.3	3.3	0.65

The price of the "Tub" Two-Gang condenser is 21s. without dial, or 29s. 6d



Polar "Tub" two-gang condensers made up into a four-gang unit with suitably disposed drum drive.

with drum dial. A Four-Gang assembly as illustrated, with drum dial consisting of two separate units with the dial forming the connecting link sells at 50s. 6d.

The makers are Wingrove and Rogers, Ltd., Arundel Chambers, 188-9, Strand, London, W.C.2.

"ELFSON" MOVING COIL LOUD SPEAKER.

By comparison with other moving coil loud speakers of similar performance the "Elfson" unit is exceptionally light and compact. The pot magnet, which takes 67 mA. at 210 volts, is constructed of high permeability steel and is only 4in. in diameter and $3\frac{3}{8}$in. deep. The moving coil is 2in. in diameter and works in an air gap $\frac{1}{4}$in. deep. It carries a low-resistance winding and a 20 : 1 transformer is housed in the crystallic-finished metal base.

The sensitivity is well up to standard and the quality of reproduction of speech and music is equally good. Frequency tests show that the output in the bass between 50 and 150 is higher than at any other point in the range. There is a mild resonance at 3,000 cycles, and the output rises slightly between 5,000 and 6,000 cycles, otherwise the response above 200 cycles is practically uniform.

"Elfson" moving coil loud speaker; D.C. model.

Models are available for A.C. and D.C. supplies, including 6-volt accumulators, the price of D.C. models being £3 17s. 6d. and of the A.C. £6 7s. 6d. The makers are Messrs. Wilson and Elford, Priory Road, Aston, Birmingham.

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"SPA SAFETY AERIAL FUSE."

We are pleased to announce that the rather unsatisfactory nature of the material used for the earthing spring in the "Spa Safety Aerial Fuse" made by F. E. Harmer and Co., Ltd., Knowsley House, Bolton, Lancs, and reviewed in our issue of April 15th last, was noticed by the makers soon after despatching a sample to us. This was immediately altered to phosphor bronze before any quantity had left the works.

This affords much greater tension, and the resilience of the material assures definite contact when the fuse melts.

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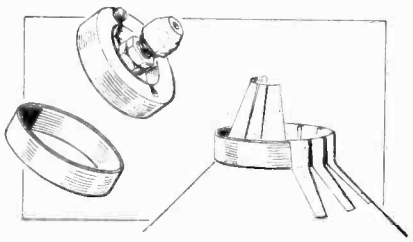
WEEDON "ADAPTADISK."

Constructors of cone loud speaker units will be interested in this new device for transmitting the drive to the apex of the diaphragm. It consists of an aluminium centre boss which fits inside a light metal ring. The diaphragm is cut to form serrations and clamped between the two elements by tightening up a taper set in the centred boss, which is provided with a saw-cut extending across a diameter.

The great advantage of the device is that it is adaptable to any angle of cone, and is therefore especially convenient for experimenting with different cones.



Weedon "Adaptadisk" cone centre which fits cone diaphrams of any angle. The diaphram serrations can be cut off flush or bent over and glued down as shown.

The device is practicable only on the assumption that the material of the cone is not buckled or weakened when cutting the serrations and fixing the clamping ring. With ordinary care, however, no difficulty should be experienced in making a satisfactory fitting.

The price, complete with four-jaw collet chuck, is 1s. 6d., and the makers are Messrs. J. H. Weedon and Co., 20A, Lisle Street, London, W.C.2.

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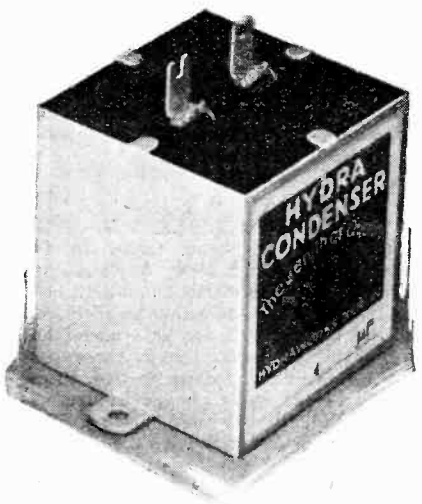
HYDRA "ZENITH" CONDENSERS.

A new process of manufacture has enabled the makers of Hydra condensers to compress certain of their types into a space one-third the size of that required hitherto. So far this applies only to those rated at 1,500 volts D.C. test. They are contained in the same size cases used to house the 500-volt D.C. test range; a 4-mfd. size in the new range measuring $1\frac{3}{4}$in. × $1\frac{3}{4}$in. × $2\frac{3}{8}$in. in height overall.

They are available in values of from 0.1 mfd. to 10 mfd., the prices ranging from 2s. to 18s. 6d., and supplies can be obtained from Louis Holzman, Ltd., 37, Newman Street, London, W.1.

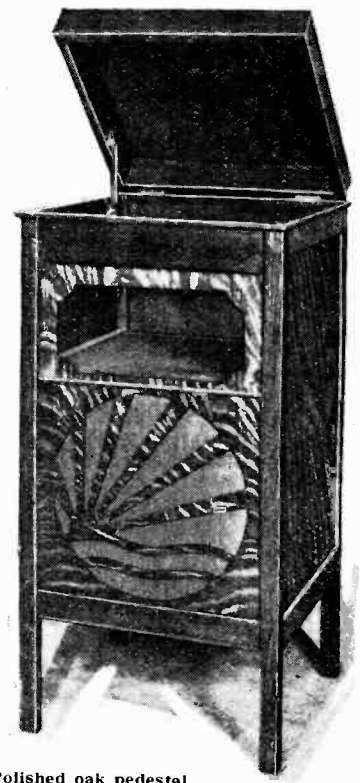


New Hydra "Zenith" 4-mfd. condenser; 1,500 volts D.C. test.

RADIO GRAMOPHONE CABINET.

A well-made pedestal-type radio-gramophone cabinet with generously proportioned compartments for the accommodation of gramophone equipment, wireless receiver, loud speaker and batteries, or a mains unit, has been placed on the market recently by the London Super Cabinet Co., 19, Pritchard's Road, Hackney Road, London, E.2. Not its least attractive feature is the price, which is £2, finished in polished oak.

It is divided into three main compartments. The upper portion, in which will be assembled the gramophone turntable, pick-up and possibly other small accessories, measures 17in. × 16in. × $4\frac{3}{4}$in. deep, including the recessed lid.



Polished oak pedestal radio-gramophone cabinet made by The London Super Cabinet Co.

The depth below the motor board to the loose base on which the set can be built is $8\frac{3}{4}$in., which, with suitable disposition of the components, allows ample room for the accommodation of an electric, or a spring gramophone motor. The set baseboard measures $17\frac{3}{8}$in. × 17in. from back to front. This compartment is partially closed by an ornamental frame behind which the control panel will fit. The overall size of this window is $13\frac{3}{8}$in. × $9\frac{1}{16}$in.

The lower part of the cabinet is reserved for the loud speaker and batteries, or mains unit as the case may be. Ample space is allowed, and, if necessary, the output stage could be accommodated here. A large ornamental grill, covered at the back by tinsel, forms the front to this compartment. The overall height of the cabinet is 3ft. $3\frac{1}{2}$in.

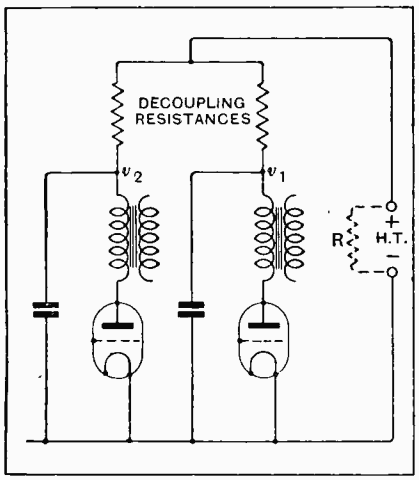
Modern Terms Defined

"Motor-boating"—Its Cause and Cure.

(*Continued from page 440 of April 22nd issue.*)

Back Coupling.—A term covering all types of unintentional coupling in which energy is transferred from a later stage to an earlier stage in a receiver. It is, however, most frequently used in connection with low-frequency coupling caused by the internal resistance of the H.T. supply. Since this resistance is common to the anode circuits of all valves, any alternating voltage developed across it by one stage will be communicated to the others and distortion or "motor-boating" may result.

Decoupling.—The measures taken to neutralise the effects of back coupling described above. The decoupling of anode circuits is most effectively accomplished by including a by-pass condenser and a resistance of high value in series with each H.T. supply. The decoupling resistance must be high compared

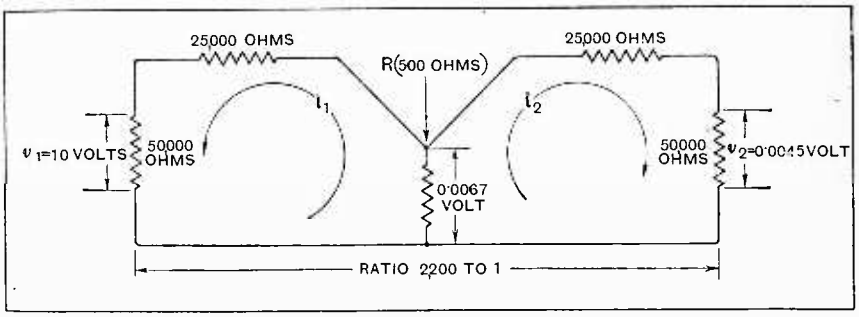


Two-stage decoupled amplifier and—

with the resistance of the source of H.T. current, and high also compared with the impedance of the by-pass condenser at the low frequencies at which most of the troubles due to back coupling occur.

The function of the decoupling resistances will be best understood by referring to the accompanying diagram, which shows two decoupled stages, together with the equivalent electrical circuit. Let us assume that the H.T. current is drawn from a battery with an internal resistance of 500 ohms, that the total impedance of each valve, including the primary of the inter-valve transformer, is 50,000 ohms at, say, 50 cycles, and that the decoupling resistances are each fixed at 25,000 ohms. Now consider the point v_1 in the upper diagram and assume, for the sake of argument, that in spite of the presence of a by-pass condenser a stray alternating E.M.F. of 10 volts is able to leak into the H.T. supply circuit. Due to the presence of the decoupling resistance, however, only 0.0067 volt will be developed across the battery resistance. This E.M.F. will be transferred to the anode circuit of the preceding valve, but will experience a further reduction by the decoupling resistance of that valve. With the values chosen only 0.0045 volt, or one 2,200th part of the original stray voltage will pass from one anode circuit to the other.

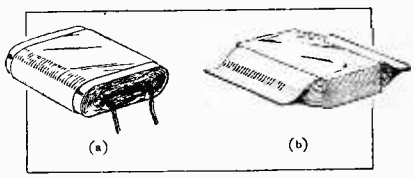
Similar principles may be applied to the grid circuits of a receiver where bias is obtained from a common resistance in the H.T. circuit. In other cases the coupling due to the inclusion of unintentional resistance in more than one stage may be overcome by careful attention to the principles of scientific wiring which were described in this journal as far back as April 25th, 1928.



—its equivalent circuit illustrating the function of the decoupling resistances.

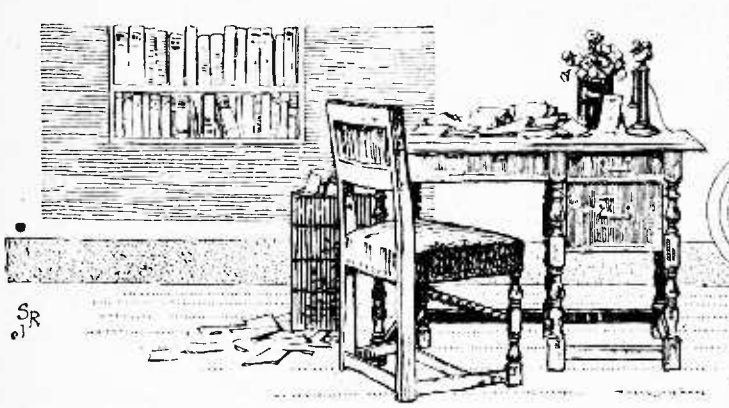
Non-inductive Condenser.—Condensers of the order of 1 mfd. and upwards are generally of the rolled foil type in which two long strips of foil, separated by waxed paper, are rolled in the form of a spiral. Charging currents must traverse this spiral in order to reach the extremities of the electrodes, and the condenser therefore exhibits some of the properties of an inductance as well as a capacity. This has the effect of increasing its impedance at radio frequencies, where, if it were a pure capacity, the impedance should be low. Thus the presence of inductance is a serious disadvantage in large capacity condensers intended for use in H.F. circuits.

Non-inductive by-pass condensers are generally constructed of a large number of separate elements assembled as in (*b*) in the diagram. Naturally, this form of construction is more costly to produce, and recent experiments have shown that by careful design the impedance of the cheaper rolled-foil condenser at high frequencies can be reduced to a satisfactorily low figure. This is accomplished by distributing the inductance and capacity in the condenser in such a way that it functions as an acceptor circuit and offers an impedance of less than half an ohm over a wide range of frequencies on the medium-wave broadcast band.



Typical methods of by-pass condenser construction: (a) rolled foil; (b) non-inductive.

(*To be continued*)



The Week's Postbag

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.

WIRELESS SIGNALS AND EARTHQUAKES.

Sir,—Your correspondent, A. B. Cousins, raises an interesting point on the effect that earthquakes have on wireless signals. As a matter of general interest, there are six of us, members of the Radio Society of Great Britain (Contact Bureau section), who have been studying all phenomena regarding the fading, blindspotting and skip of signals, with especial reference to the higher frequencies. Amongst other things, we drew up a forecast of just how earthquakes might effect signals, and since our theory was issued we have had several chances of putting this to a practical test, and in each case we have ample proof that wireless signals were affected by earthquakes. The first test was the earthquake here in Jersey, the next that of Hawke's Bay, and I noticed effects on the one mentioned by Mr. Cousins, which the other members, not being on watch, did not have the chance of proving.

Briefly, on 7 Mc. (40-metre band) an earthquake seems to have the effect of lifting the skip distance, as stations audible to each other, suddenly cease to be audible, while those at a greater distance suddenly experience a rise in signal strength. Such conditions come on and go off again for no apparent reason. Another phenomena is the deadening of signals, and so clearly did our forecast predict this, that one of our members, switching on when the New Zealand earthquake was in action, wrote to me at the time, and said he would not be surprised to hear that an earthquake had taken place, which, of course, we heard about shortly after.

It would take too long to go into details in a letter, but we think that the possible cause of these effects is simply a changing of the earth's potential. It is a well-known thing that different potentials are clearly shown by cables, and it is only a matter of theory to say that such change of potential, if serious or violent enough, will make its influence felt over long distances.

Unfortunately we have nothing to add regarding broadcast bands, but I suggest that Mr. Cousins, if he took his times, compares them with the timings of the actual shocks, to see if there is any connection.

As I am just going from home for six weeks, if Mr. Cousins cares to write to me I shall forward his letter on to one of the others who has a complete log of the earthquake effects on 7 Mc.

Unfortunately, earthquake effects seem only to influence signals when the quake is actually in progress, otherwise we might have a means of being warned, but I used the word "seem," as possibly some phenomena do actually take place previous to a quake, which have so far passed unnoticed.

Jersey, C.I. A. M. HOUSTON FERGUS, Radio G2ZC. TBA.

LOUD SPEAKER MAGNETS.

Sir,—The letter by "Discriminator" in your issue of March 18th regarding the criterion of magnet performance is of considerable interest. I have had various enquiries regarding the article published on November 26th, 1930, and the salient points are treated below. The criterion $B_g^2A_g$, where A_g is the mean cylindrical area of the gap in square centimetres and B_g is the mean flux density in the gap in lines per square centimetre, applies to cases where the radial length of the gap and the size of wire are constant. The more complicated formula in which the gap length, wire gauge, etc., are taken into account is as follows:

The output depends upon, but is not proportional to, $B_g^2A_gl_gf_s = B_g^2V_gf_s$ where V_g = vol. of gap and f_s is a space factor equal to the cross-sectional area of the copper divided by the cross-sectional area of the gap. An example may make the matter clear. Taking the case cited in the November article, p. 604 :—

$A_g = \pi db = 8$ sq. cm.

$B_g = 9{,}000$ lines per sq. cm.

Radial length of gap $l_g = 0.16$ cm.

Clearance $c = 0.015$ cm. (assumed).

Axial length of gap $b = 0.64$ cm.

Thickness of coil former $t = 0.015$ cm

Wire = 36 s.w.g. enamelled.

Diameter of copper = 0.0193 cm.

Diameter over insulation = 0.0218 cm.

Area of copper = 0.00029 sq. cm.

The radial thickness of the coil $[l_g - (2c + t)] = 0.16 - (0.03 + 0.015) = 0.115$ cm.

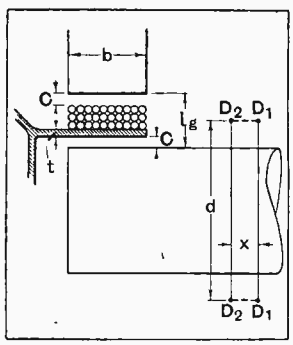


Fig. 1. Diagram showing section through magnet and moving coil; b is the axial length of the gap, and l_g the radial length of the gap. D_1 and D_2 represent consecutive positions of a single coil when used to measure the flux passing through the cylindrical surface whose diameter is d and length x.

The number of turns per layer is $\frac{0.64}{0.0218} = 29$, and the number of layers is $\frac{0.115}{0.0218} = 5$.

Thus the total number of turns is $5 \times 29 = 145$, and the total cross-sectional area of copper is $145 \times 0.00029 = 0.042$ sq. cm. The cross-sectional area of the gap is $0.64 \times 0.16 \doteqdot 0.1$ sq. cm., so that the space factor $f_s = \frac{0.042}{0.1} = 0.42$, which means that the copper only occupies 42 per cent. of the air gap.

The criterion $B_g^2V_gf_s = 9{,}000^2 \times 8 \times 0.16 \times 0.42 = 4.35 \times 10^7$.

If the gap length, the size of wire, and the thickness of the former are the same for all magnets, then l_gf_s is constant, and the criterion factor can be taken as $B_g^2A_g$.

It is of interest to indicate that if the area of the gap and the flux density are kept constant, the criterion increases with the length of the air gap. Thus if $B_g^2A_g$ is the same for two magnets, the one with the longer air gap is the better. This follows from the preceding calculation, since with the longer gap a larger size of wire can be used to wind the same number

of turns on the coil. The resistance of the wire is smaller and, therefore, the dead loss is less, which means an increase in output.

Statements of the flux density are without meaning, since, by reducing the diameter of the coil or the axial length of the gap, the flux density can be increased considerably, without a proportionate increase in $B_g^2V_g$. Also, since the field in the gap decreases rapidly near the edges (see Fig. 5 of November 25th), large motion of a short coil at low frequencies may be accompanied by distortion due to harmonics.

The importance of the space factor is realised on comparison of two magnets having equal values of $B_g^2V_g$. If $l_g=0.16$ for one and 0.08 cm. for the other, the space factors are of the order 0.42 and 0.28. The output with the 0.16 cm. gap is appreciably the greater of the two. Before purchasing a magnet the value $B_gV_g^2$ and the gap dimensions should be obtained. f_s can then be calculated and the best magnet secured.

The question of obtaining the curve showing the distribution of flux inside and outside the gap has been raised. (Fig. 5, November article.) This can be done either by a very narrow differential coil, as shown in the article in question, or by using a narrow single coil. If a single coil is drawn out from position D_1 of Fig. 1 coaxial with the pin it cuts all the flux, including internal leakage, external leakage, and gap flux. By drawing it out from D_2 and subtracting the two readings, the result is obviously the same as with a differential coil of width D_1 D_2. The mean flux density is the total difference in flux per turn of the coil, divided by the annular area πdx between the two positions.

By increasing the turns on the coil the flux can also be measured by moving the coil from position D_1 to D_2. It is easy to devise a mechanical system where D_1D_2 can have any value and any position along the pin. For mass production the mean value of the gap flux is required, and a differential coil of length b or a single coil moved a distance b, gives results rapidly, i.e., one throw. The single coil has an advantage, that since the resistance is limited to about 10 ohms, it can have twice the number of turns as a differential coil, thereby giving a greater throw on the meter.

N. W. McLACHLAN.

London. S.W.1.
March 28th.

WORKING JAPAN.

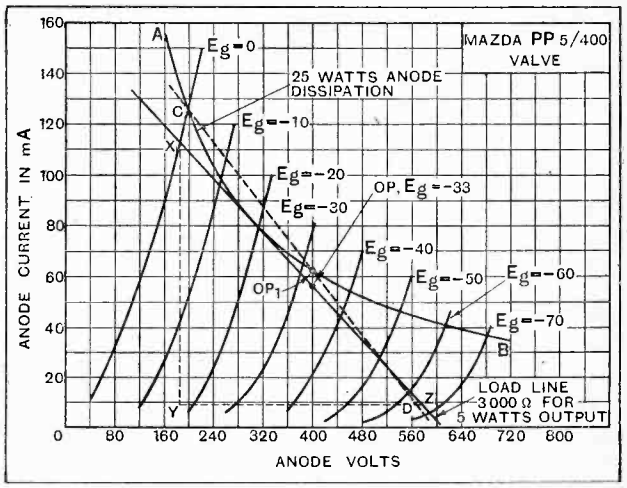
Sir,—I see in the "Transmitters Notes" of the April 22nd issue of *The Wireless World* that Mr. F. R. McNeil, G15NJ, was in radio communication with the Japanese Amateur Station J1EE, making first two-way amateur contact between Ireland and Japan, for which all amateurs will congratulate him. And also for previously working all continents on telephony. I would like to say that during the past month or so many Japanese stations have been worked by stations in this country. The stations are, to my knowledge, G5ML, G5BM, G5BJ, and maybe others, and I also had the honour to work Japanese station J5AR also. At least eight different Japanese amateurs have been heard and several worked, and, in conclusion, may I record what I think is most unusual. Whilst listening in on my short-wave receiver from 17.30 to 17.45 G.M.T., April 18th, 1931, that is, in a quarter of an hour, I heard amateur transmitting stations sending from U.S.A., South America, Japan, China, India, Ceylon, Asia, Europe, Iceland, Alaska, Canada, Sumatra and South Africa. I have never heard the whole world before in such a short space of time, and no doubt many amateurs may even supplement this list. No doubt your short-wave enthusiast readers would be glad to hear from other listeners or transmitters.

DR. JOHN R. WORTLEY TALBOT, G6WT.

Churston Ferrers, S. Devon.

THE MAZDA PP.5/400.

Sir,—In your review of the Mazda PP.5/400 valve in your issue dated April 22nd, reference is made to the anode dissipation line which, in the case of this valve, is 25 watts. There appears to be some misconception regarding the utilisation of the dissipation line in the determination of the optimum operating conditions of a power valve. In the case in question the load line has been drawn tangential to or touching the dissipation line, whilst actually the load line should be drawn such that its centre point is located at the intersection of the dissipation line and the anode voltage ordinate. Reference to the illustration will make this matter clear. In this curve the load line XZ, as published in your review of this valve, is shown by a full line tangential to the line AB. The curve of CD (dotted) shows the load line as it should be determined, in which the centre point OP_1 is drawn at the intersection of the dissipation line AB and the 400-volt ordinate.



In the case of the valve in question the feed current at 400 volts H.T., as determined by the dissipation line AB, should be 62.5 mA. The load line CD as drawn on the curve would therefore indicate that the grid bias with A.C. heating is −32 V. The optimum load is 2,950 ohms and the power output 5.5 watts, and self-bias resistance 512 ohms. Except in the case of the value of self-bias resistance, these figures are in accordance with the data which you have obtained, and in any event within the limits of variation due to difference between valves and observational error. However, in view of the fact that the load line is a comparatively recent innovation, and has been given considerable attention in your journal, it is necessary to obtain agreement as to its application.

The dissipation line is seen to be the maximum dissipation which the valve will handle under bias conditions when no signal is applied. When an A.C. signal is applied the dissipation at the anode will be reduced. In the case cited, when full input swing is applied, the total wattage input to the valve will increase by 5 per cent. (if the anode and grid-bias voltages are kept constant and the distortion is 5 per cent.), i.e., to 25.2 watts, whilst the actual dissipation at the anode will fall to 21.2 watts (that is, 26.2 minus 5 watts). On the other hand, if the valve is used for aperiodic amplification of slowly varying currents or for the operation of relays (which applications are continuously increasing), the bias point would have to be determined by drawing the load line tangential to the dissipation line.

E. YEOMAN ROBINSON.

Enfield, Middlesex.

GOOD REPRODUCTION—THE B.B.C.

Sir,—The writer of the article "Inexpensive Quality," in your issue of March 18th, makes several statements which, in my view, are open to grave doubt. I refer specifically to the following: (i) 250 to 500 milliwatts is just right for the living room of the modern small house; (ii) "the ear has conveniently reconstructed the 50-cycle fundamental from the harmonics"; (iii) the ear compensates for deficient upper frequency response of the loud speaker; (iv) "the ear permits us to choose a unit with a cut-off below 100 cycles and above 3,500 cycles, without seriously penalising the quality of the general result"; (v) resonance between 100 and 200 cycles and between 2,500 and 3,500 can be tolerated and often definitely improve the general effect.

If one assumes that these statements refer to loud speakers that are fundamentally poor, then, I suppose, there is a certain amount of truth in them. For example, I would say that 500 milliwatts is a great deal too much power, even for a large room, with the average moving-iron loud speaker, and if such a loud speaker normally had a cut-off at, say, 150 cycles, then

a hefty resonance round about 100 would certainly give an impression of good bass to an uncritical listener, but it would not be "great stuff." However, I cannot subscribe to statements (ii), (iii) and (iv), because *my* ear, at any rate, is not so accommodating. If the article be taken as a guide to getting the best from cheap equipment (and as such, I presume, it is intended), then it will perform a useful function, but there is every likelihood of the unthinking amateur accepting such statements as axioms in all cases with entirely unfortunate results. The statement that a moving-iron loud speaker will entirely satisfy a musical ear is, however, definitely incorrect. No loud speaker at present on the market has any hope of doing that.

Really good reproduction calls for the following, at least: (i) *An output of not less than* 2 *watts for an average small room. My own set delivers* 5 *watts and is used in a room* 18*ft.*×13*ft.* (ii) An *overall* response from the radio set substantially level between 32 and 9,000 cycles. (iii) A loud speaker which will reproduce this frequency range, *with at least* 2 *watts input,* without *any* resonances, dips or peaks. I know of only one receiver on the market which will give (ii), and I have not come across any commercial loud speaker which even approaches the requirements of (iii). It is astonishing how stagnant is the design of moving-coil loud speakers as compared with those of the moving-iron type. The latter show evidence of real research and progressive design, and in certain specimens are surprisingly good within their limitations, but the less said about the former the better. In the bad old days of broadcasting, it seemed to be the accepted thing for people without technical knowledge to make and sell intervalve transformers; nowadays it is the moving-coil speaker, and it is much more difficult to design a good moving-coil speaker than a good transformer. I have often been in the swagger showrooms of swagger manufacturers when they have been demonstrating their equally swagger radiograms and what not, and I have not yet heard anything that was other than nauseating to a musician who had no radio bias. I suppose these atrocities sell, as the public will applaud a poor rendering of Liszt's 2nd Hungarian Rhapsody in a fifth-rate suburban cinema, and while I will concede that the originators of the noise are, in each case, doing their best, I would point out that it is not music.

No article has yet been published showing how a loud speaker of the moving-coil type *should* be made, so I can only conclude that, in the absence of private research, the good moving-coil loud speaker does not normally exist. It is not a little amusing to come across people who boast of their marvellous reception, and who have never been to a symphony concert in their lives, so I suppose it is not unreasonable to presume that some of these efforts advertised as "recreating the living artist" have been designed and approved by people in like circumstances.

The B.B.C. Transmissions.

This naturally brings me to the subject of the B.B.C., to which concern the music-loving public owes real gratitude for the splendid quality of their transmissions as well as of their programmes. A month ago I listened to their broadcast of "The Ninth" at home, and I have listened to the same work at the Queen's Hall. I am convinced that I lost nothing in the broadcast, although I certainly gained sundry squeaks from the National transmitter's nearest neighbour, but that is not the fault of the B.B.C. I am in no way associated with the B.B.C. nor with any company manufacturing broadcast receivers, and I do think that the B.B.C. is criticised most unfairly. That the whole Press, technical and otherwise, is the sworn foe of the B.B.C. is inevitable, but such effusions as that of Mr. C. W. Oliver's in your issue of March 4th can arouse only the ignorant and illogical of your readers, and are to be deplored. Mr. Oliver's letter displays a denial of obvious facts and good intentions on the part of the B.B.C. which is truly amazing, and no reasoned reply to his statements would have any success in changing his views. The B.B.C. does give the public what it wants, but tries also to give something a little better than it expected to get. The splendid musical revival during the past five years has been brought about by the B.B.C. and the B.B.C. alone. Through it the Promenade Concerts have been saved from extinction, the country has at last got an orchestra which will bear comparison with any in the world, the public has been given an international outlook on world affairs at a time when this has been needed more than anything else, and even elementary education for children has been revolutionised. Let it not be thought that I am a whole-hearted admirer of the B.B.C. I bitterly resent the vocalists insinuated into nearly every orchestral concert, and I thoroughly dislike the music played by the Wireless Military Band and the B.B.C. Dance Orchestra. Walton O'Donnell and Jack Payne should be put to sleep gently and unobtrusively, the former for not realising that symphonic music is not suited to a military band, and the latter for his atrocious "concert arrangements" of dance numbers. These grouses, however, do not entitle me to say that the B.B.C. does not do its job properly. I should imagine that large numbers of people adore Jack Payne, which, no doubt, is gratifying to him but not satisfying to me. The fact remains that each section of the public gets what it wants, and I do not see how the B.B.C. can be accused of adopting an attitude which "tends to make them self-complacent individually as the organisation has become as a whole." The correspondence on the testing of the Northern Regional station is eloquent testimony to the narrow-mindedness of a few "smart Alecs" in the North. Those people who are grumbling about the slowness with which this station is coming on the air would do well to buy the B.B.C. Year Book for 1931, and read the chapter starting on page 387. They cannot realise that the great bulk of the listening public knows nothing of the technical side of radio, and does not wish to know. Those are the people whom the B.B.C. has to look after.

I will conclude on a kindlier note. As Dr. McLachlan has not communicated, publicly, any conclusion he may have arrived at concerning "the optimum size of wire with regard to a balance between quality and volume," it may interest Mr. Holt, of Sheffield, to know that the size of wire in a coil has nothing to do with quality, volume, weight, or flexibility. The impedance of the coil must be matched with the impedance of the output value for maximum efficiency by means of a correctly designed output transformer. Nothing else matters half so much as that.

H. A. HARTLEY.

Isleworth, Middlesex.

[We think it proper to point out that the statement (iii) does not appear in the article referred to by Mr. Hartley. The author does not claim that the ear can compensate for deficient high-note response in a moving-iron loud speaker, but that, in recognising the instruments of the orchestra in the absence of harmonics in the upper register, "the ear ignores the wave form and of the steady note, and uses the transient at the commencement of each note as a means of identification."—ED.]

NORTHERN WIRELESS ORCHESTRA.

Sir,—Mr. Joss, the secretary of the Wireless League, quotes rather an unfortunate activity of the League when he says, in his letter to your columns in the April 15th issue, that "a petition against the proposal to disband the Northern Wireless Orchestra" had resulted in the orchestra still continuing in existence.

It isn't! In spite of strong protests from the influential Northern Press, it has gone and is being replaced only by a skeleton.

LOUIS J. WOOD.

POST OFFICE STATION INTERFERES.

Sir,—Pleasure derived from broadcasting programmes in this district is being badly interfered with by the enforced reception of Morse signals.

That their origin is local is obvious by the presence of the signals over the whole tuning range of the receiver, and one is rather suspicious of the G.P.O. Experimental Station at Dollis Hill.

Surely some legislation is necessary (if the present regulations are not adequate) by which this kind of annoying interference can be eliminated, for, after all, however small the initial cost of a concert works out to the listener, it is dearly paid for if the vocalist or the string quartette is augmented with the monotonous accompaniment of dots and dashes.

N.W.2. LISTENER.

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.

Single-valve Loud Speaker Set for D.C.

I can see no reason why one of the new indirectly heated pentodes for operation on D.C. mains should not be used as a combined detector and output valve in the same way as the A.C. version of the same valve. If you agree that a single-valve loud speaker set on the lines of the "Regional One" set, but with a D.C. valve, would be practicable, will you please give me a circuit diagram showing how cathode-heater interconnections should be made; also where to insert a voltage-absorbing resistance for the heater circuit, and from what point H.T. feed current should be picked up?

As you say, a receiver of this type should be satisfactory, but of course it would only be suitable for short range work.

In Fig. 1 the various points you raise with regard to connections are cleared up.

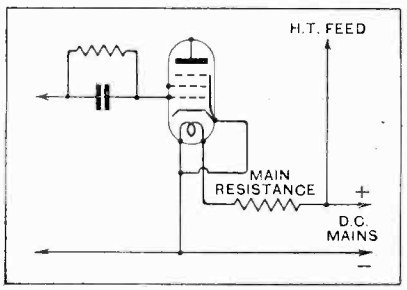


Fig. 1.—Cathode connections of a D.C. pentode acting as a combined detector and output valve.

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"Pre-Selection" Set for Battery Feed.

Do you consider that the basic circuit arrangement of the "Pre-Selection A.C. Three" described in your issues of February 25th and March 4th would be suitable for a battery-fed set?

This receiver could be adapted for battery feed, but several modifications would be necessary. In the interests of economy it would be advisable to abandon power grid detection, and, to compensate for the lower magnification afforded by battery valves, to use an L.F. transformer in place of a choke.

Removing Aerial Loading.

As suggested by the manufacturers of my receiver, I have inserted a small fixed condenser in the aerial circuit in order to improve selectivity. This has the desired effect on wavelengths over about 350 metres, but, below that, reaction becomes uncontrollable, and the set is in a state of continuous oscillation when the H.F. and coupling circuits are in tune. Can you tell me why this should be, and also suggest a cure?

This seems to be a fairly clear case of uncontrollable self-oscillation, brought about by reduction of aerial loading, and we do not think that your reaction system is directly concerned. It would appear that the set is normally stabilised at the lower end of the tuning scale, at any rate, by aerial loading.

More complete screening, and possibly decoupling, would almost certainly effect a cure, but a palliative may be found in the use of a reduced voltage for the H.F. valve screening grid.

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Bias Resistance Calculations.

In "Readers' Problems" you recently gave a formula $\left(R=\frac{E}{I}\right)$ *for calculating the correct value of resistance to use in an automatic grid-bias circuit. I am not quite clear as to how the value of I should be ascertained; will you please give me a word or two of explanation?*

As stated in the published reply to which you refer, I represents the total current (expressed as amperes, or, in practice, as a fraction of an ampere) to be passed through the bias resistance under operating conditions. If bias voltage is obtained by passing merely the anode current of the valve concerned through the resistance, the value of I can generally be taken as the anode current consumed by the particular valve concerned under normal operating conditions, as stated in the manufacturers' pamphlets, or as given in *The Wireless World* Valve Data Sheet.

It is quite usual to insert the bias resistance in such a position that the anode current for two or more valves passes through it; in this case, the right procedure is to add together the various anode currents, the necessary information being obtained from either of the sources mentioned above. In making this estimation, any current consumed by an H.T. regulating potentiometer (as used for feeding the screening grid) must be taken into account if matters are so arranged that the potentiometer current passes through the bias resistance.

o o o o

The "Everyman Two."

Will you please show me how to connect a gramophone pick-up to the "Everyman Two" receiver, described in your issue of February 25th?

If possible, I should like to arrange matters so that sockets may be fitted at the rear of the receiver to take a pair of plugs joined by a flexible lead to the pick-up itself. The use of a switch is to be avoided, unless absolutely necessary.

The simple form of connection shown in Fig. 2 will be found quite satisfactory, and complies with your requirements. In this diagram, extra wiring is indicated

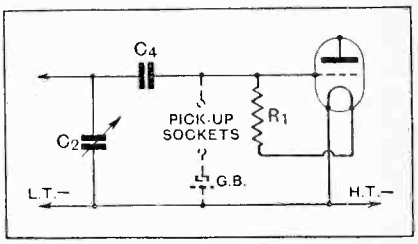

Fig. 2.—Method of adding a gramophone pick-up to the "Everyman Two" receiver.

in dotted lines, while reference lettering corresponds with that given in the original circuit diagram.

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Loud Speaker Units.

An Ediswan loud speaker unit of the type specified for the dual loud speaker described in your issue of June 18th, 1930, is no longer available; can you suggest an alternative?

The Amplion B.A.2 instrument has characteristics somewhat similar to the unit in question, and could be used in place of it in the construction of this particular dual loud speaker.

A Matter of Terminology.

In a published reply to a reader's question in your issue of April 15th, under the heading of "Filter Adjustments," it is stated that coupling is increased in a capacity-coupled filter when a larger mutual condenser is used. This does not seem to agree with the recommendation made elsewhere that when adjusting a set with a similar type of filter the variable coupling condenser should be set at minimum in order temporarily to reduce interaction between the circuits.

Will you please explain this apparent discrepancy?

We think that you are confusing the type of filter in which coupling is effected by a mutual condenser of large capacity (see Fig. 3 (a)) with the alternative arrangement, in which an extremely small condenser is connected between the high-potential ends of the two tuned circuits.

The second arrangement is sometimes referred to as capacity coupling, but possible ambiguity and uncertainty might be avoided if it were described as electrostatic coupling. This arrangement is shown in Fig. 3 (b). It differs from the ordinary capacity-coupled band-pass filter in that coupling is increased when the capacity of the condenser shown as c.c. is increased.

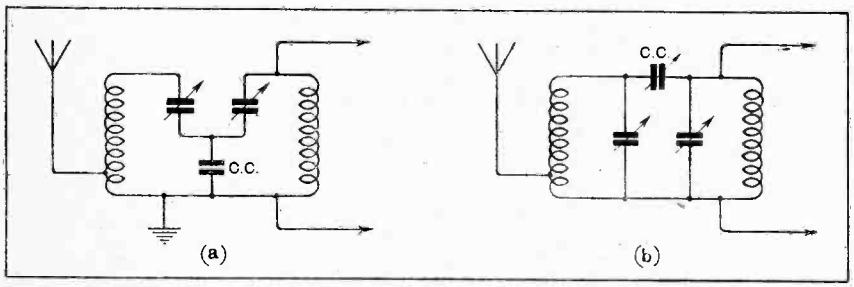

Fig. 3.—Alternative filter circuits: although a coupling condenser (CC) is employed in each case, operating procedure differs considerably.

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Background Noises.

I believe that it is generally to be assumed that an exceptionally noisy background, if not due to a fault in the receiver itself, will disappear when the aerial is disconnected. My own set suffers from this trouble, but, on making a test, I find that if all circuits are carefully retuned after removal of the aerial, a certain amount of noise is still audible. Do you think that this may be taken as implying that the noise originates in the set, and is not due to interference from neighbouring power circuits, etc.?

The sensitivity of a modern long-range set is so great that a considerable amount of interference can be picked up with the help of its exposed wiring, or, if it happens to be completely screened by, say, a connection between the set and the aerial lead-in terminal. Provided that a really considerable reduction in noise is noticed on removing the aerial, one can generally assume that the receiver is not to blame.

Lightning Arresters.

I have noticed on several occasions that during an electrical storm sparks often pass between the safety gap of my lightning arrester. My next-door neighbour, who has an apparently similar aerial, a receiver very much like my own, and the same type of lightning arrester, has never observed this effect. Do you think that it indicates that my own aerial is a better collector of energy, and that the generally superior performance of my set can be ascribed to this cause?

It is almost certain that the sparking is due to the presence of a condenser, probably of fairly high capacity, in series with your aerial circuit. During an electrical storm this condenser may be charged to a high potential, and will discharge itself across the safety gap. We assume that the aerial circuit of your neighbour's set includes no such condenser, there being complete metallic continuity from aerial to earth, or if a condenser be included, it will be of small capacity.

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Increasing Eliminator Output.

Do you think that it would be safe to increase the output of my eliminator, which is at present rated at 180 volts 30 milliamps, to 250 volts at 50 milliamps?

It is proposed to obtain this increase by fitting a new power transformer and rectifier.

We can hardly recommend you to do this. Assuming that your eliminator is a commercial product, it should be realised that even the most conscientious manufacturer cannot economically use smoothing condensers, etc., with a factor of safety greatly in excess of that normally allowed; further, the inductance of the smoothing choke (or chokes) may drop to an excessively low value when extra current is passed.

° ° ° °

Modifying a Commercial Set.

My Ekco Model 313 set, as described in your issue of January 7th, is fitted with a tapped output choke, and is intended for use with a high-resistance loud speaker. I should like to modify it so that it may be operated with a low-resistance moving-coil loud speaker, and should appreciate a word of advice as to the right procedure.

Your best course is to fit a step-down transformer, designed specially to act as a coupling between the loud speaker actually to be used and the particular type of pentode valve embodied in the receiver. Unless the transformer is to be "parallel-fed" through the existing output choke, it will be essential to remove the receiver chassis from its cabinet; this should not present any difficulty. The output choke may be identified from the published description of the set to which you refer; this component must be disconnected, but, if the alteration is to be temporary, it need not be removed, provided the new transformer is mounted externally.

° ° ° °

Parasitic Oscillations.

I have recently obtained a low-reading milliammeter for insertion in the detector anode circuit of my 1-v-1 set; I cannot understand why the reading of this instrument should fall appreciably—actually by about 20 per cent.—on switching over to the long waves. Waveband switching is arranged in the usual way by short-circuiting the long-wave sections of the coils, and I cannot see that any circuit alteration is introduced that could account for this change of current. Can you suggest anything to which it may be due?

I should perhaps add that the set functions fairly satisfactorily as a long-wave receiver, but its performance is certainly not so good as on the medium band.

We suspect that the detector valve is oscillating at some frequency differing considerably from that at which its grid circuit is intentionally tuned. Oscillations of this character are highly undesirable, and we recommend that you should try experimental alterations of grid and plate circuit constants.

If you care to send us a circuit diagram we may be able to make some more definite suggestion.

FOREIGN BROADCAST GUIDE.

BORDEAUX-LAFAYETTE

(France).

Geographical position: 44° 50′ N., 0° 34′ W.
Approximate air line from London: 462 miles.

Wavelength: 304.3 m. Frequency: 986 kc. Power: 35 kW.

Time*: Greenwich Mean Time.

Standard Daily Transmissions.

12.00, 14.00, 16.30 G.M.T., relay of Ecole Supérieure, PTT, Paris, outside broadcasts (Sun.); 20.30, main evening entertainment.

Man announcer. Call: *Allo! Allo! Ici la station du reseau Français de radiodiffusion des Postes et Télégraphes de Bordeaux-Lafayette;* between items abbreviated to: *Ici Bordeaux-Lafayette PTT* (phon.: *Pay Tay Tay*).

Closes down with usual French formula, followed by *La Marseillaise* or a local patriotic song.

(**France adopts British Summer Time.*)

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Broadcasting on Other Wavelengths.

WE are so accustomed to the idea that wavelengths of the order of, say, 250 metres to 550 metres are the most suitable for general broadcasting purposes, with the inclusion of a few long waves around 1,500 metres, that any suggestion of employing other wavelengths comes as rather a surprise.

Short-wave transmitters have, of course, come into general use for covering very great distances, and suitable, therefore, for employment for such purposes as Empire Broadcasting, but little attention seems to have been paid to the possibilities of still shorter wavelengths for broadcast transmissions over limited ranges.

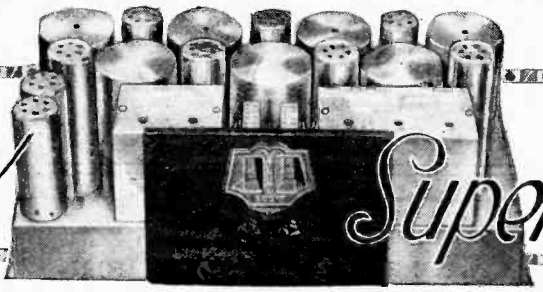
A demonstration carried out last month before a large audience in Berlin, and conducted by the Telefunken Company in conjunction with the German Post Office, has, therefore, caused a stir in broadcasting circles and developments are being watched with close attention by broadcasting authorities in Europe which are faced with similar problems to those in Germany, where it is desired to provide an efficient service of broadcasting in large cities without the objection that the high power used, if normal broadcasting wavelengths were employed, would result in the transmission extending over a very large area and producing mutual interference between transmitters in different parts of the country. Readers will remember a recent article in which we described a suggestion put forward by a German engineer, Manfred von Ardenne, wherein he proposed that a short wavelength should be employed for redistributing broadcast programmes over densely populated areas; the German Post Office, in conjunction with the Telefunken Company, appears to have been working along somewhat the same lines, and the successful demonstration of broadcast reception which they gave employed a wavelength of 7.05 metres, the experimental transmitter being located in Berlin and the reception carried out at Charlottenburg, just outside the German capital.

For some time past experimental transmissions on wavelengths between 6.75 and 7.05 metres have been conducted in Berlin, and reception by amateurs throughout the city is reported to have been entirely satisfactory. It is claimed that the apparatus for reception can be extremely simple and that the signal strength up to about 30 kilometres is adequate for all ordinary purposes, so that with the transmitter centrally situated a whole city can easily be served. What has hitherto been regarded as a definite disadvantage in the employment of wavelengths of this order for broadcasting, namely, the fact that the radius that they will cover is only within the distance of optical vision, is proving to be a point of very definite merit where broadcasting over cities is concerned, because quite a number of separate programmes could be sent out in this way in any city without any risk that the waves would carry on and interfere with other transmissions farther afield.

We hope to be able to publish shortly a more complete account of these experimental results.

In This Issue

THE Selectivity OF THE Superheterodyne



Part I.—The Causes and Prevention of Interference.

By W. T. COCKING.

THE interference to which the ordinary set is subject is known as "adjacent channel" interference, since it is due to stations working with only a small frequency separation from that of the desired station. It is in the elimination of this type of interference that the superheterodyne is so satisfactory, for reasons which will be discussed later. This is usually the only type of interference which has to be considered in designing an ordinary set, but this is not the case with the supersonic receiver. There are at least four other types of interference which can be troublesome and which are not found at all with straight H.F. circuits, while other sources of trouble may assume much greater proportions with the superheterodyne. In a carefully designed receiver most of the sources of interference can be reduced to negligible proportions, and those which remain can often be eliminated by the proper operation of the set. So little has been written on the subject, however, and the troubles may reach such alarming proportions, if due consideration is not given to them in the receiver design, that it is thought that a complete survey of the problem will be of interest and help to those who are experimenting with this method of reception.

THE special advantages of the superheterodyne have long been recognised. It gained its reputation in the days when effective high-frequency amplification was almost impossible upon the broadcast band, although such amplification could be obtained quite easily upon a wavelength of 6,000 metres or so. With the advent of the neutrodyne circuit and screen-grid valves, H.F. amplification became really effective, and so the supersonic receiver became unfashionable. Extremely high selectivity is an essential, and the ordinary tuned H.F. set cannot easily be made to give the necessary freedom from interference due to strong local stations. It is not too much to say that, since the revival of the superheterodyne by this journal in October last, it is likely to continue in favour until such time as a means is devised of giving the tuned H.F. set the same high selectivity.

Adjacent Channel Selectivity.

The adjacent channel selectivity is almost wholly determined by the overall response curve of the intermediate frequency amplifier, since the tuned circuits at the fundamental frequency have comparatively little effect. The intermediate frequency is the same whatever the frequency of the signal being received, and so we find that the selectivity and amplification are practically constant over the whole tuning range of the receiver. This is quite different from the ordinary set, where both selectivity and amplification vary considerably with the tuning.

The high selectivity which is obtainable is due to two things; the low frequency to which the circuits are tuned, and the highly efficient circuits which are easily obtainable at this low frequency. If we judge the selectivity of various circuits by the percentage difference of the interfering frequency, we find that whatever the frequency to which they are tuned the selectivity is approximately constant, other factors, of course, being similar. This is not a practical way of judging selectivity, however, for the reason that stations are not spaced upon a percentage basis, but upon the basis of a constant frequency difference. Suppose, for instance, that we wish to receive a station with a frequency of 1,000 kc. (300 metres) and there is an interfering station upon a frequency of 1,010 kc.; that is, 10 kc. difference. Then the tuning circuit must cut out a signal which is only 1 per cent. off tune, and this is quite difficult.

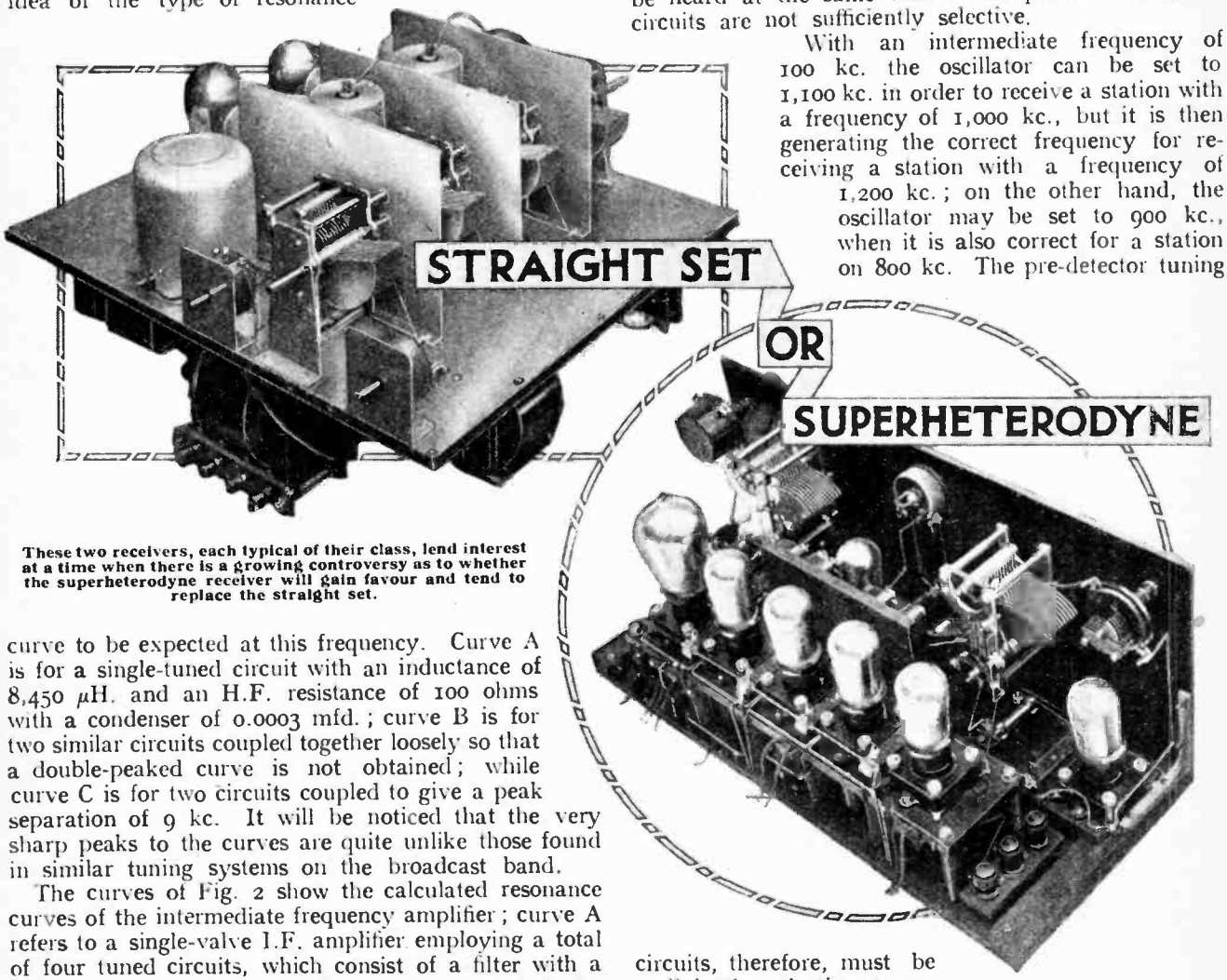
Now, if we use a superheterodyne with an intermediate frequency amplifier tuned to 100 kc., the interference will still be separated by 10 kc., and will appear with a frequency of 110 kc. This, however, is now 10 per cent. off tune, and it is correspondingly more easy to eliminate it. This is really the whole secret of the selectivity of the superheterodyne, and it can be seen that the lower the intermediate frequency the greater the adjacent channel selectivity. Extremely high selectivity, therefore, can be obtained by proceeding to extremes; an intermediate frequency of 20 kc. is about the limit, and with this frequency the interfering signal will be 50 per cent. off tune, and it will be as easy to separate the two stations as it is at present to separate with an ordinary set two stations with frequencies of 1,500 kc. and 1,000 kc. (200 and 300 metres).

This is not a complete statement of the facts, however, for it is usually necessary to receive a band of frequencies extending for 5 kc. on either side of the resonance frequency in order to obtain the best quality. In the case of a 20-kc. amplifier this means that the resonance curve must be flat over a band between 15 kc. and 25 kc.,

Selectivity of the Superheterodyne.—

which is equivalent to plus and minus 25 per cent. of the carrier frequency. A band-pass filter which will do this is not particularly simple, but, of course, it could be constructed. Such a low frequency, however, is undesirable for many reasons, and in practice it becomes necessary to use as high an intermediate frequency as possible. This will be discussed in more detail later in this article, and it is sufficient to say here that a frequency of about 100 kc., or a wavelength of 3,000 metres, is the most generally satisfactory for use in this country.

Suitable band-pass filters can easily be constructed for an intermediate frequency of this order, and very high selectivity and amplification are readily obtainable with first-class quality. The curves of Fig. 1 give an idea of the type of resonance



These two receivers, each typical of their class, lend interest at a time when there is a growing controversy as to whether the superheterodyne receiver will gain favour and tend to replace the straight set.

curve to be expected at this frequency. Curve A is for a single-tuned circuit with an inductance of 8,450 μH. and an H.F. resistance of 100 ohms with a condenser of 0.0003 mfd.; curve B is for two similar circuits coupled together loosely so that a double-peaked curve is not obtained; while curve C is for two circuits coupled to give a peak separation of 9 kc. It will be noticed that the very sharp peaks to the curves are quite unlike those found in similar tuning systems on the broadcast band.

The curves of Fig. 2 show the calculated resonance curves of the intermediate frequency amplifier; curve A refers to a single-valve I.F. amplifier employing a total of four tuned circuits, which consist of a filter with a peak separation of 9 kc. and a loosely coupled single-peaked filter. Curve B is for a two-valve I.F. amplifier with a total of six tuned circuits, comprising two filters with a 9-kc. peak separation and one loosely coupled circuit. This last curve is extraordinarily good, both from the points of view of quality and of selectivity. The high-note loss is by no means excessive, while the straight, steeply sloping sides give a very high order of adjacent channel selectivity. Such an amplifier is quite practical, and can be obtained merely by the assembly of suitable components which involve little in the way of adjustment in the setting up of the amplifier.

Second Channel Interference.

In view of such high selectivity it would appear that interference problems would be negligible; this is not the case, however, for the frequency changer and the tuned circuits which precede the first detector can be very prolific sources of trouble. It is well known that there are two settings of the oscillator dial at which any station can be received, but it is not so generally realised that at any oscillator setting two stations will be heard at the same time if the pre-detector tuned circuits are not sufficiently selective.

With an intermediate frequency of 100 kc. the oscillator can be set to 1,100 kc. in order to receive a station with a frequency of 1,000 kc., but it is then generating the correct frequency for receiving a station with a frequency of 1,200 kc.; on the other hand, the oscillator may be set to 900 kc., when it is also correct for a station on 800 kc. The pre-detector tuning circuits, therefore, must be sufficiently selective to reduce to a negligible amount a station working with a frequency different from that of the desired station by twice the intermediate frequency; that is, in this case, 200 kc. A single-tuned circuit will usually provide sufficient selectivity for this purpose where the signals are all fairly weak, but it is quite insufficient

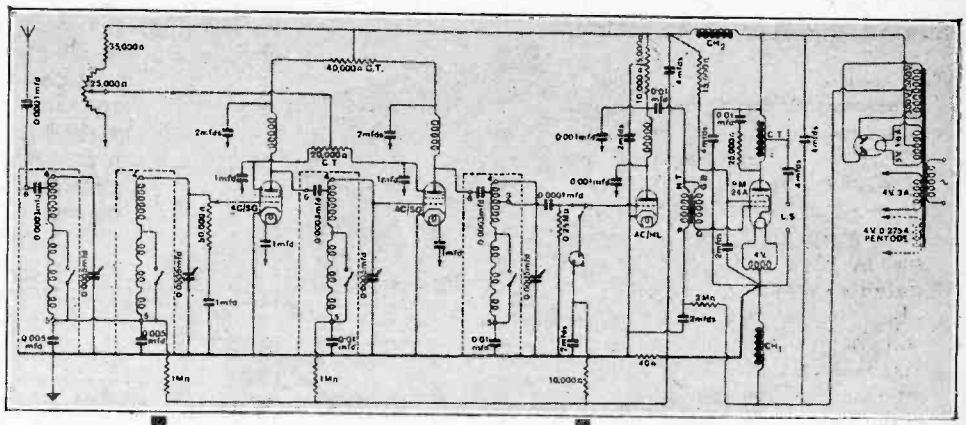
Selectivity of the Superheterodyne.—close to a powerful transmitter such as Brookmans Park. In such circumstances quite high selectivity is needed if interference is to be avoided, and the majority of the latest American superheterodynes employ three tuned circuits before the first detector, while some use as many as four.

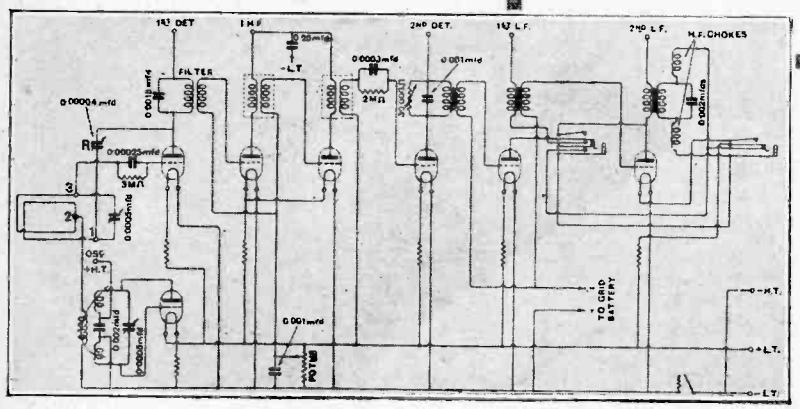
It is, of course, very desirable to cut down these circuits to a minimum, for they introduce all the ganging and wave-changing troubles of the ordinary tuned H.F. set, and so it becomes necessary to compromise somewhat. At the present time two tuned circuits preceding the first detector appears to afford a satisfactory solution; second-channel interference is not eliminated close to a powerful station, but it is quite absent on other stations.

Now, it will be seen that, since there are two oscillator settings for each station, it is possible to change from one to the other when second-channel interference is experienced, and complete freedom is then obtained. This, of course, is only possible when the oscillator tuning condenser is not ganged to the pre-detector circuits, and it would fail should there be two powerful stations spaced 400 kc. apart, or four times the intermediate frequency.

A heterodyne whistle is usually heard with second-channel interference, and its pitch varies with the setting of the oscillator condenser. Such a whistle alone, however, is no absolute proof of second-channel interference, for it can occur for several others reasons, which will be explained later. Whether this type of interference is experienced or not depends entirely upon the selectivity preceding the first detector, and so any means by which this can be increased will improve reception. It is well known that the resonance curve of a tuned circuit steadily falls as we go farther and farther from resonance, and so we find that the higher the intermediate frequency the greater the freedom from second-channel interference. It is for this reason, therefore, that a high intermediate frequency is recommended.

With a low intermediate frequency of some 20 kc. or so, the adjacent channel selectivity is very high indeed, but second-channel interference is very prominent unless a prohibitively large number of tuned circuits be used to precede the first detector. The intermediate frequency cannot usually be as high as the lowest frequency which it is desired to receive, and this limits us to the range between 20 kc. and 150 kc. in this country. It is not advisable, however, to use an intermediate frequency too near to the incoming frequency, and so we select 100 kc. as approximately the best frequency. From the point of view of second-channel interference it would be better to use a still higher frequency, and this is done in America, where a frequency of 175 kc. is now almost standard. Such a frequency, however, is in the middle of the long waveband, and so reception of these stations is impossible.





Circuits of the receivers illustrated on the previous page. These serve to compare the general principles and the number of amplifying stages involved.

Beat Interference.

There is a modification of second-channel interference which can be very troublesome close to a powerful station, and which is even more difficult to eliminate than second-channel interference proper. Suppose that we desire to receive a station which is transmitting with a frequency 100 kc. different from that of the local station. If the pre-detector tuned circuits are not sufficiently selective to prevent the local station from setting up a voltage on the grid of the first detector the desired station will be heterodyned by the local station and the beat frequency will be 100 kc., and so the combined signal will pass through the intermediate frequency amplifier and both

Selectivity of the Superheterodyne.—

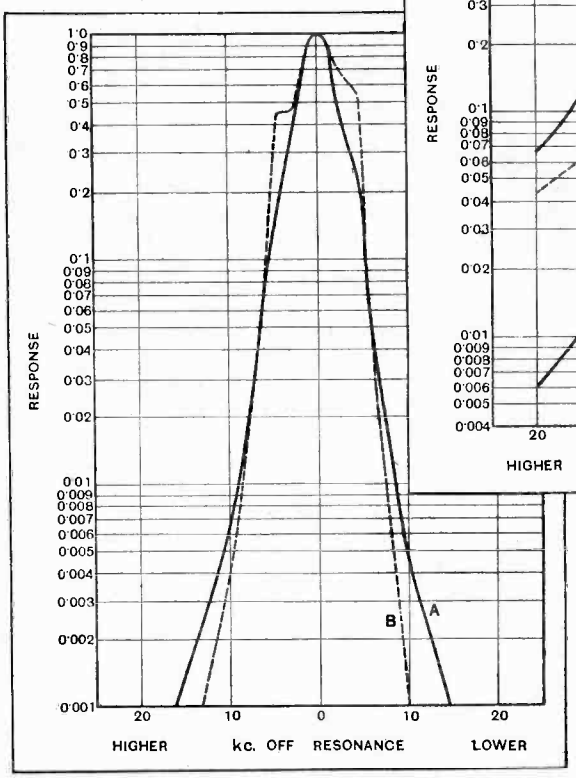
stations will be heard together. This will occur even in the absence of the local oscillator, for the local station will really act as the oscillator for frequency changing.

If, as will normally be the case, the oscillator be switched on and tuned to its correct frequency, then both stations will still be audible, but accompanied by a heterodyne whistle the pitch of which varies with the oscillator condenser setting. It is impossible to cure this trouble by dodging from one oscillator setting to the other, as with second-channel interference, and there is no way of getting over beat interference except by increasing the pre-detector selectivity. It is not usually economical to increase this sufficiently to eliminate the trouble when the set is to be used close to a strong station, and so it is necessary to get used to the fact that for every local station there will be two stations which it is impossible to receive. These stations will be spaced by 100 kc., or the value of the intermediate frequency, on either side of the local. Thus when a superheterodyne is used close to Brookmans Park beat interference will be found on the following frequencies: 1,248 kc., 1,048 kc., 942 kc., and 742 kc. Interference, therefore, will be experienced upon Stavanger, Lyons and Montpellier, Dresden and Sofia, and Sottens. Only the last of these stations is usually received well in London, and so their loss is not very important. If care is not taken in the choice of the intermediate frequency, however, a number of important stations may be blotted out; this is particularly the case if beat interference occurs with two powerful stations.

At the present time the London Regional and Midland Regional work with frequencies of 842 kc. and 752 kc. respectively; the difference is 90 kc., and so, with an intermediate frequency of this value, interference might easily be experienced over a large portion of the waveband. These two stations are very strong in London, and it has been found that even with a 100-kc. I.F. amplifier there is considerable interference on neighbouring frequencies. It is advisable, therefore, to choose a slightly higher intermediate frequency, and the trouble does not occur when a frequency of 110 kc. is used.

With this frequency beat interference will be experienced on 1,258 kc., 1,038 kc., 952 kc., and 732 kc., which correspond to Nürnberg, British Relays, Marseilles, and Katowice. Again, only one of these stations is of much importance, and so we can definitely choose a frequency of 110 kc. for the intermediate frequency amplifier. In London, any frequency between 75 kc. and 105 kc. is useless owing to beat interference between the London and Midland Regional stations, but this is quite absent with 110 kc.

Fig. 1.—Resonance curves (right) at 100kc. Curve A refers to a single tuned circuit, and curve B to two similar circuits coupled together so that a double-peaked curve is just not obtained. Curve C is for two circuits coupled to give a 9 kc. peak separation.



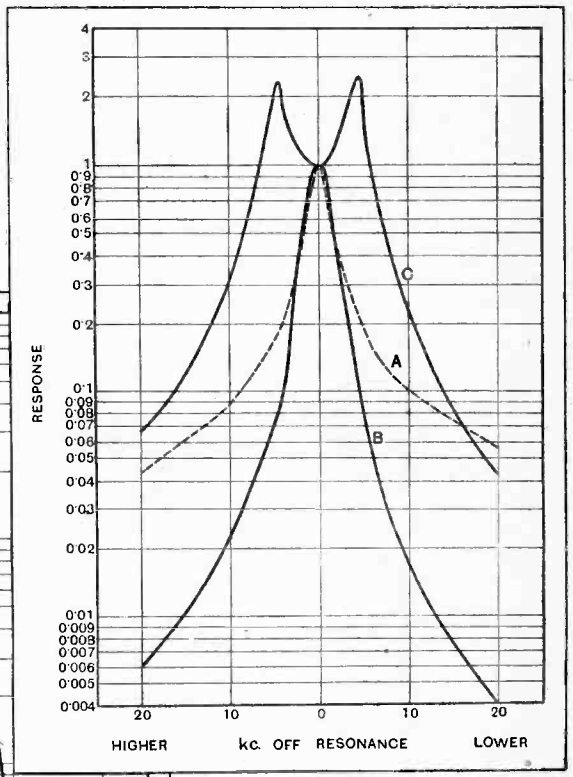


Fig. 2.—The overall curves (left) of an intermediate amplifier. Curve A is for a single-valve amplifier with two filters, one loosely coupled and one with a 9 kc. peak separation. Curve B is for a two-valve amplifier with three filters, of which one is loosely coupled and two have a 9 kc. peak separation.

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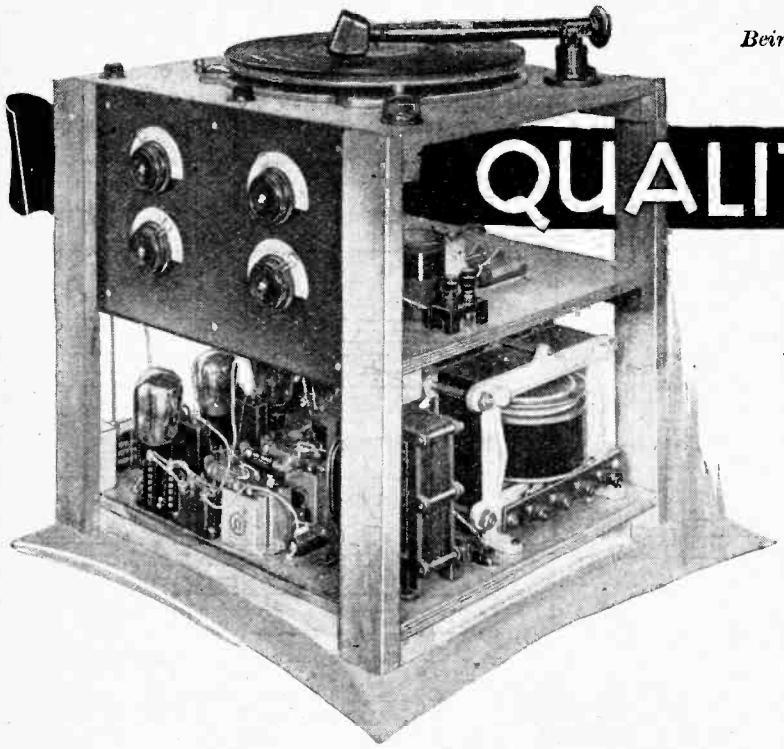
WORLD-TIME INDICATOR.

IN our issue of May 8th, 1929, we described and illustrated an ingenious device patented by Messrs. J. H. Willis and Co., consisting of a card with radial lines indicating degrees of longitude, and with the principal countries and cities of the world printed in their respective longitudinal positions around the centre in which is a rotatable dial marked with the 24 hours of day and night. Thus, by setting the actual local time on the dial opposite Great Britain, the corresponding times in various parts of the world can be seen at a glance, and vice versa. Messrs. Frank Pitchford and Co., Ltd., of Well House, Well Street, London, E.C.1, who are now producing this indicator, have sent us samples of the latest patterns. The square type is similar to that illustrated by us in May, 1929, and a convenient circular type is also available.



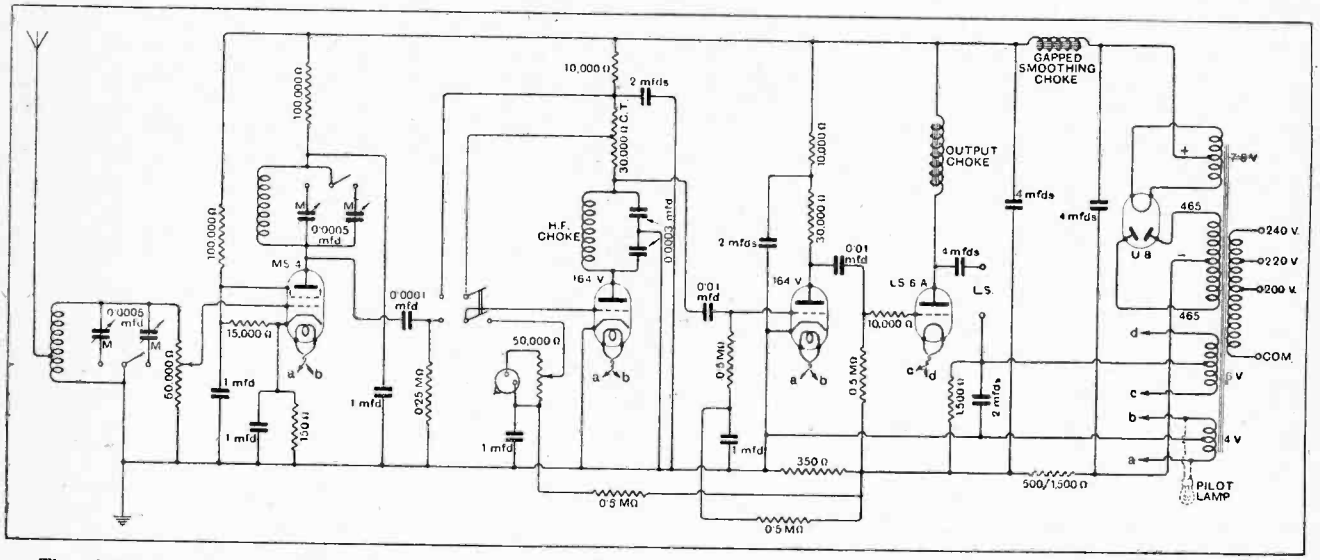
Being an addition to the Quality Amplifier.

QUALITY UNIT

All A.C. Radio-gramophone for the Moving-coil Loud Speaker.

By F. H. HAYNES.

A SET designed for long-range reception will always be inferior, as to quality of reproduction, to one arranged to receive only a local station. This statement may call for qualification, but it is true if only for the reason of the chaotic state of the European ether. The better the range-getting properties of the set, the more the heterodyning and overlapping between stations. A long-range set with its effective H.F. amplifier is, moreover, an almost certain cause of distortion. Triodes as H.F. amplifiers probably suffer least in this respect, but are now little used. Neutralising the triode to give freedom from oscillation is rarely satisfactory over the entire tuning range, and the selectivity is invariably so great that high-note loss results. Single-dial control is not permissible with the neutralised triode, while several separate dials would need to be very carefully set. The screen-grid valve has possibly worse failings. Its characteristic is such that opposite half-cycles of a modulated wave are differently amplified, and, in addition, rectification is taking place, releasing the audio signal to modulate other carriers while increasing the danger of trouble from mains hum when the set is to be operated from A.C. supply. Reaction, too, plays an important part in accounting for the satisfactory amplification given by the S.G. valve, and to augment the H.F. oscillation by reaction results in a change being brought about in the amount of modulation.



The circuit represents an H.F. stage of but moderate gain, as no provision is made for reaction, followed by a power grid detector and a resistance-coupled stage feeding the output valve. A change in the value of the anode coupling resistance of the detector is made when switching over from radio to gramophone. The two volume controls may be gang-operated on a common spindle. A resistance has been introduced into the grid circuit of the output valve to eliminate parasitic H.F. oscillation.

Quality Unit.—

These troubles are minimised by using a fairly flatly tuned H.F. stage giving but modest gain. No intentional reaction is provided, and the reacting effect in the single stage due to the anode-to-grid capacity of the S.G. valve is small compared with that acting in a two-stage H.F. amplifier. The coils in the tuned circuits may be poor, not with the object of producing adequately flat tuning, but to avoid the distortion which results when a tuned circuit of high dynamic resistance is included in the anode circuit of an S.G. valve and also the tendency to oscillate when such circuits are connected to the grid and anode. It is always best to use a poor tuned circuit, so that an S.G. valve may be used with its normal grid bias and maximum screen volts, rather than to use a good tuned circuit, cutting down the screen voltage to give stability, a hint which applies even more particularly to two H.F. stage amplifiers where the poor coils give more uniform amplification across the tuning range, and, incidentally, greater selectivity.

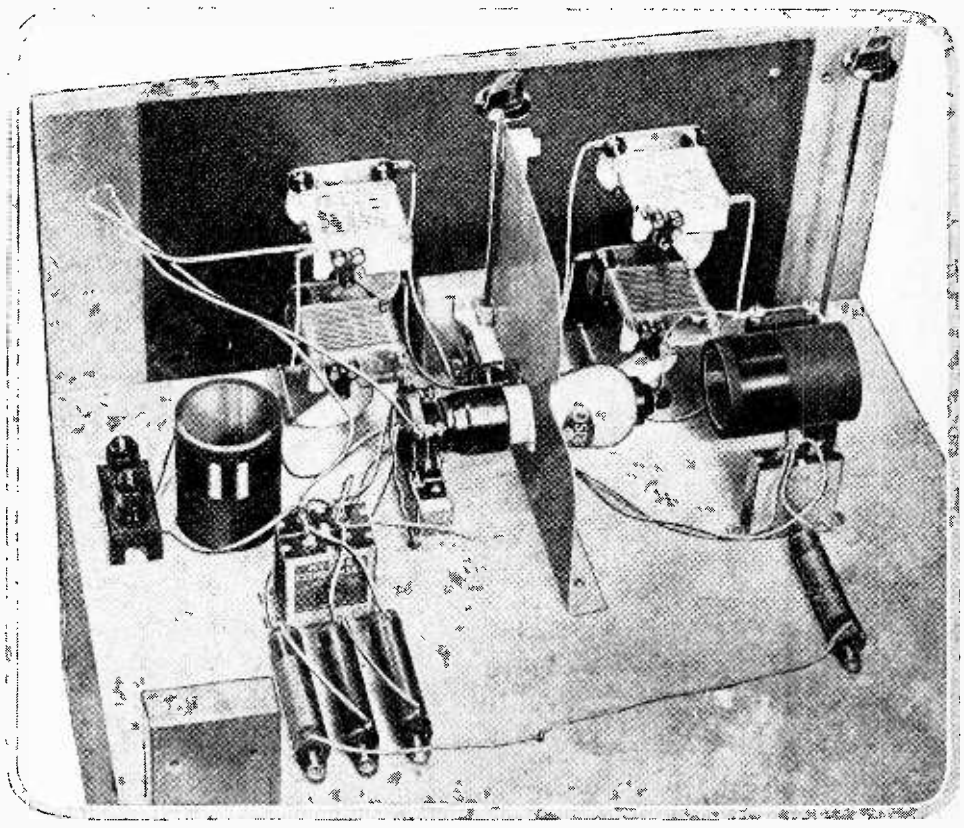
SPECIFICATION.

Local station alternative programme receiver specially designed for quality reproduction with the moving-coil loud speaker. Pre-set two range tuning on broadcast band only. Arranged for gramophone reproduction and fitted with gramophone motor. Undistorted power output up to 5 watts over a frequency range of 40 to 10,000 cycles. All-mains operated from A.C. supply. Easy construction with latitude in the choice of components.

Grid Rectification.

In considering a set for quality reception, some degree of pre-detector amplification is essential. Although a grid rectifier may be employed, being far more sensitive than the anode bend arrangement, an H.F. stage is desirable under average conditions, or the valve will be underrun as regards the signal it can handle in its anode. "Power grid" is chosen in preference to anode bend, not only because it is the more sensitive, but owing to the fact that even the anode-bend rectifier will distort, owing to the fact that the deep modulation reaches down on to the curvature of the valve characteristic.

Our circuit for quality reception, therefore, represents an H.F. stage of modest gain, avoiding the effects of reaction, followed by a power grid rectifier. The H.F. coupling is a straightforward tuned anode with neither tappings for the anode of the S.G. valve nor for the grid of the detector. Its screen voltage is fixed at the maximum stated value for the valve. Negative bias is obtained by a voltage-dropping resistance in its cathode lead, which for constant working carries the current of the screen voltage potentiometer in addition to the screen and anode currents. Volume control is arranged by a potentiometer connected across the aerial-tuned circuit. Thus while adjusting the signal to the requirements of the S.G. valve the amount of coupling across the interelectrode capacity of the valve between the tuned circuits in its grid and anode is likewise regulated so that the extent of regeneration is controlled. The L.F. and mains rectifying equipment is the "Quality Amplifier" described in the issue of March 25th and originally designed purely for gramophone reproduction. It is an all-resistance amplifier giving a practically straight-line response from 30 to 10,000 cycles. The first valve of this amplifier now becomes the detector, and it is necessary to replace the Mullard 354V, originally fitted, by a Mullard 164V. A rearrangement is necessary in the anode circuit of this valve by way of the introduction of an H.F. choke and by-pass condensers and a reduction in the value of the anode resistance. Owing to the lower A.C. resistance of the 164V, a reduction is made in the value of the coupling resistance, while when this valve becomes a detector a further reduction in the feed resistance is necessary in order to maintain maximum



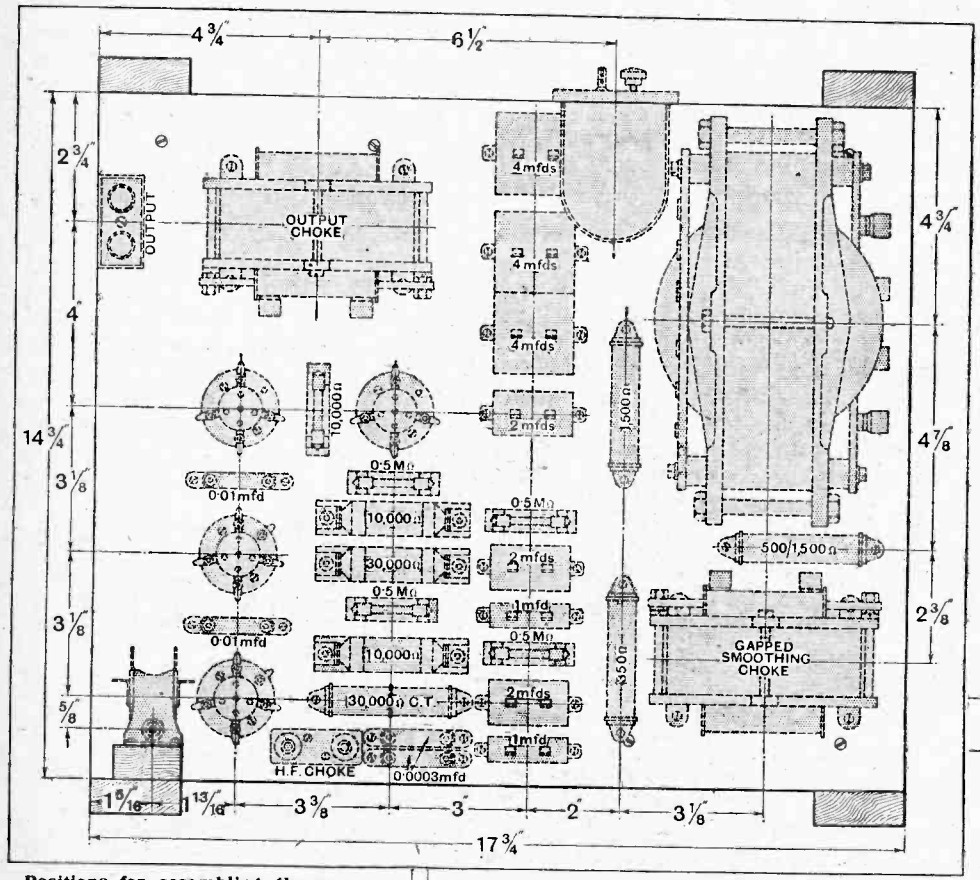
The tuning equipment of the aerial and H.F. intervalve coupling.

Quality Unit.—

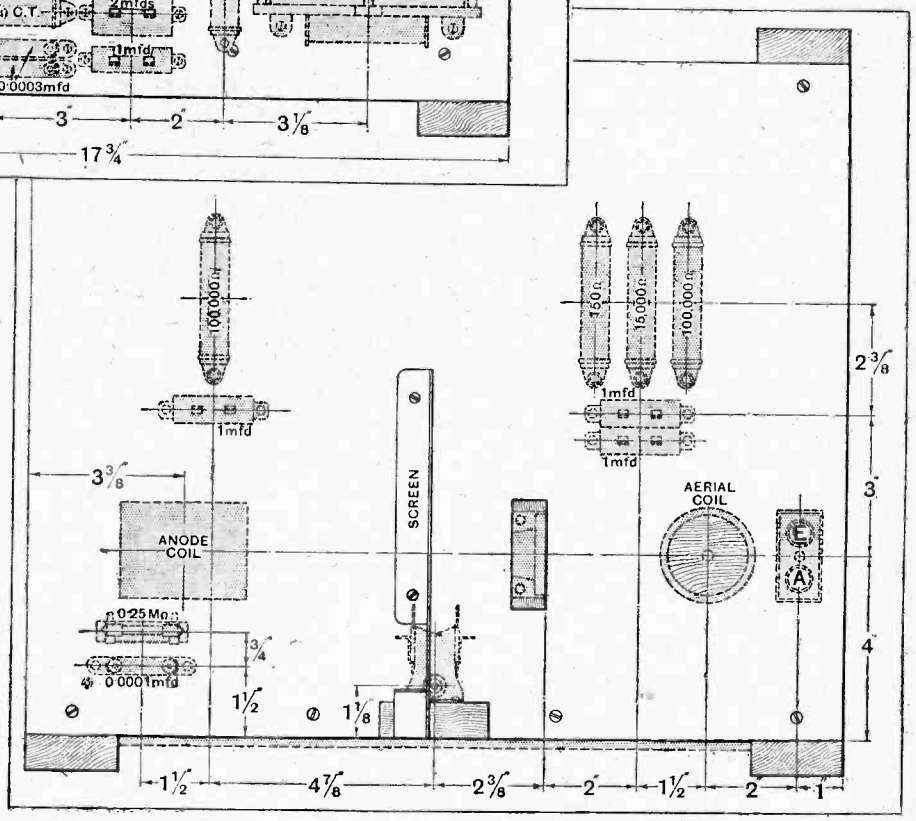
voltage on the anode in view of the increase in anode current when the negative bias is removed.

A single voltage-dropping resistance will now suffice for giving bias to the two resistance-coupled valves. Excluding the output valve, the anode current of which does not pass through this biasing resistance, a current of about 22.5 mA. is taken when the circuit is switched for the playing of gramophone records, which across a 350-ohm resistance gives a measured bias of 8 volts. For the purpose of checking over the circuits, this current is made up as follows: 8 mA. each for the two 164V valves, 2 mA. for the S.G. valve, and 4.5 mA. for the screen current and potentiometer. There is an increase of 6 mA. when the negative bias is removed from the first L.F. valve, and it becomes the detector, which results in an increase in the bias of the following valve to the normal value of about 9.5 volts. The changes necessary in adapting the "Quality Amplifier" for radio reception are therefore obvious.

All those interested in quality reproduction and, in fact, all users of good moving-coil loud speakers are ultimately forced to pursue a design on the lines of the present set, being a standard arrangement embodying well-tried practice. The apparatus used is in no way special, and, in spite of the fact that it is all mains operated from A.C. supply, the only essential requirement is that of using the right valves with the correct resistances. Any tuning condensers will do with any coils. The outfit is certain to work as intended, and the wiring may be carried out quite roughly, using No. 22 tinned wire in small-gauge sleeving, excepting the heater and filaments circuits, which require No. 18 wire. Provided the loud speaker does not hum of its own accord, there will be



Positions for assembling the apparatus on the bottom baseboard and composing the detector, L.F. stages and eliminator.

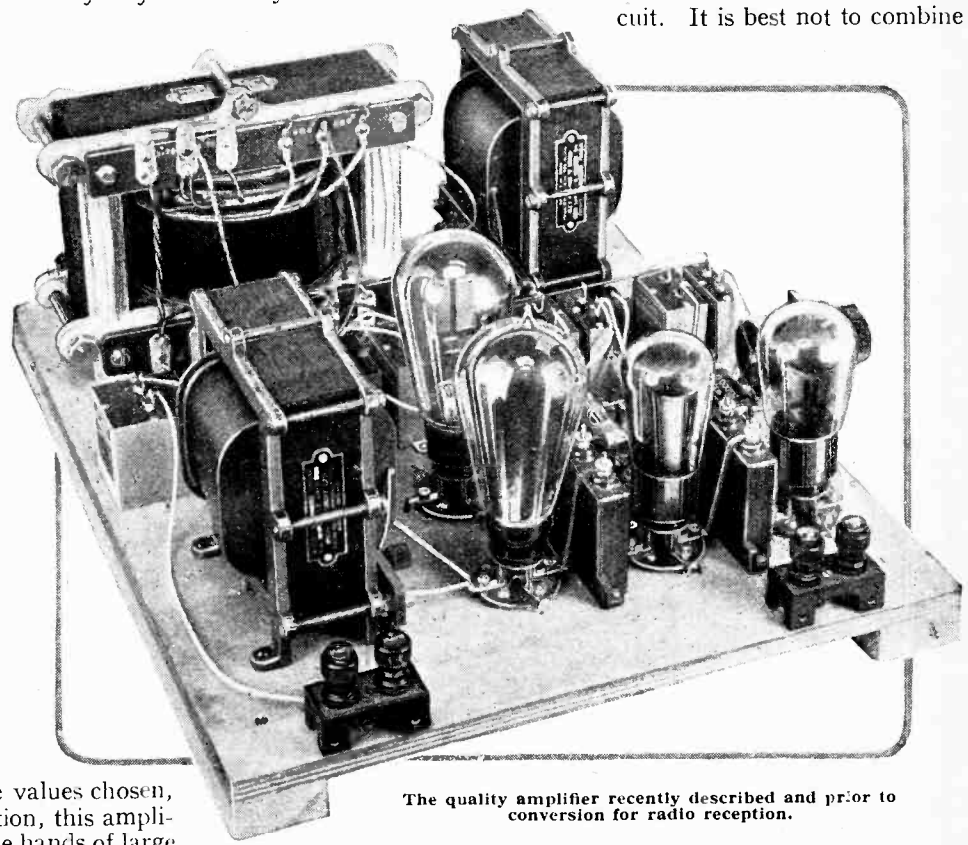


Assembly of the apparatus forming the H.F. stage.

Quality Unit.—

no mains noise, and in the present set absolute silence is obtained when the transmitter ceases, there being no hum whatever. In the design shown, the tuning condensers have been duplicated so that "pre-set" tuning with change-over switch for alternative-programme reception can be readily provided if desired.

Nine-ply panels support the three decks on which the apparatus is assembled, the gramophone motor being on the top and picking up an earth contact on the screen. Induction-type motors are safer than the commutator type, as the latter will need attention periodically when slight sparking on the brushes makes itself evident on the amplifier. Yet the brush-type model fitted in the set used for illustration here is in every way satisfactory. There is no unnecessary labour in putting the set together, and no parts need to be home constructed excepting the piece of aluminium used for the vertical screen. If the Marconi or Osram MS4 valve is of the new metal-sprayed type, a good clearance hole must be made in the screen, or its grid bias may become short-circuited. The only possible cause of failure will be a damaged resistance or a faulty condenser, and, as a safeguard, these components can all be tested before assembly, the former for continuity, and the latter for their ability to hold a charge.



The quality amplifier recently described and prior to conversion for radio reception.

Correcting Eliminator Output

Reference might usefully be made to the previous article on the "Quality Amplifier" regarding the behaviour of the L.F. amplifying stages, the reasons for the values chosen, and general hints on construction, this amplifier having proved itself, in the hands of large numbers of readers, to be easy to construct and a useful acquisition. It might be iterated that the high potential winding of the mains transformer should be 465+465 volts. If a 500+500 winding is used from an existing transformer, resistance must be introduced into the eliminator circuit so that the rectified potential on load across the smoothing condenser becomes 495 volts, as is the case with the 465-volt winding. While a value of about 500 ohms would suggest itself as adequate for this purpose, a value up to 1,500 ohms may be necessary, taking into account the regulation of the rectifier. No heating of the plates of the rectifier should be apparent, while the anode of the output valve may perhaps become just visibly hot. A milliammeter should be used, if possible, for the purpose of test, and if everything is in order, as it should be, the total anode current taken from the eliminator should be between 90 and 92 mA. On the top panel, in addition to the controls, there is room for a milliameter, which, if connected in the anode circuit of the Osram or Marconi LS6A output valve, will reveal, by showing a steady reading of between 60 and 65 mA., that the valve is not overloaded by excessive signal, as well as checking that the eliminator is delivering its correct output. This meter should be at a corner away from the front panel and remote from the gramophone pick-up. The leads from the latter should run as a thin, twisted pair in insulated sleeving wrapped all the way with tin foil, overwound by fine tinned copper wire, and taken by a route first along the back and then away to the front of the set to the switch and bias circuit. It is best not to combine a gramophone-motor starting switch with the gramophone-to-radio change-over switch, and it is no advantage from an operating standpoint.

Loud Speaker Field Excitation.

If a detector circuit meter is fitted, it must, of course, intercept the lead going to the anode resistance and beyond the H.F. by-pass condensers. The total scale should be 15 or 20 mA., and the no-signal reading of some 13 mA. should not fall by more than about one-fifth of the maximum current reading, showing the avoidance of both overloading throughout the amplifier and regeneration. A pair of meters may be conveniently fitted on a lower extension of the $\frac{3}{16}$in. front paxolin panel.

Readers have asked for details for field excitation by using the field winding of the loud speaker for smooth-

Quality Unit.—

ing purposes. This can be done by omitting the smoothing choke and substituting a field winding having a resistance not more than 200 ohms in excess of the compensating resistance used with the transformer having a 500+500-volt winding. Supposing the resistance value of the winding required is of the order of 800 ohms, though it may, in fact, be higher, then at 90 mA. about $6\frac{1}{2}$ watts will be available, sufficient for the average small-gap moving-coil loud speaker, which is, of course, preferable to the more generous gap type, owing to its higher inductance giving better smoothing. If volts are to spare, retain the smoothing choke and insert the loud speaker winding in series with it, taking a lead from the junction to a 2-mfd. condenser running to the H.T. minus.

READERS' CORNER.

A Section Devoted to the Enquiries and Personal Experiences of Readers.

THERE has been a useful response to the suggestion which we put out in our issue of April 29th, that readers themselves should offer to give replies to certain questions which are put to us from time to time where such replies can often be given by readers from their personal experiences.

The following have been selected from amongst those received. The numbers correspond with the numbers of the original questions which appeared in our issue of April 29th:—

(1) The Marconiphone Co., Ltd., Radio House, 210-212, Tottenham Court Road, W.1, write to state that they are always pleased, through their Press Department, to lend lantern slides of historic and also of general wireless interest. No charge is made for the loan, provided due acknowledgments are made to the Company.

A reader suggests that application should be made to Messrs. Newton and Co., 43, Museum Street, London, W.C.1.

(2) Messrs. Negretti and Zambra notify us that they are in a position to supply the W.E.C.O. valves of the peanut type. A Lancashire reader also states, in reply to this enquiry, that W.E.C.O. valves are still in use in the American Navy superhets, and that they are made in Canada by the Northern Electric Company, Montreal, and can be obtained from the H. M. Kipp Co., Ltd., 447, Yonge Street, Toronto, Canada. The price is about $3.

Messrs. Rothermel supply adaptors for American valves for use in English valveholders.

(3) Several readers have replied to this enquiry regarding a choice of gramophone records to demonstrate high and low note response. Two suggestions are given below:—

(a) H.M.V. Record C.1311 and C.1312, price 4s. 6d. each. Each of these is divided into sections, each illustrating one instrument: Record 1, strings; 2, wood wind; 3. brass wind; 4, percussion. Practically all the instruments used in orchestras are included.

(b) Second Hungarian Rhapsody, Liszt. Perhaps a pianoforte record is better than one by an orchestra. It is recorded on the following:—

Pts. 1 and 2.	H.M.V. DB.1013.	Piano. Backhaus. 8s. 6d.
,, ,,	H.M.V. DB.1042.	Piano. Cortot. 8s. 6d.
,, ,,	H.M.V. C.1276.	Piano. Mark Hambourg. 4s. 6d.
,, ,,	H.M.V. DB.381*.	Piano. Paderewski. 8s. 6d.
,, ,,	H.M.V. D.1296*.	Philadelphia Symphony Orchestra, 6s. 6d.

* Old Recording.

Perhaps the best here is the first, but as "value for money" the third might be preferable.

For Columbia records:—

DB.9494. J. H. Squire Octet.
DX.9-10. Sir Henry Wood and N.Q.H.O.
DB.229. Prince's Grand Concert Band.

(4) No replies to date.

(5) A reader writes that, from his experience, he can recommend the rotary converters made by Electro Dynamic Construction Co., Ltd., Devonshire Grove, London, S.E.15. Used with the new Marconiphone four-valve console (2H.F.-S.G.), the converter is quite satisfactory, no trace of interference. This firm makes a new model (unit mounted on sponge rubber, and shielded by metal case) which can be used near the set.

Two other letters have been received from readers also endorsing the suitability of the Electro Dynamic Contruction Co.'s product.

Where other makes failed, on a very rough supply, the E.D.C. converter gave every satisfaction. The inexpensive filter unit they make for this converter should be used, however.

The following additional questions have also been received:—

(6) "A. L. B.," of Lisbon, asks if any reader can recommend a reliable British correspondence school conducting a radio engineering course, and asks if any reader has experience of the I.C.S. course in wireless.

(7) "J. S."—Has any reader experience of reception of 5SW in Palestine? Are signals sufficiently dependable to make it worth while to take a short-wave receiver to that country?

(8) "L. J. L."—Has any reader succeeded in making a simple but satisfactory super-regenerative receiver for short wavelengths? If so, a circuit diagram and brief specification would be appreciated.

Enquiries or replies suitable for this section should be forwarded to the Editor, the envelopes being marked *Readers' Corner*. Enquiries and replies must be very brief.

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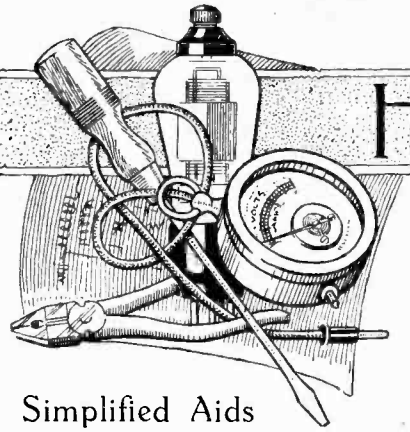
INTERVALVE TRANSFORMERS.

The Ratio as a Guide to the Inductance.

IN the case of all reliable makes of inter-valve transformer the ratio figure can be taken as a rough guide to primary inductance. Thus, if a reputable transformer manufacturer makes his products in more than one ratio it can be definitely assumed that the one having the lowest ratio has the highest primary inductance, it being intended in most cases for the purpose of following an anode-bend rectifier where the A.C. resistance of the preceding valve is, of course, very considerable. Those of exceptionally high ratio are mainly intended for following a leaky-grid rectifier, or in some cases a crystal rectifier. Great care should be taken, however, in dealing with transformers of doubtful foreign origin, since this rule of "the lower the ratio the greater the primary inductance" is seldom applicable in the case of such components, as the low-ratio model differs from the high-ratio one only in that it has fewer secondary turns, the primary being the same in each case.

Practical Hints & Tips

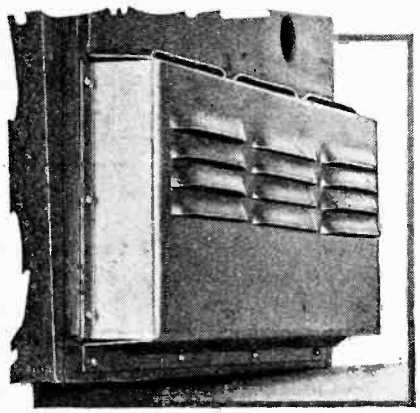


Simplified Aids to Better Reception.

HEAT DISSIPATION.

AS relatively small amounts of energy are usually dealt with in a wireless receiver, the amateur who undertakes the building of a D.C. set for the first time is apt to encounter what amounts almost to a new problem; if he entirely ignores the fact that about 100 watts—more or less—must be dissipated in the form of heat, serious damage may be done.

It is a good plan to arrange matters so that heat generated by the main voltage-dropping resistance is kept out of the containing cabinet. This can conveniently be done by mounting the resistance element under a ventilated protective cowling, in the form of an excrescence at



Projecting resistance cover of the Pye D.C. receiver.

the rear or side of the receiver cabinet.

Ventilation should be so arranged that heated air may rise freely, and at the same time cool air should be admitted equally freely to the lower part of the resistance compartment. In this way a continuous current of cooling air is ensured.

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MATCHING COILS.

In the interests of satisfactory ganged condenser control it is almost essential that all the coils used in the construction of a modern receiver with this system of tuning should be accurately matched. Although it may be possible to compensate for minor discrepancies when dealing with a set covering a single wave-range, it is practically impossible to obtain satisfactory results from the usual dual-range set unless coils with substantially identical inductance values are used.

There seems to be a general misconception with regard to the difficulties of matching, and it is often thought that an elaborate equipment of measuring instruments is necessary in order that the necessary degree of accuracy may be achieved. Actually, nothing could be farther from the truth; given a fair measure of patience, an amateur with the simplest of apparatus can match his coils even more accurately than is necessary; he can certainly afford to devote more meticulous care to the operation than can the manufacturer, to whom time is money.

If all the coils of a receiver are wound on identical formers, with the same number of turns of similar wire, spaced to an equal extent, it automatically follows that their inductance values will be similar. In practice one does not attempt to match coils of different types, and so it is generally found that only slight adjustment is necessary to make up for minor errors in winding. It should be mentioned here that the relative positions of the various windings on the formers should be determined with the highest possible degree of accuracy; the depth, width and spacing of the slots in which sectional long-wave coils are usually wound should coincide in their dimensions.

Strictly speaking, coils should be matched with regard to their inductance values only, small discrepancies in self-capacity being of less importance, as provision is always made in the design of the set for balancing them out. Further, if all coils are made to the same specification it is found that any differences in self-capacity that may exist are as a rule too small to measure, and so this factor may be ignored. This circumstance is fortunate, as it allows us to match sets of coils without making measurements of pure inductance. It may therefore be assumed that if two coils of the type under discussion will resonate to the same wavelength when shunted by exactly similar capacity values, they are matched.

A simple way of determining whether this condition is satisfied is shown in Fig. 1. A test can be made with the help of almost any receiver having a regenerative detector; it is even possible to use the set in which

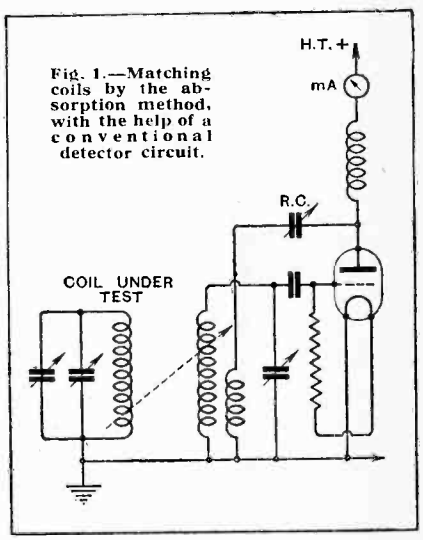

Fig. 1.—Matching coils by the absorption method, with the help of a conventional detector circuit.

the windings under test are ultimately to be used if a makeshift coil assembly is temporarily connected to the detector valve. It is necessary that a milliammeter covering a suitable current range should be inserted in series with the anode of this valve.

The coil to be tested is shunted

with two condensers, one of which must be variable with a maximum capacity not in excess of 0.0001 mfd. The second condenser may be fixed, with a capacity of from 0.0001 to 0.0002 mfd., or the variable condenser to be eventually used in the receiver will serve equally well; its fixed and moving vanes should be about half enmeshed.

Before making a test the detector valve must be made just to oscillate by increasing reaction coupling until a "dip" in the milliammeter needle is produced. One of the coil assemblies to be matched, with its long-wave winding short-circuited, is now brought into inductive relationship with the grid coil, and the two circuits are tuned to resonance; this will be indicated by a deflection of the needle. Coupling should now be loosened until this deflection is only just perceptible, and the physical position of the free coil should be marked on the bench, so that those to follow may be mounted in exactly the same place, and consequently be coupled to the oscillating grid coil to precisely the same extent.

Before disconnecting the first coil a careful note should be made of the vernier condenser reading corresponding to resonance; in making subsequent tests, none of the other circuit constants should be altered in any way.

The same procedure is followed with regard to each coil assembly, and the one which resonates with the *highest* capacity reading is then selected as a standard against which to match the remainder. The inductance values of these windings must be adjusted by removing turns—or, if the divergence is very slight, by slightly spreading the winding in such a way that some few turns are spaced to a greater extent than formerly.

It is wise to take precautions against changes of incidental capacity when substituting one coil for another, and the connecting leads may be secured so that their relative positions do not alter.

Having assured oneself that the medium-wave coils are as accurately matched as possible, the short-circuits across the long-wave windings should be removed, and these coils then dealt with in an exactly similar manner.

A D.C. "REGIONAL ONE."

Now that a suitable pentode for operation with D.C. mains is available, the possible objection that a single-valve loud speaker set, previously only practicable with A.C. supplies, involves somewhat expensive rectifying equipment is completely ruled out. A very satisfactory receiver of this type can be made quite cheaply, as a power rectifier is unnecessary. Obviously, one would not adopt a circuit of this kind for anything approaching long-range work, but for local-station reception it is most attractive. The chances of trouble are reduced to an absolute minimum; there is no risk of undesirable inter-circuit reaction, grid-bias is unnecessary, and the simplest and cheapest smoothing equipment proves to be entirely adequate.

As there is no risk of interaction, and no intervalve coupling to introduce distortion, it follows that quality of reproduction is of a high order, and, in the matter of volume, there is little difficulty in obtaining an output of 500 milliwatts or even considerably more. A set of this type is interesting to handle, if only because it responds so readily and in such a clearly perceptible way to the addition of tone-control devices. Incidentally, it always seems to the writer that this sort of behaviour is a reliable indication of a good set.

The admittedly rather crude circuit arrangement sketched in Fig. 2, in spite of its obvious lack of any pretensions to high selectivity, has proved satisfactory in practice. With the exception of the output choke, which should be specially designed for its job, no particular discrimination need be exercised in the choice of components. Almost any sort of smoothing choke, provided it has a reasonably low D.C. resistance, will serve the purpose, even if the mains supply be "rough."

For the main voltage-absorbing resistance R a woven asbestos-wire mat, costing a shilling or so, will meet the case admirably. Its resistance value will be about 400 ohms, depending on mains voltage.

The screening-grid feed resistance value must similarly be chosen with regard to mains voltage; the lower value shown in the diagram is applicable to supplies of about 200 volts. This resistance should be adjusted so that the combined anode and screen currents do not exceed some 40 milliamperes.

Such refinements as an input filter and a condenser-resistance tone control across the output choke may obviously be added; the latter is particularly desirable.

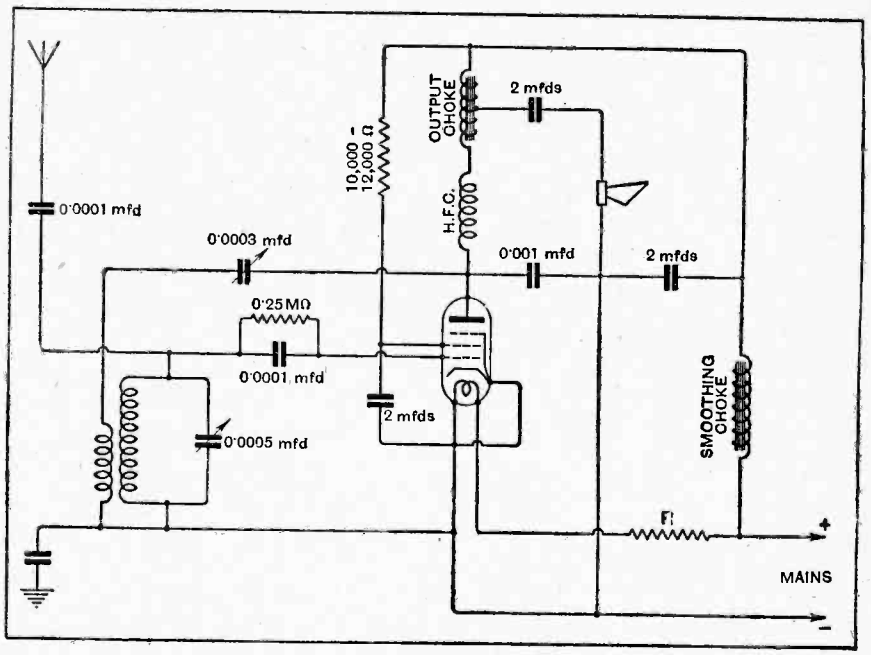

Fig. 2.—A single-valve loud speaker set for D.C. mains operation.

CURRENT TOPICS

News of the Week in Brief Review.

FRENCH FIRM TO BUILD PROPAGANDA STATION.

We learn that the Société Française de Radiophonie has captured the contract for the construction of the 100 kW. trade propaganda broadcasting station at Luxembourg.

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DISCOVERER OF HERTZIAN WAVES.

David Edward Hughes, the British scientist who discovered electro-magnetic waves, was born on May 16th, 1831, and to-morrow (Thursday) the Institution of Electrical Engineers will hold a Hughes' Centenary Commemoration meeting at 6 p.m., when Mr. Sydney Evershed will give a short discourse on the life and work of this electrical pioneer.

Although it is now a well-established fact that Hughes did indeed anticipate Hertz in the discovery of the waves, the earlier discovery was at the time regarded as so impossible that it was not announced; to Hertz, therefore, is rightly accorded the honour of being the first publicly to make their existence known.

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BIG SHOW IN BRISTOL.

Bristol, as befits a city with a broadcasting studio of its own, is to hold a Radio Week from September 21st to 30th, the chief feature of which will be the Bristol and West of England Radio Exhibition in the Colston Hall. The B.B.C. will be strong in support, and already arrangements have been made for the erection of a special studio in the Colston Hall from which actual broadcasting will take place.

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THAT PARIS STORY.

"It can't be true," was what we instinctively thought when our Paris correspondent sent us that bright little story about the immediate power increase of Radio Paris to 120 kW. Now comes the awaited postscript, which proclaims that "red tape" threatens to hold up the project until October next. Apparently the cable connection between the Paris studio and the transmitter at Essarts-le-Roi cannot be completed without permission from a number of Ministries, including those for Foreign Affairs, the Fine Arts, Waters and Forests, the Home Office, etc., etc. And that, as someone has said, is that.

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MEET MR. JOHN W. ELWOOD.

Paris has a visitor at the moment in the person of Mr. John W. Elwood, vice-president of the American National Broadcasting Company, who styles himself "the ambassador of American radio in Europe." We understand that Mr. Elwood has already arranged with the German broadcasting authorities for a regular exchange of programmes every three weeks across the Atlantic, and the intention is to consummate a similar understanding with broadcasters in France.

According to French journalists, Mr. Elwood hopes to conclude similar plans with Italy and Great Britain, his motive being "to employ radio to enable all peoples to know each other and the attractions of their respective countries."

If this is the sole idea we encourage it wholeheartedly; but if, as has been uncharitably suggested, there is even the remotest intention of swamping Europe with American advertising, we shall not be alone in making an early protest.

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RUSSIAN "FRIENDS OF RADIO."

The Soviet Government is showing legitimate pride in the huge increase in the number of Russian listeners. In a new statement by the Commissariat of Commerce the figure is given as 2,764,000, and it is believed that the four million mark will be reached by the end of next year when the "45-station plan" is completed.

Listeners, on their part, are not altogether satisfied with the existing programmes and have had the temerity to form a "Club of the Friends of Radio" with the idea of bringing about an improvement.

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DX AND MATRIMONY.

Wireless has always been regarded as one of the "safe" pastimes, as compared with tennis, motor cycling, "hiking," and others which lead the way to matrimonial entanglements. And now comes the startling tale of SP3KYL, Posen, Poland. We have it from no less an authority than the American Radio Relay League that SP3KYL is one day to be married to another transmitter (who at present must remain nameless) as a result of messages exchanged "on the air." SP3KYL is Poland's YL, Miss Helen Malinowska, and the story goes that the couple became acquainted during a casual DX test in the Balkans in September, 1929. Unfortunately, the other transmitter is a poorly paid subaltern in his country's army and is forbidden by regulations to take a wife until his salary cheque reaches a certain figure.

In the belief that such a romance is unique, Miss Malinowska has written to the A.R.R.L. asking for advice, and we learn that the peculiar circumstances may prompt American "hams" to start a subscription list.

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CHEAPER LICENCES FOR CRYSTAL USERS?

The question of adjusting the wireless licence fee "in proportion to the privileges enjoyed" was raised by Miss Eleanor Rathbone in the House of Commons last week, but did not draw a very encouraging answer from Major Atlee, the Postmaster-General. In his reply, Major Atlee said that, with more than 3,600,000 licences in force, it was essential that the licensing system should be kept as simple as possible. Any arrangement under which the amount of the licence fee depended on the type of apparatus employed would introduce many difficulties, and he did not consider that a change would be in the public interest.

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E.R.P. SCREEN-GRID PORTABLE.

Messrs. Electrical and Radio Products, Ltd., whose S.G.4 portable was reviewed in our last issue, ask us to state that this receiver is now issued in an improved model at a retail price of £12 12s. The milliamp. consumption does not exceed six.

THE WIRELESS PILLOW. Although the idea of concealing a radio reproducer in a pillow is not new it is interesting to note that the device has reached the stage of commercial production. The pillow shown in the picture is composed largely of sponge rubber and is made specially for use in Pullman cars, ships and hospitals.

ENEMAINS

A.C. and D.C. Transportables

Exceptionally Good Quality of Reproduction: Built-in Moving Coil Loud Speaker.

IN designing these three-valve all-mains receivers the makers have set out to give something out of the ordinary in the matter of quality of reproduction. To this end they have incorporated a small-type moving coil loud speaker in both models, with the result that really excellent quality has been obtained without adding appreciably to the weight of the set.

The radio circuit is basically the same in both A.C. and D.C. models, and comprises a screen-grid H.F. stage, and a grid detector, transformer coupled to a pentode in the output stage. The H.F. valve is followed by tuned anode coupling in which the long- and short-wave coils are connected in parallel when receiving on short waves. Reaction is obtained by coupling to the tuned anode circuit. The screen-grid voltage is adjustable by means of a potentiometer to which access is obtained by unlocking and removing the back panel. This control enables the best compromise to be made between stability and sensitivity, and ensures that the utmost magnification is obtained from the particular valve fitted to the set. In view of the fact that individual valves of the same make and type often show not inconsiderable differences of characteristic, the advantages of a control of this type will be appreciated by those who like to feel that all their valves are working to capacity.

A gramophone pick-up may be connected in the grid circuit of the detector through the medium of a jack on the front panel. In the A.C. model the contacts on the jack automatically introduce a negative bias when the pick-up plug is inserted.

Indirectly heated valves are used throughout in the A.C.3, and the H.T. supply is provided by a full-wave metal oxide rectifier of the "voltage doubler" type. Grid bias is obtained by the use of cathode return lead resistances and the H.T. is decoupled at every point.

In the D.C. model the valves are directly heated and the filaments of the H.F. and detector valves are paralleled to bring their combined current up to 0.25 amp. for connection in series with the PT625 output valve. The series mains resistance is of heavy construction and well ventilated, four tappings being provided for supply voltages from 200 to 250 volts. Grid bias for the output valve is provided by the fall in potential across a 60-ohm resistance in series with the filaments, but the H.F. and detector valves both work with zero bias. As in the case of the A.C. receiver, an adjustable screen-grid potentiometer is fitted inside the set at the back. The circuit is protected by fuses in both positive and negative mains leads, while fixed condensers are included in series with the external aerial and earth leads. There is thus no danger of a short-circuit in the case of an earthed positive main through the aerial falling to the ground in a gale.

The range of these sets on the self-contained frame aerial is sufficient to give four or five Continental transmissions in addition to the usual B.B.C. stations at a volume level sufficiently high to enjoy the programmes. By using an outdoor aerial the number of foreign stations could, of course, be considerably augmented.

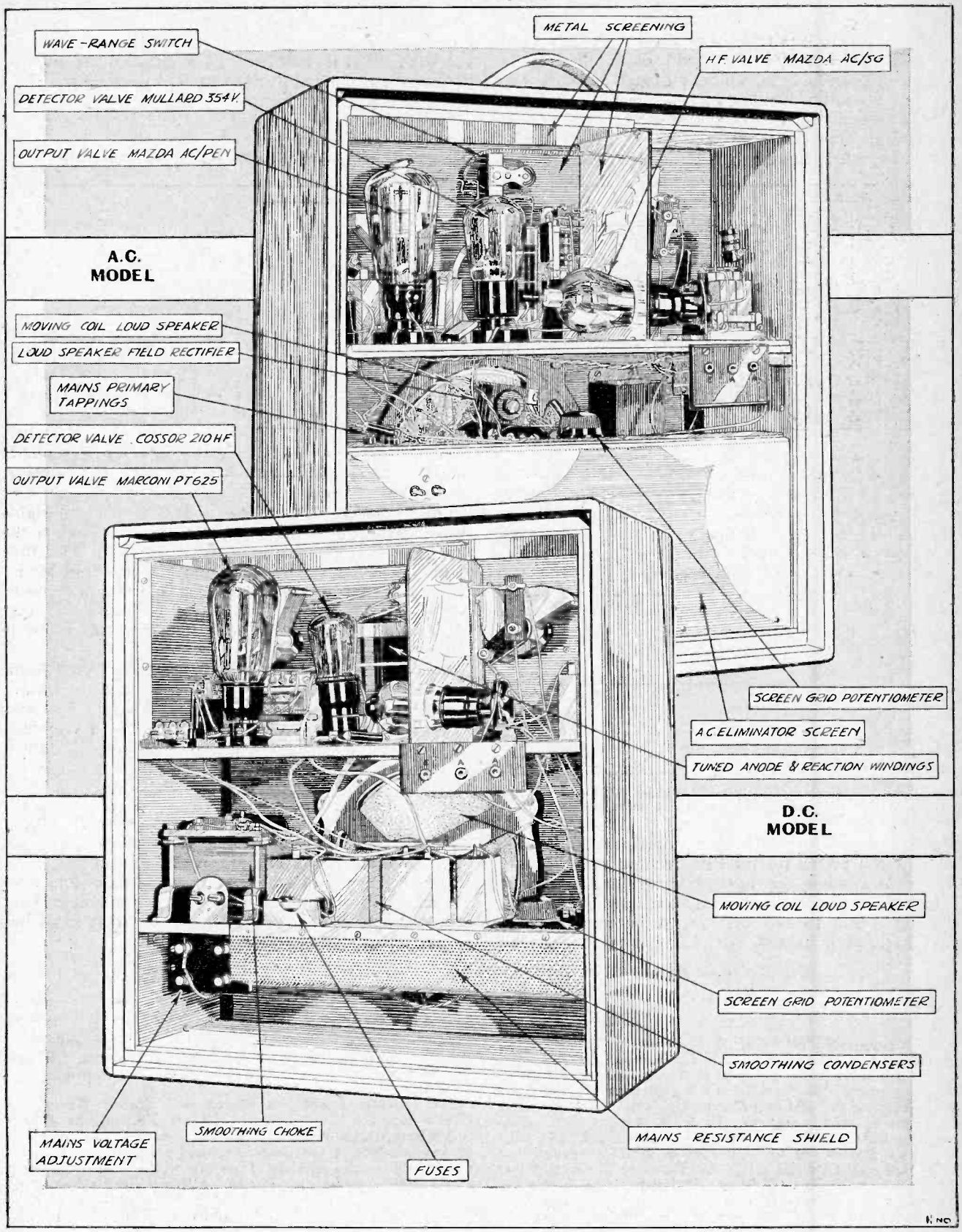
Selectivity is decidedly above the average, and in London neither of the Brookmans Park transmitters occupied more than 6 degrees of the 100-degree dial. Even at a distance of only five miles the band occupied by the National transmitter is not more than 15 degrees, and the Regional transmitter is limited to 7.5 degrees. Under these conditions two foreign stations were received between the two local transmitters without any background interference.

Reaction is smooth and the controls are all easy to operate. In the A.C. model, however, a different setting of the screen-grid potentiometer was required on long and short waves to give the necessary stability with sensitivity. In the D.C. model the same setting held for both wave ranges, and it was not necessary to remove the back for adjustment when changing the wave range.

The D.C. set is remarkably free from background noise, no trace of mains hum being audible even with the

SPECIFICATION.

CIRCUIT: Three valves—screen grid H.F. (tuned anode), leaky grid detector (with reaction), pentode output valve.
CONTROLS: Two tuning, reaction, wave-range, pick-up jack, mains switch and screen grid potentiometer (inside set).
GENERAL: Self-contained frame aerial and moving coil loud speaker. Weight 38 lbs.
Makers: The Loud Speaker Co. Ltd., 2, Palmer Street, London, S.W.1.
Price: 30 guineas (A.C. or D.C.)

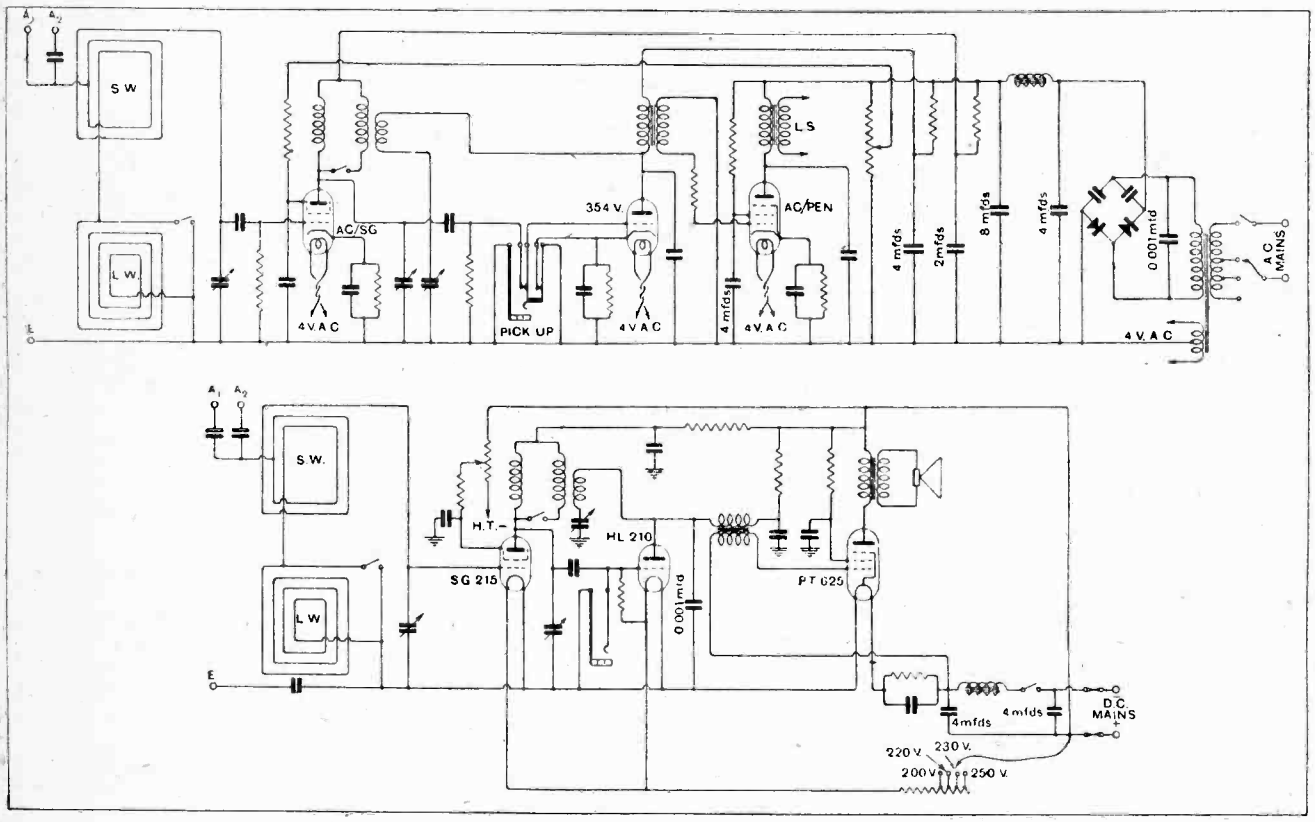


Constructional details of the Enemains A.C. and D.C. three-valve portables.

Enemains A.C. and D.C. Transportables.—ear only a few inches from the loud speaker diaphragm. The A.C. model, on the other hand, produced a certain amount of 50-cycle hum, which, although insufficient to interfere with local station reception, could be heard as a background to foreign stations. It was noticed that the separate transformer supplying the field current to the loud speaker showed signs of overheating. We understand, however, that arrangements are being made to draw the power for the field rectifier unit from an additional winding on the large mains transformer.

In the A.C. model the metal screen surrounding the eliminator unit in the base might be stiffened with advantage, as it showed a tendency to rattle when the volume was increased to maximum. The set was, however, free from objectionable box resonances, for the back panel is ventilated by a circular fret similar to that on the vertical panel in front of the loud speaker.

Some difficulty was experienced in withdrawing the PT625 valve in the D.C. set, and additional clearance above this valve would seem to be essential. No doubt this matter will be rectified in subsequent models.



Circuit diagrams of the Enemains A.C.3 and D.C.3 receivers. In the A.C. model the field current for the loud speaker is derived from a separate transformer and metal oxide rectifier, while in the D.C. model the field winding is connected in series with a resistance across the mains.

The quality of reproduction is alone sufficient to ensure success. The brilliant upper frequencies, and above all the natural quality of both speech and music, are somewhat unexpected in a compact portable of this type, and completely justify the maker's policy in fitting a speaker of the moving coil type.

Next Week's Set Review:—THE NEW AMPLION TRANSPORTABLE, Battery Model.

BOOKS RECEIVED.

The Theory and Practice of Radio Frequency Measurements. A Handbook for the Laboratory and a Textbook for advanced students. 2nd edition, entirely reset and enlarged, and including a new chapter developing the electro-magnetic equation and calculating the field near circuits and aerials. Pp. 487, with 284 diagrams and illustrations. By E. B. Moullin, M.A. Published by Charles Griffin and Co., Ltd., London, price 34s. net.

A Radio Beacon and Receiving System for Blind Landing of Aircraft, by H. Diamond and F. W. Dunmore (Research Paper No 238, reprinted from the Bureau of Standards Journal of Research, October, 1930), describing the systems used in American airports for the guiding of aircraft under conditions of no visibility, and the use of the vibrating reed course indicator, the runway localising beacon, boundary marker beacon, and landing beam. Pp. 34, with 35 illustrations and diagrams. Issued by the Bureau of Standards, Washington, D.C., U.S.A., price 25 cents.

The Orfordness Rotating Beacon and Marine Navigation (Radio Research Board, Special Report No. 10), by R. L. Smith-Rose, D.Sc., Ph.D., A.M.I.E.E., comprising a description of the principle of the Beacon, method of taking bearings by stop-watch, results obtained from observations made in ships at sea, light vessels, etc. Pp. 14. with four illustrations, snap and specimen records taken at the N.P.L., Teddington, with the automatic recorder. Published by H.M. Stationery Office, price 6d.

Unbiased

By FREE GRID.

Secret of Daventry's Popularity.

I HAD occasion recently to travel in the northern provinces of France, and I was surprised to note the great increase in the number of wireless sets used in the various cafés since my last visit to that country. What astonished me most, however, was that in a very large number of cases the receiver was tuned in to 5XX. I thought at first that it might be for the benefit of English visitors, but I found that this was not so, as I visited several small towns in which an Englishman is rarely seen and in which the English language is as almost as unknown in the cafés as the French tongue is in shops and houses of refreshment in Dover and Folkestone. I questioned the waiter upon the point, and he explained that, in the first place, stations on the normal broadcasting wavelengths were badly interfered with by ships' Morse on the Channel, and that, in the second place, British programmes were very much appreciated, except, as he explained tactfully, on Sundays, when the receivers were usually tuned in to Radio Paris.

In some of the larger towns there are a number of English-speaking Frenchmen who, I was informed, show a great appreciation of the talks broadcast by the B.B.C., though I shrewdly suspect that their appreciation is due less to the subject matter than to the fact that an excellent opportunity is vouchsafed them of improving their English. I gathered also that it is realised that good English is invariably forthcoming from British stations, and for this reason sets have been installed in a few schools. In the case of certain Continental stations, of course, the announcers leave much to be desired in the matter of correct pronunciation of their own language; in fact, their speech is to their Mother tongue as American is to English.

Din, but no Bass.

"Why is it," said a "friend" of mine to me the other day, "that wireless set designers nearly always specify for the last stage of a receiver a valve having an output of at least 500 milliwatts, and in some cases much greater than this, whereas the ordinary portable set, if you 'give it its head,' makes a terrible din even though it only employs a small two-volt power valve rated to give only about a couple of hundred milliwatts output?" "It is evident, my young friend," said I, "that you mistake me for *The Wireless World* Information Department; however, knowing something of your regrettable habits of scribbling your queries on a pawn ticket and writing on both sides of even that, I will, for this once, relieve the harassed members of that department from repeating

Harassed members of the Information Department.

what has been stated in *The Wireless World* umpteen million times; if you will listen carefully to your portable receiver you will notice that bass is conspicuous by its absence, even though the set be named 'The Rachmaninoff,' and, therefore, the word 'din,' which you have chosen to use, is a very appropriate one. If you build a receiver capable of giving an *undistorted* output of from 500 to 1,000 milliwatts you will find that volume is plentiful, but that it is quite pleasing to the ear; in your case even a relatively small output creates a false impression of *excessive* volume due to the distressing effect of the distorted output on your auditory perceptions."

Buying in Comfort.

I recently went along to the premises of a well-known West End dealer with a friend in order to assist him in the choice of a new receiver. We were courteously received and made comfortable while several good sets were put through their paces for us; indeed, we were made so comfortable that as I lounged in my chair I reflected that it only needed a cigar and a glass of barley water to complete the picture. We were by no means the only customers, but the scene was in marked contrast to that obtaining during my previous visit in October, when I found myself in the midst of a yelling, seething mob, all "buying against time," choosing hurriedly and irrationally in order to get some new receiver model at the beginning of the winter months.

I suppose the truth is that the ordinary man has still the idea—true enough a few years back—that all the manufacturers are holding their plums back until the Olympia Exhibition, and I am not sure that a few wireless traders have not got the same idea. Nothing could be farther from the truth, of course, and, as I have recently noticed with satisfaction as a confirmation of my view, the Pye Radio people have ceased to function seasonally, and are just now attracting public attention to new products of theirs which have just appeared on the market, the latest arrival being their D.C. transportable receiver. Apart from this firm, one cannot help being struck by the large number of new sets of all types that are now being put forward in what used to be the close season for radio.

I am strongly in favour of buying sets in the summer rather than in the winter—especially in the pre-Christmas season—for several reasons, apart from the fact that they can be chosen in comfort, and on merit alone, rather than for sheer novelty. Owing to the feverish desire to get the set home before Christmas, one is quite likely to find that the thing is delivered at midnight on December 24th in an unworkable condition due to imperfectly soldered connections which have escaped the vigilant eye of the manufacturers' test-room inspectors in the mad rush of autumn.

THE LOWER REGISTER in Moving Coil Loud Speakers

The Effect of the Surround.

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

(*Concluded from page 481 of previous issue.*)

THE next point for consideration is the effect of bending a small portion near the edge over and glueing to it a narrow strip of cardboard or presspahn, say ¼in. wide. This makes the edge fairly rigid. It should be clear that in the previous experiments the edge was quite free to bend—this is readily tested by hand—whereas it is now rather a different matter owing to the stiffening effect of the presspahn. Consequently, the edge cannot bend appreciably during vibration, and, therefore, the radial modes are not forthcoming as before. About 250 to 300 cycles, the seam, being stiffer and heavier than the rest of the diaphragm, causes a little commotion. This can be viewed very nicely by aid of a neon lamp or by other stroboscopic means. The diaphragm on one side of the seam moves up, whilst that on the other moves down, and vice-versa. In fact the whole thing resembles a rough sea. Greater realism can be obtained by mounting a weight (say, 10 gm.) with an adhesive to the top of the diaphragm, about halfway between the edge and the coil. Viewed stroboscopically—at a suitable frequency, of course, say 80 cycles—the weight tosses about like a ship in the Bay of Biscay on a rough night. This is due to the effect of the weight causing the diaphragm to "break-up" locally. Doubtless readers will be able to devise more spectacular sights, using the same phenomenon.

Barring weights, we find that on measuring the output resistance of the diaphragm with reinforced edge, as before, that no appreciable resonances occur, and the output is only a fraction of its value with the free edge, i.e., up to frequencies of 250 cycles. One might suggest comparison of broadcast reception with diaphragms having free and reinforced edges. Naturally, to get the full effect and obtain proper comparison, the two diaphragms must be tested with a change-over switch—which means having two pot magnets. It is tacitly assumed that a baffle is used. Owing to the relative strength of the upper register, the difference between the two cases is masked to an extent, but this can be overcome by removing some of the upper register in any manner whatsoever, orthodox or otherwise. In some cases it will be removed automatically by the faulty design of the receiver!

We now come to the third case—the diaphragm of Fig. 1 (in last week's issue) with its edge turned

SUMMARY.

1. When the edge of a conical diaphragm is quite free, so that it can bend readily, sharp resonances lasting only a few cycles occur from 50 cycles up to 200 cycles, after which they are relatively unimportant. These resonances correspond to modes of vibration of the diaphragm caused by its bending and assuming certain shapes. At the lowest resonance the mouth of the cone is oval and there are four nodes.

2. When the edge is reinforced it cannot bend easily and the radial modes disappear. The low-frequency output is considerably reduced and weak compared with the upper register.

3. Addition of a rubber annulus or surround gives a much greater low-frequency output than either a free or a reinforced edge. This is due to the surround acting as an auxiliary resonant diaphragm. When the area and tension of the surround are properly adjusted, the overall response of the loud speaker is better balanced than with either a free or a reinforced edge.

4. When the surround is very taut, or is made of a material like leather, the lower register is given by resonance of the diaphragm vibrating as a whole thereon. The resonant frequency usually lies below 100 cycles, and the bass is centred round this point. The radiation resistance—as referred to the valve circuit—reaches thousands of ohms. Being greater than the resistance of a power triode, it is adequate to cause a "crevasse" in the current-frequency curve. When the diaphragm is impulsed, the magnetic field is inadequate to stop oscillations. This method of producing "bass" is very objectionable.

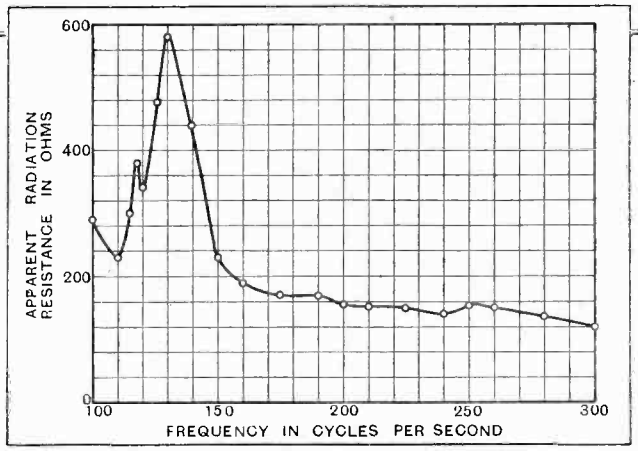
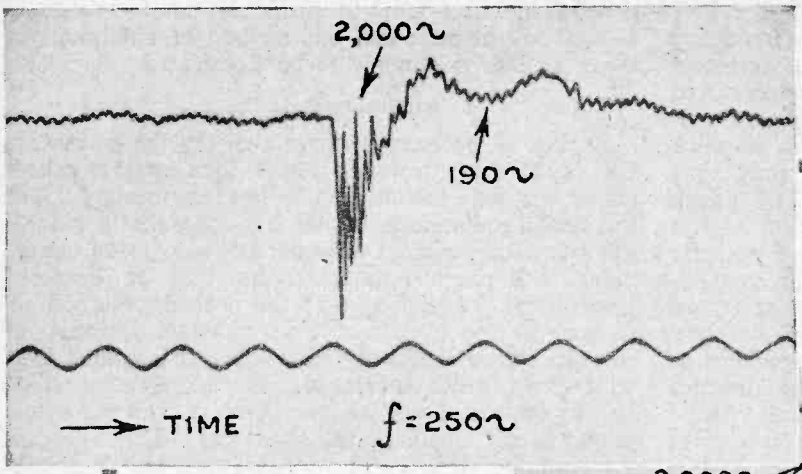
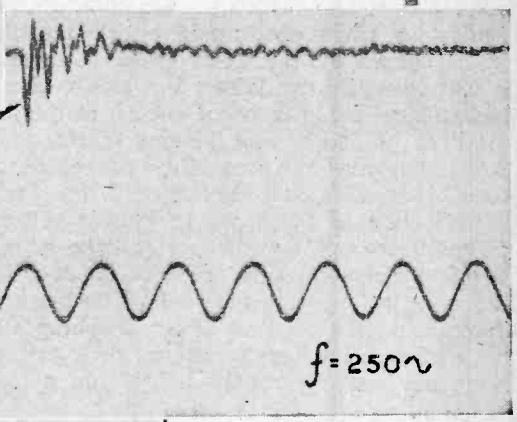


Fig. 6.—Curve showing influence of annular rubber surround on output from moving coil loud speaker at low frequencies. It should be noted that the output is much greater than with a free edge as in Fig. 4 in last week's instalment. Note that the vertical scales are different.



(Left) Fig. 7.—In this oscillogram it is seen that the oscillations of the surround are not damped out by the magnetic field.



(Right) Fig. 8.—Using the same diaphragm as in Fig. 7, but with rubber surround removed there is no trace of resonance at 190 cycles.

over, say, $\frac{3}{16}$in. or $\frac{1}{4}$in., and mounted on a rubber surround about 1in. wide. If the surround is not too taut, the natural frequency of the diaphragm, moving as a whole on the surround as the elastic member, will be seen below 20 cycles per second. This can be tested by aid of a 25- or 50-cycle gramophone record run at reduced speed. At the resonance frequency the amplitude of vibration of the diaphragm will be a maximum—there will, of course, be no sound unless harmonics are generated by the record, the pick-up or the loud speaker. I am assuming, of course, that the listener is a normal individual. It appears that there are some people who hear the long-wave station at Rugby coming through "neat," i.e., at its natural frequency. Presumably, *mutatis mutandis*, there are others who can hear zero frequency and feel zero temperature!

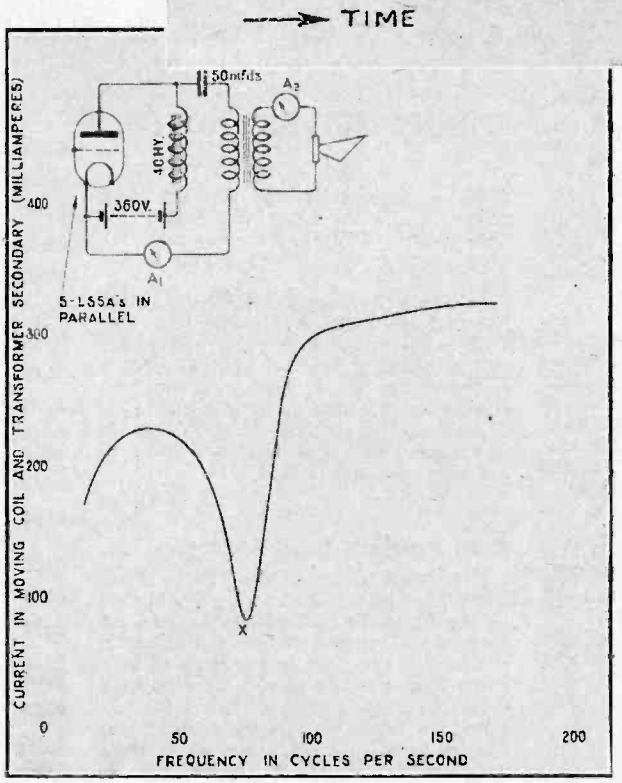


Fig. 9.—Curve showing alternating current in moving coil loud speaker when an equal voltage is applied to the grids of the power valves at various frequencies. The point X is the resonance of the diaphragm on its leather surround. The current is about 80 milliamps or $\frac{1}{5}$ its value at 150 cycles.

On testing the diaphragm as specified above, we find that the bass register has suddenly got a new lease of life. Instead of the mountain chain of the free edge or the low-lying plain of the reinforced edge, the lower register is increased considerably and there is a resonance at 129.5 cycles. This state of affairs is portrayed graphically in Fig. 6. The rubber has introduced resonances due to itself acting as an auxiliary diaphragm (it is $\frac{1}{3}$ the projected area of the cone, but moves farther). Although the resonance at 129.5 cycles looks very formidable it only represents an increase of 6 decibels (T.U.) above the level at 200 cycles, and in the lower register this is not so very serious, although obviously it would be better if it were only 3 decibels. Records show that this resonance is damped out by the magnetic field when the diaphragm is impulsed. In the *Philosophical Magazine*, p. 29, expression (9), January, 1931, the reader will find a formula by aid of which the resonance frequency of the surround itself can be calculated provided the resonance frequency of the diaphragm on the surround is known. In the present case the latter is 18.7 cycles per second, whilst the former is about 129.5 cycles per second. This gives a ratio of $\frac{129.5}{18.7} = 7/1$, which is good agreement with the value

The Lower Register in Moving Coil Loud Speakers.—

computed from the formula. If the lower frequency had been 27 cycles the resonance of the surround acting as an annular diaphragm would have occurred at about $27 \times 7 = 189$ cycles, which is too high for well-balanced reproduction. Also by taking an impulse record—*The Wireless World*, April 3rd and 10th, 1929—it is found that the magnetic field is not strong enough to damp out the oscillations of the surround at frequencies as high as 189 cycles. This is very clearly shown by the record of Fig. 7. By way of contrast, Fig. 8 has been reproduced. It is an impulse record of the same diaphragm with the *rubber surround removed*. There is now no trace of the resonance at 189 cycles, which shows quite clearly that the influence which caused the resonance has been removed. There is a 2,000-cycle oscillation, but this is due to a main symmetrical mode (2 nodal circles) of the diaphragm—see Figs. 5*a* and 6, *The Wireless World*, January 28th, 1931. Provided the area of the rubber annulus or surround is suitable, and the tension is nicely adjusted, the reproduction of the lower register is better and more powerful than it is with a free edge or a reinforced edge. Strictly speaking, the latter is out of the question.

Lastly, we come to the case where the lower register depends upon resonance of the diaphragm as a whole on a surround of tough material such as leather. The frequency usually occurs below 100 cycles, but it depends upon the tautness of the surround. We might as well say at once that this method of obtaining the lower register is strongly to be deprecated.

Radiation Resistance.

In Fig. 9 we have a curve showing the current in the power stage working into a loud speaker whose diaphragm was mounted on a leather surround. The increase in radiation resistance is so large that it reduces the alternating current to about one-quarter its normal value. A rough estimate shows that it exceeded 5,000 ohms. Assuming that the normal radiation resistance at 150 cycles is 70 ohms, the increase at resonance is in excess of 70 fold, i.e., it is greater than 18 decibels, which is colossal. Fortunately, the reduction in current offsets this to an extent, and the actual output is not enhanced to this degree. The reproduction from an instrument with a characteristic of this nature is unpleasant and is usually accompanied by a conspicuous boom. In this case the magnetic field was inadequate to damp out the natural oscillations of the diaphragm on its surround, so that each severe impulse is accompanied by a note of 80 cycles. Also it will be observed that the resonance covers a comparatively small frequency range, and that the—so-called—lower register is centred round one frequency. The higher the resistance of the power valve the greater the resonance, since the reduction in current is less.

The Wilkins-Ellsworth Polar Expedition.

Sir Hubert Wilkins' submarine, "Nautilus," in which it is proposed this summer to make a dash under ice to the North Polar regions, will be equipped with a 200-watt transmitter, with which it is expected that communication will be maintained not only with commercial and ship stations, but with short-wave experimenters.

The chief wireless operator will be Mr. R. E. Myers, who owns the amateur station W3AJZ at Bethany Beach, Delaware, and he is confident that Canadian and American amateurs will be able to keep in constant touch with the submarine. The station will use five frequencies for calling, viz., 375, 500, 5,525, 11,050 and 16,580 kilocycles (800, 600, 54.3, 27, and 18.1 metres), and will have the choice of ten for working, viz., 375, 400, 410, 5,555, 6,620, 8,450, 8,920, 11,110, 13,240 and 16,660 kilocycles (800, 750, 731, 54, 45.3, 35.5, 33.6, 27, 22.6 and 18 metres).

The A.R.R.L. states that this will be the latest of more than fifty expeditions that, since 1923, have depended upon amateur stations to keep in touch with home.

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Other Expeditions.

The American Radio Relay League is also organising schedules between amateurs in U.S.A. and other expeditions which will journey to remote parts of the world during the coming months.

The Haart Trans-Asiatic expedition is now preparing to set out from Beyrouth across Central Asia. The party consists of 35 members, and will proceed in two divisions, one encircling the mountain ranges, while the other will follow the historic trail of Marco Polo and the track of Alexander the Great's march to the Indus.

In South America the Dickey Orinoco River Expedition is working its way 1,600 miles inland to a point where they will establish a base where the wireless operator, Mr. W. J. Lanz, will set up a station for communication with amateurs, as well as with the *New York Times*. It is expected that this station will be in operation by May 15th.

TRANSMITTERS' NOTES.

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Radio Amateur's Handbook.

The eighth edition of the "Radio Amateur's Handbook" has now been published by the American Radio Relay League. A note on the seventh edition of this useful publication appeared in our issue of February 4th, so at the present time we shall defer the consideration of this later edition to a future date, only advising our readers to order their copies as early as possible from Mr. F. T. Carter, Flat A, Gleneagle Mansions, Streatham, S.W.16.

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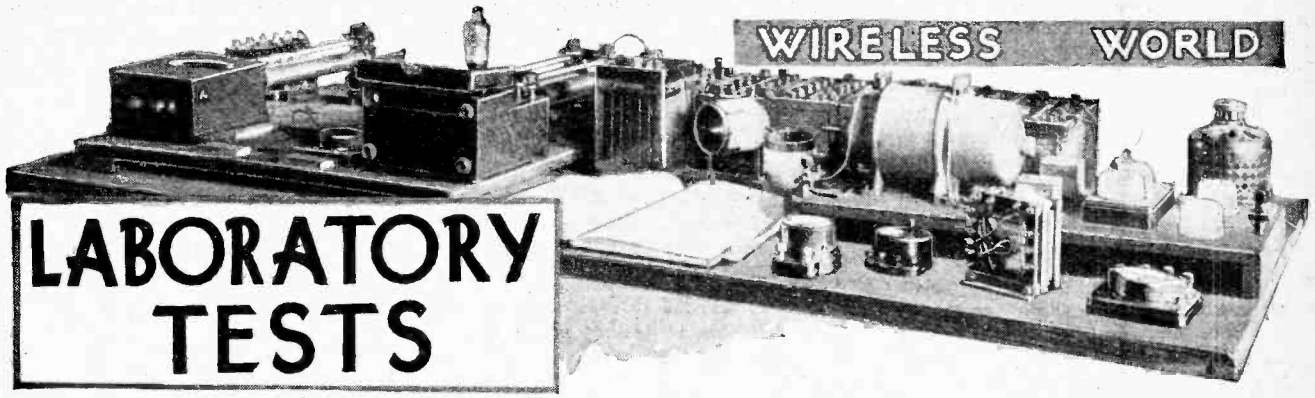
QRA'S WANTED.

CMB6, CMZ14, CNZ7, ZSF3, CE3BU, CM2IP, CM2PA, CM2FN, FQ8HP, CM1XS, LU2T, LU3UU, G12BB, NN1BX, PY1IB, PY2WA, SP2N, SU8NG, SV7BJ, TI4AB, TPIA, VE3LM, VIAP, VE1HR, VE3MT, VE4JD, VP1AZ, VS2BR, VS6AP, XG1JP, XL3M, YN1U.

NEW CALL-SIGNS AND CHANGES OF ADDRESS

G2CR	(ex 2AAA) A. L. Crane, 44, Brook Bank Rd., Lewisham, S.E.13.
G2XB	J. Browne, Ravenhurst, Frederick St., Oldham. (Change of address).
G2YD	G. A. Wright, Melbury, Kingston Hill, Surrey.
G5DI	T. Brown, 253, Helmsley Rd., Sandyford Rd., Newcastle-on-Tyne.
G5MH	D. P. McNeish, 29, Wiverton Rd., Nottingham.
G5YW	C. F. Scruby, Kent House Restaurant, Foots Cray, Sidcup. (Change of address).
G5WG	(ex FE1ES, Cairo) W. E. Corbett, c/o Philips Lamps, Ltd., 25, Stanley St., Liverpool.
G5WV	D. Woods, Malolo, St. Edmund's Rd., Felixstowe, Suffolk. (Change of address).
G6BA	(ex 2AAY) J. R. Baker, 133, Trafalgar St., Gillingham, Kent.
G6CW	J. J. Curnow, 11, Grove Avenue, Muswell Hill, N.10.
G6HJ	E. H. Jenkins, 40, Eardley Crescent, S.W.5.
G6QF	A. M. Robertson, 97, Derbyshire Lane, Stretford, Manchester. (Change of address).
G6UB	(ex 2BXU) S. W. J. Butters, Walla-Brook, Guy Rd., Beddington, nr. Croydon, Surrey.
G6YX	R. F. G. Holness, 4, Park Parade, Tally Ho Corner, North Finchley, N.12. (Change of address).
G2YC	(ex 2AZU) J. Stannard, 18, Wimpole Mews, Cavendish Sq., W.1.
G2YG	W. H. Andrews, 16, Lassa Rd., S.E.9. (Change of address).
G2YN	R. H. G. Garside, 7, Egremont Rd., Hersingham, Whitehaven.
G6JP	G. R. Jessop, Oakbank, Lena Gardens, W.6.
G6SY	(ex 2BAJ), J. F. Stanley, The Frith, Mersham, Ashford, Kent.
2AGN	C. S. Brown, 39, Westfield Way, Dormanstown, Redcar, Yorks.
2AHD	H. J. Ahier, Lansdowne House, 45, Colomberie, Jersey.
2AHX	L. E. Crabbe, 13, Luccombe Hill, Redland, Bristol.
2AYE	W. Hibbert, 42, Bushy Wood Rd., Totley Rise, Sheffield.
2BIT	J. B. Webb, Pitlands, Salcombe Hill, Sidmouth, Devon.
2AOP	S. Parr, 18, Harris St., S.E.5.
2APG	L. Cooper, 130, Walton Rd., East Molesey, Surrey.
2ARZ	A. J. Page, 41, Mayfield Rd., Chadwell Heath, Essex.
2AYB	W. Hibbert, 42, Bushey Wood Rd., Yotley Rise, Sheffield.

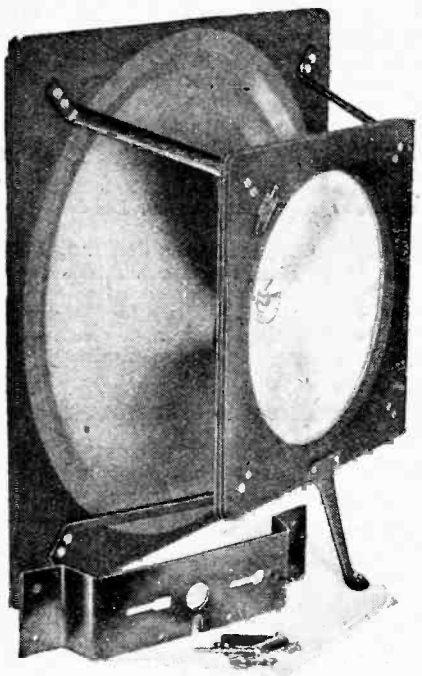


LABORATORY TESTS

A Review of Manufacturers' Recent Products.

WATES MODEL 31 DOUBLE-CONE CHASSIS.

Several improvements have been incorporated in this new version of the Wates Universal chassis. Parchment is still used for the smaller cone, but the larger cone is now made with a new type of



Redesigned Wates Universal cone chassis.

treated paper, and the method of suspending this cone has been modified to give greater freedom of movement. This has resulted in better reproduction of the bass.

The universal plate carrying the movement has been designed to accommodate most of the moving-iron movements at present on the market, and detailed instructions are given for assembling as many as twenty-four leading makes.

The chassis is available in three sizes, and an all-round reduction in price has been effected, as follows: 20in., 11s.; 14in., 9s.; 12in., 8s. The makers are the Standard Battery Company, 184-188, Shaftesbury Avenue, London, W.C.2.

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"KONDUCTITE" METALLIC PAPER.

A material possessing the screening qualities of sheet metal, but being as easy to work as paper, has been introduced recently by Gramo-Radio Amplifiers, Ltd., 1A, New London Street, London, E.C.3. Its special designation is "Konductite," and it consists of stout tinfoil tenaciously glued to thin cartridge-type paper. It can be employed as a covering for baseboards, lining the interiors of cabinets, as a metal backing for panels, and numerous other purposes.

Reasonable care should be exercised when handling the material and when mounting components on surfaces covered by it, since a tear, or long scratch, may lead to a break in the continuity of the screening.

"Konductite" is available in sheets costing 2s. and measuring 30in. x 20in.

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"SIMPLICON" GANG CONDENSERS.

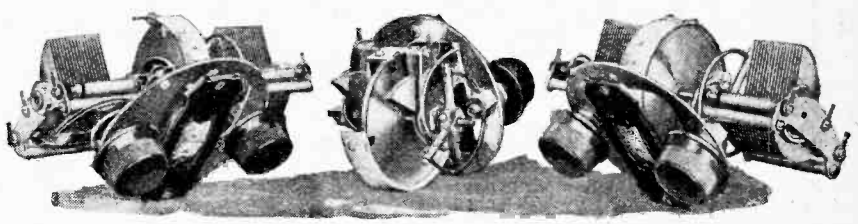
Consequent upon the modern trend towards simplification in the control of receivers there has arisen a demand for condenser assemblies embodying two or more units mounted on a common driving shaft. In the "Simplicon" range there are three two-gang condensers, all of which are fitted with drum dials and slow-motion drives. The model C.A. 2-gang I.R. unit embodies two 0.0005 mfd. condensers and a small three-vane condenser which can be used either as a trimmer or as a reaction control, according to the requirement of the circuit.

The main tuning control is mounted on the right of the escutcheon plate while the subsidiary control is located on the left. The moving vanes associated with the right-hand condenser of the unit are insulated from the driving shaft and the frame, but those of the left-hand condenser are electrically connected to both the spindle and the frame.

Since both condensers must run in step it was decided to measure the capacity of each at various positions of the scale. As a preliminary the minimum capacities were measured, and as there was found to be a difference of 6.5 micro-mfds. between them a small trimming condenser was connected across the smaller, and its capacity adjusted to bring the minimum capacities to the same value in each case. The following measurements were then made:—

Scale.	Right-hand Condenser Capacity in Micro-mfds.	Left-hand Condenser Capacity in Micro-mfds.	Difference in Micro-mfds.
0	33.8	33.8	—
10	36.4	36.8	0.4
20	57.0	56.8	0.2
30	73.0	72.4	0.6
40	107.3	105.8	1.5
50	138.2	133.4	4.8
60	180.0	173.0	7.0
70	218.0	231.0	13.0
80	306.0	306.5	0.5
90	379.0	394.0	15.0
100	481.0	492.0	11.0

To effect satisfactory ganging it is felt that a small trimming condenser, with accessible control, should be connected across each condenser in the assembly since the difference in capacity swings first in favour of one and then in favour of the other. This cannot be compensated for by a single trimmer. The price of this model is 26s.



A range of "Simplicon" 2-gang condensers.

A few measurements were then made with the C.A. 2-gang R.S. model, in which is incorporated a rocking mechanism for moving one set of fixed vanes through a small angle. In this unit both sets of moving vanes are electrically connected to the driving spindle. It was found possible to maintain both condensers in step throughout the scale with the aid of the trimming afforded by the rocking stator on one condenser. The price of this model is 25s.

There is also a 2-gang unit embodying condensers with paxolin dielectric. Trimming is achieved by rocking one set of fixed plates, and the price of this model, designated the C.B. 2-gang, with 0.0005 mfd. condensers, is 17s. 6d. The makers are Williams and Moffat, Ltd., Ladypool Road, Sparkbrook, Birmingham.

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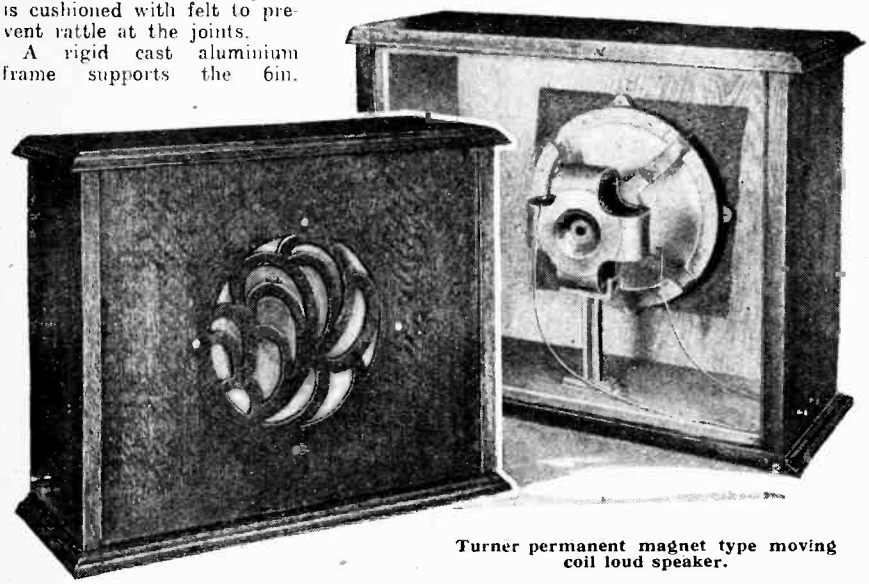
TURNER MOVING COIL LOUD SPEAKER.

This instrument is noteworthy for the solidity of its construction, not only in the loud speaker unit itself, but also in the cabinet. The latter is constructed of thick oak, and the back panel is cushioned with felt to prevent rattle at the joints.

A rigid cast aluminium frame supports the 6in. diaphragm, which is provided with a high-resistance moving coil suitable for use (through a filter circuit, of course) with output valves having an impedance in the region of 2,000 to 2,500 ohms. A low-impedance winding can be supplied for those who prefer to use a step-down transformer. A Darwin cobalt steel permanent magnet provides the field, and the pole pieces are nickel-plated to prevent rust.



Turner permanent magnet type moving coil loud speaker.

The sensitivity is decidedly above the average, and the frequency characteristic is in many ways ideal. The majority of receivers give a satisfactory output in the middle register, but are often deficient in the bass and treble. The Turner loud speaker should do much to compensate for this common fault since the output above 3,000 cycles and below 300 cycles is decidedly greater than the range of frequencies between these limits. There is a slight dip at about 2,500 cycles, but otherwise the response between 300 and 3,000 cycles is sensibly uniform. The reproduction of both speech and music is alike excellent.

The price of the loud speaker unit alone is £3 15s., while the complete instrument housed in an oak cabinet measuring 18in. × 16in. × 7in. is £5. The makers are Messrs. Turner and Sons, "Springfield," Langley, Maidstone, Kent.

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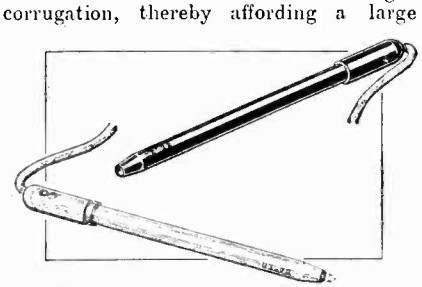
"EELEX" TESTING PRODS AND EARTH BOWL.

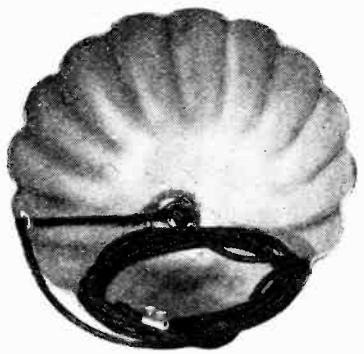
The spring-loaded testing prods illustrated here are a modified version of the original pattern reviewed in these pages in our issue of June 4th, 1930. The new style is fitted with brass contact points of much larger diameter, and it is now no longer necessary to maintain pressure on the spring-loaded caps to keep the brass contact point in the out position. By pressing in the cap and giving it a half turn, the contact is locked in the out position.

The external finish has been improved also, but the price remains as hitherto, namely, 3s. 6d. per pair, consisting of one red and one black to distinguish positive and negative leads.

The "Eelex" earth bowl is made from stout galvanised iron and measures 8¾in. in diameter. The sides have a slight corrugation, thereby affording a large contact surface for the diameter chosen. When buried in the ground the weight of earth inside the bowl augments the contact pressure between the underside and the surrounding soil. Firmly attached to the inside of the bowl is a seven-stranded insulated cable 7ft. in length and terminating in a brass connection for an extension lead, if this is found necessary. The price is 5s. 6d., and the makers are J. J. Eastick and Sons, Eelex House, Bunhill Row, London, E.C.1.



Eelex spring-loaded testing prods.



Eelex fluted earth bowl.

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Trade Notes.

The Limit Engineering Co., Ltd., Albion Street, King's Cross, London, N.1, have acquired new premises at 15-29, Windsor Street, Essex Road, Islington, London, N.1. The telephone number is Clerkenwell 2721-2, and the telegraphic address Gramolimit, Nordo, London.

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The Turpin Engineering Co., Ltd., 177, The Vale, Acton, London, W.3, announce that they have been appointed sole concessionaires in Great Britain for "Dinin" lighting, starting, and high- and low-tension radio accumulator batteries.

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Catalogues Received.

Electradix Radios, Electradix House, 218, Upper Thames Street, London, E.C.4.—Illustrated catalogue No. 75, dealing with measuring instruments, electrical apparatus, a wide range of motors, generators and converters; also a varied range of goods of the type in which this firm have long specialised.

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The Ever Ready Co. (Great Britain), Ltd., Hercules Place, Holloway, London, N.7.—Display broadsheet, "The Right Battery for Your Portable," tabulating in alphabetical order the majority of proprietary portable sets and the recommended type of Ever Ready H.T. battery.

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The Rothermel Corporation, Ltd., 24 and 26, Maddox Street, London, W.1.—Illustrated folder dealing with the full range of Magnavox loud speakers.

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Burne-Jones and Co., Ltd., Magnum House, 296, Borough High Street, London, S.E.1.—Illustrated folder describing the Magnum range of A.C.-operated sets, also illustrated folder of Magnum components.

BROADCAST BREVITIES

By Our Special Correspondent.

Empire Broadcasting.—The Vaudeville Vote.—New Governors?—Blind Wireless Users.—Triumph of Adrian Boult.—Broadcasting from Hyde Park.

Bouquets for 5SW.

Raptures in Australia over the "surprising increase" in the strength of 5SW led me to question B.B.C. officials concerning the experiments still in progress at the Chelmsford short-wave station.

Apparently all that takes place in the way of experiment is the switching on and the switching off. Day by day (Saturdays and Sundays excepted) the transmitter automatically hands out the Daventry National programme.

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"Excellent Strength."

It seems that no change whatever has been made, either in power or wavelength, which remain at 10 kilowatts and 25.53 metres respectively. Yet Mr. R. N. Shaw, writing in "Wireless Weekly" (Australia), reports that it is now possible to listen to "this powerful station" at really excellent strength on the loud speaker up till at least 7.30 a.m. and occasionally to 8 o'clock.

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Listening to Big Ben.

No doubt the signal-strength increase is due to the ordinary seasonal variation, but it is interesting to note that Australians have lost none of their interest in Empire broadcasting, and are looking forward to a good reception period just at a time when our own receiving conditions are getting a little so-so.

"One of the early-morning thrills," says Mr. Shaw, "is the hearing of Big Ben in London striking the hour of 7 o'clock the previous night."

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The Case of Mr. Rhynehart.

I sympathise with Mr. A. S. Rhynehart, of Bronte (N.S.W.), who, in his enthusiasm, sent a request to the B.B.C. for half an hour's gramophone recital before the usual morning transmission. With more or less logic, Savoy Hill replied that as the work of the station continues to be almost entirely experimental in character, no special programme can be prepared.

One day, however, when the Colonial Office has bestirred itself, Mr. Rhynehart may hear something better than a gramophone record. . . .

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B.B.C. and Television.

Because a portable television transmitter has been installed in No. 10 studio, it must not be inferred that television will shortly make its appearance during regular programme hours.

This Vaudeville.

All-day vaudeville, with an alternative consisting of dance music and occasional news, would suit some members of the community, but it is reassuring to be told officially by the B.B.C. that the idea of such a scheme is not being entertained.

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Popular "Verdicts."

While the assessment of public taste by means of ballots and relay systems provides some useful "pointers," Savoy Hill seems disinclined to regard popular "verdicts" of this sort as indications that the existing programme arrangements must be materially altered.

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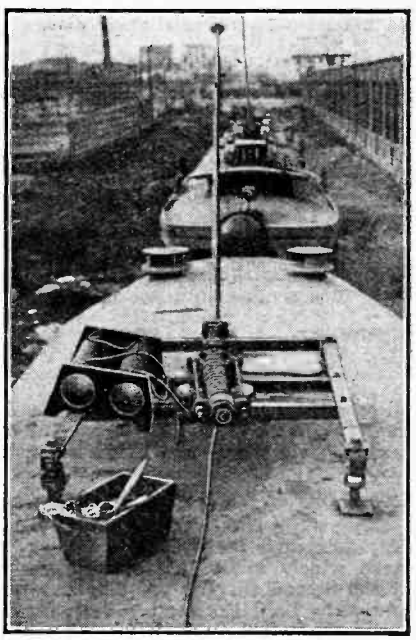
Little and Often.

There can be no doubt that certain types of programme which seem most in demand actually owe part of their popularity to the fact that they are administered in carefully measured doses. Paraphrasing the poet: The little more, how much it is; the little too much, and oh! take the dam thing away! It would be thus even with vaudeville—that eclectic collation of all that matters—and possibly, too, with dance music, though to many people continual jazz is as vital as oxygen.



NIPPED IN THE BUD. The Italian broadcasting authorities are co-operating with tramway officials in the elimination of electrical interference. Our photograph shows an interference suppressor attached to the collector of a tram. Successful tests are reported.

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Brighter Programmes for Summer-time.

During the summer the B.B.C. programmes will be a little more yeasty than of late, but apart from this I can discover no signs that the latest demands of an enlightened public are producing any volcanic activity in the Programme Department.

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Choosing New Governors.

The Very Rev. Dr. Sheppard, late Dean of Canterbury and one of the first "broadcasting parsons," has been mentioned as a possible candidate for a vacancy on the B.B.C. Board of Governors. I believe that the choice of Dr. Sheppard would be very popular, but at present all talk regarding future Governors is extremely premature.

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How It Is Done.

Naturally, the prophets would be no prophets if they did not get busy fairly early, and already it seems they are prodding bent pins into the pages of biographical reference books in the hope of spotting a winner in the Governorship Stakes, although the contest does not fall due until the end of the year.

The five Governors now on the Board will then be eligible for re-election, though it is worth noting that, according to the Charter, there will still be vacancies for two more.

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The Prince and Blind Listeners.

The "Wireless for the Blind" Fund could hardly have a more powerful advocate than the Prince of Wales, who will make an appeal for a further £15,000 in his broadcast speech at the Clothworkers' dinner on May 27th.

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A Wise Decision.

I hear that the National Institute for the Blind are already in possession of a thousand complete installations, which will be presented to blind listeners in the North immediately the Moorside Edge station is working on a service basis. It is considered unwise to hand over these receivers until a constant signal strength is assured, as nothing could be more confusing to a blind man than day-to-day variations in the quality of received signals.

Simplified Control.

The aim of the Fund is to provide blind people with complete equipments, including aerial and earth systems, so that operation is reduced simply to the working of a switch.

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Northern Regional Takes Over.

Many listeners in the North must have been pleasantly surprised by the announcement that Moorside Edge will "take over" the Regional programme completely as from Sunday next, May 17th. The fun will begin when Northern National starts up on 301.5 metres. I understand the first tests are to take place almost immediately.

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And Now the "Nat."

There is, of course, a good wavelength separation between 479 and 301 metres, but I expect there are sets still in use in Northern parts which only a lack of range prevents from mixing 5XX with PCJ. Anyhow, we shall see.

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A Symphonic Triumph.

Last Wednesday's symphony concert at the Queen's Hall brought to an end the most ambitious musical season yet arranged by the B.B.C. The greatest achievement, of course, has been the creation of that wonderful ensemble, the B.B.C. Symphony Orchestra, with its 114 picked players, and a word must be said, too, about the undoubted triumph of Mr. Adrian Boult.

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Mr. Boult's Success.

Mr. Boult has more than justified the faith placed in him by the B.B.C. when they persuaded him to leave Birmingham and take over one of the most responsible musical posts in the kingdom. He has shone not only as a conductor, but as an organiser, with that rather rare talent of keeping the army on the march without over-banging the drum.

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The Personal Touch.

Remembering personal interviews with the B.B.C.'s Musical Director, I should say that much of his success in management has been due to his dignity and tact, combined with a total absence of "side."

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Tons of Money.

The B.B.C. have no cause to grumble in regard to the financial aspect of the season. There have been twenty-three concerts, and the house has been practically full at every one. A slight falling-off has been noticeable during the last month, but this must be attributed to the rival claims of Covent Garden opera, which has made its influence felt in more than one London concert hall.

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And Now—the "Proms."

Autumn is upon us! Or, in other words, the "Proms" programme is being arranged. Another eight weeks' season is planned, lasting from August 8th to October 3rd, and need it be added that the conductor will be Sir Henry Wood? This will be Sir Henry's Thirty-seventh Promenade Concert Season. A good proportion of the concerts will be broadcast by the B.B.C.

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The Missionary's Wireless Set.

"How Missionaries are Using Wireless" will be the subject of the Monthly Missionary Talk on the National B.B.C. programme from 4 to 4.15 p.m. on Sunday next, May 17th. The subject will be dealt with by Mr. Hubert W. Peet, editor of the Far and Near Press Bureau, who is in close touch with missionaries all over the world. As one of them tells him, "Wireless is helping to prevent us becoming old fogies and 'moss-backs.'"

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Second City of the Empire.

Glasgow Civic Week begins on May 29th, and the B.B.C. is helping to make widely known the various merits of the Second City of the Empire. Recently the Lord Provost broadcast a talk on the aims of Civic Week. On May 26th Mr. George Eyre-Todd will tell Scottish listeners all about the Glasgow of the past. Advancing to the Glasgow of To-day and To-morrow, Mr. Rosslyn Mitchell will broadcast on this subject on May 30th. Mr. Rosslyn Mitchell's voice has been heard many times from the Glasgow studio, and he is very popular with Scottish listeners.

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A. J. Alan.

A. J. Alan is to make a welcome reappearance on May 19th (National), when he will tell a new story, which he has called "Mr. Pappas." Regional listeners will hear the story on May 21st.

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Crowds, Choirs, and Bands.

The control engineers will have plenty to occupy them on Empire Day, May 23rd, when the B.B.C. will relay an open-air celebration in Hyde Park. Community singing will be conducted by Mr. Gibson Young, and listeners will hear massed bands of the Coldstream, Irish, Welsh and Scots Guards, and massed choirs of London churches.

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Damping Our Spirits.

A friend comments on the fact that Henry Hall's Glenagles Hotel Band has adopted a characteristic opening foxtrot as a sort of trade mark—in the manner of Jack Payne. What grieved my friend the other evening, however, was the sudden recognition that, for broadcasting from the Midland Hotel, Manchester, Henry Hall has chosen as his hall-mark (hi!) "Share My Umbrella."

The savage irony of this comes badly from a band originating in the "land of the mountain and the *flood*."

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All About Northern Regional.

On May 19th the North Regional Director will give a talk on "The Development of Northern Broadcasting." The coming into full operation of the Regional Scheme in the North on Sunday next will provide him with ample material to interest thousands of listeners.

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Talks on Unemployment.

Sir William Beveridge made a successful début at the microphone last autumn when he contributed his views on the series on "Trade Within the Empire."

Listeners will hear him again on May 19th, when he is to give the first of a new series of talks on the causes of unemployment.

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Shingled Shakespeare.

National vaudeville on May 22nd will be given by Tommy Handley, comedian; Fred and Mary, in "Matters of the Moment" (their names hide the identity of two popular broadcasters); Bransby Williams, in Dickens character studies; Marius B. Winter and his Dance Orchestra; the Carroll Sisters, in harmonised duets; Leonard Henry, comedian; and a sketch by Frank Burton entitled "Shingled Shakespeare," in which the parts of the Hairdresser and the Lady will be taken by Ivan Samson and Lilian Harrison respectively.

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Obviously.

From the Savoy Hill Postbag:—

"Naturally, being a pianoforte tuner, I can tune without oscillating."

FUTURE FEATURES.

National (261 and 1,554 metres).

MAY 17TH.—International Youth Service.

MAY 18TH.—"The Dream of Gerontius" (Elgar), relayed from the Queen's Hall, London.

MAY 19TH.—"Die Valkyrie," Act 3, relayed from the Royal Opera House, Covent Garden.

MAY 20TH.—"Dr. Abernethy—His Book," a play in one act by Alicia Ramsey and Rudolph de Cordova.

MAY 21ST.—Speeches by the Right Hon. J. H. Thomas and the Right Hon. Stanley Baldwin, at the Annual Banquet of the Royal Empire Society, relayed from the Connaught Rooms.

MAY 23RD.—"The Gypsy Princess," a musical comedy.

London Regional.

MAY 17TH.—Sunday Orchestral Concert—28.

MAY 18TH.—"Dr. Abernethy—His Book."

MAY 20TH.—Programme of American Dance Records.

MAY 21ST.—"Lohengrin," Prelude and Act 1, relayed from the Royal Opera House, Covent Garden.

MAY 23RD.—Vaudeville programme.

Midland Regional.

MAY 19TH.—A Bach Concert by Members of the Birmingham Bach Club, relayed from the Cathedral, Birmingham.

MAY 22ND.—Programme of Shakespearean Music.

West Regional (Cardiff).

MAY 20TH.—Cardiganshire Musical Festival, a concert relayed from the University Hall, Aberystwyth.

MAY 22ND.—A West Country Variety programme.

North Regional (Manchester and Leeds).

MAY 21ST.—"Put Not Thy Trust," a play in one act by Muriel Levy.

Glasgow.

MAY 19TH.—Opening of the General Assembly of the Church of Scotland; a Devotional Service in St. Giles' Cathedral; Opening ceremony in the Hall of Assembly (from Edinburgh).

Belfast.

MAY 20TH.—A Record Vaudeville programme.

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.

LONG WAVES.

Sir,—By all means modernise 5XX. This station is most useful to people living in remote places (Glasgow, for instance), as the writer, who, although possessed of a modern commercial 2 H.F. detector transformer set with moderate outside aerial system, finds that this B.B.C. station alone can be depended on to give a reliable fadeless transmission at sufficient strength during daytime. The writer, through living in Glasgow, had never realised until recently, when Slaithwaite tried herself out, how vastly improved was the modern quality of transmission, probably due partly to the transmitter gear, and partly to the modern more efficient land line linking up the studio. This long land-line relay has always been a quality spoiler to remote stations, but Slaithwaite has demonstrated how greatly this defect can be overcome. Of course, the fading from this latter station rules it out as a supplier of reliable programme fare, and so, during daytime, we turn to 5XX to deliver the goods, and next best to Kalundborg, which obliges if Morse permits.

Glasgow. W. B. HAWKSLEY.

REGIONAL SCHEME.

Sir,—For your information 5GB, locally the best station, cannot now be listened to here after dark since the change of wavelengths; apparently we are in the sky area now, distance 70 miles—trouble, fading and distortion.

No one, apparently, listens to the local relay, so at the moment we have 5XX and 2ZY and the foreigners.

London Regional impossible after dark, good until—fading, distortion.

London National—ditto, only worse.

Glasgow—frequently the best B.B.C. transmission, as no one interferes with it.

The local popular winter sport is to obtain the worst possible 2- or 3-valve set and then distort and interfere with everything.

We cannot listen-in on Saturdays or Sundays because of set interference; and yet one hears so much of removing industrial static. REG. T. ASHTON.

Hanley, Staffs.

AMATEURS AND SUNDAY BROADCASTS.

Sir,—I was interested in the letter you published in *The Wireless World* for April 18th from Mr. Hum concerning the question of B.B.C. broadcast programmes on Sunday mornings.

As an amateur transmitting enthusiast I agree entirely with Mr. Hum's remarks.

I had been under the impression that the B.B.C. were very considerate regarding the amateur transmitter and that they would observe a "quiet period" during Sunday mornings. It is impossible for me to work on the 160-metre band during broadcast hours owing to interference with neighbours' reception. In view of the foregoing remarks I can only work on that band on Sundays, during the mornings.

As there are many amateurs situated in the same position as myself, it means that if the B.B.C. commence broadcasts on Sunday mornings we shall be forced to cut out our experiments on the lower frequencies.

As is already known, much useful work is being carried on by amateur transmitters on the 160-metre band and, to me, it seems hardly conceivable that the B.B.C. would wish to stop serious experimenters from developing results which may possibly lead to reliable long-distance communication on this waveband.

The present-day long-distance commercial communications on the higher frequencies were made possible, in no small way, by experiments conducted by amateur transmitters.

I am sure that other readers must have their own views on this subject; may we hear them? JAMES L. ROE (G2VV).

Farnham, Surrey.

TESTING LOUD SPEAKER MAGNETS.

Sir,—Since writing my letter of March 28th, on the testing of loud-speaker magnets, I understand that a statement has been issued to the effect that the differential coil method described in my article of November 26th, 1930, is inaccurate. Any method of measurement is inaccurate unless the measuring instruments are used properly. For example, a badly made differential coil, or one which is removed from the position D_1D_2 of Fig. 1 will not give the correct value of the flux in the air gap. But one might just as well say that an expensive ammeter with the wrong scale or with an incorrectly adjusted zero is inaccurate.

If the two coils of a differential system are electrically and mechanically identical, their centres being situated respectively at the extreme edges of the air gap, the fluxmeter reading obtained on withdrawal of the system is equal to that when one of the coils is moved from end to end of the gap. It is a simple matter to construct a differential coil so that portions of the former on which it is wound act as stops on the magnet pin and the outer pole face. This ensures that the central planes of the two coils are in line with the extremities of the air gap. Fig. 5 of my November article is simple and suggestive, but there are other ways of achieving the same result.

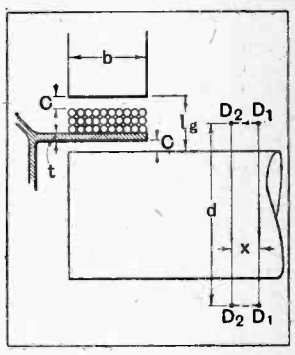

Fig. 1.
Diagram showing section through magnet and moving coil; b is the axial length of the gap, and l_g the radial length of the gap. D_1 and D_2 represent consecutive positions of a single coil when used to measure the flux passing through the cylindrical surface whose diameter is d and length x.

I wish to make it quite clear, therefore, that the method described in this journal, November 26th, 1930, is accurate and reliable when used in the proper manner. It has been tested against other methods, including that where the current of an electromagnet is reversed. The results were all in agreement. N. W. McLACHLAN.

London, S.W.1. April 22nd, 1931.

WOBBLY ORGANS.

Sir,—As far as the cinema organs which we hear broadcast are concerned, can "Free Grid" and Mr. Robert Reid Jones say with their hands on their hearts that the tremulant or the milder celeste device are abused? It is another matter, of course, if they are thinking of organs which they have heard at first hand; but why bring up such experiences in a *wireless* journal? The controversy "Cinema *v.* Church Organ" has been the cause of many intemperate letters in the musical Press recently, in which the "down with cinema organs" brigade has displayed much ignorant prejudice.

Does Mr. Jones seriously assert that cinema organs are not regulated as carefully as church organs? His limitation of cost point is utterly ridiculous, too, for quite a small unit organ for cinema use will run away with £3,000, and the cinema people would seem able to pay it, whilst the average church is hard put to it to raise £100 for renovation of an instrument held together by brown-paper, string and faith, let alone find the £600 to £1,000 for a modest new organ!

No, Mr. Jones; you are wide of the mark: dud organs *and* dud organists are found in both realms, but the best British

cinema organs are built by the same people who build many of our notable church and concert instruments, and with equal care.

Let Mr. Jones ponder on these facts, which are easily verified: The cinema organ which we hear on the National every Thursday was built by the same firm that made the organ which we also hear on Thursdays—that at Westminster Abbey (incidentally, it is the largest unit organ in Europe); and, by common (if grudging) consent, one of the cinema organists who broadcasts is placed among the world's half-dozen best recitalists.

Plympton, Devon. L. J. VOSS.

Sir,—In view of the recent correspondence under the heading of "Wobbly Organ," I feel that some remarks concerning these much-"slated" instruments would not be out of place.

In the first instance, I should like to point out to "Free Grid" (*The Wireless World*, April 8), that the so-called wobble (the proper name of which is tremulant) is by no means due to the acoustic properties of the cinema, but is a mechanical effect obtained inside the organ by its builders. Now as regards the difference he has noticed between church and cinema organs. The root of this difference lies in the music, as the purposes to which an organ is to be put decides the tonal character of the instrument. Therefore, the church and cinema organ are built to two totally different tonal standards. In the one case an instrument is required on which it is possible to imitate a jazz band or wail out a sobbing melody on a "swannee" whistle or do any of the hundred-and-one things required in the accompaniment of pictures, and in the other case a solemn-toned instrument to accompany psalms, hymns, and play straight organ music. To make matters a little clearer, I will draw an analogy. It is obvious to anyone acquainted or unacquainted with musical technique that an ordinary dance band would have great difficulty in trying to play, say, one of the Beethoven Symphonies; and in the same way the B.B.C. Symphony Orchestra would put up a very poor show in trying to play "Choo Choo" as Jack Payne does. This comparison holds good where cinema and church organs are compared.

As regards the constant wobble of which complaints are so frequently heard, this fault lies with the man playing the instrument, and is due to the constant use or misuse of the stop labelled Tremulant. The remedy is obvious.

Before closing, I feel that the letter from Mr. Robert Reid Jones calls for some remarks. It would be interesting to know on what authority he states that "many cinema organs are badly constructed from the tonal standpoint." From what tonal standpoint? If Mr. Jones means from the tonal standpoint of a church organ, then I agree with him. As I pointed out earlier in this letter, a jazz band cannot satisfactorily perform a Beethoven Symphony, and I am wondering whether our friend has been trying to play a Bach Fugue on a cinema organ. *Errare est humanum.* To quote further from his letter: "The pipes are thrown in and tuned up without any attention being paid to the regulation of each individual stop." I can only surmise from his remarks that Mr. Jones has been unfortunate enough to see and hear some extremely inferior work by a little-known or cheap make, and that in applying these comments to "many cinema organs" he is making a gross mistake. Obviously he has not examined work by the most reputable builders, such as Compton, Wurlitzer or Christie. It is a well-known fact in the trade that the workmanship, materials and final finishing of a cinema organ has, if anything, to be better than a church organ, owing to the colossal wear and tear these instruments are subject to, as against the bi-weekly use of most church organs.

Ealing, W.5. CLIFFORD HAWTIN.

DEAF AIDS.

Sir,—I was delighted to read Mr. M. R. Balbi's letter in a recent issue of *The Wireless World*, and follow his polite exposition of what is, to my mind, one of the greatest ramps in the electrical and wireless industry.

Having a relative who is afflicted with serious deafness, I followed with interest the enquiries to several of the widely advertised suppliers of deaf aids. Picking what appeared to be the neatest and most efficient instrument, my friends made the purchase, and received for the sum of £15 an ordinary carbon microphone embodying a variable resistance, a miniature single earphone and a battery case containing a non-standard-size three-volt dry battery.

The instrument was certainly well finished and the sensitivity up to standard, but nothing more, and representing in value perhaps a little more than £2.

What to me is the most ridiculous part of the whole outfit is the instruction which reads: "Flashlamp batteries must not be used." Why? Because, if the case was made suitable for them, the battery could be purchased for a few pence, and not at the exorbitant prices, from a shilling upwards, charged by the suppliers of the instrument.

As Mr. Balbi states, it is time that someone put an end to this profiteering by marketing a well-finished and electrically sound device at a price which makes it a commercial proposition. LEONARD H. LEE—G5FH.

West Smethwick.

THE STENODE.

Sir,—As an owner of a stenode wireless set which I received a few weeks ago, and had built for me as a special order by the courtesy of Mr. Joseph, the managing director of Messrs. R. I., which firm, I understand, builds the Stenode Company's receivers for them to the Stenode design, I was interested in the correspondence between Mr. Hallows and Mr. Cocking. Like Mr. Hallows, I am able to receive Muehlacker with perfect quality and quite free, of course, from London Regional or any heterodyne whistle. In fact, with this receiver I have found no trouble in separating stations nine kilocycles apart.

Uckfield, Sussex. G. A. McLACHLAN.

Sir,—The article on the Stenode in *The Wireless World* of April 29th is very interesting, but it still does not give a definite and convincing answer to the fundamental question which is the crux of the whole matter, and which may be expressed thus: Given reception conditions such that any ordinary receiver would sound a clearly audible heterodyne note (for example, of 5,000 cycles, due to two transmitters working on frequencies 5 kilocycles apart), *will* the Stenode, when tuned to one of these transmitters, cut out the heterodyne note, whilst faithfully reproducing modulation frequencies of 5,000 cycles and over?

Until this question is finally answered in the affirmative, one is inclined to suppose that the high audio frequencies are boosted up on the L.F. side to the same extent as they are cut off on the H.F. side, and that the heterodyne note will be there all the same. A. K. GORDON.

Crowborough, Sussex.

TALKIE TROUBLES.

Sir,—I must say I like the assumed ignorance of your contributor "Free Grid," and I have read with interest your correspondents' comments arising from his remarks upon motor-boating in the reproduction of "talkies."

One contributor blames this sound to "sprocket-hole noise," and points out that the frequency is 96 cycles per second. Providing the film is running at the correct speed, sound of this frequency is obtained; but I do not think that this could be mistaken for motor-boating, as, of course, the note produced is the "G" contained in the second octave below middle "C" (physical pitch).

The frequency of the sound produced, however, by the picture frames, or objects in the frame, might be as low as 24 to the second, which would not be distinguishable as a musical note, and would resemble "motor-boating" to a marked degree.

I have had considerable experience in the presentation of talking pictures, and have always found that "sprocket-hole noise" is easily "cured," but it is not possible in every instance to eliminate the "framing" type of noise, as, if the apparatus is set for a correctly printed film any small portion of badly printed film will produce the unwanted sound.

I may add that it is often quite possible, on examining the film with the naked eye, to see the cause of the trouble.

London, N.W.11. J. S. SUTHERLAND.

READERS' PROBLEMS

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.

Replies to Readers' Questions of General Interest.

Too Simple?

I have found that by merely connecting the terminals of my pick-up potentiometer (which is included in the carrier arm) across the grid leak associated with the first L.F. stage good reproduction is obtainable. The set embodies a detector, followed by resistance- and transformer-coupled L.F. stages.

Do you think that some other method of connection would give better results than this simple way of fitting the pick-up?

Provided that the values of your coupling resistance and grid leak are high in comparison with that of the pick-up potentiometer, there is not the slightest reason why the simple method of connection you describe should not be entirely satisfactory. If the resistances in question (both of which are, in effect, in parallel with the pick-up potentiometer) have a comparatively low value, amplification will be less than it might be, and, moreover, high-note reproduction may be impaired. By temporarily removing the two resistances you will be able to judge whether their presence is doing any harm. If it is, it will be advisable to fit a change-over switch, connected in the usual way, in the first L.F. grid circuit.

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Output Valves.

An output valve is sometimes classified in terms of its anode wattage dissipation; is this expression synonymous with "power output"?

No; statements with regard to anode wattage dissipation relate only to the amount of D.C. energy dissipated in the anode circuit of the valve. Power output, as generally quoted nowadays, refers to the amount of L.F. energy which the valve is capable of passing to the loud speaker, and is in every case less than the wattage dissipated in the valve.

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Selectivity of an Old Receiver.

Although the selectivity of my three-valve set (with neutralised triode H.F. stage) compares quite well with that of many modern sets I have heard, it is hardly good enough for present-day conditions. The set was built nearly four years ago, from information published in "The Wireless World," although no particular design was copied in its entirety. Litz-wound coils are used. Short of making drastic alterations, can you suggest any way of improving selectivity without sacrificing range?

Our usual advice in cases of this sort is to suggest the use of a coupled aerial circuit; if the necessary apparatus be made up into a unit the alterations to the receiver itself can hardly be described as drastic.

It may also be pointed out that the use of an efficient modern H.F. valve of considerably higher impedance than the type usually specified for a set such as you describe will invariably improve selectivity without introducing any very noticeable loss in H.F. amplification.

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Bias for the Car Set.

I intend to make a small detector-L.F. set for use in my car, and to feed the valve filaments from the 12-volt accumulator which supplies current for starting and lighting. Two-volt valves, wired in parallel and consuming a total current of 0.3 amp., will be used: will you please show me how the surplus L.T. voltage of 10 may be used to supply grid bias, thus avoiding the need for an extra battery for this purpose.

By inserting the voltage-reducing resistance in the negative battery lead, as shown in Fig. 1, you will be able to obtain any bias up to 10 volts. Grid voltage will be determined by the position of the tapping on the resistance element. If adjustable bias is not needed, the full 10 volts will be obtained if the L.F. valve grid return lead is joined to the "battery" end of the resistance.

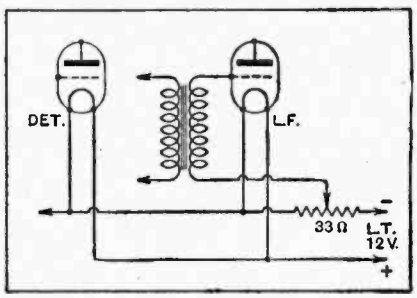

Fig. 1.—Twelve-volt car battery as a source of L.T. and grid bias voltage.

Where Screening is Unnecessary.

I am thinking of making a very small and compact detector-L.F. set with a built-in frame aerial for short-distance reception with headphones. Do you think that it would be worth while to screen all the receiver components—except, of course, the frame aerial?

It can generally be assumed that screening confers little, if any, benefit in the case of any receiver not having H.F. amplification. As you are attempting to build an extremely compact set, it is probable that the use of metallic screening would be definitely prejudicial to its performance, as the efficiency of the built-in frame aerial would probably be impaired by the proximity of a mass of unnecessary metal-work.

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Resistance-coupled L.F. Amplifiers.

A year or two ago, when resistance-coupled L.F. amplifiers were extremely popular, it was usual to specify for this purpose valves with an extremely high amplification factor. Since that time valves have changed considerably; in making a choice of a valve for use with the type of coupling in question, should one be governed by any other consideration than that of the amplification factor?

The mutual conductance of the valve is (and always has been) a matter of considerable importance when dealing with resistance-coupled valves. Unless this is high, it may be difficult to extract from the valve anything approaching its theoretical amplification without introducing a more or less serious loss of high notes. If high magnification is to be attained, however, it is essential to use a valve with a high amplification factor, the point being that unless a step-up transformer is used, magnification can never be greater than this amplification factor.

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Dual Range Coils.

Will you please tell me how much spacing should be allowed between the medium- and long-wave sections of a dual-range tuning coil?

This depends on a number of factors, such as the diameter of the windings, their H.F. resistance, and the amount of loss that can be tolerated, etc. It is difficult to be definite in giving an answer, because compactness is all-important in certain cases. However, you may take it as a rough-and-ready rule that, in coils of average dimensions, a clear spacing of about ⅛in. between windings is desirable; anything less than ⅛in. is likely to introduce appreciable losses.

Bias and Decoupling.

It is proposed to replace the screen-grid valve in my receiver with another type which consumes considerably less anode current. The set is mains-operated, and bias for the H.F. valve is obtained automatically, there being two resistances in series in its grid circuit. Will it be necessary to change both these resistances when the new valve is fitted?

We think you are confusing the functions of decoupling and bias resistances. On referring to Fig. 2, which shows the essentials of a typical arrangement, it

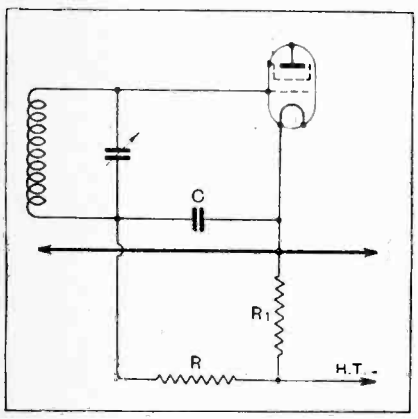

Fig. 2.—An automatic bias resistance (R_1) must not be confused with its associated decoupling resistance R.

will be seen that, although both resistances are in series, only one of them (R_1) is directly connected in the cathode-anode feed circuit. It is across this resistance that bias voltage is developed; the other resistance (R) merely deflects H.F. impulses through the by-pass condenser C.

Your question may be answered by saying that in any case only one of the grid-circuit resistances need be changed. But even this may hardly be necessary, particularly if the current of a screening-grid potentiometer is normally passed through the bias resistance.

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Rise of Voltage.

My three-valve set includes indirectly heated H.F. and detector valves, followed by a triode with its filament fed with raw A.C. The receiver works satisfactorily, but it is noticed that immediately after switching on the output valve passes an appreciably greater current than normally—actually rather more than the maximum at which the valve is rated. Normal conditions are reached after about half a minute.

I suppose that this effect is associated with the gradual heating of the first two valves, but I cannot quite see how anode current should be affected.

This is a matter of eliminator regulation: when the heaters of the first two valves are cool they do not consume any current, and consequently there is a rise in H.T. voltage. Due to this rise a current greater than that normally flowing is forced through the output valve anode circuit; the filament of this valve will become incandescent almost as soon as current is applied to it.

You do not say if you are using automatic grid bias, but we are inclined to think you are not; it may be pointed out that the inclusion of this arrangement will make the output stage to a great extent self-regulating, as any tendency towards a rise in current will be checked by increased negative grid voltage developed across the bias resistance.

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Using Original Components.

I have an H.F.-det.-2 L.F. set which is insufficiently selective for modern conditions. Consequently, I am thinking of adding an input filter, and would like your advice as to whether it would be wise to use the existing grid-circuit tuning condenser and coil.

In all probability your present condenser was not built with a view to being linked mechanically with another for ganged control, and so it is not likely to be of very much use in a filter circuit, which, practically speaking, must be tuned by linked condensers.

No doubt the existing coil could be made to serve, but there will be the difficulty of obtaining (or making) another coil of exactly similar inductance for the second circuit of the filter. Unless you are prepared to adopt a two-circuit aerial tuner, with separately controlled tuning adjustments, we are inclined to recommend that your existing grid-circuit components should be "scrapped."

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Directly and Indirectly Heated Valves Combined.

Unless you can see any objection to the plan, I propose to use two of the new indirectly heated D.C. valves in conjunction with a pair of P.625s in the output stage, with filaments in parallel. Do you think this would be satisfactory?

As the output valves which it is proposed to use have filaments which, when connected in parallel, will consume the same current as that of the valves with which they will be joined in series, there should be no difficulty on this score, but we must admit that the arrangement is one that is not particularly attractive. The indirectly heated valves are designed to work with unsmoothed filament current, whereas the use of directly heated output valves may be responsible for "hum" if bias is obtained automatically in the usual way. In any case, even if the supply mains are of the average voltage, these valves will be operated at something less than their maximum rating with regard to anode pressure.

o o o o

D.C. Wiring.

Will you please tell me why it is usual to run the low-tension heater wiring of A.C. sets with twisted flex wire?

Connections made in this way are practically non-inductive, and so the risk of introducing unwanted noises through direct induction from the A.C. supply is minimised

It is not of any particular advantage that the wires should be twisted; so long as the "go" and "return" leads are parallel and close together the formation of an external field will be prevented. If preferred, flat twin conductors may be used.

o o o o

Temporary Battery Bias.

The output valve of my receiver is a triode, with its filament heated with A.C. through a transformer; grid bias voltage for this valve is developed across a resistance connected between the centre tapping of the filament-heating transformer and H.T. negative. In an attempt to reduce "hum," which is rather too pronounced to be pleasant, I should like to try the effect of using battery bias, in order to see if the trouble is traceable to this part of the circuit. Will you please describe, as simply as possible, how free grid bias may be replaced by battery bias?

You should find it quite easy to make a test with a bias battery. First, short-circuit the present automatic bias resistance, and then disconnect the wire at present leading from the L.F. coupling device (transformer or grid leak) to H.T. negative. A bias battery should now be inserted at the point where the circuit has been broken; its negative pole will be joined to the L.F. coupling device.

o o o o

FOREIGN BROADCAST GUIDE.

HILVERSUM

(Holland).

Geographical position: 52° 13′ N., 5° 11′ E.

Approximate air line from London: 226 miles.

Wavelength: 298.8 m. Frequency: 1.004 kc. Power: 8.5 kW.

Standard Time: Amsterdam (20 minutes in advance of G.M.T.).*

Standard Daily Transmissions.

08.40 B.S.T., news (Sun.); 10.10, sacred service (Sun.); 12.40, concert (week-days); 13.10 (Sun.); 14.40, gramophone records (Sun.), sometimes followed by relay of athletic sports; 17.10, gramophone records; 18.40, 20.55, 22.55, concert; 23.40, gramophone records (daily).

Male announcer.

Call: *Hier Hilversum de Avro* (V.A.R.A. or whichever association is responsible for the broadcast).

Interval signal (for V.A.R.A. only): Chimes G D E B D B.

Usually closes down at 00.20 (midnight B.S.T.) with time signal and chimes followed by the words: *Ik wensch U goeden avond, Dames en Heeren; wel te rusten* (sleep well).

**On May 15 Holland adopts Summer Time, thus bringing Amsterdam time to 20 minutes in advance of B.S.T. On July 1, Hilversum will exchange wavelengths with Huizen for a further period of three months.*

The Wireless World AND RADIO REVIEW

(19th Year of Publication)

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A State of Flux.

FOR a good many years past we have been inclined to sneer at people who have spoken of wireless as "still in its infancy," and with very good reason, because the achievements which the science has made possible are much too far removed from the nursery to permit of any such suggestion.

But we must beware of allowing the pendulum to swing too far in the other direction and so permitting us to make the still less pardonable mistake of thinking that wireless has reached finality and that we must not expect any changes of importance in the future. Such a suggestion is entirely misleading, and if we confine ourselves for the moment only to the question of the design of receivers for broadcasting, and bear in mind the requirements of receivers of the immediate future to suit the changing conditions of reception, we shall find that we have here ample evidence to refute any assumption that we are approaching finality in design and that changes are to be mere refinements.

Perhaps never before in the history of wireless receivers in this country has there been such a "state of flux" in the matter of design as exists to-day. Good standard receivers, we know, will remain serviceable for a long while to come, but the manufacturers who are concerned with the production of new models have to-day a wider choice to enable them to strike a distinctive note and show individuality in design than ever before. As has generally been the case in the past, the valve sets the pace; and there are indications of many important modifications or new types which will be available shortly. In addition, new ideas in selectivity, in the design of superheterodyne receivers, and in the tuning of straight sets, together with the design of screened inductance coils have presented many new problems.

In attacking the two main problems of receiver design, that of selectivity and quality, an approach is being made both through circuit and valve design, the former as evidenced by precise investigation on the waveband covered by H.F. couplings combined with uniformity of selectivity and amplification over the tuning range, and the latter by developing H.F. valves devoid of rectification and distortion. At no previous time since broadcasting began has there been more evidence of intensive research work on the part of the manufacturers than at present, and as the complication of radio receiver design increases so is a more complete understanding of the obscurities being gained. The solution of the obscure problems recently presented is providing designers with material which, put to good use, should contribute outstanding results to the sets of the near future.

To suggest, therefore, that receiver design is reaching a state of stagnation and that real progress has reached its summit is to disregard the obvious indications which exist—that we are now passing through a stage in receiver design far more promising and carrying greater fascination and interest than at any other period in the history of broadcasting.

In This Issue

Ultra-Short-Wave Broadcasting

Exploring the Possibilities of a New Local Transmission Scheme.

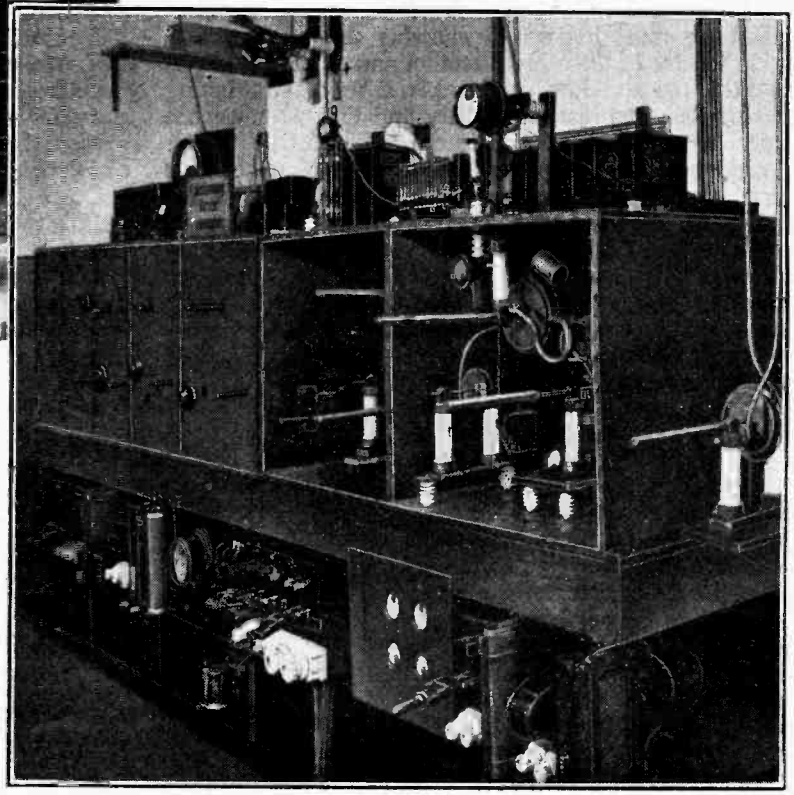
By ERICH SCHWANDT, Berlin.

Dipole Aerial of the Telefunken experimental transmitter. Wavelength 7.05 metres.

SINCE October, 1930, the German Post Office and the Telefunken Company have carried out ultra-short-wave broadcasting experiments on an extensive scale, and every radio amateur in Berlin has been in a position to receive—with the help of a simple home-constructed adaptor connected in front of his ordinary broadcast receiver—the experimental transmissions on 6.75 and 7.05 metres. Only amateurs in Berlin have had this advantage, for these waves will not reach farther than about 40 kilometres from the broadcasting station which is situated in Berlin.

These very interesting tests have led the German authorities to the definite conclusion that ultra-short-wave broadcasting is possible, that it possesses many advantages over long-wave broadcasting, and that before long an ultra-short-wave broadcasting service will be opened. These test transmissions were intended chiefly to obtain an exact survey (by means of small receiving equipments mounted in motor cars) of the field distribution in Berlin and of the strength of signals to be expected, and especially to obtain information as to the

(Below) The Telefunken experimental transmitter, which was first in action at Nauen, and, since October, 1930, has transmitted twice a week in Berlin.



Ultra-Short-Wave Broadcasting.—

absorption caused by the houses and metal structures. They have given such excellent results that tests in television transmission have been carried out, since in the present state of technique the ultra-short waves offer the one and perhaps only chance of supplying television of a quality which will satisfy the public taste.

Optical Range.

It was originally thought that the ultra-short waves —i.e., the waves below 10 metres—would be particularly suited for long-distance transmission, and it had already been suggested that a service of telegraphy should be instituted with America by means of an ultra-short-wave beam. At present, however, such long ranges present enormous difficulties. Meanwhile, whilst others have been occupied in testing out the "ultra-shorts" simply from the point of view of such beam-communication over great distances, the Telefunken Company has been experimenting with their use for broadcasting, thus taking advantage of what had hitherto been regarded as a defect—the fact that their range is limited to an optical path. The space radiation from an ultra-short-wave transmitter never returns to earth. Thus one can only work with the ground wave, whose range is limited to that of the eye, and for masts of ordinary height this amounts only to some 30 kilometres at most. It becomes possible not only to erect an ultra-short-wave broadcasting station in every big town, all working on the same wavelength without interfering with each other, but one can also contemplate a television broadcasting service giving pictures of fine detail; since in the absence of the space wave there is no fear of the signals being wiped out and split up.

As early as 1929 propagation tests in Berlin on ultra-short waves began under the direction of Dr. Schröter, with a view to determining their suitability for broadcasting. The first transmitter was erected on the roof of a building; it worked on a 3.4-metre wave. A little later a transmitter was built at the Research Institute of the A.E.G. in the Reinickendorf district of Berlin, working on waves from 3.2 to 11.6 metres. It was found that on a wavelength greater than 8 metres a distinct space wave had to be reckoned with, whilst for any waves below 7 metres there was an extraordinary increase of absorption by the masses of buildings in the capital. The waveband between 6 and 8 metres was therefore indicated as the most suitable, and a new test transmitter was accordingly built for a 7.05-metre wave. This was erected first of all in Nauen, but was transferred in October, 1930, to Telefunken House in Berlin. It is a five-stage, quartz-controlled transmitter (illustrated herewith), in which the frequency is doubled in each stage.

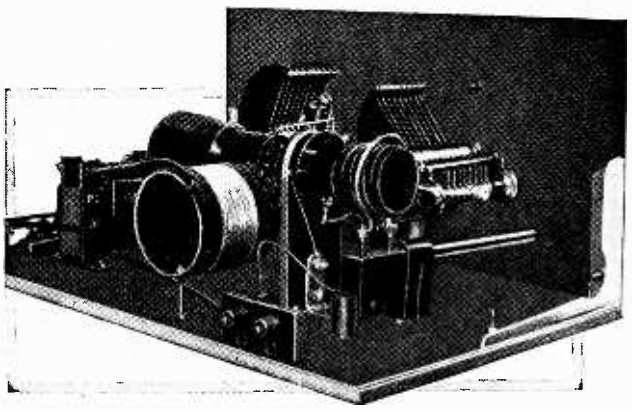


Fig. 1.—Ultra-short-wave adaptor, for home construction, 7-10 metres.

Television Possible.

The Berlin tests, carried out first with two and later on with three transmitters, showed that the 7-metre wave, from a dipole aerial (shown in the title illustration) raised 50 metres above the earth and supplied with energy by a feeder capacitively coupled to the transmitter, gave a normal range of 15 kilometres, which could be extended to 30 kilometres by the use of very sensitive receivers. The maximum ranges, obtainable under quite specially favourable conditions only, reached 60 and 120 kilometres. Beyond that, reception was impossible even on the most sensitive receivers. These results, together with others obtained elsewhere, confirmed the assumption that the *space wave made no appearance* and that the *pure ground wave only* was concerned. It was also found that the waves between 6 and 8 metres were subject to electrical disturbances to a degree ten to a hundred times less than long waves; in fact, the only interference observed being that from the ignition systems of motor cars. The ultra-short waves, therefore, make it possible to establish in large cities a local system of broadcasting which is practically free from interference and which — if the present assumption of a purely ground-wave reception free from any space-wave effects is correct—can be modulated with very broad side-bands and thus provide broadcast television.

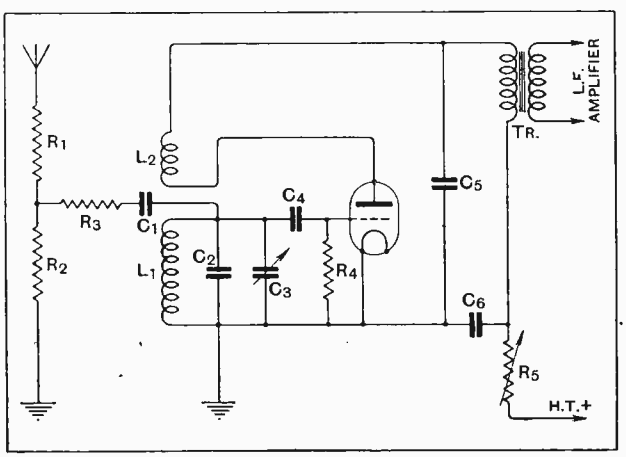


Fig. 2.—Diagram of connections of Telefunken ultra-short-wave receiver.

An increase in power of the Telefunken Company's experimental transmitter is proposed, from its present value of about 1 kilowatt to 8 kilowatts, for the sake of carrying out tests in television with a large number of picture elements. For this purpose a powerful transmitter is essential, since the width of the side-bands makes it necessary to use little or no reaction in the

Ultra-Short-Wave Broadcasting.—

receiver. It is probable that for receiving television use will be made of the superheterodyne method—perhaps with the necessary constant heterodyne wave emitted from a second transmitter, so as to avoid this wave having to be generated locally and with insufficient constancy.

Aperiodic Aerial Coupling.

An experimental reception of the 7.05-metre waves took place in Berlin recently before a large audience. The apparatus consisted in a simple one-valve adaptor, using grid rectification, in the output circuit of which was a transformer with its secondary connected to the gramophone pick-up terminals of an ordinary broadcast receiver (Figs. 1 and 2). The audio-frequency stages of the receiver served merely to amplify the rectified ultra-short wave. The coupling to the aerial was by means of an aperiodic T-link composed of three non-inductive resistances, while reaction was adjusted by altering the anode voltage by means of a variable high resistance. The quality of reception was excellent; the reproduction was particularly good on the higher tones, the lower tones suffering only very slight diminution in comparison.

Prof. Leithäuser, who built an ultra-short-wave transmitter at the Heinrich Hertz Institute in Charlottenburg, and also developed a number of receivers, recommends the use of the Armstrong super-regenerative principle on account of its greater sensitivity. This principle, however, introduces the risk of a certain amount of interference between neighbouring receivers, which would have to be overcome.

The use of ultra-short waves in a broadcasting service is expected to pave the way for simultaneous sound and television transmissions of high quality, though how soon progress to this point can be expected it is still impossible to predict.

DEARER "TIME ON THE AIR."

New Problem for American Broadcasters.

By Our New York Correspondent.

THE demand for "time on the air" in America is reaching the point where station managers and operators are beginning to consider whether the time has not arrived when they can profitably demand an increase in their rates.

Rumours have been flying around for some time that the National Broadcasting Company will increase the rates it charges advertisers for time, but this is not generally regarded as likely to occur for some time, because of the comparative newness of wireless advertising and the eagerness of the N.B.C. and its rival, the Columbia Broadcasting System, to attract more industrial concerns to their medium. It is perhaps of interest to record that last year the N.B.C. sold more than £4,000,000 worth of "time on the air," and its concert bureau (artists' agency) did a business of about £1,400,000—figures which show the relative financial importance of the advertisement and entertainment branches.

£216 Per Hour.

The projected increases in rates refer more to member stations of the N.B.C. and C.B.S. chains. In the case of N.B.C. chain stations these receive a flat rate of £10 an hour, regardless of their powers or local rates. The latter vary from about £40 an hour to the £216 per hour rate of one 50-kW. station. For sustaining or non-commercial programmes (i.e., those produced by the N.B.C. at their own expense, not sponsored by a manufacturer) the stations pay the N.B.C. a flat rate of £5 per hour. All telephone-line costs are paid for by the N.B.C.

The Columbia System also pays its member stations £10 per hour to take sponsored programmes, but gives five hours per week of its sustaining programmes without cost, except in the cases of a few stations in the larger cities, which get more.

The situation at present is that the member stations, while needing the N.B.C. or C.B.S. sponsored programmes to round out their local daily programmes, feel that they should receive from the chains a higher rate for taking them. They argue that, since their local rates are higher than the £10 rate paid them by the chains, they are losing money while taking chain programmes. The chains, on their part, need the support of the provincial stations because they base their arguments in favour of broadcasting as a medium for national advertising, and base the rates they charge the sponsor (advertiser) on the number of provincial stations they can guarantee will take the programme and on the comprehensive nation-wide coverage of those stations.

It would appear, therefore, that whereas the chains cannot yet raise their rates to the advertiser the locals feel that they can, with justice, raise their rates to the chains. Thus it looks as if the chains are about to suffer a cut in profits until such time as they feel in a position to "raise the ante" to the manufacturer who wishes to buy advertising space on the ether.

Search for More Stations.

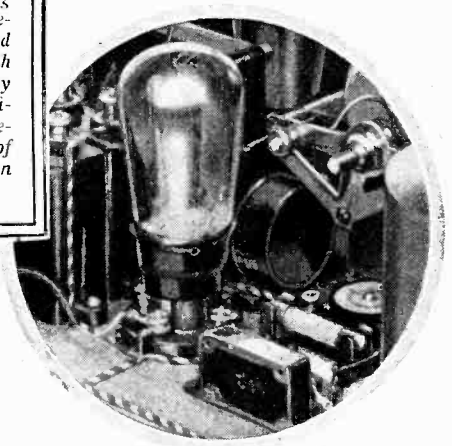
The acuteness of the situation may be judged from the fact that some of the chain stations have demanded from the advertisers, and received, the difference between their local rates and the £10 paid them by the network. It is for this reason that the N.B.C. recently found it necessary to lease WTAM, Cleveland, Ohio, and offer to buy WLW, Cincinatti, Ohio, besides casting an eye on several other stations.

Avoiding Detector Distortion

OF the methods of detection in general use to-day, the power-grid scheme developed in this country by "The Wireless World" probably gives the least distortion. All grid rectification circuits are, however, liable to a certain degree of high-note loss on account of the audio-frequency shunt effect of the grid condenser. In the accompanying article an ingenious circuit arrangement is described whereby the grid condenser can be reduced to a much smaller value than would normally be used, without any loss of rectification efficiency, and with a corresponding reduction in the loss of output at the higher modulation frequencies.

Leaky Grid Detection Without High-note Loss.

By F. M. COLEBROOK, B.Sc., D.I.C., A.C.G.I.



ALL known forms of rectification employed in broadcast reception have at least one feature in common. They involve somewhere in the circuit an element which has to satisfy two conditions, namely, that it shall have a low impedance at the radio-carrier wave frequency and a high and effectively constant impedance at the audio-frequencies of the modulation. A brief consideration of the well-known grid-circuit rectifier will perhaps make this clear to those for whom it is not so already. However, it may be arranged in practice, the grid-circuit rectifier is essentially as illustrated in Fig. 1. It is well known that the rectification is produced in virtue of the curvature of the grid current-grid voltage characteristic, and it is therefore the actual radio-frequency grid voltage (e_g in Fig. 1) which is important and not the input radio-frequency voltage (e in Fig. 1). For efficient rectification it is necessary that e_g shall be as large as possible compared with e. In other words, the radio-frequency impedance from A to G must be as low as possible compared with the radio-frequency impedance from G to F. In the standard arrangement illustrated this condition is satisfied as far as possible by making the grid condenser of suitable magnitude—usually from one hundred to three hundred micro-microfarads.

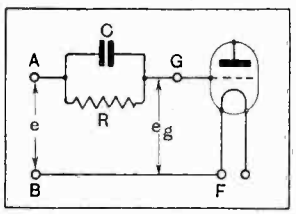


Fig. 1. — The conventional circuit of the grid rectifier.

This, somewhat crudely stated, is the reason for the first of the above conditions. The reason for the second is not quite so clear, and in order to arrive at it it will be necessary to consider the actual reproduction of the modulation by the rectifier—what the Americans rather inaptly call the "demodulation process."[1] The rectification of a continuous- or carrier-wave potential by the curvature of the grid voltage-grid current characteristic will result in an increase in mean grid current. This increased grid current flowing through the "grid-leak" resistance R will cause a lowering of mean grid potential. This in turn will cause a lowering of mean anode current, but for the present we are chiefly interested in the change of mean grid potential. The way this depends on the carrier-wave voltage is illustrated in Fig. 2.

The Cause of High-note Loss.

Suppose the carrier-wave voltage be e. The corresponding point on the "rectification characteristic" is that marked B in Fig. 2, and the corresponding change of mean grid potential the point marked E. Suppose the carrier wave to be modulated between the limits $(1+m)e$ and $(1-m)e$, as shown in the diagram. It would naturally be assumed that the corresponding changes of mean grid potential would be represented by an alternation between the points D and F in synchronism with the modulation. Assuming the region A-B-C of the rectification characteristic to be practically a straight line, the corresponding variation D-E-F of the mean grid potential would represent practically perfect reproduction of the modulation, both as regards amplitude, frequency, and wave-form.

Unfortunately, the process will only occur in this ideal manner at audio-frequencies so low that the resistance R is not short-circuited to any appreciable extent by the capacity C. The variation D-E-F will, therefore, represent the performance of the rectifier at the lower end of the audio-frequency scale only. At higher audio-frequencies the capacity C, though small, will, nevertheless, be large enough to affect the impedance of the C-R combination. Take, for example, as typical values C = 200 micro-microfarads and R = 1 megohm. At a frequency of 4,000 cycles per second the effective impedance of the combination has fallen

[1] The modulation of a continuous radio-frequency wave means causing its amplitude to vary at the modulation frequency. The logical interpretation of "demodulation" would therefore be converting a modulated wave into one of constant amplitude. But this is not what actually happens as a result of rectification, so the term, though widely used, is inappropriate.

Avoiding Detector Distortion.—

to about 200,000 ohms, i.e., about one-fifth of its value at, say, 200 cycles. The consequence of this is that the modulation frequency grid voltage changes instead of following the rectification characteristic A B C will actually occur in accordance with a line of smaller slope, such as A′ B C′, and will correspondingly be reduced from the ideal value represented by an alternation over the range D E F to a much smaller alternation D′ E E′. To be strictly correct the variation will follow a closed elliptical path in the plane of the diagram, but that fact is not essential to the present simplified description.

The way the audio-frequency output will vary with modulation frequency for a given carrier-wave voltage and modulation percentage can be predicted from a knowledge of the valve characteristics and the circuit constants, but the analysis is rather beyond the scope of the present article. The curve of Fig. 3 gives some idea of the kind of variation which may easily occur in practice. It is apparent that appreciable over-emphasis of the low frequencies will result. This is particularly undesirable in relation to ordinary tuned circuit reception, since it accentuates the effect of side-band cutting.

Reducing High-note Loss.

How, then, can this effect be avoided or minimised? One ingenious circuit has already been proposed for this end—the push-pull power-grid system. The essential features of this arrangement are shown in Fig. 4. No by-pass condensers are required in this circuit, so that the audio-frequency output should be practically independent of frequency. The writer has no actual experience of the circuit, but the fact that it has been incorporated in the new Science Museum receiver may be taken as a guarantee of its performance. It may be pointed out, however, that its application to any existing receiver of conventional design would involve considerable structural alterations. The alternative device proposed in this article is not claimed to have any superiority over the push-pull system as regards performance. It has, however, some advantage in respect of adaptability to existing receivers, and it does not require the additional valve of the push-pull system.

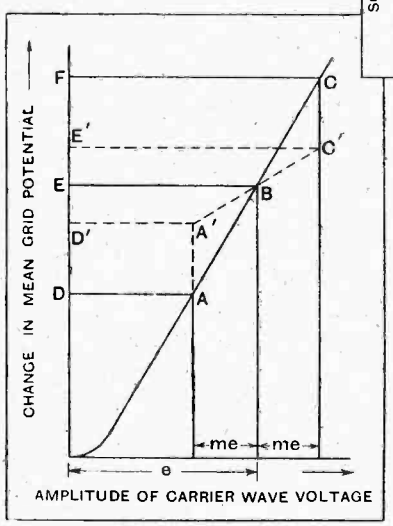


Fig. 2.—Showing how the mean grid potential changes with increase of carrier-wave voltage.

The essential features of the circuit are illustrated in Fig. 5, which shows that it differs only from the usual system in the substitution of a so-called "acceptor" circuit; that is, an inductance and variable condenser in series, for the fixed by-pass condenser. By suitable design of the inductance the series tuning capacity can be kept to a very small value—it should not be allowed to exceed about 50 micro-microfarads at the longest wavelength. When tuned to series resonance such a system, even with very small compact inductances of relatively high resistance, will have a much lower impedance than any fixed condenser that could be used consistently with the second of the conditions referred to above. On the other hand, its audio-frequency shunt effect, with associated loss of the higher audio-frequencies, will obviously be considerably less than that of any fixed by-pass condenser that satisfied the radio-frequency condition. In fact, the dotted curve in Fig. 3 shows the audio-frequency characteristic calculated for the same conditions as for the full-line curve, but with the capacity reduced to 33 micro-microfarads from its original assumed value of 200 micro-microfarads. This curve may be taken as an indication of the levelness of the frequency characteristic easily obtainable with this tuned by-pass system. It is probably quite good enough, but could, if necessary, be made even better by still further reducing the tuning capacity below 33$\mu\mu$F. The restriction of the tuning capacity to a low value—preferably not more than 30 micro-microfarads or so—will permit of the use of a larger value of grid-leak resistance than would otherwise be permissible, with a consequent increase of rectification efficiency.

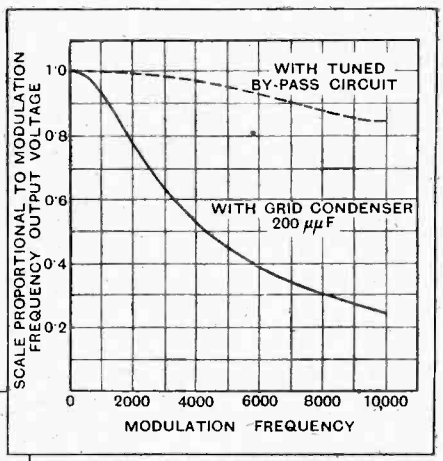


Fig. 3.—Working response characteristic of a detector valve with and without tuned by-pass circuit.

Design Details.

The inductance can be made very small and compact, as it is not necessary that it should be of low resistance. For the medium waveband, for example, 300 turns of No. 46 copper wire on a former about 1½in. diameter × 2in. long is quite satisfactory, and a compact coil suitable for the long waveband can be made by winding 600 turns of, say, No. 44 copper wire in a groove in a disc-shaped former, the groove being of internal and external diameters ½in. and 2in. and $\frac{1}{16}$in. wide. Such designs have the merit, important in the present instance, of giving a small self-capacity. For the condenser there is now a wide choice of small commercial types with a maximum value of 50 to 100 micro-microfarads. It need not exceed 50.

It is, of course, an objection to the circuit that it involves an additional control. This is not very serious, however. It might rule it out in the case of sets where

Avoiding Detector Distortion.—

everything had to be sacrificed to simplicity of control, but for the numerous enthusiasts who seek quality rather than simplicity, it is no drawback. Incidentally, it provides another element of selectivity. This, however, invites the question as to whether it does not also contribute to the side-band cutting associated with tuned circuits, and so defeat its own object. The answer is that it does not. The inductances need not be of low resistance. In fact, the designs suggested would be of rather high resistance. Also, the resonance is inherently flat on account of the relatively low-shunt resistances associated with the tuned circuit. In a typical circuit it was found that a frequency-change of 10 kilocycles on a mean frequency of about a million cycles would only give an amplitude change of less than 1 per cent. There should be no difficulty in realising, or even improving, on this figure in the medium or long wavebands.

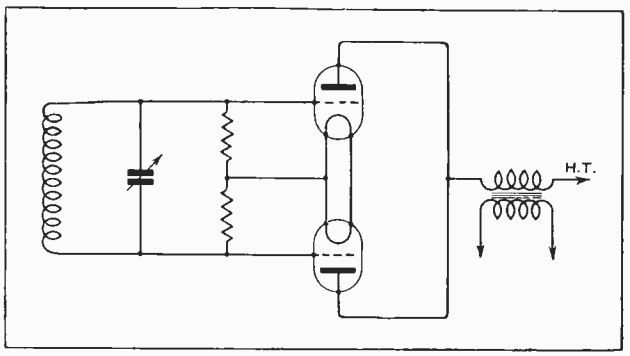
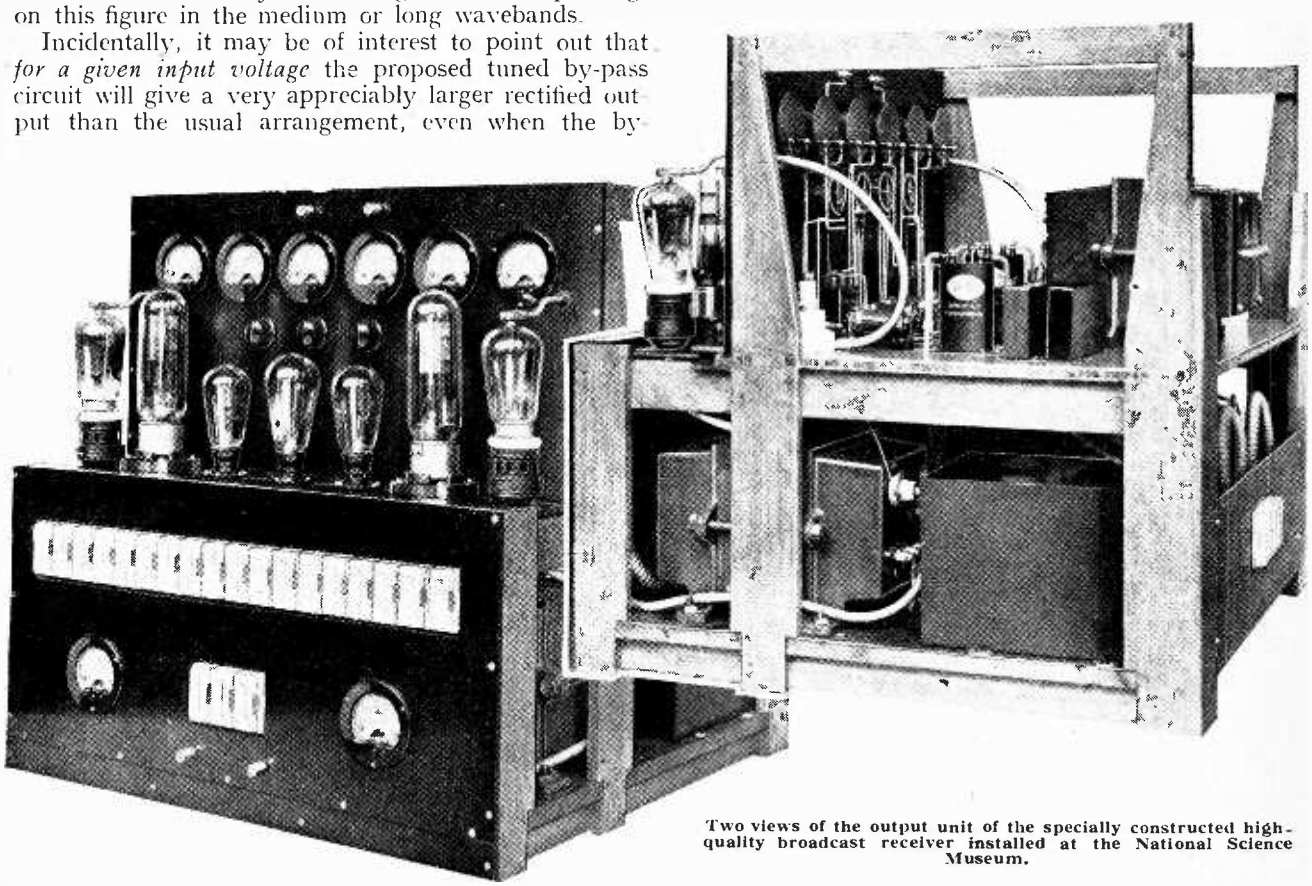


Fig. 4.—The type of push-pull power grid circuit used in the new Science Museum receiver.

Incidentally, it may be of interest to point out that *for a given input voltage* the proposed tuned by-pass circuit will give a very appreciably larger rectified output than the usual arrangement, even when the by-pass capacity in the latter is large enough to have quite negligible reactance. This is because the combination of the tuned circuit with the input capacity of the detector valve results in a resonance of voltage on the grid, so that the grid-voltage amplitude is even larger than that applied to the input terminals of the rectifier—that is, referring to Fig. 5, e_g is larger than e. This, however, must not be taken to mean that a correspondingly larger output would be obtained from the proposed circuit when actually used in a receiving set, because the resonance step-up of voltages on the grid would, of course, have the effect of increasing the load on the tuned circuit from which the input voltage was derived, so that in practice the consequent reduction of input voltage would probably cancel the resonance step-up of voltage on to the grid.

Note also that a similar tuned by-pass system would be equally applicable to an anode circuit rectifier with a resistance coupling to the next stage. In such a scheme, however, the impedance conditions referred to in the opening are more easily fulfilled, unless excessively high anode resistances are used, so that this refinement is less necessary.



Two views of the output unit of the specially constructed high-quality broadcast receiver installed at the National Science Museum.

Avoiding Detector Distortion.—

Finally, to anticipate criticism, the writer is not claiming any high degree of novelty in the present suggestion, for it is no more than the application of very familiar principles to a very familiar problem. A similar arrangement is referred to in a paper by Medlam and Oschwald, published in the *Journal of the Institute of Wireless Technology* in June, 1928. In that case a series resonant circuit was connected as a by-pass across an anode circuit resistance—mainly to reduce the input capacity of the detector. The authors do not seem to have realised that they were at the same time providing a very efficient by-pass arrangement as required for satisfactory rectification without high-note loss.

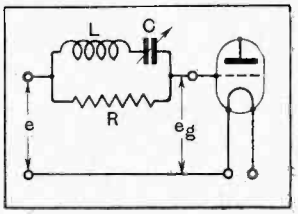


Fig. 5.—A tuned by-pass or series acceptor circuit used in place of the usual grid condenser prevents high-note loss.

One other point should be noted in conclusion. No mention has been made of the "Miller effect" input capacity of the detector, at modulation frequencies. A full discussion of this subject would require an article all to itself. It may be stated briefly, however, that this input capacity will be an addition to the shunt effect at the higher modulation frequencies, and represents a minimum below which the total shunt capacity cannot be reduced. It may be possible to consider this matter more fully at some future time, but it is clear that any circuit arrangement which permits of a reduction of the total capacity in shunt to the grid leak will give a corresponding improvement in uniformity of modulation frequency output, and the arrangement described in this article does, in fact, permit of a very considerable reduction in this total shunt capacity as compared with the original grid rectification circuit.

NEWS FROM THE CLUBS.

North Middlesex Field Days.

The spring programme of the North Middlesex Radio Society includes a series of lectures entitled "From Ether to Ear," in which the lecturers discuss stage by stage a typical receiver, beginning with the aerial system, and concluding with the loud speaker.

On Saturday, April 25th, members of the Society visited the air port at Croydon, as well as the Mitcham Direction Finding Station. Arrangements are well in hand for summer field days. The first event of this kind was held on Sunday last, May 17th, when a mobile transmitter was in operation.

Particulars of the Society will be gladly supplied to intending members by the Hon. Secretary, Mr. M. P. Young, 40, Park View, Wynchgate, N.21.

○○○○

Field Day Open to All.

Members of all radio societies are invited to partieipate in a direction-finding competition to be held on Sunday, June 21st, under the auspices of the Golders Green and Hendon Radio Scientific Society. By way of novelty the transmitter will be mobile, while the direction-finding groups will occupy fixed positions. Full particulars of the event can be obtained from the Hon. Secretary, Lt.-Col. H. Ashley-Scarlett, D.S.O., 60, Pattison Road, N.W.2.

○○○○

10-mile Transmitter Hunt.

A hidden transmitter hunt will be held by Slade Radio (Birmingham) on Sunday, May 31st, when a number of members with D.F. sets will endeavour to track the ether disturber to its lair. The members will work individually, and will start from positions approximately ten miles from the transmitter.

The Society has just held the sixth of its popular junk sales, at which a quantity of surplus apparatus changed hands to the satisfaction of all concerned.

Full particulars concerning the Society and the arrangements in regard to the coming field day can be obtained from the Hon. Secretary, 110, Hillaries Road, Gravelly Hill, Birmingham.

FORTHCOMING EVENTS.

WEDNESDAY, MAY 20th.

Gloucester and District Radio Society.—At 7.30 p.m. At the Wessex Hotel. (1) Calibration of Receivers on 160 Metres for Subsequent Field Days. (2) Discussion on "Tuned and Untuned Screen Grid."

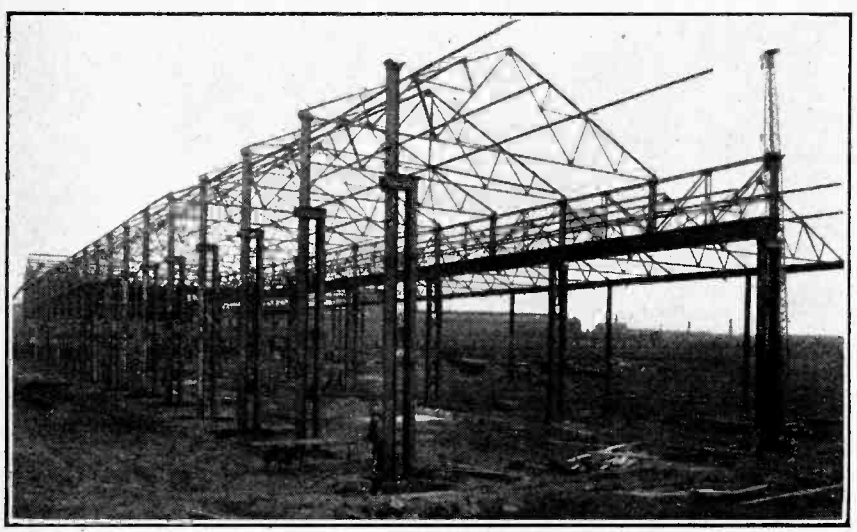
Muswell Hill and District Radio Society.—At 8 p.m. At Tollington School, Tetherdown, N.10. Demonstration by Mr. H. V. Abbott.

THURSDAY, MAY 21st.

Ilford and District Radio Society.—At the Wesleyan Institute, Cleveland Road, High Road. Talk by Mr. H. H. Curr on "Cabinet Work in Receivers and Loud Speakers."

Slade Radio (Birmingham).—At 8 p.m. At the Parochial Hall, Broomfield Road, Erdington. Lecture: "Instrument Design," by Mr. E. Smith, B.Sc. (of The Cambridge Instrument Co., Ltd.).

Woodford, Wanstead and District Radio Society.—At 8 p.m. At 20, High Street, Wanstead. General Business Meeting.



NO "TRADE DEPRESSION" HERE! At Hollinwood, Lancs, Messrs. Ferranti, Ltd. are busy on the construction of extra buildings. The photograph shows the framework of the new foundry which will increase the available space for the manufacture of radio receivers.

How to Choose an M.C. Speaker.

Mr. P. K. Turner, an honorary member of the Muswell Hill and District Radio Society, gave an informative lecture on moving-coil loud speakers on May 6th. Members benefited considerably from the useful hints given on discriminating between good and bad commercial products, and the advice on where to look for good points and for faults.

On May 13th Mr. A. J. Hall, of Philips Lamps, Ltd., lectured on short-wave adaptors.

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

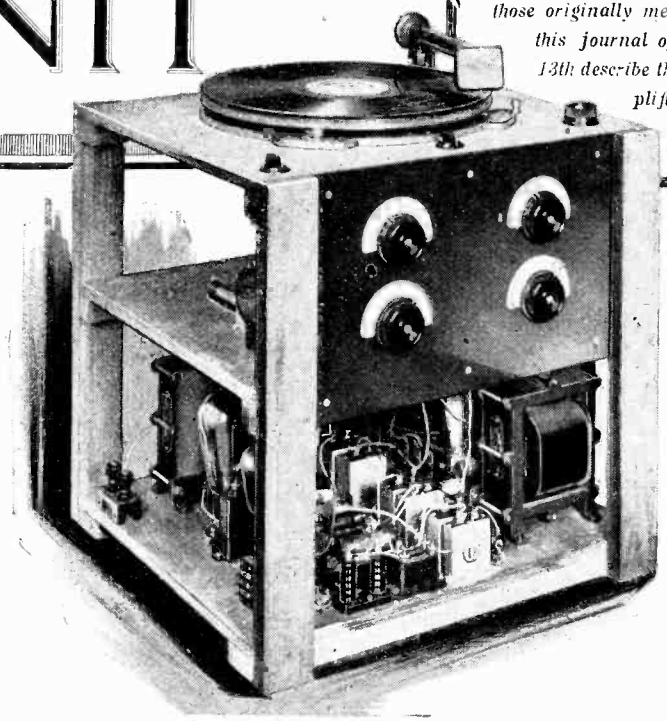
PORTABLE RECEIVER DESIGN.

Some insight into the problems associated with the development of a receiver for commercial production is to be gained from the pamphlet, "Some Notes on the Design of a Battery Operated Portable," recently issued by Messrs. Murphy Radio, Ltd., Broadwater Road, Welwyn Garden City, Herts. The receiver dealt with is the Murphy Radio Type B4 Portable, and the arguments leading up to the final balance between range, selectivity, quality of reproduction, economy of operation, and cost are given in logical sequence.

The booklet, which runs to fifteen pages, is attractively produced and well illustrated by curves and photographs. Copies are obtainable from the above address, post free.

QUALITY UNIT

A SET designed for quality reception of the alternative programmes from a local regional station is of wide appeal. Having described the circuit arrangement and given general details for construction, this article is mainly devoted to the modifications necessary when using other types of valves to those originally mentioned. The issues of this journal of March 25th and May 13th describe the making-up of the amplifier and the modifications for radio reception.



Further Details of an Easily Built Radio-Gramophone.

By F. H. HAYNES.

THE local station quality set, with provision for the playing of gramophone records, represents to a large number of listeners the acme of receivers. The construction of such a set is simple and the results are outstanding provided that the right valves are chosen and that they are correctly run. Additional details may, therefore, be usefully given to add latitude in the choice of valves. No stipulations have been made in the selection of components, and one must only bear in mind that the resistances must have an adequate watts rating, that the large-capacity condensers shall have a sufficiently high breakdown voltage, and that the transformers and chokes are of a reliable class. A list of the actual components used is, however, given as a guide. Already readers have indicated a desire to use valves they have to hand. The suitability of alternatives has, therefore, been pursued, bearing in mind the requirements of grid and anode voltages and the associated modifications to the resistances. In addition, stage gain measurements have been made so that the train of valves is correctly matched and overloading avoided. Dealing first with the H.F. stage, the Mazda AC/SG may be introduced as an alternative to the Marconi or Osram MS4. With slightly higher screen current and a lower screen voltage the potentiometer from which the screen potential is derived is exactly suitable, the screen voltage becoming 60. The heavier anode current demands a decrease in the value of the anode resistance from 100,000 to 75,000, passing a current of between 4 and 4.5 mA. In spite of the larger anode

LIST OF PARTS.

Materials for two tuning coils—ebonite or stravboard tube and a small quantity of insulated wire.

1 Mains transformer, 465 + 465 volts, 100 mA.; 4v. 3 amps.; 6v. 2 amps.; 7.5v. 2.5 amps. A 500 — 500v. transformer may be used with compensating resistance. (Rich and Bundy or "Parmeko." Partridge and Mee).

1 Smoothing choke (Rich and Bundy, type E.101) and 1 output choke (type E.102).

Resistances as follows: 2, 100,000 ohms; 1, 30,000 ohms centre-tapped; 1, 30,000 ohms; 1, 15,000 ohms; 2, 10,000 ohms; 1, 1,500 ohms; 1, 350 ohms; 1, 150 ohms. In addition, a voltage-regulating resistance will be needed should the mains transformer be wound to give an A.C. output of 500 + 500 volts. These values suit the following valves: Marconi or Osram MS4, Mullard 164V, Mullard 164V and Marconi or Osram LS6A. Alternative values are given for other valves (wire-wound type Ferranti and Colvern).

Resistances of the grid-leak type with porcelain holders: 3, 0.5 megohms; 1, 0.25 megohm; 1, 10,000 ohms (Loewe resistances and Bulgin holders).

Condensers, large-capacity type: 3, 4 mfds.; 3, 2 mfds.; 5, 1 mfd.; 1,500v. D.C. test (Zenith-type, Hydra).

Mica dielectric Condensers: 1, 0.0001 mfd.; 2, 0.0003 mfd.; 2, 0.01 mfd. (T.C.C. type 34).

1 H.F. choke (Watmel).

1 2-pole switch for change of wavelength and 1 3-pole switch for changeover from radio to gramophone. The extra contacts on the latter switch provide spacing between the grid and anode leads which are connected to it. (Burne-Jones).

Output terminals as well as aerial and earth terminals on baseboard mounting bakelite brackets (Belling-Lee).

4 Valve holders, 5-pin type (Clix).

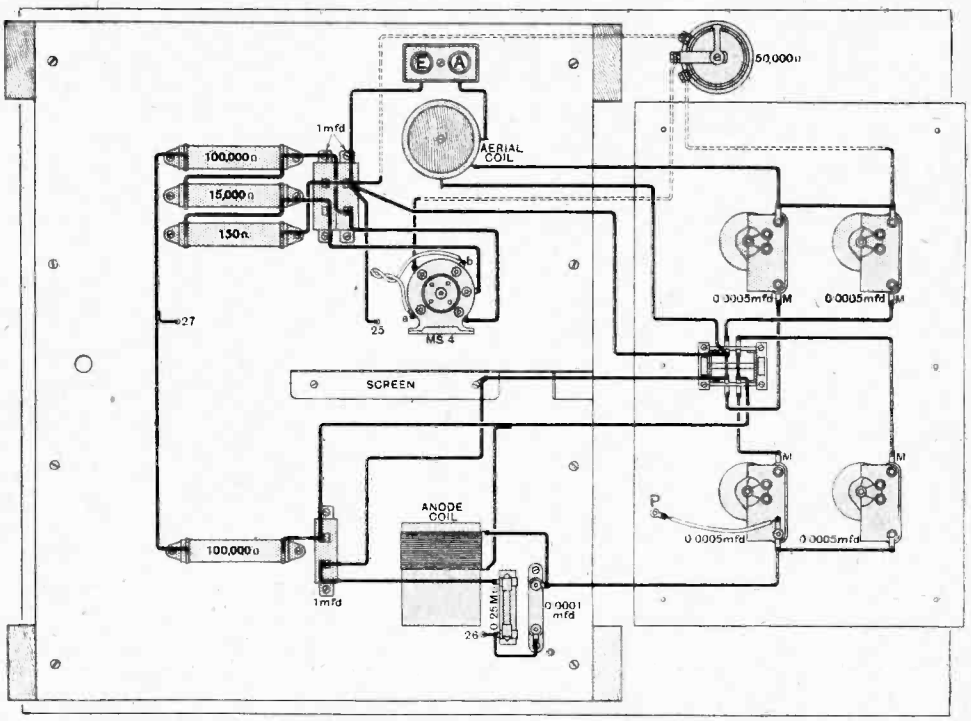
1 Valve holder, 5-pin for horizontal mounting (W.B. Universal).

Metal for screen as well as wooden panels, uprights, tinned wire and sleeving.

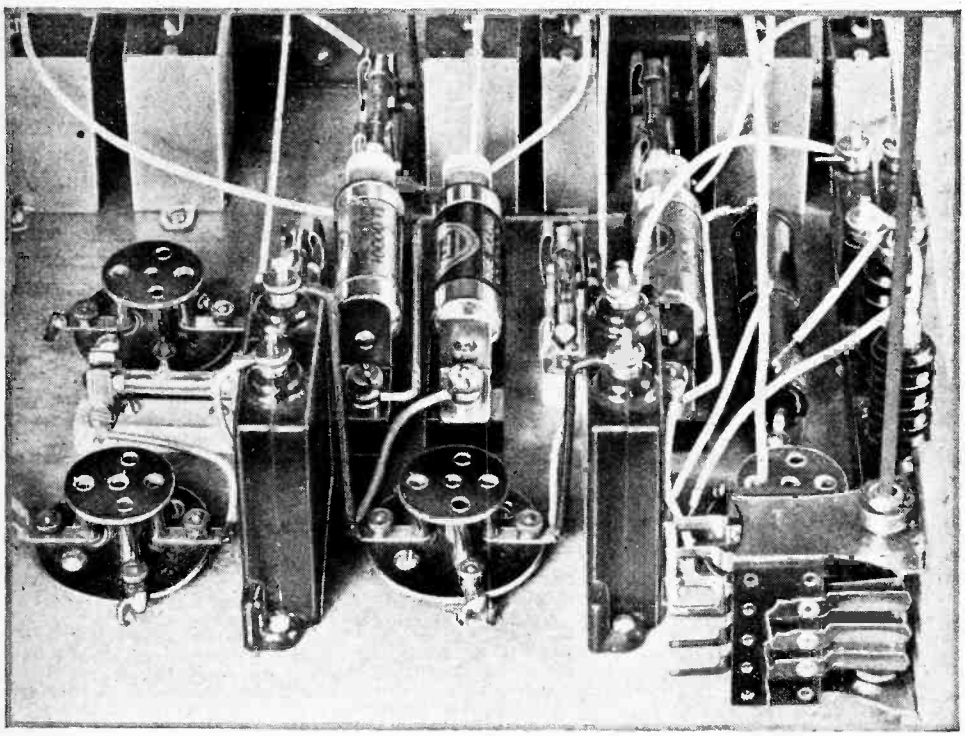
Volume control, 50,000 ohms (Colvern), gramophone motor and pick-up.

Quality Unit.—current an increase may usefully be made in the value of the biasing resistance. By substituting 200 ohms in place of the 150 required for the MS4 a bias of just over 1 volt is applied to the grid. To accommodate the Mullard S4VB valve in the H.F. stage, retain the resistance values shown in the screen and biasing circuits (p. 502 of previous issue) but substitute 85,000 ohms in the anode lead.

An alternative to the Mullard 164V valve, given as the detector, is the Mazda AC/HL. Used as an L.F. amplifier this valve passes nearly 7 mA., or with zero grid volts and arranged as a detector, 12 mA., assuming a reduction in the maximum anode voltage from 200 to 150 when changing over. Retain, therefore, the value of tapped coupling resistance specified, which was 30,000 ohms as an L.F. amplifier falling to 15,000 ohms by short-circuiting a portion when switched to radio, but increase the value of the decoupling feed resistance from 10,000 ohms to 15,000 ohms.



Practical wiring diagram of the entire H.F. stage. Leads are run by the shortest paths. The coil windings consist of 70 turns of No. 26 enamelled wire or 2in. ebonite formes. The aerial tapping point is 8 turns from the earth end of the coil though the tapping position may be modified to give maximum signal strength with adequate selectivity and depending upon aerial dimensions. To provide equal condenser settings some 5 turns may be removed from the top of the aerial coil.



The detector and amplifying stages showing the modifications including the addition of H.F. choke, anode by-pass condensers, tapped anode resistance and radio to gramophone change-over switch. The centre contacts of the switch are left unconnected, and provide more generous spacing between the grid and anode leads. The 0.01 mfd. coupling condensers are usually supplied in smaller containers than those shown.

While the calculated stage gain of this valve used as an amplifier under these conditions should be over 20 times, the actual measured magnification is of the order of 15, the reduction being largely attributed to the cancelling effect of the out of phase voltage fed back from anode to grid across the small inter-electrode capacity. When this valve is working from the gramophone pick-up, which adjusted by its volume control to the average peak output of 1 volt, a peak signal potential of 15

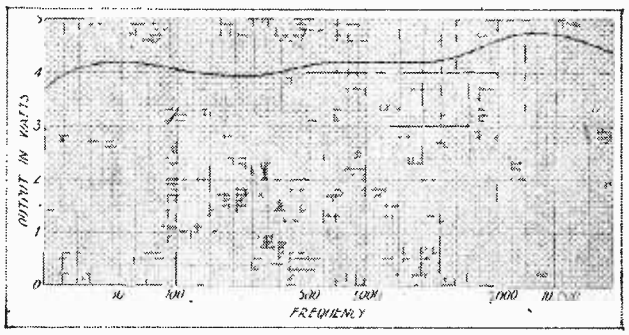
Quality Unit.—

volts is developed at the grid of the next valve. Under radio conditions this same potential may be produced by adjustment of the potentiometer associated with the tuned circuit, and is represented by a fall in the detector anode current of about $\frac{1}{6}$. In making this observation it must be borne in mind when a leaky-grid detector valve is resistance-coupled that the anode potential rises as a result of the fall in anode current when a signal is applied to the grid. A detector meter is a useful indicator, but if the ear is satisfied with the output the meter reading is of little consequence.

Matching the Successive Stages.

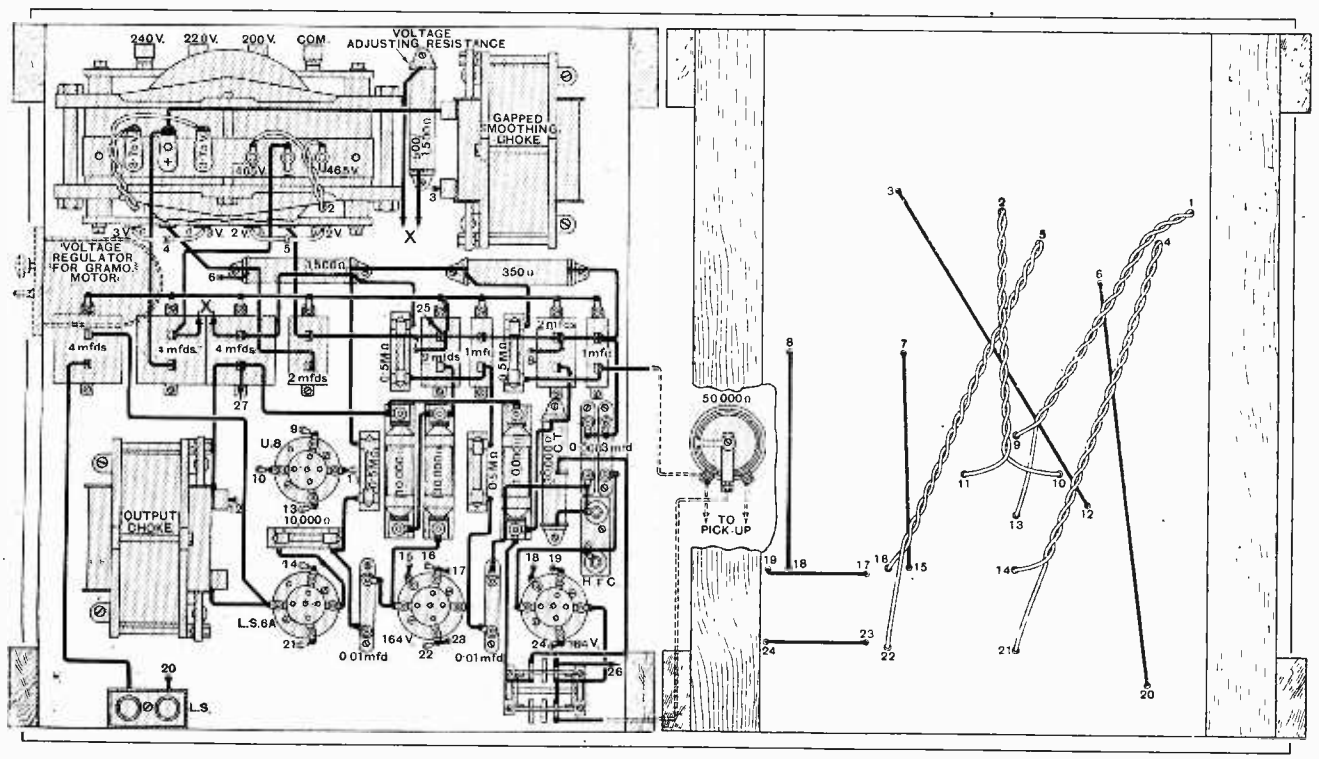
The alternative Mazda valve in the next stage is the AC/P. Passing 13 mA. the correct anode voltage is obtained when 25,000 ohms is interposed in the anode circuit. This is made up of 10,000 ohms for decoupling and 15,000 ohms for coupling. It should not be overlooked that nearly 4 watts is dissipated over the combined resistances. A simple calculation of stage gain with the AC/P valve and 15,000 ohms in its anode gives about eight times when working at normal bias. The actual magnification measures 5.5. It is rather happy that the normal bias of this valve is 15 so that it can accommodate the 15-volt peak signal delivered by the preceding valve. With a gain of 5.5 this stage is accommodated to the maximum signal voltage that may be applied to the output valve. When 1 volt peak signal is applied to the grid of the detector an 85.5-volt peak signal is fed to the grid of the output valve. This valve, an LS6A, has a negative bias of about 90 volts, so that it can readily accept, without distortion, the signal applied to its grid.

The substitution of these alternative valves demands a change in the grid-biasing resistance. A single biasing resistance of 350 ohms is shown in the circuit diagram on page 502. When using the AC/HL and AC/P valves while retaining the MS4 a current of 26 mA. is passed



Curve showing the output delivered into a resistance load from a radio signal modulated over the frequency range. A curve has already been given showing the behaviour of the gramophone amplifier separately.

by this resistance. To produce the 15 volts bias required by the AC/P a resistance of 580 ohms must be substituted, and by providing a tapping along this resistance at 120 ohms from the left-hand end a bias of 3 volts may be fed into the gramophone pick-up circuit. An increase in the current passed by this resistance results from the substitution of an AC/SG valve in the H.F.

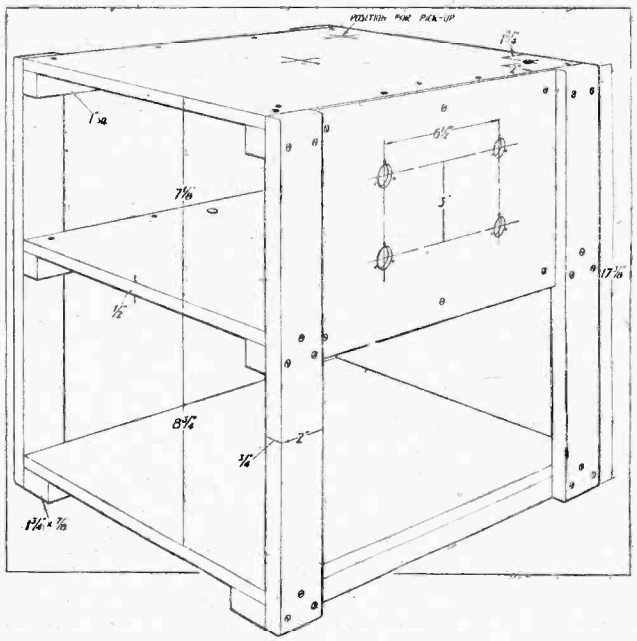


The wiring of the amplifier and rectifier showing the actual routes taken by the leads.

Quality Unit.—

stage. Becoming 28 mA, the value of the biasing resistance required is 540 ohms with a tapping at 110 ohms.

To simplify construction a practical wiring diagram has been prepared, together with a dimensional drawing of the wooden frame. To provide for remote control a small bell-ringing transformer may be attached to the underside of the middle panel, just over the mains transformer. Its primary is left connected permanently across the mains, the no-load current being, in the case of a good transformer, of little account. Its secondary feeds out to the listening point through a pair of wires, the bobbin of a relay secured near the transformer being interposed in one lead. Closing contact on this pair of leads pulls up the relay and completes the mains connections. As the relay operating wires are separated from the supply they are quite safe, but, nevertheless, it is convenient to use small gauge twin lead-covered wire for wiring an extension. While the loud-speaker leads may be similarly run, it is preferable to take two wires by alternative routes and without lead covering if a high-resistance loud speaker is to be used at a distant point. An output transformer with low-resistance loud speaker and correctly matched to the LS6A valve will remove the detrimental effects of extension lead capacity, permitting of the use of lead-covered twin wire up to moderate distances.



Dimensional drawing showing the making-up of the wooden framework.

Designed primarily for utility, this quality unit may be stowed away, or, alternatively, may form the interior of a cabinet suited to its surroundings. It has been suggested that a unit such as this may provide broadcast listening with good quality reproduction to several adjoining houses as an alternative to a public relay service.

CURRENT TOPICS

Events of the Week in Brief Review.

LICENCES FOR SET REPAIRERS.

Italian radio dealers must now obtain a licence before undertaking wireless set repairs.

oooo

THE SILENT OA'S.

In the wake of her recent revolution Peru has issued a decree prohibiting all private and amateur radio transmission. There are about thirty transmitting amateurs in Peru. They use the prefix OA.

oooo

BROADCASTING NEW YORK'S "AIR RAID."

The great aerial "combat" which will be staged over New York on Friday and Saturday next is expected to provide material for the ideal running commentary. N.B.C. announcers will be stationed on various skyscrapers, and the microphones will be so placed that listeners will be able to hear much of the actual noise involved in the "destruction of the city."

No fewer than 670 planes will be involved in the manœuvres, and two extra machines will carry N.B.C. announcers. We hope that the announcers will not be too intimately mixed up in the fray.

H.M.V. ELECTRIC GUIDE.

The Science Museum at South Kensington now has a new attraction in the form of an automatic guide, which is actually a specially designed electric gramophone developed in the laboratories of The Gramophone Co., Ltd. The instrument, which has been installed on the top floor of the main building, gives directions where to find particular exhibits, and can also give brief lectures six to seven minutes in length. It is set in operation by pressing a button.

PRESS THE BUTTON. The new "electrical guide" installed at the Science Museum, South Kensington.

oooo

PEACE PROGRAMME FROM HUIZEN.

To-night (Wednesday) the Huizen broadcasting station (1875 metres) will give a special programme dedicated to the cause of world peace.

oooo

FRANCE ENTERTAINS HER COLONIES.

Contrary to predictions, the French Colonial short-wave station has actually started transmissions, using a wavelength of 25.2 metres. The opening ceremony coincided with the inauguration of the Paris Overseas Exhibition on May 6th, when a special "Far East" programme was sent out.

oooo

INTERNATIONAL RADIO CONGRESS?

The advisability of holding an International Radio Congress in Paris in connection with the Overseas Exhibition is

being discussed by the Central Committee of French Radio Associations. The Overseas Exhibition will continue its run until November, and as many foreign visitors will attend it is felt that a splendid opportunity is created for a *réunion* of leading radio amateurs and professionals.

oooo

M. DOUMERGUE: THE RADIO PRESIDENT.

M. Gaston Doumergue, the retiring French President, has established a wireless tradition which, we hope, will be maintained by his successors. In his moments of leisure he has constantly resorted to his favourite hobby, and at one time his receiver was enviously regarded as a "world-beater" by French amateurs. Our Paris correspondent relates that when opening technical exhibitions, M. Doumergue has always lingered longest at the radio section, discussing radio problems on terms of equality with the experts.

oooo

PROF. TOSHIWAL'S EXPERIMENT.

Hatred of locusts and other insect pests has prompted Prof. G. R. Toshiwal, head of the wireless department of Allahabad University, to apply for a grant of £8,625 to attempt to exterminate the creatures with the aid of high-frequency radiations. £8,625 seems a lot of money, but we wish him luck.

oooo

ELECTRICAL MUSIC.

A congress to debate the possibilities of radio-electric musical instruments will be held by the Berlin Central Institute of Education from July 6th to 8th next. It is likely, we understand, that a concert will be arranged in which thermionic oscillators of various kinds will provide the music.

Discussion will also centre on the development of music specially composed for broadcasting.

oooo

"THE COW CAME BACK."

French radio journals are noting with delight the return of the tale, originally hatched in France two or three years ago, concerning the farmer who increased his cow's output of milk by installing a loud speaker in the milking shed. Apparently the story has gone all round the world, and is now returning to roost in the lesser journals of the land that gave it birth.

oooo

LOUD SPEAKERS ALOFT.

The Rev. Dr. Christopher F. Reisner, of New York, is being publicly acclaimed for protesting to the police against an air pilot who "vociferously insulted Easter Sunday with loud speaker advertising." According to the clergyman, the 'plane flew over the city and suburbs on the Sabbath morn, announcing a proprietary article so blatantly that residents shut their windows.

If the charge can be substantiated we are on the side of the earthbound angels.

oooo

ALBERTA FAVOURS B.B.C. PLAN.

Without debate or dissent, the Legislative Assembly of the Province of Alberta, after hearing in glowing terms of the operation of broadcasting under national auspices in England and Germany, has passed the following resolution and forwarded it to the Dominion Parliament meeting in Ottawa: "Resolved, that this assembly believes that the best interest of Canada will be served by the adoption of the policy of national ownership of radio broadcasting, and would recommend that the Federal Parliament enact necessary legislation giving effect to the recommendations of the Aird report." The Aird, or Royal Commission, report recommended Government ownership and operation, but consideration of it is being held in abeyance in Ottawa.

oooo

RADIO FLYING SQUAD FOR FRANCE.

The first tangible evidence that France is proceeding with her scheme for a wireless network to combat crime is the erection of two 150 ft. masts on the roof of the Home Office building in Paris. The station here will form the nucleus of a system with tentacles in Strassburg, Marseilles, Lyons and Bordeaux, and other provincial towns. Our Paris correspondent adds that a flying squad is to be equipped with mobile sets.

RADIO ON THE AIR ROUTES. A glimpse in the wireless operator's corner in one of the "Kent" type flying boats intended for the Genoa-Alexandria section of the Indian and African air routes. The Marconi equipment includes an A.D. 18a transmitter with a range of 500 miles.

oooo

CURBING THE CONTROL ROOM.

How much a control room engineer may interfere with the output from the orchestra in the studio has long been a bone of contention between the musical and technical staffs of broadcasting organisations. Apparently the discussion will be at an end so far as the new Budapest transmitter is concerned, for the plans include the provision of a sound-proof glass case to accommodate the conductor, who will hear his orchestra as it is heard by the radio listener.

oooo

TAKING NO RISKS!

Said to be aimed at the Rev. "Bob" Shuler, the militant broadcasting pastor of Los Angeles, whose right to operate a radio station is now being adjudicated before the Federal Radio Commission, a "Radio Slander" Bill has been passed unanimously by the California State Senate, writes our Washington correspondent.

oooo

TRADE DEPRESSION?

Despite the prevailing industrial depression, eliminator and battery manufacturers report large profits during the past year. Messrs. E. K. Cole, Ltd., scored a net profit of nearly £106,000, while the directors of the Ever-Ready Co. (Great Britain), Ltd., report a net gain of £306,110.

oooo

HUNGARY IN A HURRY.

"The immediate construction of a 150-kW. broadcasting station in Budapest" is provided for in Hungary's new radio act.

We shall listen for it to-night.

oooo

INTERNATIONAL COCK-CROWING.

The Kootwijk transmitter keeps up regular communication with the Dutch East Indies. A short time ago, according to our correspondent, while the studio windows were open in the early morning a neighbouring chanticleer began to "proclaim the morn"; this "broadcast" was picked up by the microphone and transmitted to the Far East, where in a few minutes all the roosters within hearing of the loud speaker awakened a joyous chorus.

oooo

PROGRAMMES FROM U.S.: BUT NO "ADS"!

Convinced that a tremendous market exists in America and abroad for short-wave radio sets, Short Wave and Television Laboratories, Inc., of Boston, plans to enter into a co-operative arrangement with Aviation Radio, Inc., of New York City, whereby they will combine to develop an international relay broadcasting network, using the four relay short waves now assigned to aviation radio, writes our Washington correspondent.

American programmes would be sent abroad on a regular basis, and American listeners would be urged to acquire receivers that would not only tune domestic short-wave stations, but also the short-wave broadcasters of foreign countries.

It is explained that under rules of the Federal Radio Commission, programmes relayed by short waves must be non-commercial in character. The return to those who seek to develop the short-wave transmitting and receiving field would come entirely from their markets for receiving equipment. Just as regular broadcasting was first developed without advertising to stimulate the sale of radio sets, it is believed that relay broadcasting can be developed to the same end once the public is aware of the excellence of the short-wave programmes.

A NEW TRANSPORTABLE
Amplion Battery Model

A Long-range, Self-contained Receiver.

SPECIFICATION

GENERAL: Completely self-contained, battery-operated receiver with built-in frame aerial and loud speaker.

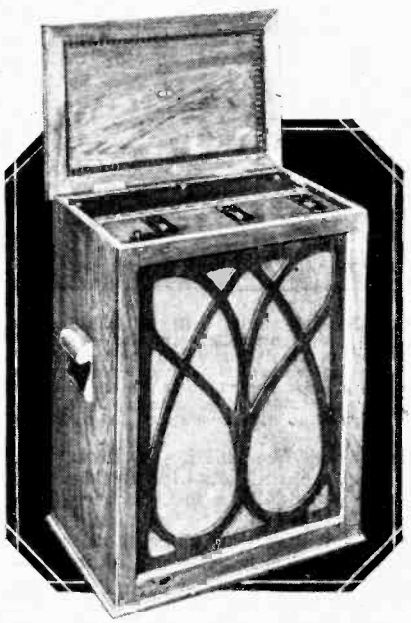
CIRCUIT: Two H.F. stages (one tuned, one untuned), followed by grid detector and transformer-coupled pentode output valve.

CONTROLS: Two tuning condensers, reaction, and combined on-off and wave-range switch.

OF late there has admittedly been a tendency among radio technicians to concentrate their efforts on the development of mains-operated broadcast receivers; those who have not access to an electrical supply system may feel, with some slight justification, that they are being neglected. But so long as carefully designed battery-fed sets with as good a performance as that of the Amplion "Cabinet Portable" are available, there will be few real grounds for complaint, because, with regard to sensitivity and quality of reproduction, it compares well with mains-operated sets of similar design. There is the additional advantage that, although the set is not really a portable in the generally accepted sense of that expression, it is light and compact enough to be taken almost anywhere, and is independent of any external source of current supply.

Being primarily intended to be moved from room to room, the set is mounted in an upright cabinet of polished walnut, which is fitted with carrying handles. All controls are grouped on a horizontal panel at the top, and, as a hinged lid is provided, these mechanical details are not obtrusive. A turntable is fitted to the cabinet, so that full advantage may be taken of the directional properties of the frame aerial.

The medium- and long-wave frame aerials are connected in series, a similar arrangement being adopted for the tuned anode coils which serve as a coupling between the first two valves. The second H.F. amplifier is linked to the detector by a choke; grid rectification is used.



Front view of the receiver, with lid open.

Electrostatic Reaction.

Elaborate precautions are taken to separate H.F. and L.F. components in the detector anode circuit, and at the same time provision is made for passing back a sufficient proportion of the detector circuit H.F. energy for reaction effects. Regeneration takes place between this circuit and the second H.F. valve grid, and is controlled by a small variable condenser. It will be seen from the accompanying diagram that, so far as H.F. energy is concerned, the detector anode circuit is "returned" to an artificially located centre point in the valve filament circuit by means of a potentiometer. It is claimed that this rather unconventional arrangement provides good reaction control on both wave bands without affecting tuning. It would also seem probable that it greatly increases the real effectiveness of the aperiodic H.F. stage.

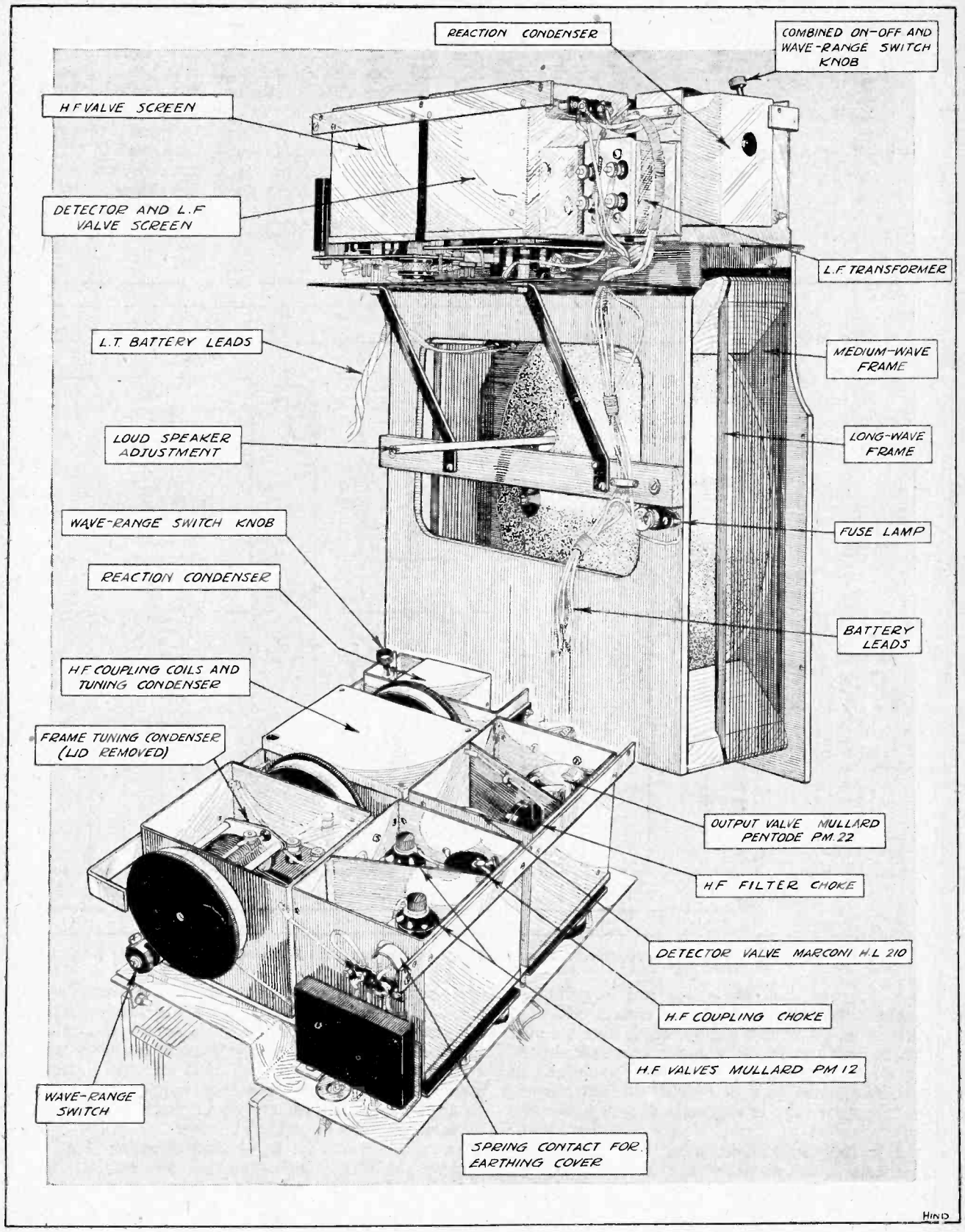
Matched Output Circuit.

Straightforward transformer coupling is used between the detector and pentode output valve, in the anode circuit of which the windings of a balanced armature loud speaker drive unit are connected. These windings are specially designed with a view to the relatively high impedance of the pentode.

As all the apparatus is mounted in close proximity to the built-in frame aerials, it will hardly be necessary to say that extremely thorough metallic screening is provided. Components associated with each individual H.F. circuit are mounted in separate boxes of tinplate, the joints of which are soldered. Separate screening is provided for the valves, and it is noticed that the loud speaker is connected by wires with braided metallic covering.

Mechanical interconnections for the "ganged" wave-range and on-off switches are cleverly devised; and, in view of the trouble that is so often given by defective contacts, it is reassuring to note that these components show no tendency to develop intermittency.

Regarding operation conditions for the valves, anode voltages actually recommended are indicated on the circuit diagram. The pentode grid is worked at 9 volts negative; this rather high bias voltage accounts for the fact that total anode current consumption is restricted to some 12 milliamperes. The L.T. accumulator cell is of the Exide unspillable type, and has a capacity of 24 ampere-hours.



Complete chassis of the Amplion cabinet portable and, below, plan view of the receiver unit.

A New Transportable.—

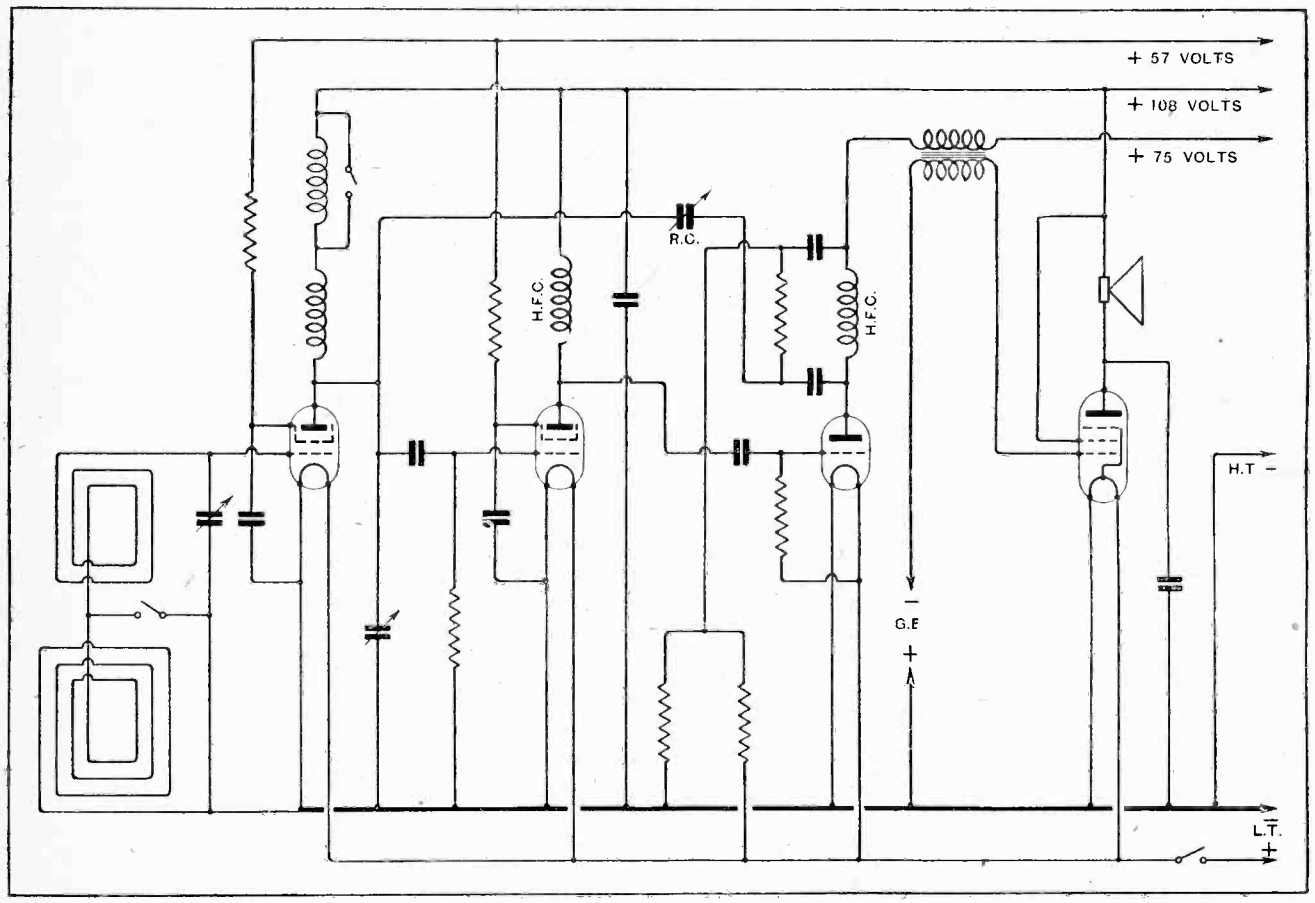
A multiplicity of controls has been avoided, but those fitted seem to be quite sufficient, and one does not feel the need for making any adjustments for which provision is not made.

Edgewise dials mounted on a horizontal panel might at first sight seem inconvenient, but actually they are easily manipulated, although the process of tuning can hardly be carried out properly except when the operator is standing up.

Range is distinctly good, particularly on the long wave-band, and any greater sensitivity than is provided by the set could seldom be usefully employed. Reaction is there to be used, but, except for real long-distance work, there is no need to adjust this control critically. The unconventional system embodied in this receiver proves to be highly satisfactory, as changes in feed-back capacity do not introduce any serious variations in tuning. There is no trace of overlap on either band, and constancy over the tuning scale is well above the average.

Judged in comparison with other battery-fed portables, no complaints whatever can be made on the score of quality. Matching of valve and loud speaker impedances must have been skilfully done, as there is a good bass response, together with a sufficiently well-marked upper register to give brilliancy to reproduction. No resonances are so pronounced as to be objectionable, and, considering the modest anode wattage, volume is highly satisfactory.

It is seldom that the directional properties of a frame aerial can be turned to better account than in the case of the Amplion set as an aid to avoiding interference. This feature, in conjunction with the natural selectivity of the tuned circuits, allows the receiver to be operated successfully in the neighbourhood of a high-power station.



Circuit diagram of the Amplion receiver. A fuse lamp (not shown) is interposed in the negative H.T. lead.

It is a somewhat laborious process to remove the receiver chassis from its container for test or repair, but, as construction throughout is sound and robust, the need for doing this should seldom, or never, arise, even if the set is subjected to much rougher treatment than a transportable of this type should ever receive. In any case, most ordinary circuit tests may be made by taking off the top and rear covers.

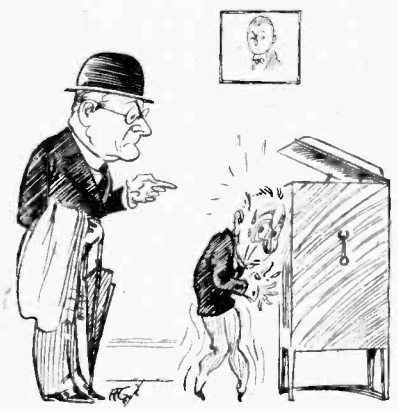
The receiver is made by Graham Amplion, Ltd., St. Andrew's Works, Slough, and its price, complete with all batteries and valves, is 22 guineas.

Next Week's Set Review:—BON MARCHÉ "SUPER-SIX" RADIOGRAM.

UNBIASED
BY FREE GRID

A Gramophile Asks . . .

A FRIEND who thinks that, because I borrowed a garden roller from him last summer (and forgot to return it), he has the right to ask me any fool question he likes, button-holed me the other day and asked what was the power output measured in milliwatts of an ordinary "acoustic" gramophone. He amplified his question by stating that he proposed to replace his existing gramophone by a home-constructed gramophone amplifier and loud speaker, and before he set to work on the design he wanted to know the power output required from his last valve in order to give him the same volume as he obtained from his existing instrument. I replied that the output of a gramophone was not measured in milliwatts, but I saw what he was driving at, and as I frankly did not know the answer I fobbed him off by telling him that he ought to be ashamed of himself for not being



"... ought to be ashamed of himself."

able to work out such a simple problem, and that I had not time to stop now, but would work it out for him at some future meeting when time was less precious.

. . . And Is Answered.

His trouble set me thinking, however, and I adopted his question as my own and propounded it to several experts—self-styled and otherwise—and the opinions I received were as varied as those obtainable by knocking at every door in Harley Street and seeking advice re a cold in the head. It is, of course, very difficult to compare the undistorted power output of a loud speaker reproducing a record via an electric amplifier and that of an ordinary gramophone because of the unfortunate necessity of deliberately restricting the bass when making a record. Not even the best of ordinary gramophones fitted with the largest and most cunningly devised horn compensates for this in anything like the manner which is possible with electrical equipment. As the result of various opinions that I collected I finally arrived at the conclusion that the output of a good ordinary gramophone was equal to that of a good loud speaker fed by an output valve having an undistorted output of 750 milliwatts, and there I must leave it, although I should gladly welcome opinions on the subject from readers.

Growing Pains at Olympia.

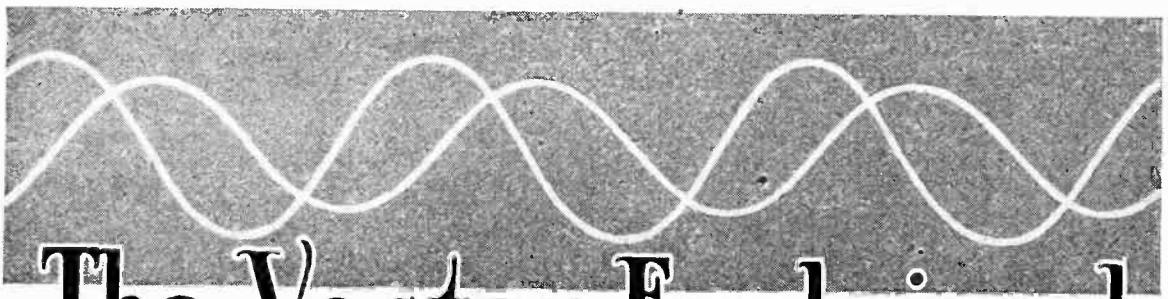
Readers of this journal will have probably noticed the announcement that this is the last year in which the National Radio Exhibition will be held in September and the last year in which it will be held in the two smallest of the three Olympia buildings. This year, by the way, there will be a great deal more space, as all three floors of the new Empire building are being utilised instead of one floor only as was the case last year. It is surprising to me how rapidly radio has grown and I well recollect that even after it had reached Albert Hall status in 1924, after graduating from the Horticultural Hall and the White City, the "Dismal Desmonds" croaked out their prophecy that it could never fill even the ground floor of the New Hall at Olympia. Next year and for the four succeeding years it will be occupying the largest and oldest of the Olympia buildings. I venture boldly to prophecy that in two years time the Radio Manufacturers' Association will find even this building too small for them and that by the end of the five years they will be renting the whole of the space at Olympia; in fact, the Exhibition will be bigger even than the motor show in all its glory.

August or September?

I am wondering, however, whether the public will take kindly to the holding of the Exhibition in the latter part of August instead of in the latter part of September as hitherto. The reason for the change, of course, is in order to allow radio manufacturers to deliver the new season's sets and components to their customers at the commencement of the radio season, i.e., when the clock goes back, instead of during the rush of the

Still on their holidays.

Christmas season as is usually the case nowadays. Although this new arrangement will prove of great convenience to the great wireless public in this respect, I am afraid that many of them will find themselves still on their holidays when the Exhibition takes place, and a great deal of annoyance will occur due to this state of affairs. Failing earlier holidays, the Exhibition organisers will have to run cheap one-day excursions from all holiday resorts, or to arrange that, on payment of the usual price of admission, a complete package of catalogues and pamphlets, such as is collected by the normal visitor, be forwarded on. *My* suggestion, however, is the issue of a "Super-special" *supplement* by W. W.



The Vector Explained

How an Alternating Current can be Represented by a Straight Line.

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

AMONG the vast numbers of those interested in the reception of broadcast programmes there is a very large proportion who take a keen interest in the design and construction of their own receiving sets. Many of these are fortunate in having had varying degrees of technical training in electrical engineering and allied subjects, and so experience little or no difficulty with the alternating current theory as it applies to receiving circuits.

On the other hand, there are a great many amateurs who have found it necessary to make, on their own accounts, a study of the elementary theory of alternating currents before they could make satisfactory progress. And it is surprising what a high degree of proficiency is attained by the majority of those who are really keen. The fundamental ideas of alternating currents, and the meaning of resistance, reactance, and impedance, seem in general to be readily grasped after quite a small amount of study. For instance, it is soon learned that, for a simple resistance, Ohm's law can be applied precisely as in the case of D.C. circuits, and that the current in the resistance is exactly in step or *in phase* with the potential difference or voltage between its ends. Similarly, it is readily appreciated that inductance in an A.C. circuit gives rise to *reactance*, which may be defined as the opposition to the flow of an alternating current, due to the "back electromotive force" set up in the coil or circuit by the alternating magnetic field produced by the current itself. The value of the inductive reactance in ohms is given by $X = 2\pi fL$, where L is the inductance in henrys and f is the frequency in cycles per second. After very little experience, it is realised that the induced E.M.F. produced in a coil by a sine wave of alternating current is represented by another sine wave just a quarter of a cycle out of step, meaning that the current is just passing through one of its maximum values as the voltage wave is going through a zero value, and vice versa.

A KNOWLEDGE of the properties of alternating currents is essential if the arrangement of and the reasons for the valves used in the radio and audio-frequency circuits of a receiver are to be properly understood. Direct current circuits depending essentially on an acquaintance with Ohm's law are readily followed, but to grasp the action of alternating current circuits such as those carrying H.F. and L.F. currents one must know the significance of phase difference, which is best followed by reference to the vector.

With the aid of analogies this article clearly explains the vector, avoiding complicated mathematical reasoning and assuming only an ordinary knowledge of arithmetic and elementary algebra.

The Meaning of a Vector.

It is when the learner first realises that the extent to which two waves are out of step, namely, the *phase difference*, has to be taken into consideration when these waves are added, subtracted, multiplied, or divided, that his peace of mind is temporarily upset. It is in this respect that alternating current calculations differ so widely from those relating to direct currents, and the normal mathematical treatment of the subject is, of course, only intelligible to those who have had special preliminary training. But, fortunately for those who have had no mathematical training beyond ordinary arithmetic and the simplest laws of algebra, there is a very simple means by which alternating current calculations can be made without recourse to complicated mathematics. This refers to the use of *vectors*.

In the first place, let us get a clear conception of what is meant by a vector. There are many quantities which possess, besides magnitude or value, some other quality, such as direction. A mechanical force is a case in point; to specify a force fully it is necessary to state both its magnitude and the direction in which it acts. Now, a vector is a simple straight line, whose length is made to represent, to a suitable scale, the magnitude of such a quantity, and it is drawn in such a way as to indicate the direction associated with that quantity. Anything which has both magnitude and direction is called a "vector quantity."

The Effective Value of an Alternating Current.

An alternating quantity, such as a current or voltage, which varies with time according to a simple sine law, thus giving a sine wave when plotted as a graph against

The Vector Explained.—

time, can also be represented by a simple straight line or vector, but in a somewhat different way from that relating to a force, as explained above. To begin with, an alternating current is one which is changing in value from instant to instant, and therefore has no fixed magnitude; but it varies between two definite and equal maximum values in the alternate directions round the circuit—that is, between the positive maximum value and the negative maximum value. Now, an ammeter reads the *effective value* of the alternating current, where "effective value" means the value of the direct current which would have the same heating effect as the alternating current in a given fixed resistance.

For mathematical reasons the effective value is often called the "Root Mean Square" value, or R.M.S. value. We are not, however, at present concerned with these details, but it is of great importance to bear in mind that the effective value is a definite fraction of the maxi-

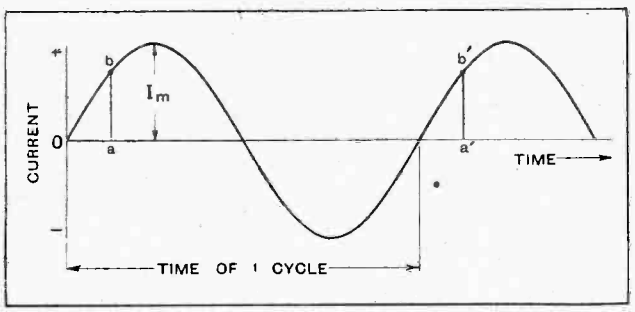


Fig. 1.—A sine wave of alternating current. If I_m is the maximum value in each direction, the R.M.S. value is $I = 0.707\ I_m$.

mum value attained by the alternating current every half cycle. When the current is represented by a sine-shaped wave, as in Fig. 1, it should be realised that the curve is a graph of current plotted against time, and does *not* represent a "wave" in the true sense of the word—that is to say, it is not a wave moving along the base-line.

Length of Vector Represents R.M.S. Value.

For a sine curve of current the effective, or R.M.S., value is 0.707 of the maximum, or peak, value; if I_m represents the maximum value of the current, as shown in the diagram, the R.M.S. value will be 0.707 I_m. For instance, if an alternating current of this wave-form reaches a maximum value of 10 amperes in each direction, the R.M.S. value will be 7.07 amperes. This simply means that a direct current of 7.07 amperes would generate the same amount of heat per second as a sine wave of alternating current fluctuating between maximum values of plus and minus 10 amperes in a given fixed resistance. So, henceforth, it will be understood that when the strength or value of an alternating current is mentioned, reference is being made to the R.M.S. value, unless otherwise stated; and similarly for electromotive forces and voltages.

Now, when we come to represent an alternating current or a voltage by a vector, the length of the latter may conveniently be drawn to represent the R.M.S. value of the alternating quantity to some suitable scale. For instance, a current whose R.M.S. value is 20 milliamperes could be represented by a straight line 10 centimetres long, so that one centimetre corresponds to 2 milliamps., and so on.

The Question of Time.

So much for the length of the vector! Now we must consider what other qualities are possessed by an alternating quantity. In the case of an ordinary force acting on a stationary body, both the magnitude and the direction of the force are fixed. But, as mentioned previously, an alternating current changes its value from instant to instant, and so the question of time is involved. By the adoption of the R.M.S. value, or the value of the equivalent direct current, to represent the useful magnitude of the alternating current, the question of time and direction appears to have been eliminated altogether, but this is only true for a single current which is not in any way referred to other currents or voltages in the circuit. For instance, if we know that a certain wire is to carry an alternating current of 10 amperes we can decide upon the minimum size of wire that can be safely used, without knowing anything further about the current; no relationship to any other current or to a voltage is inferred. And so for a single current such as this the vector representing it can be drawn in any arbitrary direction, such as horizontally or vertically, or at any angle to the sides of the paper, as shown by the line OI in Fig. 2.

But when there are two separate currents, or a current and an E.M.F., to be represented by two respective vectors, the sine waves representing them may or may not be in step, and it becomes necessary to arrange the corresponding vectors or lines in such a way that they give a measure of the extent to which the two waves are out of step or out of phase, and at the same time indicate which of the two alternating quantities is in advance of the other as regards time. This means that each vector will have to indicate, not only the R.M.S. value of the alternating quantity it represents, but also the passing of time.

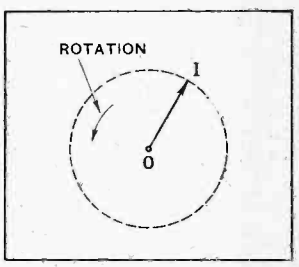


Fig. 2.—A sine wave can be represented by a straight line, called a vector, rotating about one end. The length of the line OI gives the R.M.S. value of the current. For reasons explained in the text the vector rotates about the end O, making one revolution per cycle of the current.

Now, time is usually recorded by something which is in continuous motion; for example, the hands of a clock, or the rotation of the earth on its own axis, rotational motion being the most convenient kind for registering the passage of time. This idea is introduced in connection with vectors representing alternating currents and voltages. For instance, although the vector OI shown in Fig. 2 is drawn in a certain position on the paper, the reader must imagine that the vector is rotating about the end O, like one of the spokes of a wheel or the hand of a clock, and further, that the speed of rotation is absolutely constant. Then the angle turned through in a given time interval is a measure of the length of that interval.

The Vector Explained.—

An Analogy.

To clarify this idea, let us consider a wheel rotating at a speed of, say, 50 revolutions per second. Then a particular spoke would be rotating, like the vector, about one end at the same speed as the wheel; and therefore in 1/50th second it would turn through just one revolution, or 360 degrees. So in 1/100th of a second it would swing through 180 degrees, in 1/200th second through 90 degrees, and so on; and, reversing the process, if the spoke is found to pass through, say, 60 degrees in a short interval of time, that interval will be $\frac{1}{100} \times \frac{60}{180} = \frac{1}{300}$ second.

The only difference between the analogy of the wheel-spoke and the actual vector is that whereas the spoke is really rotating in the physical sense, the vector representing the alternating current has to be *imagined* by the reader to be rotating, the angle at which it is drawn on the paper merely representing the position of the vector at some arbitrarily chosen instant. Here we can extend the analogy of the wheel and spoke; for instance, suppose that all of the spokes but one are painted white, the remaining one in which we are interested being black. If the wheel is rotated at a sufficiently high speed not one of the spokes will be distinguishable to the eye. Now suppose that a photograph of the rotating wheel is taken against a white background with a high-speed camera, so that only the black spoke shows up in the finished print. Then, obviously, the angle at which this spoke appears in the photograph will depend entirely on the instant at which the photographer released the shutter of his camera, the spoke being shown in one of the positions through which it passes every revolution. In the same way the current vector OI is shown in one of the positions through which it is imagined to pass every revolution.

Direction and Speed of Rotation.

So far no reference has been made to the speed and direction of rotation of the vector OI in Fig. 2 except that it revolves with constant speed. It is the usual convention in this country to consider the vectors to rotate in the anti-clockwise direction, as indicated by the arrow in the diagram, and therefore when the arrow is not included this assumption should be made.

Now, as regards speed of rotation, since the alternating current represented by the curve of Fig. 1 passes through a particular value, such as *ab*, say, on the rising part of the positive half-wave, once every cycle, that is to say, since the point corresponding to *b* is repeated once for each succeeding *complete* cycle, and as the rotating vector of Fig. 2 must pass through a particular angular position once every revolution, it follows that the vector must make as many revolutions per second as there are cycles per second. In other words, the rotational speed of the vector in revolutions per second must be equal to the frequency of the current in cycles per second. *One revolution of the vector corresponds to one cycle of the current*, a quarter of a revolution, or 90 degrees corresponds to a quarter of a cycle, and so on.

In its fullest sense a rotating vector must convey all the information that can be derived from the corresponding sine wave itself; that is to say, we should be able to read from it the instantaneous value of the current at any instant we choose. This would involve making the length of the vector equal to the *maximum* value of the alternating quantity and not to the effective value, as intimated previously. But, except in very specialised work, it is never necessary to know any of the instantaneous values other than the maxima, and it is, therefore, much more practical to employ R.M.S. values for the lengths of the vectors, as this obviates the necessity of using the factor 0.707.[1]

When there are two alternating quantities *of equal frequency* they will be represented by two respective vectors *each rotating at the same speed*, and, therefore, the angle (if any) between these two vectors will be a fixed one in spite of the rotation, just as the angle between two spokes of the wheel already considered remains unchanged. So the next step is to see how this fixed angle between two rotating vectors represents the phase difference between the two corresponding sine waves.

(*To be concluded.*)

[1] Those readers who desire further elementary details in this respect are referred to the article on sine waves by the present writer in *The Wireless World* of October 16th, 1929, under the heading of "Wireless Theory Simplified."

BOOKS RECEIVED.

Willings Press Guide, 1931.—498 pages of useful information, including list of newspapers and periodicals published in Great Britain, with the name and address of the publishers. Index to class papers, London suburban papers, provincial publications, Dominion and Colonial publications, foreign publications, etc. Published by Willing Service Advertising, Willing House, 356-364, Gray's Inn Road, London, W.C.1.

The Radio Handbook, including television and sound motion pictures, by J. A. Moyer and J. F. Wostrel. Definitions, formulæ, tables, methods and practice arranged in a convenient form for ready reference. Pp. 886, with numerous illustrations and diagrams. Published by The McGraw-Hill Publishing Co., Ltd., London, W.C.2, price 25s. net.

Cours Élémentaire de Télégraphie et Téléphonie Sans Fil, by F. Bedeau, D.Sc., with a preface by General Ferrié. A text-book for advanced students covering the general theory and practice of wireless telegraphy and telephony. Pp. 424, with 330 diagrams. Published by Libraire Vuibert, Paris, price Fcs. 60.

Filters for the Reproduction of Sunlight and Daylight and the Determination of Colour Temperature (Bureau of Standards, Miscell., Publ. No. 114), by R. Davis and K. S. Gibson. Pp. 165, with 33 diagrams, 37 charts, and formulæ and bibliography. Published by the Department of Commerce, U.S.A., price 45 cents.

High Frequency Alternating Currents, by Knox McIlwain and J. G. Brainerd.—A text-book for advanced students comprising the theory and calculations relating to Resonance Phenomena, Coupled Circuits, Valves, Amplification, Modulation, Detection, Filters and other problems connected with transmission and reception. Pp. 510+xiii. with 226 diagrams and illustrations. Published by John Wiley and Sons, Inc., New York, and Chapman and Hall, Ltd., London, price 30s. net.

Broadcast Brevities

Teutonic thoroughness was demonstrated recently in the Munich studio where speakers on the subject of anti-gas measures actually wore masks!

By Our Special Correspondent.

Power of 5XX. — Bach Cantata Surprise. — No Alternative. — Second in Command. — N.B.C. President on Sponsored Programmes.

The Time Has Come . . .

The idea of waging a "power war" between European broadcasting stations has always been discouraged in these columns, but there comes a time when the sword must be unsheathed . . . etc.

That time has surely come for British broadcasting with the reconditioning of Daventry 5XX.

oooo

More Power from 5XX.

Mr. Noel Ashbridge has himself announced that Britain's one and only long-wave station is about to be rebuilt, but, from what I can gather, there is a disposition at headquarters *not* to increase the existing power output, which, nominally at all events, is in the neighbourhood of 35 kilowatts (Geneva rating).

Compared with the power, or projected power, of some of our close Continental neighbours, this is ridiculously low.

oooo

Our Forceful Neighbours.

No one, of course, wants a 100-kilowatter at Daventry spreading itself all over the receiver dials and blotting out our old friends Radio Paris and Königswüsterhausen, though, sadly enough, it is our old friends themselves who are piling on the kilowatts in a way which will soon put Daventry in the shade. This fact alone might be held insufficient to justify a power increase to 60 kW., but some of the well-fed listeners in the south may perhaps overlook the claims of that multitude of British licence holders who derive all their programmes from 5XX.

oooo

The Only Solution.

Many of them will be outside the scope of the Regional scheme, and, unless an alternative long-wave programme is found possible, the most they can hope for is an improvement in the curate's-egg-like transmissions from Daventry.

No doubt a modernised transmitter would help, but the real solution requires a good many more kilowatts.

oooo

The Derby.

The Derby will form the subject of a running commentary again this year, when it is run on June 3. Mr. R. C. Lyle, the well-known racing correspondent, will be responsible for the description, which listeners to the National programme will hear.

oooo

"G. B. S."

A speech by Mr. George Bernard Shaw is to be heard by National listeners on May 30th. His subject will be "Saint Joan," and the occasion is the five hundredth anniversary of her martyrdom.

Ten Sundays Without Bach.

The Bach Cantatas are to cease—for ten Sundays! Then they will be resumed with fresh vigour. I learn that the break will occur from June 28th to August 30th inclusive.

Last year there was a short gap in the series during the holiday absence of the conductor, Stanford Robinson, but, apart from this, the series has continued almost uninterruptedly since the first cantata was broadcast in May, 1928.

oooo

Horse Racing on Sunday!

No sooner had Sir John Reith left our shores than the B.B.C. shocked fifteen million listeners by broadcasting the Kentucky Derby until nearly 12.15 a.m. on Sunday last!

oooo

Trouble in Newcastle.

A word of sympathy is due to Newcastle listeners, who are protesting against the apparent intention of the B.B.C. to keep their local station on the 238.5-metre wavelength while serving up the National programme.

As a Novocastrian explains to me, the only alternative to 5NO is 5XX, which also transmits the "Nat." items.

oooo

Too Much "National."

It had been hoped that Newcastle would be given the same wavelength as Northern Regional, viz., 479.2 metres, the feeling being that this would involve no interference with the Slaithwaite transmitter, while ensuring Newcastle listeners a more varied fare than they can expect at present.

For the time being, however, there seems to be no inclination at Savoy Hill to shift Newcastle from the national common wave. Plymouth listeners suffer in precisely the same way, but Aberdonians can boast of at least a little Scottish variation on the eternal Daventry.

oooo

An Official Promise.

Officials assure me, however, that Newcastle is not by any means forgotten, and that, with the growth of the Regional scheme, steps will be taken to provide Tyneside listeners with as good and varied a service as anywhere in the country.

oooo

Advice to Lonely Scots.

The same cheerful promise does not apply, I fear, to the Scottish Highlands and the Western Isles. The B.B.C. engineers practically confess than there can be no satisfactory alternative programme in these regions. 5XX, which gives great pleasure in Inverness, must continue to serve all those lonely tracts outside the pale of the new Falkirk transmitter, and the only remedy for listeners in the solitary sheilings is to pack up and come south!

FUTURE FEATURES.

National (261 and 1,554 metres).

MAY 26TH.—"The Stage Revolves," feature programme by John Watt.
MAY 27TH.—Speech by the Prince of Wales at the Wireless for the Blind Fund Dinner, relayed from Clothworkers' Hall.
MAY 28TH.—Symphony Concert.
MAY 29TH.—"Assault on Professor Weltmann," a play, by Felix Mendelssohn.
MAY 30TH.—Mr. G. Bernard Shaw: "Saint Joan."

London Regional.

MAY 25TH.—"Götterdämmerung," Act 2, from Covent Garden Opera House.
MAY 27TH.—"The Stage Revolves."
MAY 28TH.—Vaudeville.
MAY 29TH.—"The Magic Flute," Act 1, from the Opera House, Covent Garden.
MAY 30TH.—Programme of Students' Songs.

Midland Regional.

MAY 28TH.—"Music of the East," orchestral programme.
MAY 30TH.—Musical Comedy programme.

West Regional (Cardiff).

MAY 27TH.—Concert by the Bristol Hippodrome Orchestra
MAY 28TH.—Welsh Variety Programme.

North Regional (Manchester and Leeds).

MAY 25TH.—"Bill's Battle of the Roses," a farcical sketch by Edwin Lewis.

Glasgow.

MAY 24TH.—Special Meeting and Demonstration: "The Churches and Peace," relayed from Edinburgh.

Belfast.

MAY 26TH.—Novelty programme relayed from the Hippodrome Theatre, Belfast.

The Admiral in Command.

Savoy Hill has quite a nautical flavour these days. It began a few weeks ago, when the Sea Shanties were broadcast, and now the atmosphere is positively salty. The reason, of course, is that an Admiral is on the bridge.

Sir John Reith's American visit is expected to last quite two months, during which period Admiral C. D. Carpendale, the Controller, takes over administrative command.

oooo

Sir John Reith's Tribute.

Admiral Carpendale came to Savoy Hill in June, 1923, and the work he then did and the impression he created are best summed up in Sir John Reith's own words, culled from his book, "Broadcast Over Britain."

"When we were all somewhat jaded and bewildered by the extreme vicissitudes and complexities of the earlier months, he (Admiral Carpendale) came with the clear and unprejudiced mind of the outsider with the experience of an administrator and the enthusiasm of a zealot."

oooo

International Fame.

Besides holding the tiller at Savoy Hill, Admiral Carpendale is one of the "biggest noises" in European broadcasting, being, of course, President of the International Broadcasting Union, to which post he was elected by international consent.

oooo

"Ship Ahoy" in Portland Place.

Talking of matters nautical, it is surprising how closely the new Broadcasting House resembles a ship when viewed from Regent Street. The lattice masts remind one of an American battleship, while the balcony over the main entrance suggests a cross between the bridge of a liner and an open-air pulpit.

oooo

Paint Pots at Savoy Hill.

At Savoy Hill people are discussing whether the building will be ready for occupation quite so soon as was expected. What we see from the street is still only an empty shell, and a tremendous amount of carpentry and decoration will be necessary before even an engineer will set foot inside the place.

Is there anything significant in the fact that the Savoy Hill building is being repainted?

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Philomel Again.

This week the B.B.C. are once more prevailing on the good nature of the nightingale. Each evening, when the birds are in song, the late dance music is being interrupted for a relay from a wood in Berkshire.

It is hoped that listeners may hear the birds several times during this season, as in past years.

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Other Songsters?

As a soloist the nightingale is universally popular, but I think the time has come when the B.B.C. might attempt to give us some more original, if less musical, efforts by members of the humbler creation.

Why Not the Cuckoo?

"On First Hearing a Cuckoo in Spring," by Delius, has been heard several times, and we all know how good it is. How much more thrilling it would be, though, to hear the actual first cuckoo. "Mother of Eight," Peckham," reveals in her letter to the Press that she has stolen a march on the B.B.C. this year, but there is no reason why in 1932 the Corporation should not be first in the field. A prize could be offered to the listener who first found a suitable listening-spot.

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Above Reproach.

There is one excellent reason why crickets, frogs, corncrakes, and even the roaming tom cat should be called upon to supply vocal accompaniment to the late dance music during the coming summer. We should at last be sure that there was no song-plugging.

IN COMMAND AT SAVOY HILL. Admiral C. D. Carpendale, Controller of the B.B.C., who takes charge at headquarters in the absence of Sir John Reith in America.

Sunday Evening Broadcasts to U.S.

I am glad that the B.B.C. has turned round upon its critics with more than accustomed severity over that little matter of the Sunday evening transmissions to U.S.A. As many listeners are aware, the Columbia broadcasting authorities in America have been hiring a studio at Savoy Hill for short-wave transmissions across the Atlantic *via* Rugby on Sundays at 6 p.m.

The arrangements began during last year's Naval Conference, when American publicists took this opportunity to keep their public informed as to the trend of events. The scheme was immensely popular from the start, and since then many prominent Britishers have spoken or recited for the benefit of Columbia listeners.

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The Right Answer.

And now aggrieved listeners in this country have protested that, as licencees, they are being defrauded of their due, since the transmissions are limited to the short wave. But, as the B.B.C. points out, these items are paid for by the Americans, and do not concern listeners in this country. For this retort I am grateful; most readers of *The Wireless World* would oppose any proposal that the B.B.C. should encroach on those precious Sunday evening hours when we can get Continental stations that are barred on other nights in the week.

oooo

Plea for Puff Programmes.

With his back to the wall, Mr. Merlin Aylesworth has been valiantly lashing out at the critics of sponsored programmes. There is a "stag at bay" touch about the proceedings, which suggests that the National Broadcasting Company of America is not quite so sure of public support as it used to be.

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Mr. Aylesworth at Bay.

The President of the N.B.C. took up the defensive attitude in a speech recently made at Princeton, N.J., where he faced the hounds in the shape of newspapermen, who, in Mr. Aylesworth's words, regard radio "as a serious and dangerous competitor for advertising and circulation patronage, ready to bite the very hand that fed it."

oooo

The Last Resort.

In the course of a vivacious speech he startlingly declared that commercialised programmes were adopted as a last resort when American broadcasting was at the point of premature death a few years ago.

"The radio industry as a whole was first asked to contribute a small percentage of its yearly income. This failed to materialise. The public was then solicited for voluntary contributions wherewith to secure professional talent in place of amateur talent. The returns were so small that they were returned by the broadcasters with thanks."

oooo

Philanthropists Would Not Oblige.

"Philanthropists were approached with the thought that they might create endowments for broadcasting. The reaction was that broadcasting could scarcely compete with the older libraries, universities, and other institutions competing for endowments. The licensing of receivers and the taxing of listeners was suggested as a means of raising funds for the continuation of broadcasting. The public promptly resented the idea. . . ."

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And Then . . . .

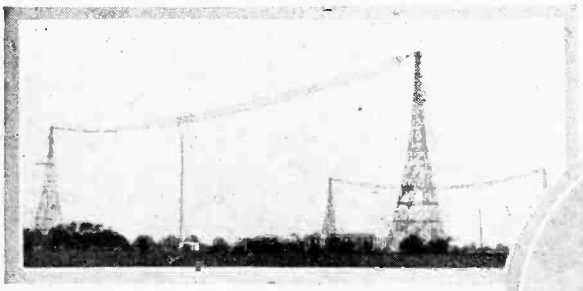
So the pitiful tale went on. Finally, according to Mr. Aylesworth, at a time when broadcasters were at their wits' end for a solution of the economic problem, the sponsored programme appeared as "an altogether logical development."

oooo

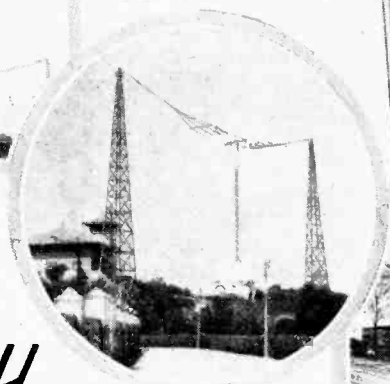
. . . the Logical Development.

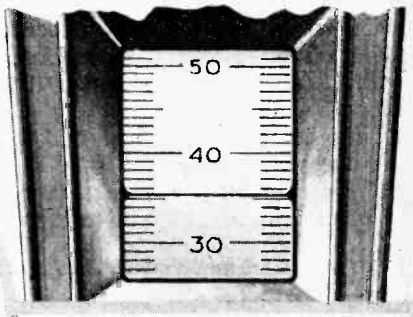
If this address was intended to boost the sponsored programme as something to be desired, I am not surprised that the American public is beginning to chew its tuning dials.

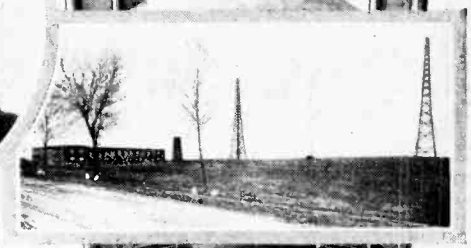
Perhaps there will be another "altogether logical development."

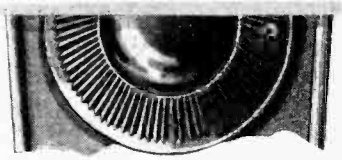


London National 261m.
Barcelona 263m.
Hellsburg 267m.









The Selectivity of the Superheterodyne

Part II.—Eliminating Oscillator Harmonics.

By W. T. COCKING.

IT is often found that with a superheterodyne the local station is audible at more than two settings of the oscillator dial. This is due to harmonics of the oscillator beating with either the fundamental or harmonics of the local station, and it is, of course, an undesirable state of affairs, since unnecessary interference is caused. There should be no difficulty in recognising the settings at which a station is received by means of the harmonics, since it is weaker than at the correct setting, and it is often accompanied by a certain amount of distortion.

The only satisfactory cure for the trouble lies in the elimination of oscillator harmonics. Their complete elimination is usually difficult, however, but a considerable improvement can be made by careful attention to the design of the oscillator. In general, it may be said that the trouble is not excessive provided the oscillator has its anode circuit tuned, and that the valve is operated with the correct anode and grid voltages. The trouble may be cured, however, by the adoption of a tuned link circuit for the coupling between the separate oscillator and the first detector, as recommended recently in the pages of this journal by A. L. M. Sowerby.[1]

It is usually unnecessary to go to such lengths, however, and the ordinary well-designed oscillator circuits can be considered to be satisfactory. In this connection it is well to point out that most single-valve frequency changers[2] are a very prolific source of the trouble, and in consequence they cannot be recommended for general use.

IN the first part of this article consideration was given to the overall response curves which are to be expected in a well-designed superheterodyne. It was shown that the selectivity and sensitivity of this type of receiver were of a high order and not easily approached by other methods. In Part 2 of the article the problems of cross-modulation and long-wave interference are discussed and suggestions made for the design of a band pass filter for the I.F. amplifier.

Cross-modulation.

Interference from cross-modulation may be experienced with the superheterodyne just as with tuned H.F. circuits, but the trouble is usually more apparent owing to the higher adjacent channel selectivity. The tuned circuits preceding the first intermediate frequency valve usually provide quite a high degree of selectivity, and so cross-modulation is only rarely found at this point. The trouble generally occurs when a stage of H.F. amplification is used preceding the first detector, and the writer has experienced such trouble from this form of interference that he usually prefers to dispense with such amplification.

With an I.F. amplifier capable of receiving a station with a frequency separation from the local of more than 10 kc., it has been found that such selectivity is indeed obtained when no H.F. stage is used, and that it is perfectly practical to receive Algiers with no interference, and Mühlacker with only slight interference, within nine miles of Brookmans Park. When a pre-

[1] "The Frequency Changer of the Superhet," October 29th, 1930.

[2] See "Frequency Changers" *The Wireless World*, May 6th, 1931.

The Selectivity of the Superheterodyne.—

liminary stage of H.F. is added, however, cross-modulation is so bad that interference is experienced on all stations which are nearer than about 40 kc. to the local station.

It will be seen, therefore, that the advantages of a preliminary H.F. stage are very dubious when the set is to be used close to a strong station, however good it may be in districts where there is no powerful station.

Long-wave Interference.

Now, it will be obvious that since the intermediate frequency amplifier is working upon a fairly low frequency it will receive directly a station on that frequency if it can find its way into the circuits. These low frequencies are occupied by C.W. telegraphy stations, and any interference will take the form of C.W. Morse; it is readily recognisable by the fact that it is audible only when a carrier is tuned in, and its pitch varies with the setting of the oscillator condenser.

There are two ways in which this interference can reach the set; it may be due to direct pick-up in the I.F. amplifier, or it may reach these circuits through the first detector and the pre-detector tuning system. The former source of trouble can be removed by screening the I.F. amplifier, but the latter is more difficult. Interference is almost inevitable when a frame aerial is used directly preceding the first detector, but it may usually be eliminated by the adoption of a preliminary stage of H.F. or a suitably designed band-pass filter in conjunction with the frame aerial.

The writer usually prefers an outdoor aerial, however, and it is his experience that long-wave jamming is somewhat less severe in this case. No preliminary H.F. stage is desirable, because of cross-modulation, and so a band-pass filter must be used for the coupling between the aerial and the first detector. Now, it has been found that the type of band-pass filter which is used has a marked effect upon long-wave interference. Experiments have shown that the filter coupling must be by mutual inductance, and that it is quite inadmissible to use either the capacity filter or the more modern mixed filter.

The reasons for this are quite easy to understand; the tuning coils themselves offer a negligible reactance to currents of the intermediate frequency, and so the usual filter circuit of Fig. 1 (*a*) may be redrawn as in Fig. 1 (*b*), which shows the effective circuit for low frequencies. The reactance of a condenser increases with a decrease in frequency, and so all these condensers offer an appreciable impedance to currents of the intermediate frequency. The important reactance is that of the coupling condenser C, and this is sufficiently high to allow an appreciable proportion of the applied long-wave signals to reach the grid of the first detector.

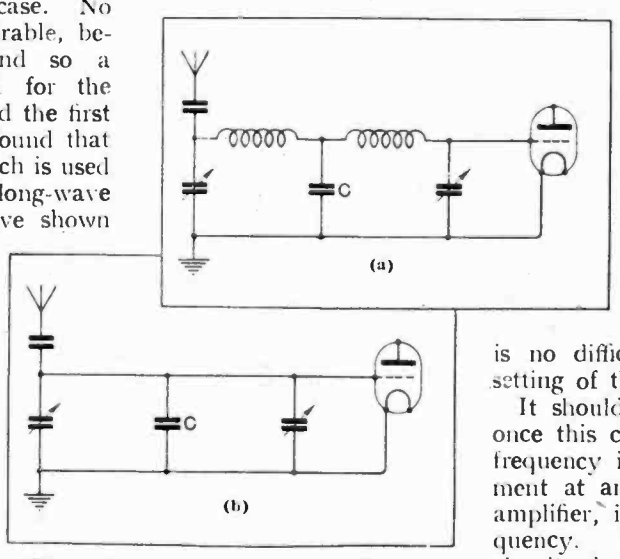


Fig. 1.—The usual capacity filter of Fig. 1 (a) can be redrawn as in Fig. 1 (b) to show the effective circuit at the intermediate frequency. The reactance of the condenser C is sufficiently high to allow long-wave signal voltages to be developed across it.

Now, when mutual inductance coupling is used in the filter, as in Fig. 2, signals can only be transferred to the secondary circuit through this mutual inductance M. The reactance of this decreases as the frequency decreases, and so the long-wave interference is very greatly reduced. With the superheterodyne the filter coupling must be by mutual inductance, and no other form is usually permissible.

It has been found that the input circuit of Fig. 2 will usually give complete freedom from long-wave interference when receiving stations on the medium waveband. On the 150-300 kc. (2,000-1,000 metres) waveband, however, interference may be very prominent, since the input tuned circuits are tuned to a frequency which is not very different from the intermediate frequency. On this waveband, therefore, it is necessary to adopt other means for the prevention of long-wave interference.

The Acceptor Circuit.

The most obvious solution is to use a wave-trap tuned to the intermediate frequency, and one such circuit is shown in Fig. 3, where L and C form a rejector tuned to 110 kc. Although this circuit is quite effective in reducing the interference, it suffers from the disadvantage that it reduces signal strength considerably. In general, therefore, it is more satisfactory to adopt the acceptor circuit of Fig. 4. It has been found that this acceptor circuit reduces long-wave interference to a negligible amount, and at the same time it gives no audible reduction in signal strength. The value of the inductance L can be the same as that used in the intermediate frequency amplifier, while the condenser C, which should be of the adjustable compression type, must be adjusted while the set is in operation until the interference vanishes. This adjustment is quite critical, and so there is no difficulty in locating the precise setting of the condenser.

It should be clearly understood that once this circuit is tuned to the correct frequency it requires no further adjustment at any time, since, like the I.F. amplifier, it operates upon a fixed frequency. It should be noted that the circuit is only effective upon the 1,000-2,000 metres waveband, and that it gives no reduction in long-wave interference on the medium waveband. This is due to the low impedance of the tuned circuit, with which it is in parallel.

A further source of interference which deserves mention lies in the possibility of harmonics of the intermediate frequency reaching the grid circuit of the first detector.

The Selectivity of the Superheterodyne.—

Such harmonics will be found in the output of the second detector, and they may lie within the tuning range of the set, when they will give rise to a form of regeneration. For example, with an intermediate frequency of 110 kc., the second harmonic is 220 k.c., and the third is 330 kc.; these are the strongest harmonics, and they both fall within the 1,000/2,000 metres waveband and so may cause trouble.

Summary.

It is essential, therefore, to use an efficient filter in the second detector anode circuit in order to localise these currents and to prevent them from reaching the grid of the first detector. This is by no means difficult, but it is necessary to use larger condensers and chokes than are required for a straight H.F. set.

It will be seen, therefore, that although the superheterodyne is open to interference from many sources which do not affect the tuned H.F. circuits, this interference need not be at all serious. By careful design long-wave interference and harmonic troubles can be reduced to a negligible extent, while second-channel interference and beat interference are compensated for by the extremely high adjacent-channel selectivity which is available. Even although the superheterodyne does not give complete immunity from interference, it allows the reception of many more stations than is possible with a tuned H.F. set in a congested locality.

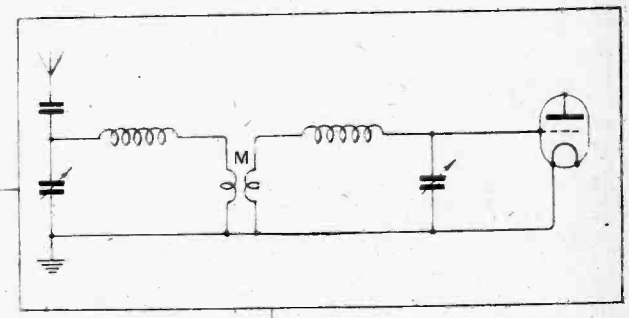


Fig. 2.—By using a filter coupled by mutual inductance, long-wave interference becomes negligible when receiving signals on the medium waveband.

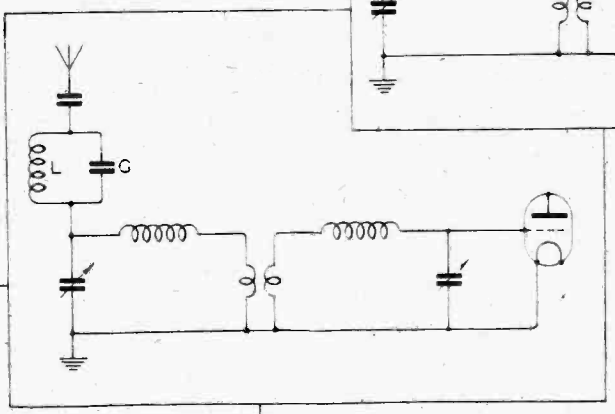


Fig. 3.—The rejector circuit LC is tuned to the intermediate frequency, and it effectively cuts out long-wave jamming when receiving on the 1,000-2,000 metres waveband. The circuit reduces the efficiency somewhat.

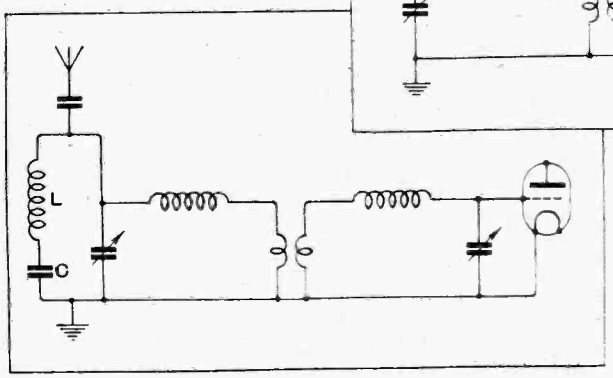


Fig. 4.—Instead of using the circuit of Fig. 3, an acceptor circuit LC may be used with much greater efficiency. The condenser C is varied while the set is working until long-wave jamming is eliminated. The circuit is not effective on the medium waveband, hence the necessity for the mutual inductance coupling in the filter.

The usual difficulty, however, is that the interference takes a form to which few are accustomed, and so it appears more noticeable than the usual jamming due to poor adjacent-channel selectivity. It will be found that a well-designed supersonic receiver is quite delightful to handle when one has once got used to its peculiarities, and the sensitivity and adjacent-channel selectivity are so high that it is often difficult to find the local from among the welter of foreign transmissions which can be tuned in. There is no method by which such high selectivity and amplification can be obtained so easily; furthermore, these desirable features need involve no deterioration in quality of reproduction.

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.

INEXPENSIVE QUALITY.

Sir,—Although there have occasionally appeared letters of appreciation of the quality of the B.B.C. transmissions—as apart from programmes—in your correspondence columns during the last seven or eight years, Mr. H. A. Hartley's letter (May 6th, page 494) is good to read.

Those of us who consider themselves "musical," whether by nature or study, or both, and are also keen on constructional work, will no doubt agree with him when he stresses the difficulty of faithfully reproducing the real quality the B.B.C. gives our sets if these same sets can be made to avoid distorting it during the course of "digestion."

He is right about the moving-iron loud speaker unit, but faithful reproduction does not, by any means, rest solely on the unit; to my mind, it is largely a question of the owner's knowledge of the real vocal and instrumental tones and their respective qualities, and then how to faithfully reproduce them by selection of manufactured apparatus or designing and making his own.

No doubt others agree with Mr. Hartley's remarks about Walton O'Donnell and Jack Payne and their programmes, but

they both have a tremendous following in these Isles and on the Continent, chiefly, perhaps, because their bands can play, in the full sense of the term.

The same applies to "our" B.B.C. symphony orchestra, approaching the finest in the *world* now, surely? Yet they occasionally have to play stuff worse than anything Jack Payne inflicts.

Jack's job is frankly light music of a flippant character, but occasionally the Symphony Orchestra have to groan and whine out stuff devoid of harmony or sense; but that is nothing to do with the quality of the transmissions which remain consistently good.

RENDISLE.

London, S.E.20.

Sir,—Under this heading Mr. H. A. Hartley makes some criticisms *re* good quality. I also have been experimenting. I have found no set capable of giving the quality I desire. I am therefore arranging to have a series of amplifiers each capable of delivering a straight-line output over a *restricted* band of frequencies. These will each in turn be connected to a super-moving coil, also with straight-line output of restricted bands of frequencies. I estimate the output equivalent to the B.B.C. Symphony Orchestra to be umpteen watts, which I shall supply to my room measuring 10ft. by 6ft. with padded walls. I shall then pay the German broadcasting authorities a sum of money to close down Mühlacker.

I should then have perfect reproduction, or as near to perfection as I can get, but what this has to do with "Inexpensive Quality" is for Mr. Hartley to solve.

VERITAS.

London, S.E.15.

Sir,—In making a few remarks on Mr. Hartley's letter in your issue of May 6th, I must say I think his criticism not in any way helpful.

"Inexpensive quality" is at least decided in his opinion, though that opinion was probably formed without the opportunity of comparative tests between good M.C. and moving iron speakers, switch arranged to change over at any moment.

It requires no confirmation that moving iron speakers have been so much improved that they give exceptionally good reproduction, and the manufacturers, who must produce commercially, are to be congratulated on the quality obtained from a design so fundamentally poor.

I think Mr. Hartley may not accept a statement that the better the speaker the more you recognise the loss of quality due to *transmission*, and the M.C. reproduction, I believe, *is* accepted by many as the nearest approach to good quality obtainable through our congested ether.

Allow me to give some short extracts from this entertaining letter of Mr. Hartley's.

(1) "No loud speaker at present on the market has any hopes of doing that," i.e., satisfy a musical ear.

(2) "I have not heard anything that was other than nauseating to a musician," etc.

(3) "So I can only conclude that, in the absence of private research, the good M.C. speaker does not exist."

(4) "A month ago I listened to their (the B.B.C.) broadcast of "The Ninth" *at home*, and I have listened to the same work at the Queen's Hall. *I am convinced that I lost nothing in the broadcast.*"

(5) "It is not a *little* amusing to come across people who boast of their marvellous reception."

(6) "No article has been published showing how a loud speaker of the M.C. type should be made."

It seems that everyone, even criminals and those that criminally criticise, make errors in carrying out their plans, and Mr. Hartley should have been so careful with his letter that he did not stultify himself with his own pen.

Referring to extract 6, *The Wireless World* has for five years been giving designs and explaining the requirements of M.C. speakers and all the difficulties to be met with in their production. From time to time the whole design of the standard type M.C. speaker has been discussed with illustrations.

I wonder what is Mr. Hartley's secret of reception, as apparently there is no speaker made suitable to his particular requirements.

THOS. P. PRATT.

DEAF AIDS.

Sir,—I have read with interest Mr. Balbi's letter in your issue of April 29th.

I am sure Mr. Balbi cannot realise the difficulties in fitting the deaf with aids to hearing.

Frankly, not one in fifty of the wireless retailers would have sufficient knowledge to guard against possible damage to the ear by fitting unsuitable instruments, also about fifty per cent. of the deaf cannot use an electrical aid.

I have through my hands in the course of a year hundreds of repairs to these aids, a number of which wireless retailers have tried but failed to repair.

An electrical instrument costing £1 would be a liability, not an asset, on the score of maintenance.

W. H. PETTIFOR.

London, S.W.1.

Sir,—With reference to Mr. Charles Balbi's letter in your issue of the 29th inst., we beg to point out that we recently put on the market a deaf-aid set, the "Hear-Easy," at 18s. 6d. This has been advertised in your journal, and is very popular, but we do not think that it is an industry likely to "blaze."

The lack of care and technical knowledge, and the age and infirmity of many deaf people is the great difficulty.

FOR LESLIE DIXON AND CO.,
H. LESLIE DIXON, M.I.E.E.

Sir,—May I earnestly advise radio dealers not to follow Mr. Balbi's advice to start selling deaf aids? Reform in the selling of these instruments is needed badly, but the time is not yet ripe, nor is the radio dealer the man for the job. Two years ago I started in this business with just the ideas expressed in Mr. Balbi's letter; I had money and ideas then, now only the ideas are left!

Mr. Balbi has been, I know, connected with a deaf-aid business in a technical advisory capacity, but I do not think he has had any experience of selling aids. If he had he would not advise radio dealers to take up the work. It is a whole-time job and needs the patience of Job.

He says these instruments can be sold for £1 if mass-produced. Suppose they can be sold wholesale for 10s., giving the dealer 10s. gross profit. The average time taken to sell one aid decently—that is, sell one which really does help the defective ear in question—is about an hour and a half, and the chances are that it will be brought back as no use in a week's time.

Most of the trouble lies in the fact that deaf people want far more than can be given at present. The argument seems to be, "If my eyes are bad I go to an oculist, and he, with the help of a pair of spectacles, gives me practically perfect sight. Why cannot the same be done for deaf ears with the help of a suitable instrument?" If we lived in a perfect world, it could!

Provided the type of deafness is suitable for an electric aid, close-to conversation is fairly easy; 99 per cent. of deaf people want more than this. They want to hear all that goes on at a mothers' meeting; hear a sermon from the back of the church; hear the talkies; hear a whispered conversation the other side of the room—all with apparatus which must be invisible, foolproof (very!), weigh next to nothing, and work with a run-down battery. This is not exaggeration; it is solemn fact learnt by much bitter experience. Not all deaf people are like this, of course, but the reasonable ones are few and far between. I have known people break the carbon diaphragm, replace it with an *enamelled stalloy* diaphragm, and then return the instrument to me very annoyed because it would not work.

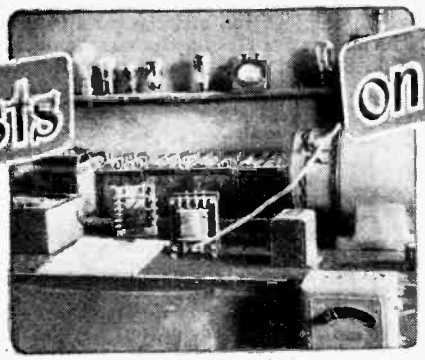
I know how utterly hopeless it is for a radio dealer to make money by selling deaf aids—even enough to make it barely worth while—that is, if he wants to do it decently. If he is the type of smart salesman we all know he may make a "do" of it for a time; he has only to promise much and the people will come; but the promises cannot be kept.

If deaf aids would do for ears what spectacles do for eyes it would be a very different thing; as things are, I can only express my surprise at Mr. Balbi—knowing what he does—making the suggestion contained in his letter.

R. G. KENNARD.

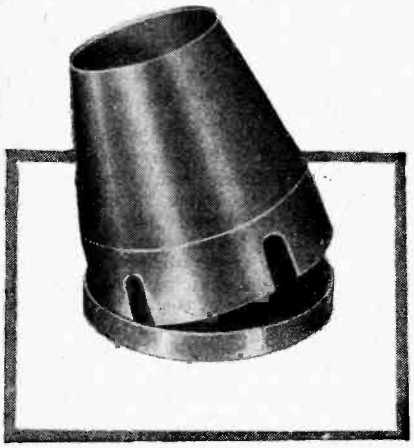
Kingswood, Surrey.

Wireless World Laboratory Tests on New Apparatus



"ENEMAINS" MIDGET VALVE SCREEN.

This valve screen has been designed primarily for use in the "D.C. Band Pass 5" receiver described in our issues of February 4th and 11th last. It replaces the home-made screen illustrated and enclosures the lower portion only of the valve. It would appear, to be suitable for employment in receivers where adequate screening of the anode leads is provided and some additional shielding is required for the grid lead.



"Enemains" truncated valve screen for use where the anode circuit is adequately shielded.

The makers are The "Loud Speaker" Co., Ltd., Palmer Works, 2, Palmer Street, Westminster, London, S.W.1, and the price is 1s. 9d.

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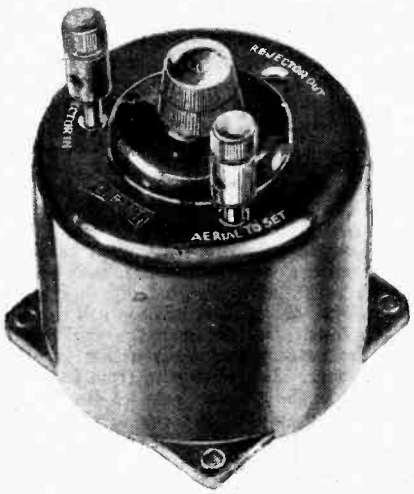
EXIDE IDENTIFICATION LABEL.

A novel means of identification for Exide celluloid type accumulators has been introduced recently by the Chloride Electrical Storage Co., Ltd., Clifton Junction, near Manchester. This takes the form of a label on which the owner's name is written, after which it is inserted into a special celluloid pocket on the side of the cell. The label, as can be seen from the illustration, is provided with a tear-off tag which can be retained for the purpose of identifying the battery on the occasions it is collected from the charging station.

When the tear-off tag is removed it is practically impossible to withdraw the identification label from its pocket.

This little device should serve to safeguard the owner against accidental change of identification tags and assures that he will always receive his own accumulator.

New device for identifying Exide batteries when left at a charging station.



Ferranti rejector for the new Northern Regional area.

FERRANTI REJECTORS.

This unit (illustrated) has been designed especially to deal with the new Northern Regional transmission on 479 metres. The range covered by the unit is from 440 metres to 550 metres; that is to say, it will act as a rejector over this band. Particular care has been taken in designing the coil to render the rejector as efficient as possible, and it is claimed that stations operating on wavelengths as near as 30 metres to that of the rejected station can be received efficiently and without undue loss of power.

The makers are Ferranti, Ltd., Hollinwood, Lancashire, and the price is 7s. 6d. Similar rejectors for use in connection with the Midland and London Regional transmissions are available, also, at the same price. The wavelength on which the unit is to be employed should be specified in all cases.

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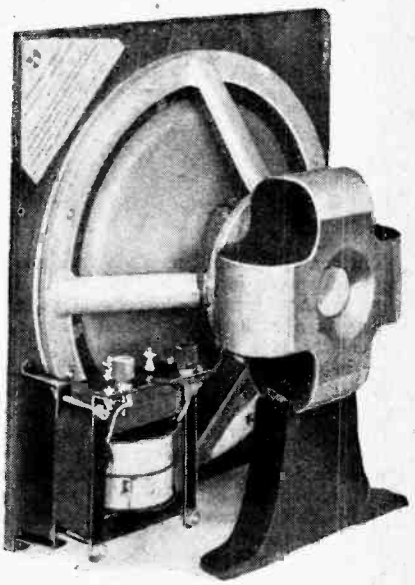
A NEW W.B. LOUD SPEAKER.

This unit is of similar design to the type PM1 chassis reviewed in this journal on February 25th. The principal alteration lies in the use of a smaller permanent magnet, which has enabled the price to be reduced to £4 10s.

The sensitivity is satisfactory, but is not quite so high as in the earlier model. The frequency response, on the other hand, is, if anything, better. The excellent high-frequency response between 2,500 and 5,000 cycles has been maintained and the bass response from 150 cycles downwards has been improved without becoming unduly prominent. Between 300 and 2,000 cycles the output is uniform, but at a lower level compared with the response at the top and bottom of the musical scale.

A baffle measuring $11\frac{1}{2} \times 11$in. is supplied with the unit, but a larger baffle might be employed with advantage from the point of view of low-note response. Enclosing the unit in a cabinet with an open back would achieve the same object.

The moving coil is of the low-impedance type, and a suitable output transformer giving two alternative ratios can be supplied for a further charge of 15s. The makers are Messrs. Whiteley Electrical Radio Co., Ltd., Nottingham Road, Mansfield, Notts.



W.B. type PM2 permanent-magnet moving-coil chassis and double-ratio output transformer.

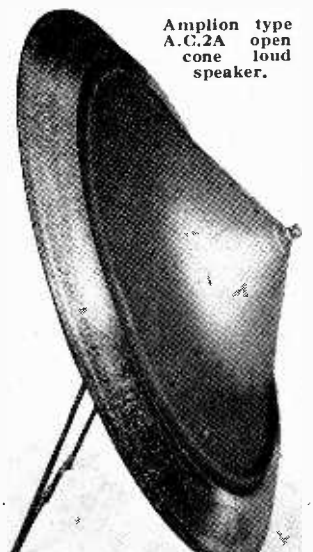
AMPLION A.C.2A AND A.C.6 LOUD SPEAKERS.

These instruments are both included in the Amplion "popular" range of loud speakers, and are specially designed for use with small sets. The prices are extremely reasonable having regard to the standard of performance provided.

The same diaphragm and unit are used in both models, the unit being mounted inside the angle of the cone in the A.C.2A model. The unit is of an entirely new design, and is of the adjustable single-acting type with the speech coil surrounding the top of the reed and its adjacent pole-piece. The diaphragm is 10in. in diameter, and its edge is provided with a felt rim to eliminate all possibility of chattering.

The D.C. resistance of the unit was found to be 1,045 ohms, and its impedance at three representative frequencies was as follows :—

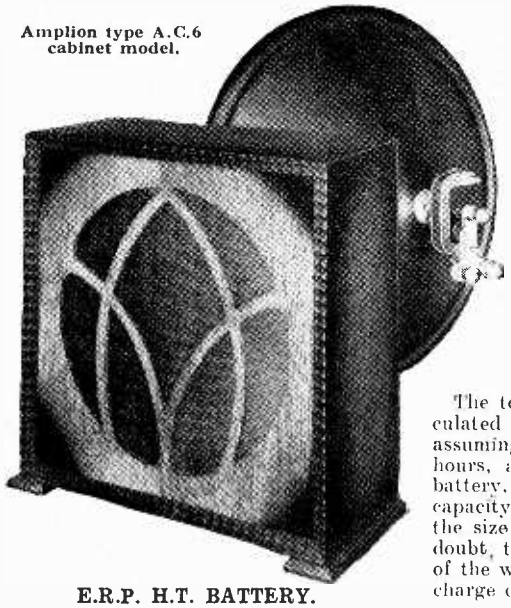
Frequency (cycles).	Impedance (ohms).
200	1,980
800	4,840
3,200	12,200



Amplion type A.C.2A open cone loud speaker.

The reproduction of music is very pleasing, and speech is quite satisfactory. By comparison with more expensive types, the speech is a little low- pitched, but not sufficiently so to incur adverse criticism. The useful frequency range covered is from 150 to 4,000 cycles, the bulk of the output being located between 300 and 2,000 cycles. The response over the latter band of frequencies is uniform in the A.C.6 model, with the exception of a slight resonance between 400 and 500 cycles. This shows up also in the A.C.2A, and there are further slight resonances in this model at 1,700 cycles and between 2,500 and 3,500 cycles.

The A.C.2A model is designed to hang or stand in any position, and is priced at 15s. The cabinet dimensions of the A.C.6 are $13\frac{1}{2} \times 13\frac{1}{4} \times 6\frac{1}{8}$in., and the price is 25s. The makers are Messrs. Graham Amplion, Ltd., St. Andrews Works, Slough, Bucks.



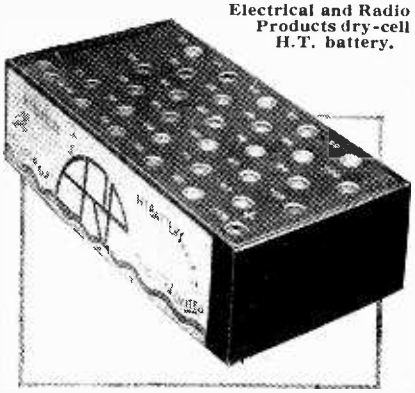
Amplion type A.C.6 cabinet model.

E.R.P. H.T. BATTERY.

The battery dealt with in this review has a nominal voltage of 108 and is of the standard capacity type; that is to say, its maximum economical discharge rate is of the order of 10 mA. In common with our usual practice, we discharged the battery intermittently through a fixed resistance, the value of which was chosen to set the current initially at about the maximum value. On the graph reproduced here, the rest periods have been omitted and only the actual working hours shown. When discharged intermittently, such as is the case with a wireless battery, it is permissible to maintain the battery in commission until the E.M.F. of each cell drops to 0.75 volts. On this basis the working life of the battery under discussion is about 350 hours. It can be seen from the curve that for the greater part of its life the voltage is maintained at a rather low level; indeed, it is not much in excess of that at its end point.

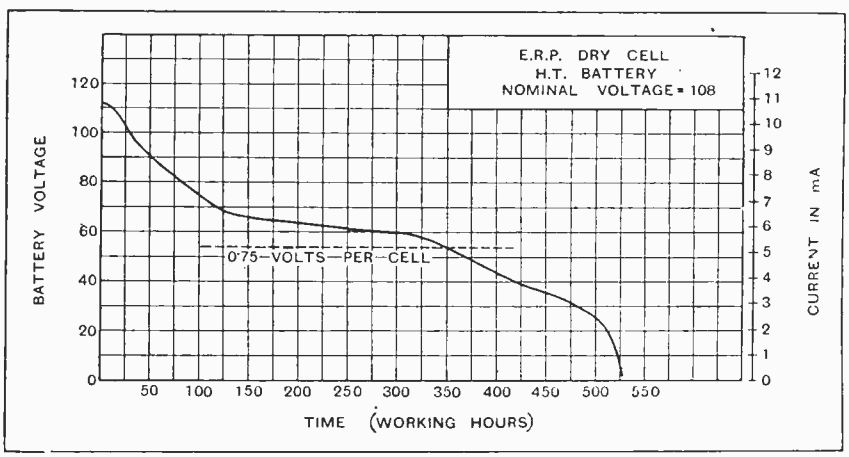
During the first 125 hours the voltage fell steadily from the initial value of 112 volts to 68 volts, but during the following 175 the change amounted to 14 volts only. As a consequence it may be found necessary to utilise a boosting battery to maintain the voltage at a higher working level after the battery has been in use for some 100 hours or so. However, if the initial current does not exceed about 8 mA.s the general level of the voltage should be higher than that shown for a much longer period, and it might be worth while to over-bias slightly the output valve solely for the purpose of economising the current and thus maintaining the voltage at a higher level.

The total capacity of this battery, calculated from the discharge curve and assuming 350 hours' work, is 178 watt hours, and as there are 72 cells in the battery, each cell affords 2.47 watt hours' capacity. Now, this is somewhat high for the size of cell employed, and is due, no doubt, to the fact that for more than half of the working life of the battery the discharge current was no more than 6 mA.s.



Electrical and Radio Products dry-cell H.T. battery.

E.R.P. batteries are made by the Electrical and Radio Products, Ltd., Empire Works, Horley, Surrey, in the 108-volt size only, and the price is 12s. 6d.



Discharge curve of E.R.P. 108-volt dry-cell H.T. battery.

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.

"Band-Pass Four" Adjustments.

Adjustments made to the tuned circuits of my "Band-Pass Four" receiver do not seem to hold good over the entire medium-wave tuning range. Can you suggest the possible cause for this trouble, and a way of remedying it?

It would seem probable that either your tuning coils or variable condensers are imperfectly matched. We suggest that you should try the effect of adjusting capacities at the lower end of the tuning scale (at about 250 metres) by means of the trimmers only, and then, at about 500 metres, by the process of adjusting the condenser rotors. This should be repeated several times, until settings that hold good over the whole scale are found.

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A Completely New Design.

I should like to make a set on the lines of the "Pre-Selection A.C. Three," but for use with indirectly heated D.C. valves. In order to use existing parts, a transformer will be used as a coupling for the H.F. stage, and will be tuned by a separate condenser. Further, I should like to use transformer coupling between the detector and output valves.

Will you please give me a circuit diagram, with values marked, showing these alterations?

We are afraid that the alterations you propose are so drastic that a complete re-design of the receiver would be necessary in order to deal adequately with your question. Unfortunately, this would be beyond the scope of the Information Department, but we may add that a D.C. mains set, including at least some of the features you require, will probably be described in the pages of this journal at an early date.

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Converting a Power Grid Detector.

When connecting a gramophone pick-up to a valve acting as a power grid detector, should this valve be treated exactly as an ordinary grid rectifier?

Generally speaking, yes; so far as the grid circuit is concerned, the two types of detector may be treated in exactly the same way. There is a possibility, however, that when anode current is reduced by the application of negative bias, anode voltage will rise appreciably, due to lower losses in the feed resistance, but as these circuits are all more or less self-compensating it is seldom necessary to take this into account.

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A.C. and D.C. Compared.

As I already have a P.625 valve, which gives an adequate output for my needs, I propose to use it in conjunction with D.C. indirectly heated H.F. and detector valves. The P.625 output valve will, of course, be joined in series with the others, and a resistance will be shunted across its filament in order to absorb the surplus quarter-ampere.

Battery bias will be used, as my D.C. supply is of 200 volts only, and I would prefer not to sacrifice H.T. voltage.

My question is with regard to the grid return connection for the output valve. Would it be correct to connect the positive side of the grid bias battery to the centre point of the filament-shunting resistance, as in an A.C. receiver?

In your case A.C. receiver practice is not applicable. The ends of the filament, when it is heated by raw A.C., are simultaneously at equal and opposite potentials, and by connecting a potentiometer in the usual manner a zero point on the filament may be artificially located, so that hum is avoided. With a D.C. set, on the other hand, the superimposed ripple and the other interfering irregularities are, as often as not, of a unidirectional nature, and no good purpose would be served by a filament potentiometer. The normal method of connection is shown in Fig. 1, from which you will see that the grid return lead is joined to the negative side of the filament through the bias battery.

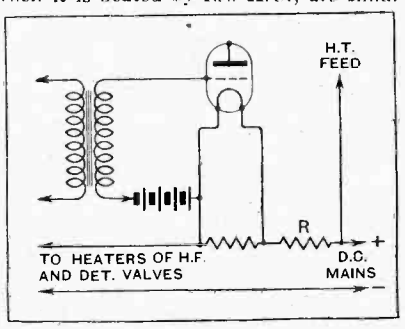

Fig. 1.—Grid circuit of a triode output valve with battery bias and a shunted filament joined in series with indirectly heated D.C. valves.

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So It Should!

A milliammeter connected in the anode circuit of my power grid detector shows that this valve is overloaded when the set is accurately tuned to the nearest station: downward deflections of the needle are considerably greater than is laid down as the maximum in articles dealing with this subject. The set is a conventional H.F.-det.-L.F. combination. Can you suggest an easy way of stopping this overloading?

We see that you live about fifteen miles from a high-power station, and in these circumstances overloading of the detector is only to be expected with a set as described. If this did not take place, it could safely be assumed that something was radically wrong with the H.F. amplifier.

The remedy is to fit some form of pre-detection—or, better, pre-H.F.-volume control.

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High or Low Resistance?

It is proposed to reconstruct a somewhat out-of-date moving-coil loud speaker, which is obviously capable of improvement. The moving coil is burnt out, and will have to be rewound. Do you recommend me to put on a high- or low-resistance winding?

It is rather difficult to give definite advice in this matter, but it may be pointed out that low-resistance moving coils are more popular, because of their general robustness and comparative ease of construction. It is a matter of some importance, however, that a coil of this type should be operated in conjunction with a well-designed transformer, which must be chosen with a view both to the characteristics of the output valve and the impedance of the coil itself.

An Unnecessary Resistance.

Is a separate decoupling resistance necessary when screening grid voltage for an H.F. valve is controlled by a 50,000-ohm potentiometer shunted across the main H.T. feed leads?

In the case of a set with a single H.F. stage, it is unnecessary to fit a separate resistance, except in rare cases when the potentiometer is mounted at a considerable distance from the valve-holder. When a single potentiometer is used to control the screening grid voltage fed to two or more valves, however, separate decoupling resistances are generally essential.

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Double Filters.

Probably due to my exceptionally unfortunate situation with regard to interference, I find that a "one-H.F." set with a tuned input filter has barely sufficient selectivity. Consequently, I am thinking of replacing the single-tuned H.F. inter-valve coupling by another filter, making a total of four tuned circuits in all. The inter-valve circuits will be tuned by a separate pair of ganged condensers, and coupled together by a small condenser rotated on the spindle.

Can this arrangement be applied to a parallel-feed coupling? If so, will you please give me a circuit diagram, and say if any loss of signal strength is to be anticipated?

The arrangement you propose to use is quite practicable, and is shown diagrammatically in Fig. 2.

Grid Circuit Smoothing.

I am sending you a circuit diagram of my A.C. set, which works very satisfactorily, except for a slight hum which is only present when a carrier wave is being received. Can you suggest any additional alterations that may improve matters in this respect?

The circuit shown is fairly conventional, as are the values of components, except that the by-pass condenser associated with the bias resistance of the H.F. valve is smaller than usual. We suggest that "modulation hum," from which your set is clearly suffering, will probably be reduced if you add an extra capacity of 2 mfds. in this part of the circuit.

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High L.F. Magnification.

I am sending you a circuit diagram showing the connections of my det.-2-L.F. A.C. mains set. Results are fairly good, but there is much more mains "hum," and a noisier background than I like. Can you suggest anything that would improve matters in this respect?

Your diagram (not reproduced) shows a grid detector followed by two transformer-coupled L.F. stages, and we notice that efficient modern valves are used. It seems that the overall L.F. magnification provided by this receiver is excessively high, and we are rather surprised that you are not troubled with actual self-oscillation. This high magnification is undoubtedly largely responsible for hum. Methods of reducing hum to a certain extent have been indicated on your diagram,

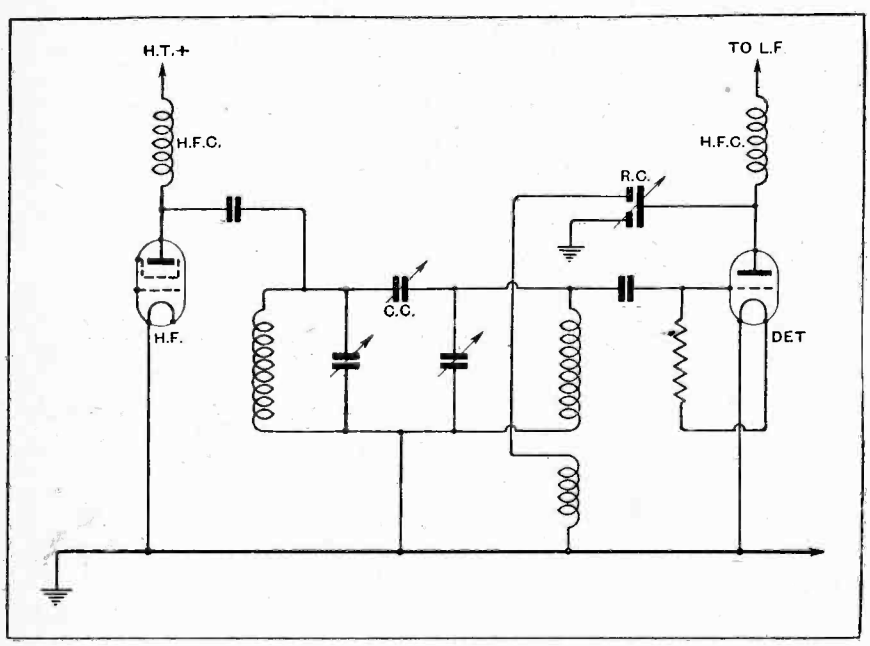

Fig. 2.—Intervalve filter circuit with choke feed.

A small loss in sensitivity is to be anticipated through the use of a filter; further, there will be an additional slight loss in range because reaction will not work quite so well as with a single circuit coupling.

but we cannot promise that these will be entirely successful. Unless the maximum attainable L.F. magnification is especially desired, we are inclined to recommend that one of your magnifying stages should be of the low-gain resistance-coupled type.

FOREIGN BROADCAST GUIDE.

TURIN
(Italy).

Geographical position: 45° 4′ N., 7° 41′ E.

Approximate air line from London: 578 miles.

Wavelength: 296.1 m. Frequency: 1,013 kc. Power: 8.5 kW.

Standard Time: Central European (coincides with B.S.T.).

Standard Daily Transmissions.

10.15 B.S.T., News (Sun.); sacred music (Sun.); 16.15, play (Sun.); 19.15, concert or gramophone records; 20.00, time signal, news; 20.55, operatic relay or concert; 23.00 or 23.30, dance music (Mon., Thurs., Fri., Sat.).

Woman announcer.

Call: EIAR (phon.: *Eh-yah*) *Radio Torino.*

(As the station frequently exchanges programmes with Milan and Genoa, the call usually incorporates the names of these cities, e.g., *Radio Milano, Torino e Genova.*)

Interval Signal: Nightingale.

Closes down with the words: *EIAR Radio Torino. Fine della transmissione. Buona notte a tutti,* followed by Fascist hymn and Italian National Anthem.

NOTE: *Trieste on 247.7 m. (1,211 kc.) will shortly be added to this group.*

A Workshop Hint.

Can you tell me of a good method of removing the insulation from the ends of very fine silk-covered wire? I find that there is a tendency for the wire to break if it is scraped with a knife in the usual manner.

A small piece of sandpaper, folded into a spill, and used more or less as a brush, is a satisfactory appliance for carrying out this operation. The end of the wire should be placed on a smooth and flat surface, and then gently stroked with the sandpaper until the insulation is removed.

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Current Rating Exceeded.

I have just completed a single-valve loudspeaker set with an indirectly heated pentode. The general circuit arrangement is similar to that advocated in your journal, and results are good. However, I find, on inserting a milliammeter, that combined screen and anode currents amount to almost exactly forty milliamps; this is rather in excess of the rating for the valve. Do you think that any harm will be done to it?

The current consumption of your valve is about normal for a pentode operating as combined detector-amplifier, and is so slightly in excess of the normal rating that its life should not be sensibly affected. If you wish, however, a reduction of a few milliamps could be made by adding a little resistance in the screening grid circuit; power output should not be affected to any noticeable extent.

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Short Waves.

THE listener is so interested in the reception of stations on the normal broadcast band of 200-550 metres, and there is such a choice of stations receivable, that it is easy to overlook the possibilities which await him if he descends to lower wavelengths, or, as we should perhaps more scientifically express it, ascends to the higher frequencies.

We are undoubtedly at the present time entering upon a period of intense activity on the shorter wavelengths throughout the world, and those who seek novelty and may have tired of reception of the "local" stations of Europe can to-day count upon world-wide reception on short waves with quality and strength of a very high order.

The recent relay by the B.B.C. of the Kentucky Derby gave an excellent opportunity for the listener unaccustomed to the possibilities of short-wave reception to judge of the quality that might be expected, and direct reception with a short-wave attachment to an existing set can be counted upon to give quality of this order almost regularly.

American short-wave stations have increased their power and made great progress during recent months and, considering that the present time of the year is normally poor for long-distance short-wave reception, we may anticipate that results will be even better later in the year.

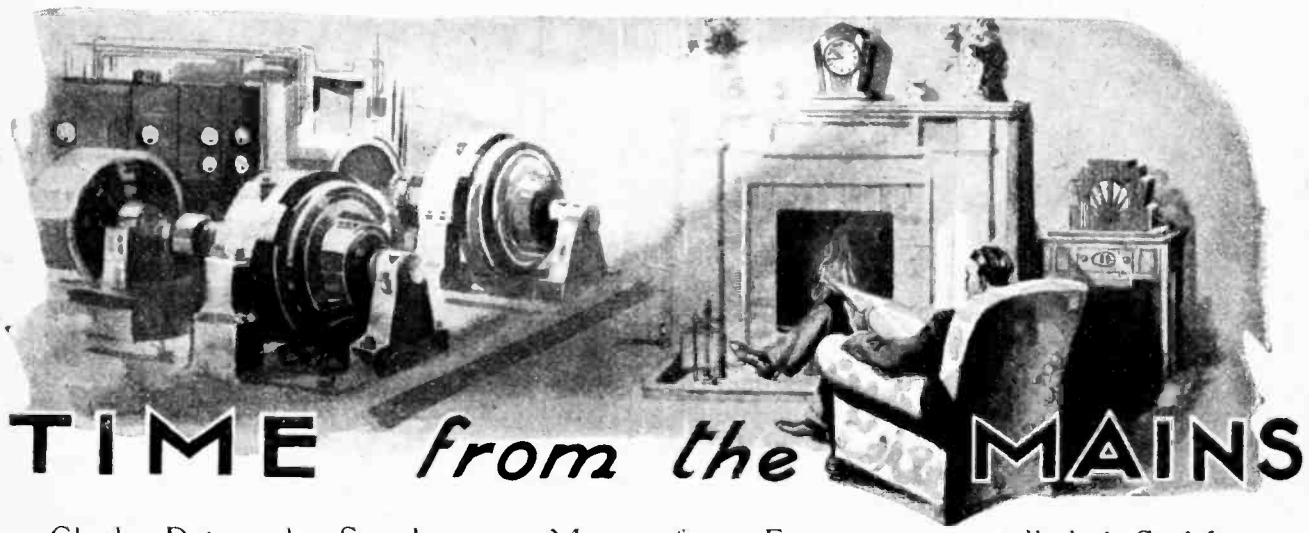
Searching over the short-wave band produces a feeling of acute disappointment that we should be ourselves so poorly represented in the ether on wavelengths of this order as compared with other nations. The Empire short-wave broadcasting station, 5SW, has, we know, made some progress, but the improvement is a sad disappointment when we consider the rapid strides made elsewhere.

Even the B.B.C. themselves cannot paint a very rosy picture of their activities in connection with 5SW, for in their Fourth Annual Report, which has just appeared, they state under the heading "Imperial Relations":—

"The question of 'Empire' broadcasting advanced during the year. The proposals alluded to in last year's Report were discussed first with the Government Departments concerned, then, after some modification, at the Colonial Office Conference on the 30th June, and, lastly, at the Imperial Conference, in October. The Colonial Office Conference gave emphatic support to the scheme and the Imperial Conference suggested that the Corporation should circulate their proposals to the various broadcasting organisations of the Empire."

What has happened since the "emphatic" support of the Colonial Office Conference in June last and the Imperial Conference in October? Have the B.B.C. acted on the suggestions and circulated proposals to the various broadcasting organisations of the Empire? If they have done so, we would expect to find a statement to that effect in the B.B.C.'s report. Much dissatisfaction with Empire broadcasting is certain if the B.B.C. do not give evidence of greater enthusiasm for the project than they have shown hitherto.

In This Issue



TIME from the MAINS

Clocks Driven by Synchronous Motors from Frequency-controlled A.C. Mains.

THE idea of utilising the regular pulsations of alternating current supply mains for the purpose of timekeeping is by no means new. As long ago as 1895, soon after Ferranti had shown the advantages of alternating current from the point of view of economy in generation and distribution, Mr. F. Hope-Jones, in an article in the November, 1895, issue of a journal known as *Lighting*, forecast that the domestic clock of the future would be driven by a small synchronous motor connected to the household supply mains and suitably geared to the hands of the clock.

Frequency Meters.

Obviously, the success of such a system depends on the constancy of the supply frequency, and it is only during the last two or three years that the idea has had any prospect of practical realisation. Hitherto, power station engineers have had little incentive to strive for *absolute* accuracy in the control of frequency. Where the necessity has arisen for running two or more machines in parallel they have not been required to do more than bring the *relative* frequencies of the machines to the same arbitrary value before switching in. Assuming a nominal frequency of 50 cycles per second the actual frequency at the time of synchronising might be 49.5 or 50.5, depending on the load and speed of machines already connected to the mains. While such deviations of frequency would pass unnoticed by consumers of power for heating, lighting and traction, a synchronous electric clock geared for 50.0 cycles would, under these conditions, gain or lose nearly 15 minutes a day. The recent development of the "Grid Scheme," and the problems of load sharing between large numbers of stations feeding into a common distribution system have necessitated the enforcement of an absolute standard of frequency control. The ordinary switchboard frequency meters are no longer regarded as satisfactory, and the frequency is now adjusted on a time basis by comparison with high-grade pendulum clocks, which are regularly checked with Greenwich time.

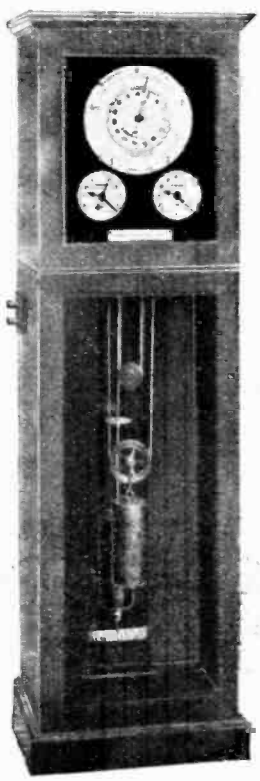


Fig. 1.—Everett-Edgcumbe master-frequency meter.

The Warren Synchronous Motor.

The pioneers of frequency control in this country are Messrs. Everett, Edgcumbe & Co., Ltd., and Fig. 1 is an illustration of their 1931 model Master-Frequency Meter. The standard clock is equipped with an invar pendulum and is gravity controlled, the weights being wound up electrically. A synchronous motor rewinds the weights continuously, and the gearing is so adjusted that at the correct frequency the speed of rewinding is exactly the same as the rate of fall permitted by the escapement. The pendulum clock drives a seconds hand on the large upper dial, the outer scale of which is fixed. The inner disc rotates and is driven by a Warren synchronous motor from the mains. This dial carries a red zero line and is also calibrated in seconds. Normally, the clock pointer and mains-driven dial rotate together, and any deviation from the standard frequency in either direction is immediately shown by a difference in the relative positions of the two pointers. The small subsidiary dial on the right shows standard time, and that on the left registers "frequency time." In the unlikely event of the main dials falling out of step unobserved by a complete revolution, the error would be recorded by the comparative readings of the subsidiary dials.

Time from the Mains.—

One of the first undertakings to adopt frequency control in this country was the London Power Company. This company, with its generating stations at Willesden, N.E.; Grove Road, N.W.; Bow, E.; Deptford, S.E.; and Battersea, S.W., constitutes a subsidiary "grid" in itself. The nerve-centre of the system is the Control Room at Ergon House, Horseferry Road, Westminster, from which the frequency of the current generated at each of the outlying stations is controlled. The master-frequency meter incorporates a special "Synchronome" clock which transmits second impulses over private lines to each of the generating stations. Here sub-standard meters are used to compare the standard time received over the land-lines with "frequency time" taken from the bus-bars of the generators; while at Ergon House the standard clock keeps a check on the frequency of the system as a whole.

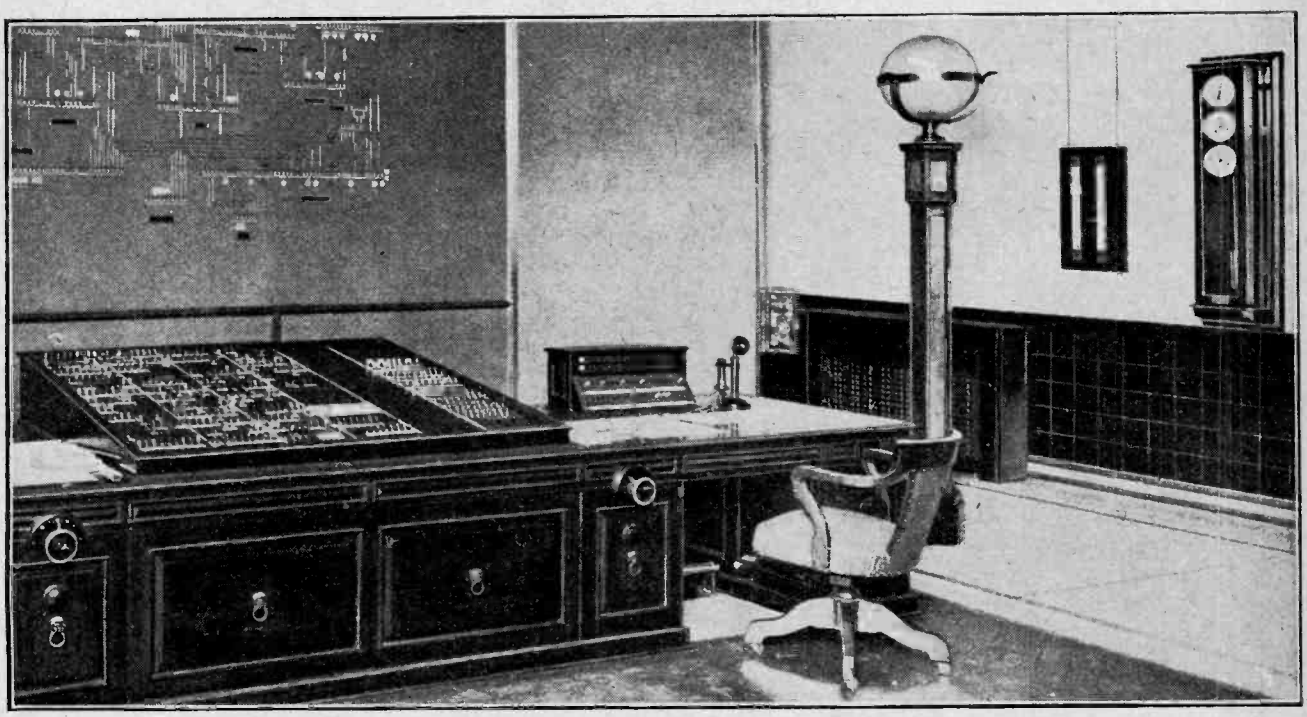
LIST OF ELECTRICITY UNDERTAKINGS SUPPLYING FREQUENCY-CONTROLLED A.C.

Belfast Corporation.
Cheltenham Corporation.
Croydon Corporation.
Dawlish Elect. Co.
Leicester & Warwick Elect. Power Co.
Manchester Corporation.
Portsmouth Corporation.
Southampton Corporation.
Teignmouth Elect. Lighting Co.
Torquay Corporation.
London Power Co., Ltd.
Wimbledon Borough Council.
Metropolitan E.P.S. Co.
North Metropolitan E.P.S. Co.
Ringwood E.S. Co.
West Hampshire Elect. Co.

NOTE:—*This list is not necessarily complete, as the number of companies adopting frequency-control is increasing almost daily.*

A list of electricity undertakings already equipped with frequency-control apparatus is given on this page. The number is steadily increasing, and it is confidently anticipated that before long the frequency of the A.C. mains throughout the country will be accurately controlled.

The small synchronous motors used in frequency meters and clocks present many interesting problems to the designer, and considerable ingenuity is displayed in the commercial examples now available. One of the earliest and best-known examples is the motor designed by H. E. Warren and incorporated in the "Telechron" clocks which have been in use now for some time in the U.S.A. This type of motor is also used in the range of Everett-Edgcumbe frequency meters and synchronous clocks. Fig. 2 shows a cross-section of the type B motor which is only about 2½in. square. A laminated field magnet A, with field windings B, is divided into four sections at the poles. One pair of diagonally opposite poles is provided with thick copper rings. The eddy currents set up in these rings produce a rotating magnetic field in the gap which drags round the steel armature disc D. On switching on the current the mechanism first functions as an induction motor, but with this difference, that the armature reaction is due to magnetic hysteresis and not to eddy currents as is usually the case. At synchronous speed, which is reached, even under load, in a fraction of a second, magnetic poles are established at definite points in the steel armature and the motor continues to run at synchronous speed, considerable force being required to drag it out of step. The motor is geared down to give one complete revolution per minute of the driving spindle E when supplied with A.C. at exactly 50 cycles per second. The gearing runs in oil and is enclosed in a hermetically sealed brass case F. The power consump-



A corner of the control room of the London Power Co., Ltd., Ergon House, Horseferry Road, Westminster, showing master frequency meter on extreme right.

Time from the Mains.—

tion at synchronous speed is between 3 and 4 watts and the power factor is approximately 0.4. The torque of the motor is 500 gram-centimetres, which provides more than 1,000 times the power of an ordinary spring-driven clock.

Everett-Edgcumbe "Synclocks" incorporating the Warren motor are available in a wide range of cases suitable for industrial and domestic use. An interesting feature of these clocks is the provision of a small indicator for the purpose of recording any interruption in the current supply. The necessity for a device of this nature in a self-starting clock is obvious, for otherwise the results of a temporary failure of the mains during the night might go unnoticed, with ludicrous or perhaps serious consequences. The indicator takes the form of a red-and-white shutter which is visible through a small hole in the clock face. Normally this is held up by the motor electro-magnet and shows a white disc. Should the supply current fail for any reason, local or otherwise, the magnet releases the shutter and shows a red disc. When the current is restored the clock restarts immediately, but the shutter is outside the range of the magnetic field and continues to show the red disc until reset by hand.

Clocks of the non-self-starting type are generally provided with a seconds hand, the continuous movement of which is a certain indication that all is well, for the clock would fail to restart after even the briefest interruption of the supply. An interesting example of this type of clock is marketed by the British Sangamo Co., Ltd., Cambridge Arterial Road, Enfield, Middlesex. The motor is provided with a 19-pole electro-magnet, and the armature speed (approximately 158 r.p.m.) is consequently much lower than that of the Warren motor. The mechanism is brought up to synchronous speed by deflecting and releasing a small lever at the back of the clock. When the lever is released a small toothed sector is engaged with one of the clock pinions and pulled back by a light coil spring. The speed of motion is controlled by an air brake attached to part of the gearing, and the size of the vanes and the spring tension are so adjusted that the motor just reaches synchronous speed as the sector disengages. The Sangamo clock is remarkable for the silence of its mechanism and the low power consumption, which is of the order of 0.75 watt.

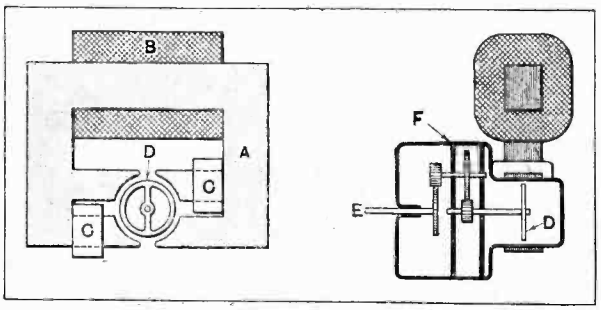
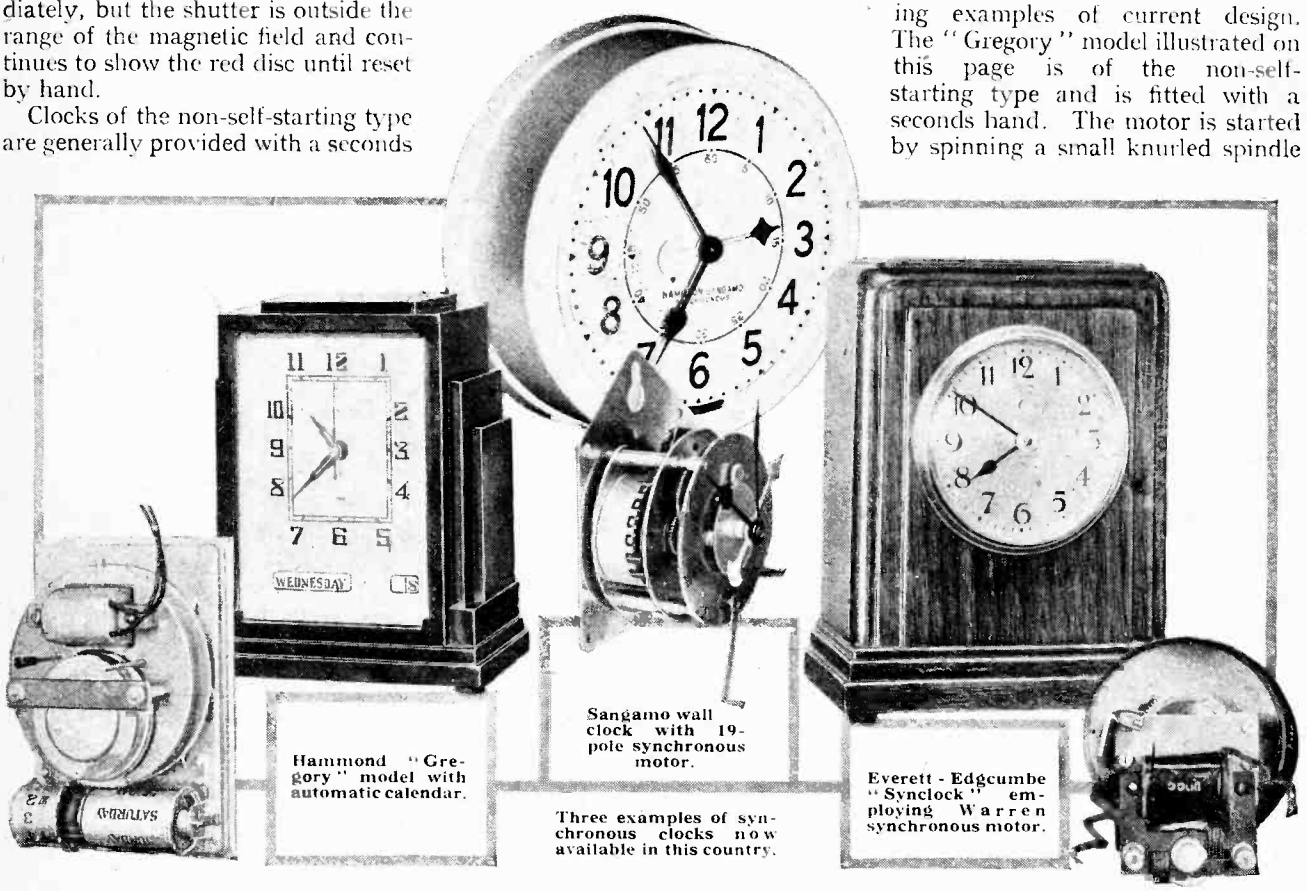


Fig. 2.—Section of the Warren type B synchronous motor. A, laminated field magnet; B, field coil; C, shading rings; D, steel armature; E, driving spindle; F, oil-tight housing.

In America, where timekeeping from the mains is now commonplace, the Hammond clock is one of the leading examples of current design. The "Gregory" model illustrated on this page is of the non-self-starting type and is fitted with a seconds hand. The motor is started by spinning a small knurled spindle



Hammond "Gregory" model with automatic calendar.

Sangamo wall clock with 19-pole synchronous motor.

Everett-Edgcumbe "Synclock" employing Warren synchronous motor.

Three examples of synchronous clocks now available in this country.

Time from the Mains.—

at the back of the clock. There is a tendency to overrun the synchronous speed in starting, but due allowance can be made for this when setting the clock to a time signal by leaving the seconds hand a few seconds behind zero in the stand-by position. A few experimental trials will show the personal equation necessary in individual cases. Not the least attractive feature of this clock is the provision of a calendar in which the day of the week and the date of the month are changed automatically at midnight. The Hammond clock is obtainable in this country from the Rothermel Corporation, Ltd., 24-26, Maddox Street, London, W.1.

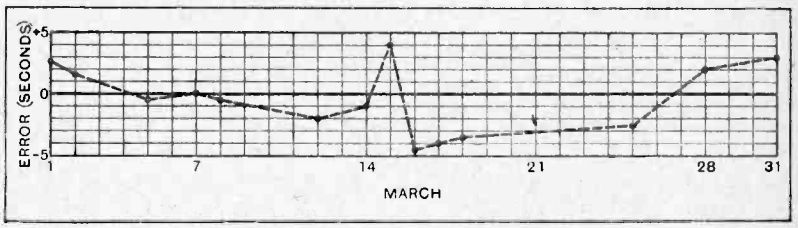


Fig. 3.—Error curve of Hammond clock connected to North Metropolitan supply mains during March, 1931. The rate was checked by the B.B.C. time signals from Greenwich.

The curve in Fig. 3 shows the performance of the Hammond clock during the month of March this year when connected to the North Metropolitan supply mains. It will be seen that the deviation from Greenwich time does not exceed 5 seconds in either direction. A further test at Croydon for a period of nearly a fortnight gave a similar result, the maximum error being of the order of 4 seconds.

The important point to remember is that the *average* time is maintained indefinitely. Small errors may creep in occasionally, but they are immediately rectified at the generating station by the engineer in charge. Taken over long periods the accuracy provided is equal to that of the most expensive pendulum clocks; in fact, of the type of clocks with which the master-frequency meters in the generating station are fitted. The reliability is the reliability of the supply mains, and most people will agree that any inconvenience which may be caused on the rare occasions when the current fails is more than compensated for by the accuracy provided and the fact that no rewinding is required.

In conclusion, the initial cost is no higher than that of a medium-grade spring clock, and at 1d. per unit the cost of running does not exceed 3s., and in some cases is as low as 6½d., per annum.

THE PROTECTION OF PENTODES.

Preventing High Voltages when the Loud Speaker is Disconnected.

SEVERAL writers have pointed out that it is quite possible to generate dangerously high voltages in the anode circuit of a pentode. In particular, *The Wireless World* has recently cautioned its readers against disconnecting the loud speaker while the set is switched on, and one valve manufacturer at least definitely recommends that a resistance, about equal to the optimum anode load, be permanently wired in circuit across the output choke or transformer.

Now, if the loud speaker is light enough, as are most of the permanent magnet types, both moving iron and moving coil, it is often convenient to move it from room to room, as circumstances demand, and to connect it to the set by means of a plug and jack.

A Useful Jack Circuit.

With a battery-operated set the use of a single filament-control jack Fig. 1 (*a*), which has often featured in the pages of this journal, will ensure that withdrawing the plug switches off the set and so protects the valves. With a mains set the same object can be achieved by arranging the filament contacts to operate a relay which switches the set on and off. This is not always convenient, and in addition there is the possibility that time lag of the control circuit may be long enough to permit valve damage. There is, however, an easy way out of the difficulty. We can retain the on-off switch and at the same time completely protect the output stage by wiring up a single-circuit closed jack as shown in Fig. 1 (*b*).

Except for a few remarks upon the value of R, the arrangement needs no explanation. As regards R, its value depends upon whether the loud speaker is connected via an output filter or direct in the anode circuit of the pentode. In the former case, we may use any value from the optimum anode load (about 10,000 ohms with present-day pentodes) to the fraction of an ohm we obtain by shorting terminals 2 and 3 and shall presumably use the latter for reasons of economy! In the latter case, the most convenient value for R will be the D.C. resistance of the speaker, as this will prevent the anode dissipation of the pentode from rising on the disconnection of the loud speaker. Finally, the presence of R, since it is not in circuit when the loud speaker is connected, will not affect the quality or volume in any way, and protection will be assured against the development of high voltages. W. F. C.

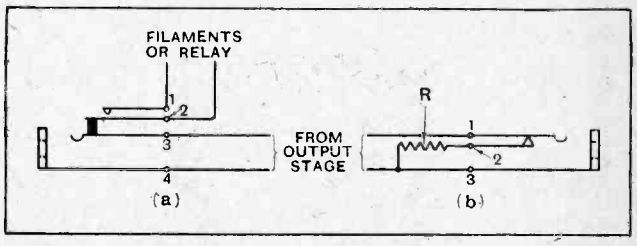


Fig. 1 (a).—With battery-fed pentodes this jack circuit for the speaker is satisfactory. (b).—A limiting resistance ensures that high voltages are not developed.

A Little Known Fact About Interference

IN the detection of a modulated wave, there is an interesting effect due to an interfering transmission which has hitherto been generally neglected. With the rapid increase in the number of powerful stations, this effect becomes of importance. The author puts forward a strong case for the inclusion in a receiver of a highly selective input circuit or pre-selector, and points out the advantages of power grid detection with strong signals.

The Apparent Demodulation of an Interfering Transmission by a Stronger One.

By F. M. COLEBROOK, B.Sc., D.I.C., A.C.G.I.

IN an article published in *Experimental Wireless* in June, 1928, Dr. R. T. Beatty called attention to the interesting fact that the acoustic interference produced by a modulated transmission, separated by a supersonic frequency difference from that to which the receiving circuit is tuned, is very considerably less than would be inferred from the selectivity of the receiving circuit. He pointed out that this must be due to a mutual action between the two transmissions and the receiver which was not taken into account in the simple theory of tuned circuit reception. He proceeded to describe this mutual action, and to show how it would, in fact, account for the disparity between the observed interference and that which would be expected from the relative received voltages. His paper was a valuable contribution to the theory of reception, and, though the explanation was expressed in terms of very simple and familiar ideas, it came very near to the truth; but unfortunately it proved too much.

It showed, in fact, that if the received voltage from the interfering station was less than that from the station to which the receiver was tuned there would be, with a perfect detector, no acoustic or modulation frequency interference at all. Dr. Beatty realised, of course, that this was not consistent with experience, and suggested that the discrepancy was attributable to the imperfection of the detector. Some while later, however, Butterworth turned his attention to the subject, and a paper by him appeared in *Experimental Wireless* in November, 1929, giving a more exact analysis. He avoided a rather dangerous approximation implicit in Beatty's theory, and arrived at conclusions more consistent with experience.

Unfortunately, however, Butterworth's explanation was not given in terms of simple and familiar ideas. On the contrary, it involved two varieties of elliptic integral and a lot of adroit, but complicated, mathematics, so there are probably many interested persons who would find it difficult to understand. The subject is, nevertheless, an important one, and is likely to become more rather than less important as the number of modulated transmissions increases, so it will be a pity if it is not more widely understood. This article, therefore, is an attempt to convey at least some idea of the matter in comparatively simple language. I would like at this point to acknowledge my indebtedness to Butterworth for permission to attempt this somewhat difficult task.

Both Beatty and Butterworth have described the reduction in the interference as an apparent demodulation of the weaker transmission by the stronger one. I am inclined to think, however, that it can be represented somewhat more clearly as a modification by each transmission of the apparent rectification characteristic of the detector in relation to the other. Incidentally, this mode of presentation has the advantage of emphasising another and equally important aspect of the matter, not explicitly referred to by either of the above authors, namely, that the interfering transmission will, if sufficiently strong, so affect the apparent rectification characteristic in relation to the wanted transmissions as to cause some degree of amplitude distortion of the modulation frequency output, even with a perfect detector.

The Perfect Detector.

For simplicity of explanation we shall assume perfect rectification, i.e., a rectifier having zero conductivity in one direction and constant conductivity in the other, as shown in Fig. 1. There are no such rectifiers in practice, but large amplitude grid rectification, or "power grid" rectification as it has been called, gives a fairly close approximation to it. There is, indeed, a very general tendency in modern receiver design to realise this type of rectification as closely as possible.

Suppose that a receiver embodying such a detector is tuned to a continuous wave transmission of frequency f_1, and that there is in consequence a resonant potential difference of amplitude V_1 applied to the detector. The direct current or potential output of the detector will be

A Little Known Fact About Interference.—

proportional to the mean value of alternate half-cycles of the signal voltage as shown in Fig. 2. The mean value of half a cycle of a sine wave is proportional to the amplitude of the sine wave, so that if we imagine V_1 to be increased steadily from zero and measure the rectified output, we should obtain a straight-line result as in Fig. 3. This line will be referred to as the normal rectification characteristic of the detector. (It must be clearly distinguished from the d.c. characteristic of the detector, which is shown in Fig. 1.) If the transmission be modulated, i.e., if the amplitude V_1 be varied at audio-frequencies, the rectified output will be similarly varied as shown in Fig. 3, and in consequence of the uniform slope of the rectification characteristic the modulation frequency output will be a faithful copy of the modulation of the transmission.

This statement will not be strictly true in practice, for the *effective* slope of the rectification characteristic will depend to some extent on the modulation frequency owing to the variation of the modulation frequency impedance of the output circuit of the detector. This fact will not affect the main argument, however; and, to avoid unnecessary complication, it will be assumed that the output is uniform over the modulation frequency range.

Supersonic Beat Frequency.

Now suppose that there is an interfering transmission of frequency f_2, the difference $f_1 - f_2$ being supersonic. The receiver is not tuned to this transmission, but if it be powerful enough it will, nevertheless, give rise to an appreciable potential difference V_2 on the terminals of the rectifier. The total potential difference acting on the rectifier will now be the sum of these two potential differences. These differ in frequency, so there will be the well-known heterodyne variation of the total amplitude as shown in Fig. 4a. If, as we suppose, the beat frequency is a high supersonic frequency, the rectified output will not follow the high beat frequency variations, but will only record their mean value over a large number of beat frequency periods. Generally speaking, the time constant of the grid-leak condenser combination will be so large that the supersonic variations will actually be smoothed out in this way—for the same reason that even high audible frequencies are somewhat reduced in amplitude.

Detector Load Impedance.

Another way of saying the same thing is that the detector load impedance is low at high audio-frequencies, and even lower at supersonic frequencies. Now, if the envelope of the heterodyne pattern were a sine wave, the mean value dotted line in Fig. 4a would also be a sine wave, and the mean value of the dotted line variation over a large number of beat frequency periods would not differ from the mean value of the original undisturbed transmission (since the maximum and minimum values of the dotted-line variation would be proportional to $V_1 + V_2$ and $V_1 - V_2$, and its mean value would therefore be proportional to V_1). The rectified output of the detector would then be no different from what it was before the interfering transmission came in, so that, if the interfering transmission were modulated, it would still not affect the detector output and there would be no acoustic or modulation frequency interference at all. This actually was the rather misleading conclusion of Beatty's original explanation, and the inexactitude lay in the assumption that the envelope of the heterodyne pattern was a sine wave. In actual fact it differs appreciably from a sine wave. This becomes immediately obvious if we go to the extreme case when the amplitudes of the component signals are equal, as in Fig. 4b. The average value of the dotted-line variation in this case is clearly greater than that of the original undisturbed transmission, and since this case differs in degree only and not in kind from that shown in Fig. 4a, it may be expected that the same is true for Fig. 4a.

The exact form of the dotted-line mean value can, of course, be calculated and its average over a large number of beat frequency periods determined, but the detail of this is rather beyond the scope of the present article. It involves the elliptic integrals already referred to. The important point, however, is that the direct rectified output of the detector is actually increased by

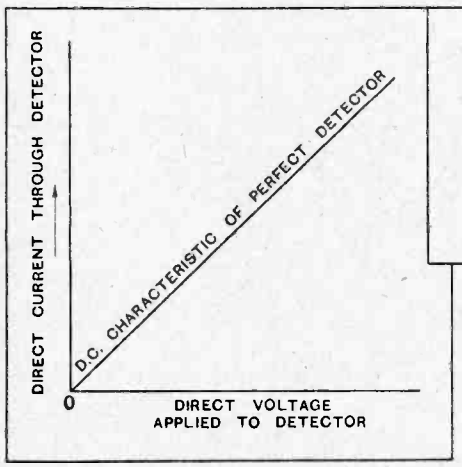


Fig. 1.

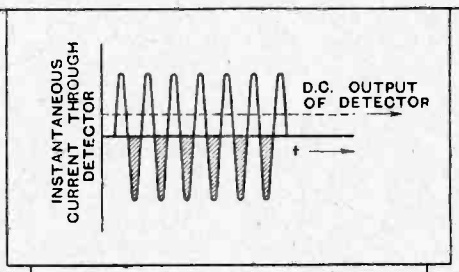


Fig. 2.

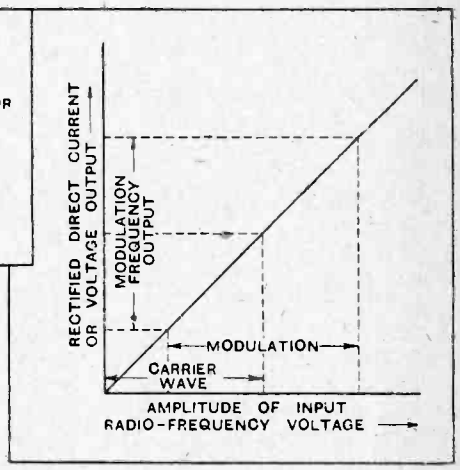


Fig. 3.

Fig. 1.—Direct current characteristic of the perfect detector. There are no such detectors in practice, but the power-grid type with a large input approximate to it.

Fig. 2.—Rectifying action of a perfect detector.

Fig. 3.—Rectification characteristic of perfect detector.

A Little Known Fact About Interference.—

the presence of the interference, however small this may be. Now imagine that, keeping the interference constant, we vary the original transmission from zero up-

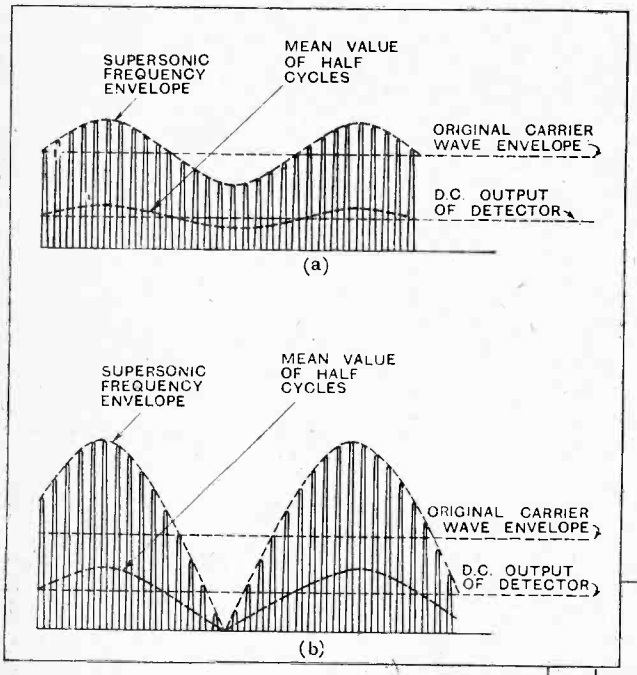


Fig. 4.—(a) Action of perfect detector with supersonic interference of small amplitude. (b) Action of perfect detector with supersonic interference of equal amplitude.

wards and measure the rectified output in the same manner as for the original rectification characteristic shown in Fig. 3. The output will no longer be zero at the origin, since the interfering transmission will produce its own full effect at that point. As explained, however, the interfering transmission will produce less and less effect as we increase the voltage of frequency f_1 up to its original undisturbed value, and the final result will be a curve like that marked (*a*) in Fig. 5. This, then, is the new effective rectification characteristic of the detector in relation to the wanted transmission when the interference is present. It is obviously very different from the original rectification characteristic, which is also shown on the diagram for comparison, and the important point about it is that it is very curved toward the foot, and will therefore give a certain amount of amplitude distortion of the modulation if the latter is deep enough to bring the minimum value of the potential from the wanted transmission into the curved region. This amplitude distortion will also be associated with the introduction of spurious harmonic frequencies. Thus we arrive at the first conclusion, namely, that a perfect rectifier is no longer perfect in the presence of appreciable interference, even though the heterodyne beat frequency is supersonic.

The effect is not, of course, very marked unless the interfering potential difference is appreciable compared with the carrier wave potential difference given by the wanted transmission, and unless the modulation depth is fairly large. Such cases will, however, quite often occur in practice, as, for example, when a distant station is received at a point near another station. It is true that the receiver will be tuned to the distant station and not to the other, but a relative field intensity of the order of a hundred to one or so may easily counterbalance the resonance effect of tuning and give an interfering detector voltage comparable with that of the desired transmission.

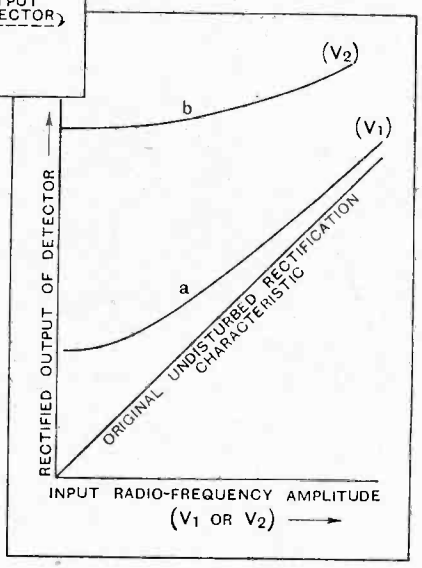


Fig. 5.—Effect of supersonic interference on the rectification characteristic of a perfect detector (a) for the stronger signal; (b) for the weaker signal.

Mutual Demodulation Effect.

We can now consider the other aspect of the matter, the so-called mutual demodulation effect of the two transmissions. It is fairly clear from the diagram of Fig. 5 that apart from the foot of the characteristic, where the interfering potential difference is equal to or greater than that of the wanted transmission, the slope of the apparent rectification characteristic is not very much less than that of the original undisturbed rectification characteristic; and, since the modulation frequency output depends on this slope, it is not very much affected by the interference. In other words, there is very little apparent demodulation of the stronger transmission by the weaker one. The case of the interfering transmission is, however, very different, for, assuming its potential difference to be less than that of the wanted transmission, it is only the curved foot of the rectification characteristic which comes into play. If we assume the wanted transmission to give a relatively large constant potential, we can determine the apparent rectification characteristic in relation to the interfering transmission in precisely the same manner as before. The result is a line such as that marked (b) in Fig. 5. It is very much curved, and is of much less effective slope than the original rectification characteristic. The consequence is that what Butterworth calls the acoustic ratio of the interfering transmission to the wanted transmission is, assuming equal depth of modulation in the two cases, very much less than the carrier wave voltages. For example, Butterworth shows that with a carrier wave ratio of 1 to 10, the acoustic output ratio would only be 1 to 200, and with a carrier wave ratio of 1 to 5 the acoustic ratio would be 1 to 50 and so on.

The above theory is, of course, somewhat idealised and simplified. In practice the rectification characteristic will not be a straight line through the origin, but will itself be a line somewhat curved at the foot. For

A Little Known Fact About Interference.—

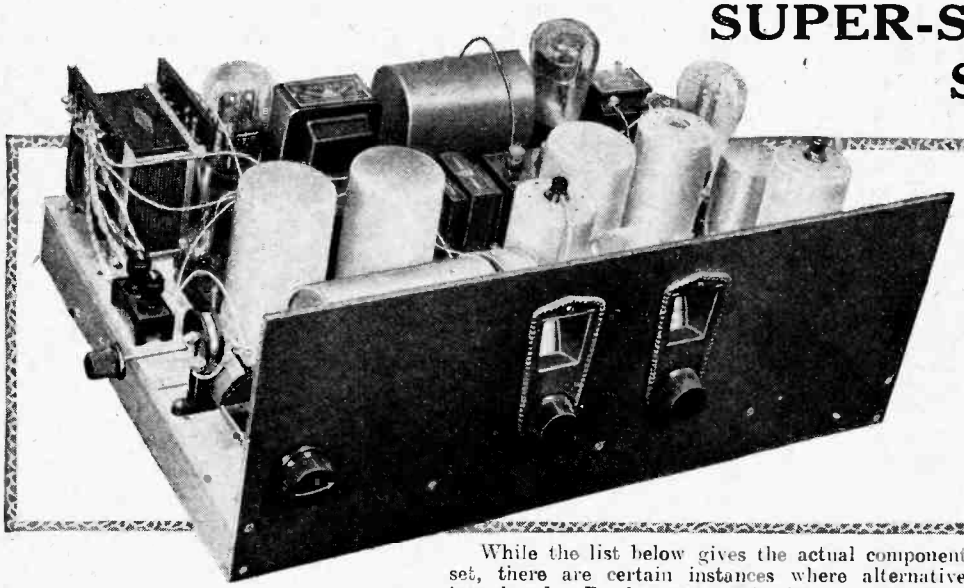
large amplitude operation, however, the behaviour will be approximately as described. For small signal amplitudes, on the other hand, where the curved lower part of the characteristic only is concerned, the rectification will be practically square law, and in this case there is no mutual demodulation effect at all, the acoustic outputs being approximately as the square of the carrier wave voltages. We have here, therefore, an additional argument in favour of large amplitude rectification. As Butterworth points out, it gives, in virtue of the apparent demodulation effect, a gain in effective selectivity which may be as much as two to one as compared with square law rectification, in addition, of course, to the superior fidelity of reproduction inherent in the straight-line characteristic.

It may also be pointed out that the demodulation process provides an additional argument in favour of high selectivity in the input stage of a receiver, with subsequent audio-frequency correction for the effect of side-band cutting, for the smaller the ratio of the interfering carrier wave potential difference at the rectifier to that of the wanted transmission, the greater will be the demodulation effect upon the interference, and the less will be the modification of the effective rectification characteristic in relation to the wanted transmission.

NEXT WEEK: A Full Description and Preliminary Constructional Details of a Superheterodyne of Outstanding Merit

will be included in our issue of June 3rd under the title of "The Wireless World"

SUPER-SELECTIVE SIX



A high-quality long-range receiver for modern conditions.

SPECIFICATION.

Five valve superheterodyne.
All A.C. mains operation with valve rectification.
Two tuning controls.
Band-pass tuning.
Ganged waveband switching.
Dual ganged volume control.
New non-radiating frequency changer.
Special circuit for cutting out long-wave interference.
Power grid detection.
Pentode power output of 1,900 milliwatts.
Special tuned smoothing circuit.
18 kc. selectivity on powerful local stations.

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

LIST OF PARTS REQUIRED.

1 Mains transformer, primary 240 volts 50 cycles, secondaries 275–0–275 volts 60 mA, 2.5–0–2.5 volts 1.6 amp., 4 volts centre-tapped 5 amps., 4 volts centre-tapped, 1 amp. (Parmeko).
1 L.F. choke (Varley D.P.12).
1 L.F. transformer (Varley Nicore 1).
1 L.F. choke, 20/50 henrys (R. I. Hypercore).
1 H.F. choke (Wearite H.F.O.).
1 Pentode output choke (Atlas C.P.S.).
1 Two-gang condenser, 0.0005 mfd., and drum dial (Polar Tub).
1 Variable condenser, 0.0005 mfd., and drum dial (Polar Universal).
2 Grid leaks, 0.25 megohm (Ediswan).
1 Porcelain grid leak holder (Bulgin).
3 Fixed condensers, 0.0001 mfd. (T.C.C., Type 31).
2 Fixed condensers, 0.001 mfd. (T.C.C., Type 33).
2 Fixed condensers, 0.002 mfd. (T.C.C., Type 33).
2 Fixed condensers, 0.1 mfd. 400 volts D.C. test (T.C.C., Type 50).
1 Fixed condenser, 0.05 mfd., 400 volts D.C. test (T.C.C., Type 40).
8 Fixed condensers, 1 mfd., 400 volts D.C. test (T.C.C., Type 50).
4 Fixed condensers, 2 mfds., 400 volts D.C. test (T.C.C., Type 50).
3 Fixed condensers, 4 mfds., 800 volts D.C. test (T.C.C., Type 80).
2 Fixed condensers, 2 mfds., 800 volts D.C. test (T.C.C., Type 80).
1 Pre-set condenser, 0.0005 mfd. maximum (Polar).
1 Resistance, 1,000 ohms to carry 1 mA. (Watmel).
2 Resistances, 600 ohms to carry 8 mA. (Watmel).
1 Resistance, 500 ohms to carry 5 mA. (Watmel).
1 Resistance, 280 ohms to carry 35 mA. (Watmel).
1 Resistance, 10,000 ohms to carry 5 mA. (Watmel).
1 Resistance, 10,000 ohms to carry 1½ mA. (Watmel).
2 Resistances, 20,000 ohms to carry 5 mA. (Watmel).
1 Resistance, 7,000 ohms to carry 8 mA. (Watmel).
2 Resistances, 30,000 ohms to carry 3 mA. (Watmel).
1 Resistance, 40,000 ohms to carry 3 mA. (Watmel).
6 5-pin A.C. valve holders (W.B.).
3 Valve screens (Colvern).
2 L.F. transformers, 110 kc. (Colvern).
1 Twin volume control potentiometer, 25,000 ohms (Colvern).
1 Aerial band-pass coil and screen (Watmel).
1 Secondary band-pass coil and screen (Watmel).
1 Oscillator coil and screen (Watmel).
4 Ebonite shrouded terminals (Belling-Lee).
2 Terminal mounts (Belling-Lee).
1 Mains plug, 5 amps.
1 Bakelised panel, 21×8×$\frac{3}{16}$in.
Sleeving, copper foil, wire, screws, etc.
1 Baseboard, 21in.×14½in.
15in. half-round brass rod for switch ganging.
1 Slab coil.
1 Cabinet (Camco).

UNBIASED * * *

By FREE GRID.

A Query from Slaithwaite.

A man wrote to me the other day enclosing a letter of introduction from an acidulous aunt of mine (to whom, so far as I am aware, I have never done any harm) and bewailed the fact that the new Northern Regional station is almost within the proverbial stone's throw of a new house into which he has just moved. His moan is that he wishes to receive only the two Slaithwaite transmissions and yet—so he supposes in his letter—he will have to use a large number of valves to separate the two transmissions. "How many valves," he wails, "shall I need?" I wrote to him explaining that he would require no more valves than if he lived a dozen miles away and that, in any case, selectivity does not come by valves alone. It was evident, from his somewhat tart reply, that he thought I was pulling his leg and that he had been reading a lot of rot about valves and selectivity. I have sent back to him a full explanatory letter pointing out that if he has mains available all he needs to have, in order to enjoy perfectly good loud-speaker reception from one transmitter without any background from the other, is one valve only, and that should be a power pentode used as a combined detector and output valve in the manner shown many months ago in this journal.

If he is compelled to use battery valves I have suggested a plain detector and L.F. In either case it is obvious that no reaction will be needed. He must first guard against direct pick-up on the coils by employing very complete screening. Every joint of his screening box will, of course, have to be soldered so that it is absolutely flux-tight, the variety of flux referred to being of the etheric variety and having nothing to do with "Fluxite." As for his aerial, he can, I have told him, very well emulate the example of the small boy and use a bent pin; at any rate, I have had no trouble in doing the trick with a crystal set placed by the road-side at the very gates of Brookmans Park.

Did the Grid Leak?

An acquaintance came to me in great excitement the other day announcing that he had made a new radio discovery. On questioning him I found that he had merely had an experience which I suppose must have come to all of us during the gradual evolution of the L.F. amplifier, namely, that removal of the grid leak in an R.C. stage had no audible effect whatever on the quality of reproduction. When I told him that this was nothing new he at once exclaimed petulantly that this was just one other case confirming his opinion that in radio, theory and practice seldom agreed. I have found that there are quite a number of people who preserve their ordinary sanity in everyday affairs but who throw all reason to the winds where radio is concerned. They seem to think that if a case is found where practice appears to fly in the face of theory, then the theory itself must be wrong. Perhaps nothing could better illustrate the futility of this idea than the case of the grid leak in the R.C. amplifier already quoted. There is nothing wrong with our theory of the action of an R.C. amplifier as at first might be supposed; the trouble lies, of course, in the fact that all our components are still, relatively speaking, so poor that they sometimes lead us widely astray. The explanation in this case was, I suppose, that the incidental leakage resistances between the grid and filament of the valve were actually lower than that of the grid leak itself.

. . . made a new radio discovery.

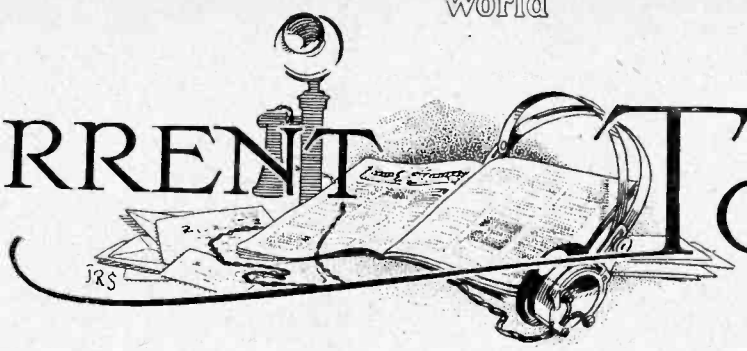
An Amazing Test.

I remember how an otherwise perfectly sane man of great business acumen whose judgment in the City was considered something to rely upon, once told me that moving coil loud speakers were no better than the cheapest of horn-type instruments. Upon cross-examining him I found that he had based his judgment solely upon a test which consisted of connecting first one and then the other of the two loud speakers concerned to the output terminals of a superannuated 3-valve set with a general-purpose valve in its output stage.

"We Want Welsh."

I was having a few days' peace and quiet in a remote part of Brittany recently, and in the course of conversation a rather curious question was put to me. I was asked whether the B.B.C. would transmit programmes in the Welsh language from the projected Western Regional station. The reason for the question was, of course, that in this part of France the Breton language, which is akin to Welsh, is far more often heard than French; indeed, there are villages, I am told, where French is as much a strange tongue as English. No French station caters for the inhabitants, who are, therefore, pinning their hopes on the erection of a Welsh station. I saw it announced in *W.W.* that the B.B.C. refuses to consider an all-Welsh station, as there are insufficient Welsh listeners. Perhaps they will now reconsider their decision; otherwise, it may happen in the end that the Welsh people will find solace in listening to tongue-twisting vowels emanating from Brittany, and may even subscribe towards a station there, although I think the latter possibility is extremely remote.

CURRENT TOPICS



Events of the Week in Brief Review.

POOR OLD DAVENTRY!

Königswüsterhausen, it is expected, will be operating on its new power of 75 kilowatts within the next few days. At present it uses the same power as Daventry 5XX, viz., 35 kilowatts.

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HAVE YOU HEARD "POSTE C. 12,000"?

"Ici poste C. 12,000," followed by a cock-crow, indicates that the new French Colonial station is transmitting. The figure is intended to refer to the kilocycles, but French amateurs have already pointed out an inaccuracy. The actual wavelength of the station is not 25 metres, as one would gather, but 25.17 metres, equivalent to 11,920 kc.

The station employs directional reflectors of the Chireux-Mesny type, which can deflect the beam towards Asia, Africa, America or any other required direction.

THE MIKE SMASHER.

M. Raimu, a well-known Paris actor, has earned a new reputation as a breaker of microphones. It appears that his voice is so rich and resonant that the delicate microphone membranes are unable to withstand it. French technicians are considering the development of a tougher instrument that shall be thoroughly Raimu-proof.

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WIRELESS NOT WHOLLY TO BLAME?

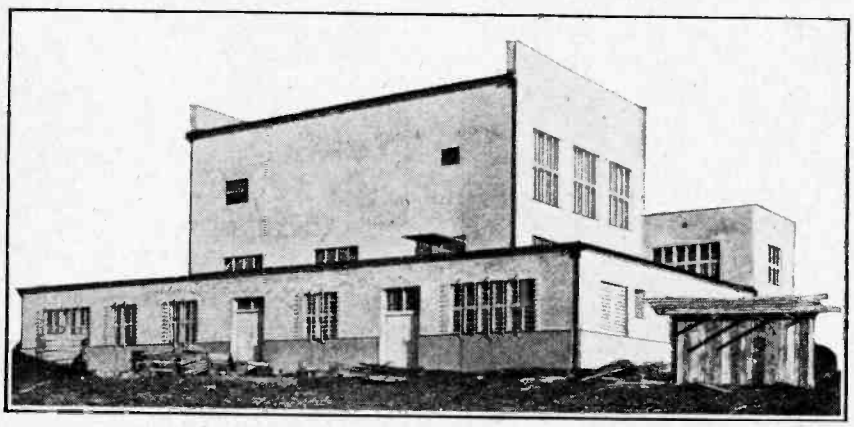
From a letter in the daily Press :—

"The extraordinarily low temperature and lack of sunshine which have characterised our weather during the last month or so must be accounted for by one or both of the two following causes :—

1. The numerous earthquakes which have recently occurred.

2. The immense extension of wireless all over the world.—E. W. Moody, Southampton."

This is encouraging. In the old days there was never a doubt that wireless was to blame, wet or fine.



RADIO ARCHITECTURE : THE LATEST. This box-like structure will house the transmitting equipment of Czecho-Slovakia's 120 kW. broadcasting station at Cesky Brod, which will add its voice to the general European clamour within the next few months.

WHERE DENMARK LEADS.

Denmark still heads the list among European countries in the number of broadcast listeners per thousand population, the number being 119.5. Sweden comes next, according to the International Broadcasting Union, with 78.99.

Britain still holds third place with 77.5 per thousand population, and is followed by Austria with 63.34 and Germany with 56.23. Hungary and Norway come close and then comes Finland, which has stepped down a place in favour of Norway.

AMERICA'S 1 IN 3.

"Though they may be discouraging to certain broadcasters, showing that there are far fewer sets in use in many States than the stations in those States have been wont to claim, the radio census figures thus far released by the United States Census Bureau are considerably heartening to the radio trade," writes our Washington correspondent.

With nearly half the States reported, the figures reveal that less than one-third of the homes in the average State have radio receivers.

AMATEURS RECOGNISED AT COPENHAGEN.

American amateurs are rejoicing over the fact that one of their number, Mr. Kenneth B. Warner, Secretary of the American Radio Relay League, has been chosen as a technical adviser to the U.S. delegates attending the Radio Communications Committee which opens at Copenhagen to-day (Wednesday).

Our American cousins are not alone in hoping that Mr. Warner's presence will secure a better recognition of the rights of amateurs all over the world.

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THE LATE CAPTAIN G. R. WILLANS.

It is with very great regret that we learn of the death of Captain Gilbert Rolland Willans, which occurred on Thursday, May 14th, as a result of blood poisoning.

Captain Willans had been associated with broadcasting since almost the earliest days, his first appointment in the industry being as manager of the Marconiphone Department of Marconi's Wireless Telegraph Company. His abilities as a pioneer and organiser were quite exceptional, and his friends, to whom he was known affectionately as "G. R.," will recognise that his untimely death has cut short the promise of a brilliant career.

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PROVINCIAL STATION WITH PARIS STUDIO.

An interesting innovation is the opening of a special Paris studio by the Lille P.T.T. broadcasting station, enabling provincial listeners to enjoy exclusive concerts and news from the French capital.

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CAN SETS BE SEIZED?

Radio receivers, the Danish Government has decided, belong to the category of articles which cannot be seized for debt.

This repeats a recent German ruling on the point. According to a correspondent, a Berlin court has declared that a wireless set must be regarded as a "household utensil" legally exempt from seizure, since it fulfils an indispensable function in modern life.

We hear of a further curious case of special interest to the set constructor. A German amateur's home-built receiver was recently held for debt, but the seizure was regarded as irregular for two reasons; first, because it was a household article, and secondly because the price obtainable at a public sale would not nearly correspond with the value of the work expended upon it by the constructor.

AN EGG YARN.

We are beginning to expect something good whenever the name of Mr. O. H. Caldwell appears on the Atlantic horizon. Mr. Caldwell was formerly a member of the U.S. Federal Radio Commission, but he is now making excellent progress. Here he is, verbatim :—

"At least 50 per cent. more eggs will be produced for market if the poultry farmer offers to his hens the same opportunity to hear good radio programmes that he extends to his family. The secret in getting the most out of the hens by the radio system is to turn on the broadcasts early in the day and keep them going until chicken bedtime. This method increases the average hen-hour production and brings a new spirit of service to the chicken coop."

Which shows that there *is* a use for sponsored programmes.

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LORD CLARENDON AND S.A. AMATEURS.

The Earl of Clarendon, who recently severed his connection with the B.B.C. on receiving the appointment of Governor-General in South Africa, has lost little time in renewing his association with wireless. His Excellency has graciously accepted the Presidency of the South African Radio Relay League. His Presidential address not only makes good reading, but shows that our cousins in South Africa are to be congratulated on having a real "friend at Court".

After referring to his former connection with wireless operations as chairman of the British Broadcasting Corporation, Lord Clarendon said: "Short-wave transmission has captured the imagination of the world. Listeners any day can hear amateurs sending out their messages, receiving replies and conversing in the Morse code with distant parts of the world. For Kenya to call up Irak, India, Ceylon, Australia or New Zealand is to-day a commonplace, and amateurs in Mexico and Peru are able to call up their fellow-amateurs and converse with them in this country."

After expressing a hope that there would be a continuance of the happy relations at present existing between amateurs and the South African Post Office, Lord Clarendon touched upon the subject of Empire broadcasting.

"When," he said, "I was in charge of the administration of the British Broadcasting Corporation I can assure you that we all wished, so far as it was possible, to develop that service at the earliest possible moment. It would be amiss and out of place for me to go into minute detail as to why that service is not in extensive use to-day, but I will go so far as to say this, that those who are responsible for the development of the service to-day are as anxious as we were a few years ago to get it functioning at the earliest possible moment."

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A STARTLING "COMEBACK."

Just when he was thought to be dead, the Australasian amateur has suddenly jumped into life again and, according to our Wellington correspondent, is now constructing all electric sets at a rate which is causing some discomfiture among the Post Office officials. Apparently Australia has not quite made up its mind whether the home constructor is to be trusted with mains sets, and a move is afoot to establish an inspection service to prevent the "ham" attaching his gear to the mains until it has been duly certified.

Most of the parts available for home construction are said to be British, which is rather strange considering that the Americans monopolise the market of complete sets.

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A CLEAN SWEEP.

In order to "clear up" the French ether the Federation of Private Broadcasting Stations in France has prepared a plan, in co-operation with the Manufacturers' Union, which would suppress Lyons-la-Doua, Beziers, Marseilles, Montpellier, Toulouse P.T.T., Alpes-Grenobles, Radio-Normandie, and Radio-Vitus.

But, as neither the owners of these stations nor the listeners in their respective areas have yet been consulted, we are not disposed to scratch out these names on our calibration chart. Broadcasting stations, unless they are of the British relay variety, are not so easily throttled.

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INVISIBLE "RAILS" FOR AIR ROUTES.

Coming out of the laboratory after many years of development, the visual radio range beacon for the guidance of aeroplanes along given courses by means of visual instrument readings rather than aural signals received through earphones will shortly be placed in daily service in America.

The airway selected for the inauguration of the service is the Kansas City-Los Angeles section of the trans-continental air route.

The method to be used, which was described in *The Wireless World* of August 28th, 1929, makes use of direct radio beams along the route on which the planes are required to travel. Any divergence from the straight course is visually indicated by means of a pair of vibrating reeds which show at a glance whether the error is to the right or the left.

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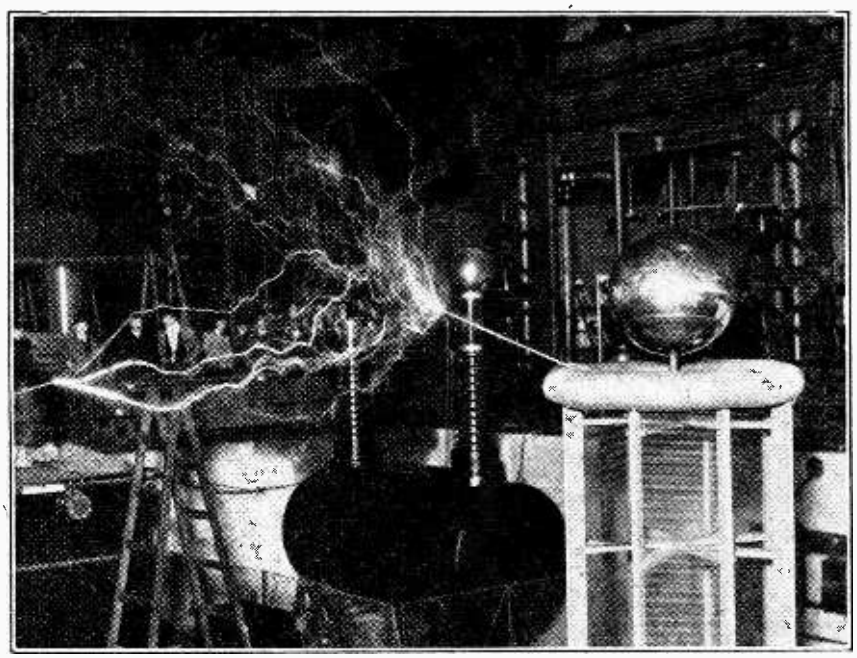
WIRELESS RIVALRY IN MALTA.

Malta is one of the few places (writes a correspondent) where true competition in wireless apparatus can be said to exist, and it is an unpleasant fact for British manufacturers to note that in these circumstances, and despite some advantage to them from the large British (Navy and Army) population, the sales of their products occupy at best third place. Not only are far more Italian receivers sold than British, but even American sets outsell them. The reason is stated to be purely the high cost of the British products, as they are admitted to be freer from hum on the local 100-cycle supply than the American sets, sharing this advantage with those from Italy.

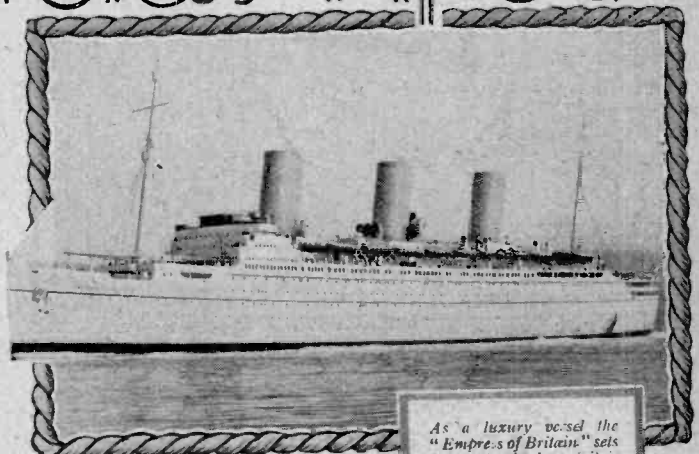
"There may also, however, be a certain dislike of British sets owing to the widespread discontent with the heavy local licence fees, for which the British Naval authorities are commonly blamed, one guinea being payable for the first and ten shillings for each subsequent year; and for this, as one disgruntled listener expressed himself, the Admiralty and the Eastern Telegraph Co. provide "unlimited Morse practice."



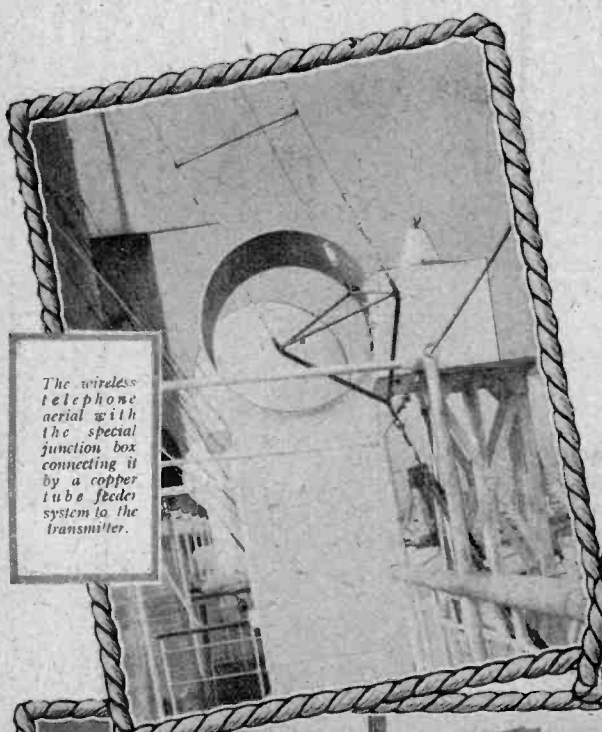
A MILLION VOLTS TO ORDER. A corner of the Ferranti works at Hollinwood, Lancs, showing the recently installed Tesla coil equipment at the moment of discharge. The voltage is just over a million. The high-frequency generator provides a discharge at an oscillation frequency of 120,000 cycles per second. The secondary winding is seen on the right.

Modern Wireless Afloat

AS befits the most up-to-date ship in the world, the "Empress of Britain," which has just been put in commission by the Canadian Pacific Lines, carries the most complete radio equipment ever installed on any ship. The Marconi installation includes telegraph transmitters and receivers for long and short wavelengths; short-wave telephone apparatus for two-way conversation; lifeboat sets and a direction finder, in addition to a band repeater system.



As a luxury vessel the "Empress of Britain" sets a new standard, and it is appropriate that the radio equipment should be "up to the last minute" in design and efficiency.



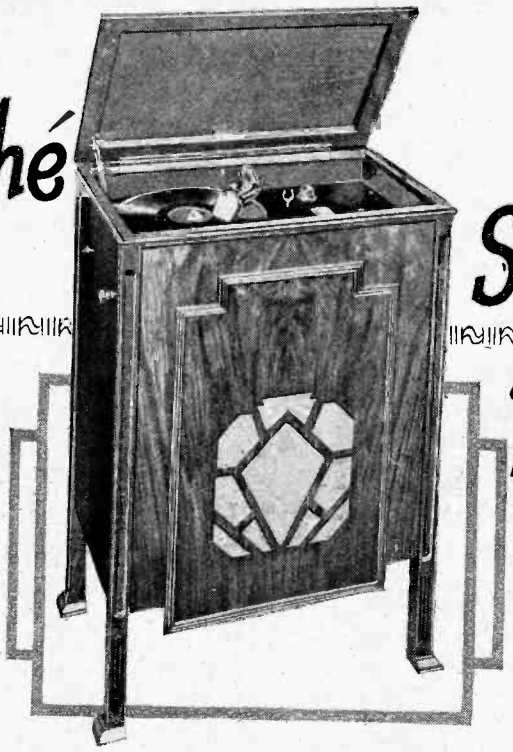
The wireless telephone aerial with the special junction box connecting it by a copper tube feeder system to the transmitter.

On the right is the Marconi short-wave telegraph transmitter and receiver. The broadcast receiver for use with the repeater system is on the extreme left.

The photograph on the left shows the Marconi telephone receiving room. The right-hand picture gives a glimpse of the long-wave telegraph plant. The 2 kW. transmitter is on the left.

No fewer than four large cabins are devoted to the ship's wireless equipment, while an unusually elaborate aerial system is also necessary, and this is suitably arranged between the masts and also from the fore and mainmast heads. The direction finder is installed in the chart room.

Bon Marché Super-Six Radiogram



A High-grade Dual-purpose Instrument at an Attractive Price.

DURING the past two or three years the development of the radio-gramophone has progressed rapidly, and in the matter of range and selectivity is not inferior to that of the most expensive radio receivers of advanced design. Prices, too, have fallen, and the radio-gramophone, once the luxury of the privileged few, is now attracting a far larger section of the community.

The new Bon Marché Super-Six radio-gramophone conforms to modern standards both as regards performance and external appearance, and at the attractive price of 29 guineas should make a strong appeal to those who have hitherto regarded a cabinet radio-gramophone as being beyond their means. It is an excellent example of the value that can be offered by buying components in the right market and assembling them in a high-grade cabinet.

All-metal Chassis.

The principal component, if it can be so termed, is a six-valve American all-metal A.C. receiver chassis. There are two H.F. stages, a detector and two L.F. stages, while a full-wave valve rectifier justifies the title of a six-valve receiver.

The screen-grid H.F. stages are transformer coupled, as is the input from the aerial circuit. A triple-gang condenser tunes all three circuits, and the single tuning dial is calibrated in kilocycles over the medium wave-range. Originally the receiver was designed for medium wavelengths only, and has subsequently been modified to include the long waves also. There is, however, sufficient space on the dial to mark the settings of long-wave stations in pencil. The work of extending the wave-range has been carried out very thoroughly, and the long-wave unit is neatly fitted to one side of the chassis. It has been found necessary to include a small trimming condenser across the secondary of the long-wave input transformer to ensure accurate ganging. This control is brought out at the right-hand side of the cabinet, but once adjusted to the aerial it should require little attention as the calibration holds over practically the whole of the waveband.

Pre-H.F. Volume Control.

In accordance with the best modern practice the volume control is fitted before the input to the first H.F. valve, and should do much to mitigate cross-modulation troubles. It takes the form of a wire-wound potentiometer connected across the primary of the input H.F. transformer. The resistance is graduated to give a linear change of volume throughout the range of movement of the control. In the minimum position the potentiometer arm engages with a quick-break tumbler switch and interrupts the mains supply to the receiver. For local station reception the aerial can be open-circuited by a small switch, the capacity of which is sufficient to pass all the energy required.

One of the most interesting features of the circuit is the employment in the detector stage of a screen-grid valve. This functions as an anode bend rectifier and, as in the case of the H.F. valves, is biased by the fall in potential across a resistance connected in the cathode return lead. A resistance-capacity filter in the anode circuit prevents H.F. currents straying into the L.F. amplifier, which is resistance-coupled throughout. The gramophone pick-up is connected in series with the grid circuit of the detector valve and is short-circuited, together with its volume control potentiometer, by a single-pole switch. In later models the pick-up volume control and switch are combined in a single unit as in the case of the radio volume control.

SPECIFICATION.

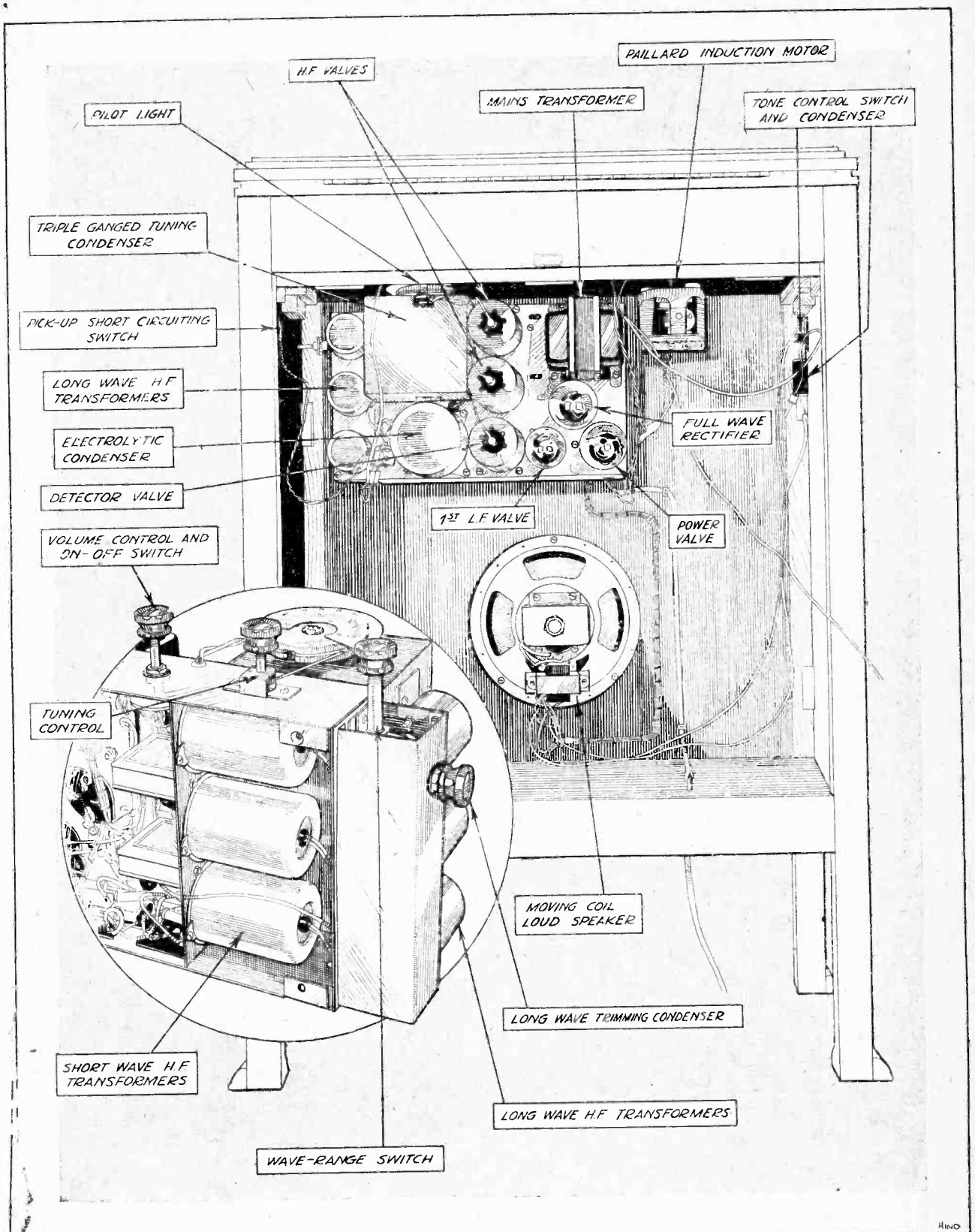
CIRCUIT: Two screen-grid H.F. (transformer-coupled); screen-grid anode bend detector; two L.F. (resistance-coupled). Ganged tuning. Pre-H.F. volume control.

CONTROLS: Single dial tuning (calibrated in kilocycles). Volume control and main switch. Wave-range switch. Trimming condenser (long waves). Pick-up switch and volume control. "Local" aerial switch. Tone control. Automatic motor switch on turntable.

GENERAL: Moving coil loud speaker. B.T.H. pick-up. Paillard induction motor.

PRICE: 29 guineas.

MAKERS: Bon Marché, Ltd., Brixton, London, S.W.9.



Interior view of Bon Marché Super-Six radio-gramophone, with an enlarged view of a corner of the chassis, showing screened short-wave and long-wave H.F. transformers.

Bon Marche Super-Six Radiogram.—

The field winding of the moving-coil loud speaker is used to smooth the H.T. supply, and, in spite of the absence of decoupling, the circuit is in practice quite stable. Adjustment of the power transformer to the supply voltage is accomplished by soldering together appropriate leads under the transformer. This is carried out by the makers before the set is despatched, so that the exact supply voltage should always be stated when ordering.

The sensitivity is of a high order, particularly on short waves, though the range on long waves is appreciably higher than that of the majority of converted American sets. The long waves yielded six stations in addition to 5XX, but at a distance of five miles from Brookmans Park, the London Regional station broke through over the lower quarter of the dial. The inherent selectivity in the upper part of the scale was, however, sufficient to bring out Königswusterhausen without any background interference.

Short Wave Range and Selectivity.

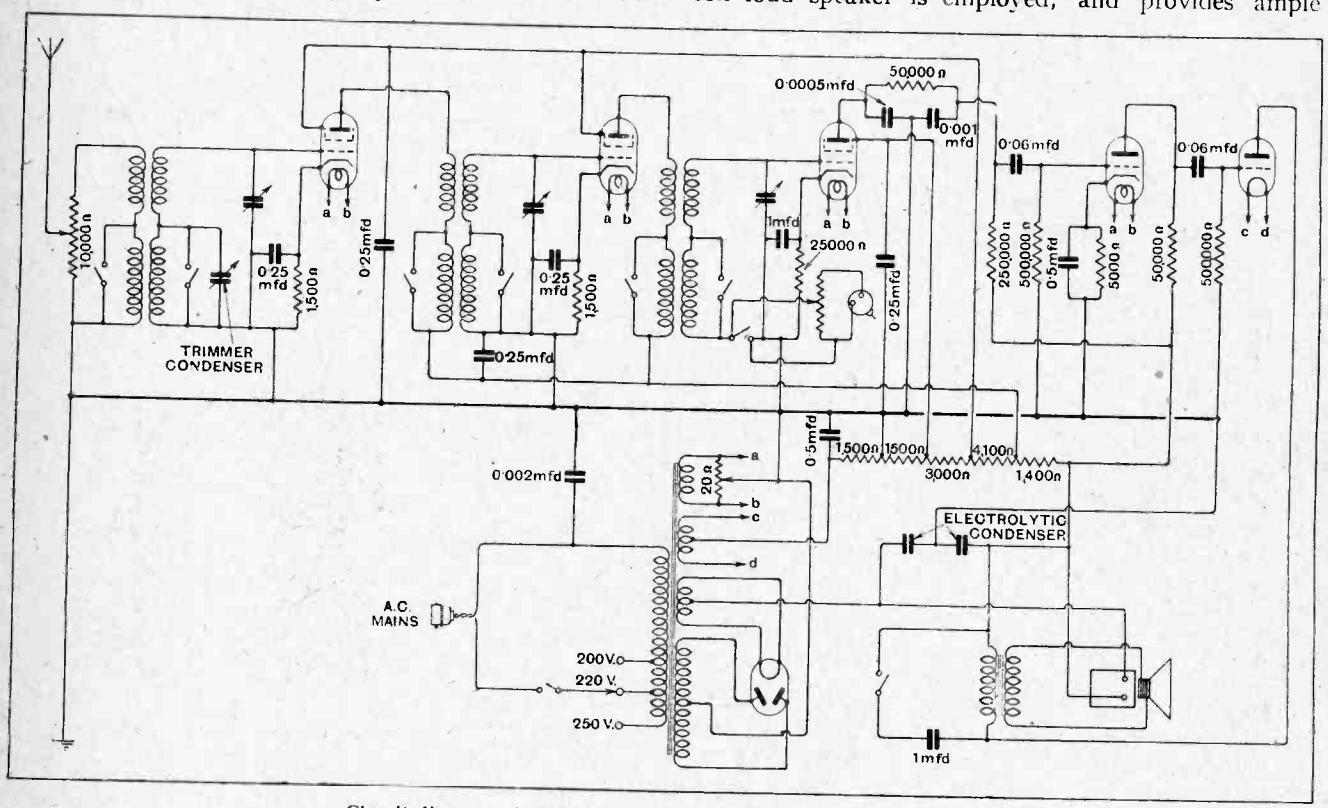
Some idea of the range on short waves may be gain d from the fact that five stations were received in daylight on two consecutive mornings. Two of these—Langenberg and Hilversum—overloaded the last valve with the volume control at maximum. After dark from 15 to 20 foreign stations could be received at full loud speaker strength. In the case of six of these any movement of the volume control from the minimum position resulted in overloading.

The selectivity on short waves allows full use to be made of the range provided. At five miles from Brookmans Park the wavebands occupied by the National and Regional transmitters were 240-285 and 325-385 metres.

The Moving-coil Loud Speaker.

The quality of reproduction is pleasing, and does not appear to suffer on the gramophone side on account of overbiasing of the detector valve. A miniature moving-coil loud speaker is employed, and provides ample volume in keeping with the dimensions of the cabinet. Speech is perfectly natural, and a brilliant upper register gives a crisp rendering of music when the so-called tone control is out of action. The cone is constructed of buckram and a small area near the apex is doped to give additional stiffness. This is done to assist the formation of nodes at high frequencies and is undoubtedly a contributory cause of the excellent response in the upper register. There is plenty of volume in the bass, but the quality suggests that this is due to a resonance in the region of 150 cycles rather than to an even distribution of output throughout the lower register.

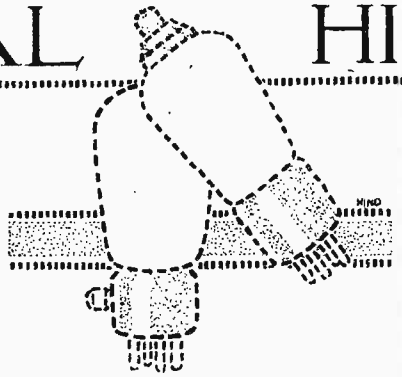
Mains hum is negligible, and the Paillard induction motor is silent in operation both electrically and mechanically.



Circuit diagram of the Bon Marché Super-Six radio-gramophone.

Next Week's Set Review:—"HIS MASTER'S VOICE" D.C. MAINS MODEL 521.

PRACTICAL HINTS & TIPS



ISOLATING THE PICK-UP.

AFTER taking pains to ensure that all the external metal parts of a D.C. receiver are "dead," so far as high mains voltages are concerned, it is illogical to connect a pick-up to the set in the conventional way. If the positive main be earthed, the leads to this component—and also its terminals, which may possibly be exposed—will be considerably above earth potential.

Although the very slight risk of danger from shock that will then exist must not be exaggerated, it is just as well to keep within the spirit as well as the letter of regulations and official recommendations dealing with this subject. By adopting either of the arrangements shown in Fig. 1 isolation of the pick-up is ensured.

Diagram (*a*) shows how blocking condensers (of about 1 mfd. or more each) may be inserted in each lead to the pick-up. This method will generally be preferred; although the use of a transformer (diagram (*b*)) is equally safe, there is but a limited choice of suitably designed components. If the second plan be adopted, it is as well to "earth" one side of the pick-up.

A warning should be offered against connecting isolating condensers in series if no volume-control potentiometer is fitted.

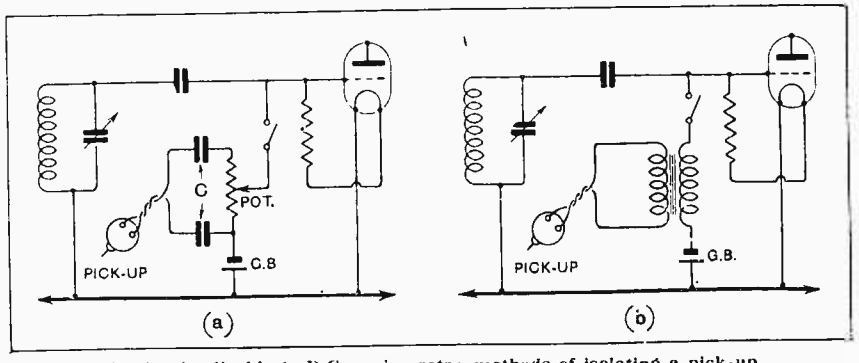


Fig. 1.—Applicable to D.C. mains sets: methods of isolating a pick-up.

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UNWANTED INTER-CIRCUIT COUPLINGS.

FEW faults in an "H.F." receiver are more annoying than uncontrollable instability at the lower end of the tuning scale. When self-oscillation is produced as the various circuits are brought into tune at any wavelength below, say, 300 metres, there is sometimes a temptation to obtain stability by reducing amplification, but such a course can hardly be adopted with a clear conscience when one is working on a set intended to be highly sensitive, especially if it is known that the amplification aimed at is well within theoretical limits.

Assuming that these limits are not exceeded, it is well known that H.F. instability must be due to unwanted couplings between plate and grid circuits. But just where this coupling is taking place is not always evident; even if one is blessed with more than the average allowance of patience, its location is sometimes a very lengthy process.

As an indication that the right line of attack is being followed it is a good plan to adjust the receiver to the highest wavelength at which self-oscillation is produced. In this condition it will be particularly responsive to the beneficial effects of any experimental alteration.

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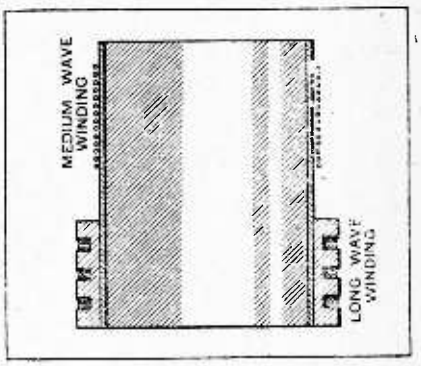
DUAL RANGE COILS

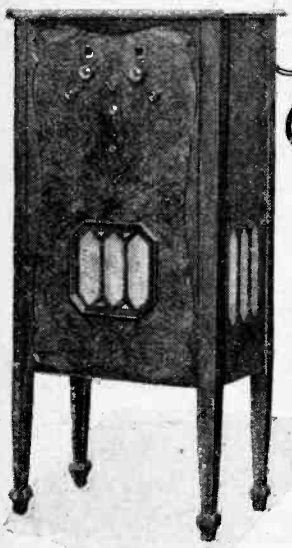
THE practice of winding the medium- and long-wave sections of a dual-range tuning coil on the same former, and then connecting both windings in series so that wave-changing may be effected merely by short-circuiting, has proved so convenient and effective that it is now almost universal.

Almost invariably, a single-layer coil is used for medium-wave reception, while a sectional winding in a series of slots serves as a long-wave loading coil. Home-made inductances constructed in this way are usually wound on a ribbed ebonite former, in which the necessary slots may easily be cut.

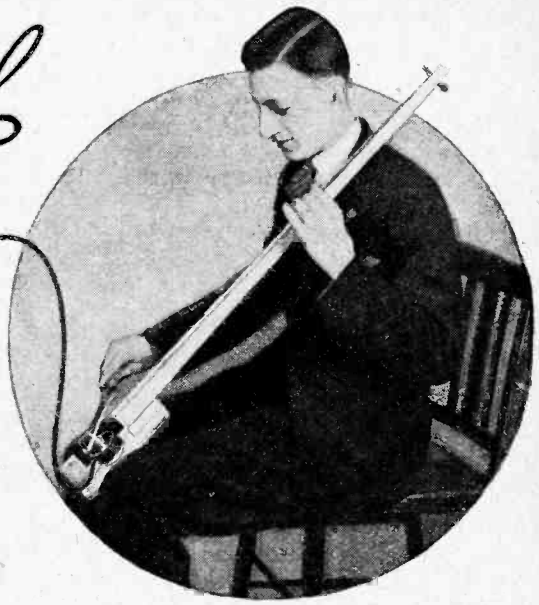


Built-up former for dual-range coil.

When a ribbed former of suitable dimensions is not available a plain tube of insulating material will meet the case, provided that a suitable support for the long-wave section can be devised. With the help of a vice, saw, and a thin flat file, slotted ebonite blocks can be made quite easily, even by those with claims to but little manual dexterity. About six of these blocks are required; they are secured by means of adhesive, or even by the tension of the winding, around the circumference of the coil former, in the manner suggested in the accompanying sectional sketch.



Electrical Cello



An Instructive Line of Experiment for the Musical Amateur.

By R. RAVEN-HART.

THE idea of replacing the sounding-board and resonance chamber of a musical instrument, such as the 'cello or the violin, by an electrical amplifier is, of course, not new, and a good deal of experimental work has been done in this direction, particularly in Germany, where the Berlin Academy of Music has taken a special interest in the subject. An article describing some of the work done by this Academy appeared in *The Wireless World* for December 10th, 1930.

One of the chief attractions of this idea, especially to the musician, is the extreme simplicity of the apparatus and the fact that, given a broadcast receiver, which in all probability already has terminals provided for connecting a gramophone pick-up to the amplifier, it is a very easy matter to connect a musical instrument in place of the pick-up and obtain really good-quality results with remarkable volume.

This article is not intended to go deeply into the subject, but merely to put some suggestions to the amateur which will provide a general guide if he is interested in investigating the subject further and developing fresh ideas of his own. The author's own preliminary efforts have proved so interesting and promising that he feels he would like others to have the advantage of any hints which he can give.

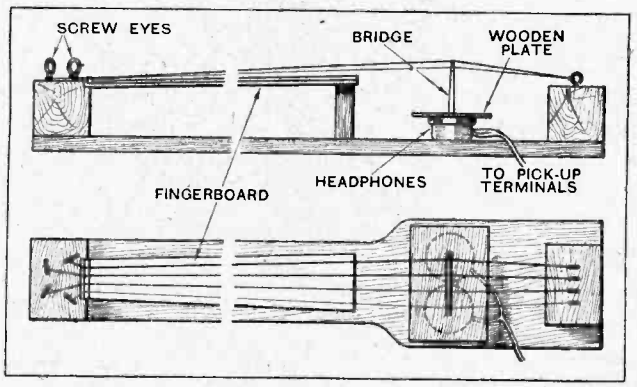


Fig. 1.—An illustration of the method of mounting the parts of the electrical 'cello on a wooden baseboard, and with two telephone ear pieces mounted side by side.

The general idea is, of course, applicable equally to any stringed musical instrument, including the violin, banjo, mandolin, etc.; but, because of the relatively large bulk of the normal type of 'cello and the cost of the instrument, the application of electrical reproducing methods to this instrument is particularly striking.

A rough experimental form of the electrical 'cello is illustrated in Fig. 1, where two high-resistance telephone ear-pieces are mounted on a board, side by side, and over them is placed a piece of thin board, such as the lid of a cigar-box, and on this, in turn, rests the normal 'cello bridge, the whole arrangement being held firmly in place by the tension of the strings. Quite a variety of modifications can be tried out, and one which gave very good results, and is perhaps the easiest to set up, is that which is illustrated in Fig. 2, and shown in use in the title illustration. Here a single-string instrument is constructed, the mechanism being mounted on a board as shown. In this experimental model only one ear-piece was used, and, instead of mounting a wooden board over the diaphragm of the telephone, the diaphragm itself was removed and in its place a strip of metal was placed across the case of the ear-piece, resting on the edges of the case, and the 'cello bridge was mounted on this. The bridge could, of course, be mounted on the diaphragm, but normally it would be found that the diaphragm would tend to bend and be unable to bear the strain of the tensioned string. The arrangement described has definite advantages, for the intermediate air space is eliminated, which would otherwise exist between the sounding board and the diaphragm of the ear-piece, and the direct drive will be found to give a firmer tone and better response in the upper frequencies. In addition, any colouration of the tone due to the natural frequency of vibration of the diaphragm is removed. The

Electrical 'Cello.—

normal diaphragm of a telephone would invariably have a peaky resonance which would be reproduced and impair the final tonal effect.

The string, or strings, of the instrument can be stretched between screw eyes, and a finger-board is fixed below them, as shown in Fig. 1. Unless a proper 'cello head can be procured, it will be necessary to obtain a hardwood substitute, or frequent retuning will be necessary, owing to the tendency of the wood to "give," and so allow the strings to get slack.

When the instrument has been completed, the leads from the telephone ear-piece are connected to a valve amplifier, as one would normally connect a gramophone pick-up. When demonstrated to an expert professional musician, the opinion was expressed that the tone on the second (D) and third (G) strings was fully comparable with that of a good 'cello; and on the first (A) and fourth (C) strings the result was stated to be *better* than that of most 'cellos, as there was a complete absence of harshness in the one case, or woolliness in the other.

The amateur-constructed instruments described would not, of course, be really applicable to practical use, for the reason that constant retuning of the strings would be necessary, as explained above; but if the experimenter is prepared to go to the expense of purchasing a complete 'cello head with finger-board neck, nut, scroll, and pegs complete, and this is fitted to a wooden support like the lower part of that shown in Fig. 1, then a really permanent and serviceable instrument results. Complete 'cello heads can be purchased separately from musical instrument makers.

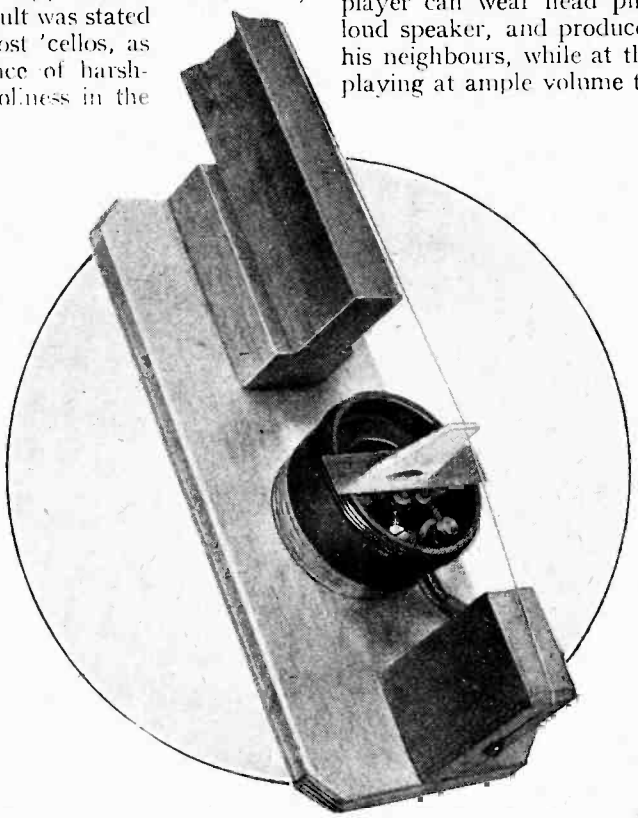


Fig. 2.—Photograph of an experimental single-stringed instrument employing only one ear piece and having a strip of soft iron in place of the usual diaphragm.

It is worth while to note that far more volume than that obtainable from an ordinary 'cello is available if a good amplifier is employed, and this possibility might prove of great interest, for instance, in orchestral work where one instrument could produce the effect of perhaps four or five! Again, a double control of volume is available, the normal control with the bow, and a second control, probably best operated by a foot pedal, which would actuate the volume control of the amplifier. Those who are familiar with stringed instruments will see that some curious possibilities are presented here, for the normally weak vibrations of the string *after* plucking may be amplified up to *fortissimo*, or, conversely, a *pianissimo* volume, but with the attack normally corresponding to *fortissimo*, can be obtained.

Another point which is of interest to the musician who may, through force of circumstances, find it inconvenient to practise because of the disturbance to others within hearing, is that with a weak amplifier the player can wear head phones instead of employing a loud speaker, and produce very little sound to disturb his neighbours, while at the same time hearing his own playing at ample volume through the phones.

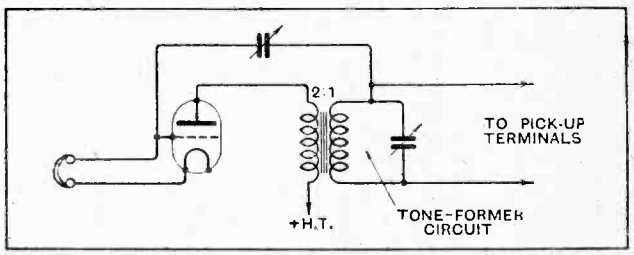


Fig. 3.—A suggested circuit which should be studied in conjunction with the author's previous article dealing with "tone formers" published in *The Wireless World* of December 10th, 1930.

Interesting Modifications.

Those who are interested in the technical side will probably want to experiment with "tone formers," as described in the article already referred to which appeared in *The Wireless World*, of December 10th, 1930. It is possible to add "tone formers" to the notes played, and thus to have available tone-qualities other than the normal 'cello timbre if desired. The circuit given in Fig. 3 should be followed in conjunction with the writer's article referred to above, which described a new musical theory. The transformer shown may be an ordinary 1:2 low-frequency transformer reversed (assuming, that is, that the secondary will stand the plate current; otherwise, shunt feed can be used), or, alternatively, a specially built transformer with a low-resistance secondary.

It may be well to add here that from rough tests it seems that it would be best to add another valve before that shown in Fig. 3, which would amplify normally and feed the second valve through a step-up, low-frequency transformer, in order that the impulses may be of sufficient intensity to set the tone-former circuit in oscillation without the need for undue juggling with the regeneration condenser. This will, of course, depend principally on the resistance of the transformer secondary, and only experiment can fix this point. It is hoped that enough has been said to interest the experimenter.

Broadcast Brevities

A New "Piano-Patter" Microphone introduced by the National Broadcasting Co. of America.

By Our Special Correspondent.

Northern "Nat." Date.—New Long Wave for Britain?—Changes at Portland Place.—"D.G." and American Methods.—Talent Famine in Scotland.

Northern National: Starting Date.

By the middle of June it is hoped that northern listeners will have braced themselves in readiness for programme-hour tests by the National transmitter at Moorside Edge, working on 301.5 metres. At first, I learn, the tests will consist of a full alternative service from the end of the first News on two nights a week.

Then, if no catastrophes occur, the engineers will take the big step of introducing a full-time alternative on or about Sunday, July 12th.

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Ultra-Short-Waves at Copenhagen.

Three major matters are down for consideration at the meeting of the International Consulting Committee on Radio Communications which meets to-day (Wednesday) at Copenhagen.

First on the agenda comes the consideration of the efficiency of the ultra-short-waves as a means of treating Europe's interference problem, and it will not be surprising if an interesting plan is drawn up for submission to the Madrid Conference next year.

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Another Long Wave for Britain?

A proposal to widen the existing broadcast bands will also be debated, while another suggestion of great import to British listeners is the opening up of more long waves for high-power broadcasting.

At least two representatives have gone from Savoy Hill, and it is to be hoped that they will immediately stake a claim for an additional long wave for Britain, which would give an alternative programme to listeners who at present have to rely on 5XX.

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All Eyes on Madrid.

Unfortunately no definite action can be taken on the decisions of this International Committee, but its task is sufficiently important as laying the foundations for the world wireless conference at Madrid.

It is assumed, by the way, that the changed political conditions in Spain will not affect the venue of the conference. Madrid was chosen at the Washington Conference four years ago.

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Architectural Changes at "B.H."

Here is a piece of good news for the listeners who place studio audiences in the same category as electricity pylons, pneumatic drills, sewage dumps and other public nuisances. It has been found that the large studio at Broadcasting House cannot comfortably contain more than 750 persons in the auditorium as compared with the 1,000 originally planned for.

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Mocking Echoes.

The discovery has arisen out of the acoustic tests which have been in progress during the last two or three weeks. As so often occurs on the completion of a building, the acoustics have not panned out in practice in quite the obliging way that they did on paper. Unsuspected resonances have leaped out from odd corners.

Sacrificing Space.

The sacrifices necessary make a considerable inroad on the space available to the audience and finally remove any doubts as to whether the B.B.C. could run a rival show to the Queen's Hall, which is next door but one.

FUTURE FEATURES.

National (261 and 1,554 metres).

JUNE 3RD.—Running commentary on the Derby.

JUNE 5TH.—Two plays: "Fame," an ironic comedy in one scene, by Gideon Clark, and "Robinson," a fantasy in one act, by L. E. Bunnett.

JUNE 6TH.—Running commentary on Trooping the Colour, relayed from the Royal Horse Guards' Parade.

London Regional.

JUNE 3RD.—"A Princess of Kensington" (German), a concert selection from the comic opera.

JUNE 4TH.—"La Forza del Destino," Act 2, relayed from the Royal Opera House, Covent Garden.

Midland Regional.

JUNE 6TH.—"Mid Northern Mists," orchestral concert.

West Regional (Cardiff).

JUNE 4TH.—Concert at the Garden Fête organised by the Bristol Choral Society.

North Regional.

JUNE 4TH.—A Beethoven concert, relayed from the Town Hall, Leeds.

Glasgow.

JUNE 4TH.—"A Glasgow Cycle—The Living Past," feature programme, written by Rosslyn Mitchell.

Belfast.

JUNE 1ST.—"Autumn Fire," a play in three acts, by T. C. Murray.

The Big House.

As "moving day" draws nearer and nearer the B.B.C., like a timid bridegroom, is just beginning to realise the irrevocability of the step which will be taken in August next, for conditions at Portland Place will be vastly different from those obtaining at the old home on Savoy Hill.

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The Lease.

The present headquarters have been admirably adapted to meet the needs of broadcasting, but everyone realises that if the B.B.C. were to walk out to-morrow, the existing premises could be converted into flats or even an hotel with a minimum of inconvenience. Moreover, the terms of the lease allow for its transference at short notice.

Not so with Broadcasting House.

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A White Elephant.

It would be difficult to imagine a more perfect specimen of white elephant than the strange new building in Portland Place—if the B.B.C. elected to leave. Nobody is more aware of this than the members of the owning syndicate; consequently it is ordained that, when there, the B.B.C. shall "stay put," and the terms of the lease stress this point with crystal clarity.

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High Rental.

While I am not permitted to disclose the actual rental of the new building, it is worth remarking that a fiat has gone forth at Savoy Hill enjoining the strictest economy in all directions, not entirely excluding the Programme Branch. It was at first thought that the development of the Regional scheme was the controlling factor in this decision, but commitments in regard to Broadcasting House are now known to be very heavy.

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The "D.G." and Sponsored Programmes.

Heads are still being wagged over Sir John Reith's visit to America, but I refuse to believe that the "D.G." will allow himself to be dazzled by the glittering profits which the National Broadcasting Company of America is reaping from sponsored programmes. Nor can I picture him yielding to inducements to make a permanent stay in the interests of American broadcasting.

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American "Pep."

It is quite conceivable, though, that Sir John will bring back with him some fresh ideas for "putting pep" into the B.B.C. programmes.

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Putting It Across.

After a week of listening to the short-wave relays from America I have come to the conclusion (rightly or wrongly) that the Americans fall behind us far more in matter than in manner. Being primarily concerned with the retention of the listener's interest in their sponsored programmes, they have developed a spasmodic but not ineffective technique which might be copied to a limited extent over here.

No Interval Signals.

For example, the notion of an interval signal passes the comprehension of an American broadcaster. As Mr. E. P. James, the N.B.C. time salesman, explained to me a few months ago, the slightest break in the continuity of the transmission loses listeners, who promptly switch over to a rival station. Hence, from early morning to late at night, the Yankee programmes gush out ceaselessly in a way which we only experience in the vaudeville programmes.

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More Surprises Wanted.

On the other hand, the material broadcast is usually so puerile and so puffed up with advertisements that only the continual element of surprise keeps listeners from switching off.

If just a little more of the surprise element could be infused into the B.B.C. transmissions there would be far fewer complaints of dullness and lack of variety.

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Touring Scotland for Talent.

Mr. Cleghorn Thomson and his lieutenant, Mr. Moray McLaren, are conducting a "tour for talent" in preparation for the millennium—that blissful period when, it is hoped, the Scottish Regional transmitter will be disseminating programmes that are 70 per cent. Scots.

But I am scarcely surprised to hear that the talent is not being found in very plenteous quantities.

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When Daventry Butted In.

In the early days the Scottish stations put out programmes that were practically "all Scotch," and everybody was satisfied. Soon, however, long-wave Daventry butted in with the manifestly superior programmes from London, and Scotsmen grew dissatisfied with the "kailyard" type of entertainment. Ever since then there has been a gradual abandonment of the local programme idea until, nowadays, the lonely Highlander capers to the latest dance hit in London with the same bored expression as the frequenter of London night clubs.

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A Lost Art?

It will be a strange reorientation if Scots listeners return uncomplainingly to the "wee but and ben" sort of entertainment, which, to judge from the search now in progress, is becoming a lost art.

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B.B.C.'s New Popularity Meter.

It never seemed likely that the B.B.C. would allow the owners of relay systems to hold a monopoly in the art of discovering the likes and dislikes of listeners, and now a genius in the engineering department has hit upon a plausible method whereby the B.B.C. can themselves check the relative popularity of each item.

It is very simple. One just counts the oscillators.

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So Simple.

Apparently oscillation complaints reached Savoy Hill in bundles just after the Royal Command Performance. The engineers infer from this that countless listeners were forcing their receivers to obtain the maximum volume of reception, in spite of the Buggins family. In other words, oscillation increases in direct proportion to popular approval. Q.E.D.

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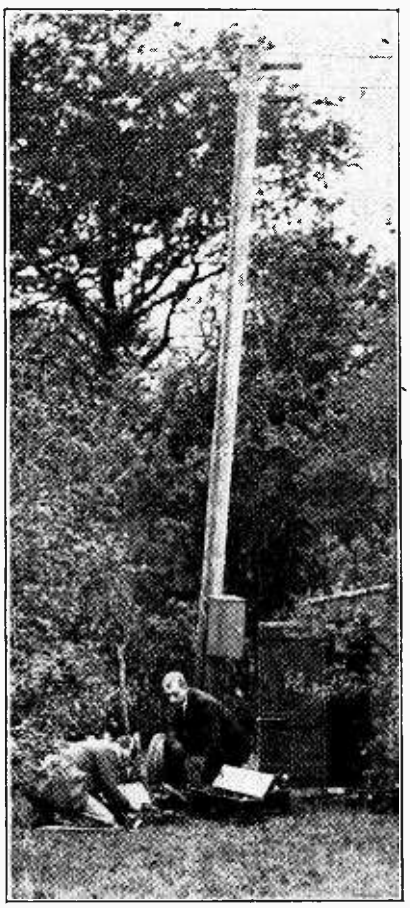
The Nightingales.

The nightingales are fulfilling their contract. The Pangbourne site seems to be the best that the B.B.C. has yet chosen, and it is to be hoped that this particular sanctuary will always be available for broadcasting purposes.

It may not be generally known that the chosen spot is in the grounds attached to the mansion of the late Mrs. Gertrude Vandervell, who died a few months ago.



SETTING THE SONG TRAP. B.B.C. engineers with their portable equipment at Pangbourne for relaying the notes of the nightingale. Note the special telegraph line.

In Memoriam.

When the question of broadcasting the nightingales came up for discussion this year some doubt was felt as to whether the site could still be used. But, on being consulted, the relatives of Mrs. Vandervell at once expressed the opinion that the deceased lady, who always took the keenest interest in the broadcasts, would have wished that the arrangement should continue.

Could one imagine a more fitting memorial?

The R.A.F. Pageant.

A running commentary on the Royal Air Force Pageant will be relayed from Hendon on June 27th. Squadron-Leader Helmore may be the commentator.

Later that day an eye-witness account will be broadcast of the cricket Test match at Lords.

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Relaying Wimbledon Tennis.

During the week from June 22nd to 27th breaks will occur in the normal broadcasting programmes between 3.20 and 5.15 each day to enable a running commentary to be given on the All-England Lawn Tennis Championship Meeting at Wimbledon. At the close of each day's play also an eye-witness account will be broadcast.

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The Searchlight Tattoo.

The Aldershot Command Searchlight Tattoo will be relayed from Rushmoor Arena on June 13th. It will open with Retreat and Tattoo by the massed bugles and massed drum and fife bands of the Aldershot Command.

A musical ride by a Royal Horse Artillery Battery follows; then comes an old-time drill display by the 2nd Battalion Queen's Own Cameron Highlanders, accompanied by the massed pipes and drums of the Scottish regiments.

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A "Mike's-eye" View.

"Our Town" is a snappy "mike's-eye view" for broadcasting on the National wavelength on June 12th, and the Regional on June 13th. With L. du Garde Peach as author, Ernest Longstaffe as composer and Gordon McConnel as producer, this musical sketch should be one of the week's best things.

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Good Get-aways.

The coming series of broadcast narratives, "Escape," which is to be launched by Mr. J. R. Ackerley on June 6th, will include several well-known authors of escape stories, among them Hugh Darnford, who wrote "The Tunnellers of Holtzmonden," A. J. Evans, the author of "The Escaping Club," and E. H. Jones, of "The Road to Endor" fame. A German who got away from a British camp will also relate his experiences.

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Golf Thrills.

Eye-witness accounts by Bernard Darwin of the Open Golf Championship will be relayed from Carnoustie on the National wavelength on June 4th and 5th.

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Nasal Music.

M. Paul Dermée, a French musical authority, has hit the nail on the head by saying that it is absurd to encourage the composition of music specially intended for broadcasting. M. Dermée's remark is aimed at a number of well-meaning folk who consider that the imperfections of the microphone, amplifier, and loud speaker should be pandered to by the development of music in which high and low notes are dispensed with in favour of an abundance of notes in the middle register.

"It would have been just as harmful to the gramophone in its early days," says M. Dermée, "if it had been given a diet of music entirely nasal."

THE VECTOR EXPLAINED

Expressing Phase Difference as an Angle.

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

(*Concluded from page 544 of previous issue.*)

LET us first consider two alternating currents which are exactly in phase or in step with each other, such as the currents taken by two non-inductive resistances connected in parallel across a source of alternating voltage, as shown in Fig. 3. To simplify the explanation, numerical values (R.M.S.) of 4 amperes and 6 amperes will be assumed, and to obtain the corresponding maximum values we must *divide* each of these by 0.707, giving 5.656 and 8.484 amperes respectively.

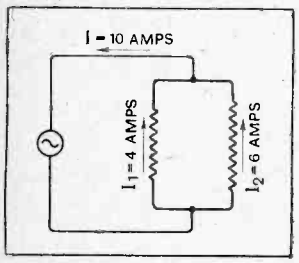


Fig. 3.—Two resistances in parallel take currents which are in phase with one another. In this case $I = I_1 + I_2$.

Assuming the frequency to be 50 cycles per second, the time of one cycle will be 1/50th second. The two sine waves representing the currents in question are drawn to scale in Fig. 4 and are denoted by the full-line curves drawn exactly in step. They both attain their maximum positive values at the same instant and pass through their zero values together.

Now let us suppose that it is required to find the curve representing the sum of these two currents at all times. At any point, such as *a*, on the base-line draw a vertical line, cutting the current curves at *b* and *c*, as shown. Then, at the instant represented by *a*, one of the currents has a value of *ab* amperes and the other of *ac* amperes. Thus at this instant the sum of the two currents will be $ab + ac$ amperes, and if we add on to the length of *ac* an extra length, *cd*, equal to *ab*, the length *ad* gives the value of the total current. By repeating this process for numerous points along the base-line a series of such points as *d* is obtained, enabling the resultant current wave to be drawn. If the curves are carefully plotted to scale it will be found that the new curve is also a sine wave which is exactly in step with the original ones. This is shown by the dotted curve of Fig. 4.

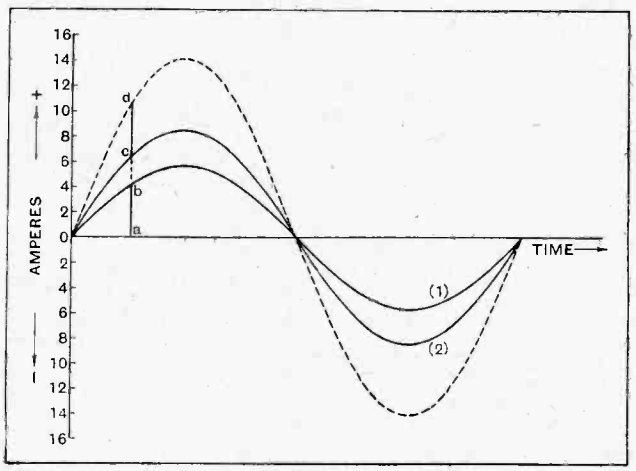


Fig. 4.—Sine curves in phase representing the currents of Fig. 3. The dotted curve is the sum of curves (1) and (2) found by adding instantaneous values. For any point on the base-line $ad = ac + ab$.

It should be particularly noted that the maximum value of the sum is equal to the sum of the maximum values of the individual waves. Thus the maximum value of the total current wave is $5.656 + 8.484 = 14.14$ amperes, and, multiplying this by 0.707, we obtain, for the effective, or R.M.S., value of the total current, $14.14 \times 0.707 = 10$ amperes. *But this is just equal to the sum of the R.M.S. values of the individual currents*—a very important conclusion which shows that, for two alternating currents (or voltages) in phase with each other, their R.M.S. values may be added together arithmetically to give the R.M.S. value of the resultant. This is only true when the waves are in phase.

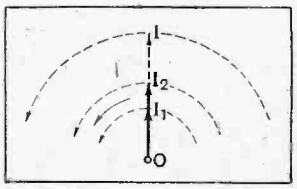


Fig. 5.—Vectors representing the currents of Fig. 3. When the currents are in phase the vectors coincide with each other. When drawn to scale $OI = OI_1 + OI_2$.

Vectors in Phase.

If the two individual currents of 4 amperes and 6 amperes (R.M.S.) are to be represented by vectors, the lengths of the latter would be made to correspond to these current values to a suitable scale; for instance, choosing a scale of 2 amperes to the inch, one vector would be two inches long and the other three inches.

Now since the angle between the vectors is to represent the phase difference between the corresponding sine waves, and since, in the present instance, there is no phase difference, it follows that there will be no angle of inclination between the vectors; in other words, the vectors will be parallel to each other, and if they both rotate about the same

The Vector Explained.—

point O, one must coincide with the other. Thus if OI_1 and OI_2 are the two vectors in question, they must be drawn as shown in Fig. 5, one lying over the top of the other.

We have already seen that the R.M.S. value of the sum of the two currents is 10 amperes, and so, using the same scale, the vector representing the total current will be five inches long. Note that this is equal to the sum of the lengths of the other two vectors. Further, it was seen that the curve representing the total current in Fig. 4 is in phase with the other two, and consequently the vector OI will coincide with the vectors OI_1 and OI_2 as in Fig. 5.

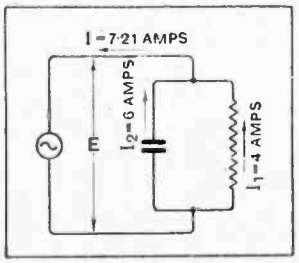


Fig. 6.—A condenser and a resistance in parallel take currents a quarter of a cycle out of phase. In this case $I = \sqrt{I_1^2 + I_2^2}$ as shown by Fig. 8.

The rules are, then, (a) *for two quantities in phase the corresponding vectors are drawn coincident or parallel;* and (b) *the R.M.S. value of the sum of, or difference between, two waves or vectors in phase is found by simple addition or subtraction of the individual R.M.S. values.*

Currents a Quarter of a Cycle Out of Phase.

The next step is to consider a case where the two alternating quantities concerned are out of phase, that is, where the two sine waves do not reach their maximum positive values together. To simplify the reasoning, the rather special case will first be dealt with in which two alternating currents of equal frequency are just a quarter of a cycle out of step, so that one just reaches its maximum value as the other passes through zero. If a non-inductive resistance is connected in parallel with a condenser, as shown in Fig. 6, to a source of A.C. supply, the resistance will take a current exactly

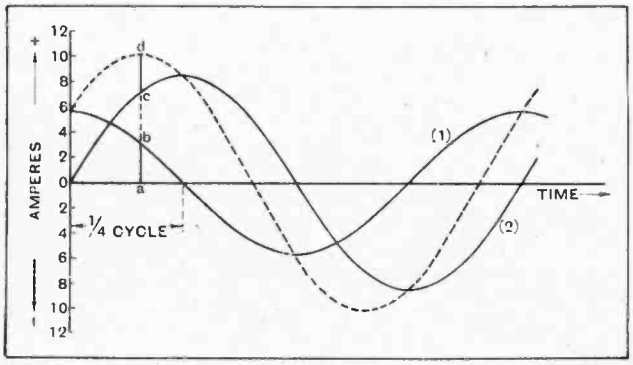


Fig. 7.—The sine curves (1) and (2) represent the currents of Fig. 6, being a quarter of a cycle out of step. The dotted curve gives the sum of these two currents at all times.

in phase with the supply voltage, whereas the condenser will take a current which leads this voltage by just a quarter of a cycle. Hence the two currents must themselves be just a quarter of a cycle out of step with respect to each other.

Let the current taken by the condenser branch have an R.M.S. value of 4 amperes and that taken by the resistance branch 6 amperes—the same values as used before. Then the maximum values will be 5.656 and 8.484 amperes respectively, and the two corresponding sine waves are plotted to scale in Fig. 7 as curves (1) and (2) respectively. It should be pointed out that curve (1) is in *advance* of curve (2) because the former reaches its maximum positive value earlier than the latter—it must be remembered that the curves are not moving along the base-line!

Now the curve representing the total current is found by the same process of addition as explained for the case of two waves in phase, but here extra care is needed regarding positive and negative values. At a point on the base-line where the current values are of opposite sign the resultant current is given by the difference between the individual values, being in the direction of the larger one. As before, the total current is given by the dotted curve, whose maximum value is seen to be 10.2 amperes. Multiplying this by 0.707 we get for the effective value of the total current: $10.2 \times 0.707 = 7.21$ amperes.

This result elicits a very important aspect, namely,

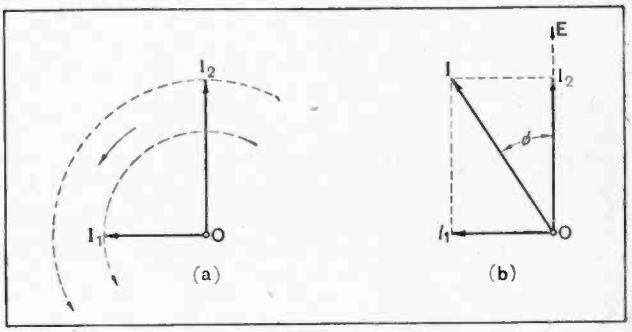


Fig. 8.—Vectors representing the currents of Fig. 6. OI is the "vector sum" of OI_1 and OI_2.

that the sum of two alternating currents depends on the phase difference between their corresponding waves—we have seen that the sum of 4 amperes and 6 amperes is equal to 10 amperes when the separate currents are in phase, and now we find that the sum of 4 amperes and 6 amperes is only 7.21 when the phase difference is a quarter of a cycle.

Vectors at Right Angles.

Of course, the addition of actual curves is much too tedious for practical work, so let us now see how vectors can be used to give the same result in a very much simpler way.

Since one revolution of a vector represents one cycle of the alternating quantity, it follows in this case, where the two alternating currents are out of phase by a quarter of a cycle, that the two corresponding vectors will have an angle representing a quarter of a revolution between them, that is, the angle between the vectors will have to be a right angle or 90 degrees. So the two vectors OI_1 and OI_2 are drawn at right angles to each other as shown in Fig. 8 (a). If these are drawn to scale, OI_1 would represent the 4 amperes in the condenser branch of Fig. 6, and OI_2 the 6 amperes in the resistance branch.

The Vector Explained.—

Since the imagined rotation is anti-clockwise, OI_1 is said to *lead* OI_2 by an angle of 90 degrees or by a quarter of a cycle. This conforms to the circuit of Fig. 6: if the vector representing the supply voltage were included it would be parallel to OI_2 in Fig. 8.

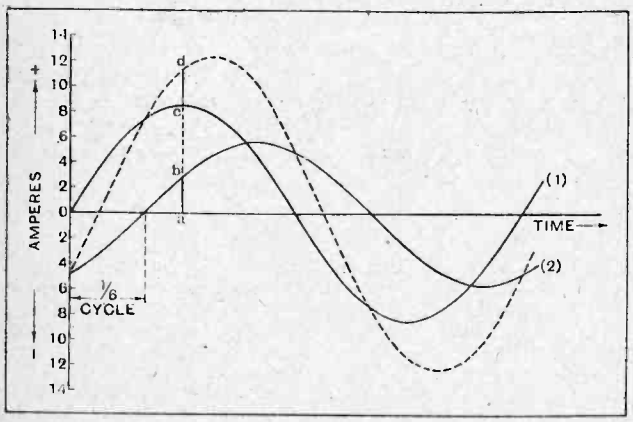


Fig. 9.—Curves (1) and (2) represent currents of 6 amperes and 4 amperes (R.M.S.) respectively, out of phase by 1/6th cycle. The dotted curve gives their sum at all times.

It is a very easy matter to find the sum of the two currents from the vectors of Fig. 8 (a). All that is necessary is to complete the rectangle O I_1 I I_2 as shown in Fig. 8 (b) and to draw the diagonal OI. Then the length of OI gives the R.M.S. value of the total current to the same scale as the other vectors. Fig. 8 (b) is a simple vector diagram.

The length of OI can be found by actual measurement on a diagram carefully drawn to scale, or, being the diagonal of a rectangle, it can very easily be calculated, viz., $OI = \sqrt{4^2+6^2} = \sqrt{52} = 7.21$ amperes. (Square roots are best found from tables.)

This result agrees exactly with that obtained from the curves. The method is thus verified, and we see that the use of curves can be dispensed with altogether.

The angle of OI relative to the vectors OI_1 and OI_2 gives the phase relationship of the resultant current to the other two—OI leads OI_2 by the angle shown as ϕ.

Phase Difference Expressed as an Angle.

It now remains to consider the more general case where two alternating quantities to be represented by vectors are out of phase by any odd fraction of a cycle. In Fig. 9 the two full-line curves represent the same two current values as considered previously, namely, 6 amperes and 4 amperes respectively, but they are now shown out of step by one-sixth of a cycle. Curve (1) starts from zero first, and in a time corresponding to one-sixth of a cycle *later*, curve (2) passes through zero, so that curve (2) is said to *lag behind* curve (1) by a sixth of a cycle in this case.

The curves are plotted to the same scale as before, and the dotted-line curve gives the sum of curves (1) and (2). The maximum or peak value of the total current, as read off from the new curve, is about 12.3 amperes. Multiplying this by 0.707 gives for the R.M.S. value $12.3 \times 0.707 = 8.72$ amperes.

Reverting to vectors, since one of the current curves starts from zero one-sixth of a cycle behind the other, and since one revolution of a vector corresponds to one cycle, it is quite evident that one of the two vectors representing the individual currents will have to follow behind the other, lagging by an angle corresponding to one-sixth of a revolution, that is, by $\frac{360}{6} = 60$ degrees. The two vectors are denoted by OI_1 and OI_2 in Fig. 10 (a), where OI_1 leads OI_2 by ϕ, which is 60 degrees.

From the foregoing it will be clear that, in vector notation, it is most convenient to refer to the phase difference in terms of an angle rather than in terms of a fraction of a cycle. When two currents are said to be out of phase by 25 degrees, this means that the angle between the corresponding rotating vectors is 25 degrees. In the case under consideration the two currents are said to be out of phase by 60 degrees, or one current is said to lag behind the other by an angle of 60 degrees.

Now we must find out by a trial measurement or calculation whether the procedure adopted in connection with vectors at right angles can be applied for any other angle. Referring to Fig. 10, complete the parallelogram O I_1 I I_2, and draw the diagonal OI. If the vectors are drawn to a scale of one ampere to the inch, OI_1 will be 6 inches, OI_2 will be 4 inches, and, if the angle is accurately set out, the length of OI will be found to be about 8.72 inches, corresponding to 8.72 amperes[1] in agreement with the value obtained from the curves.

It should be looked upon as a golden rule that, whenever two alternating currents or voltages are to

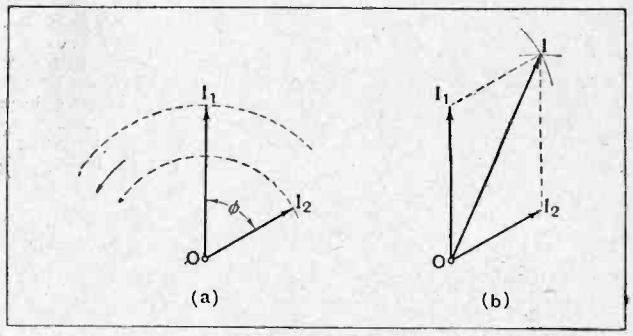
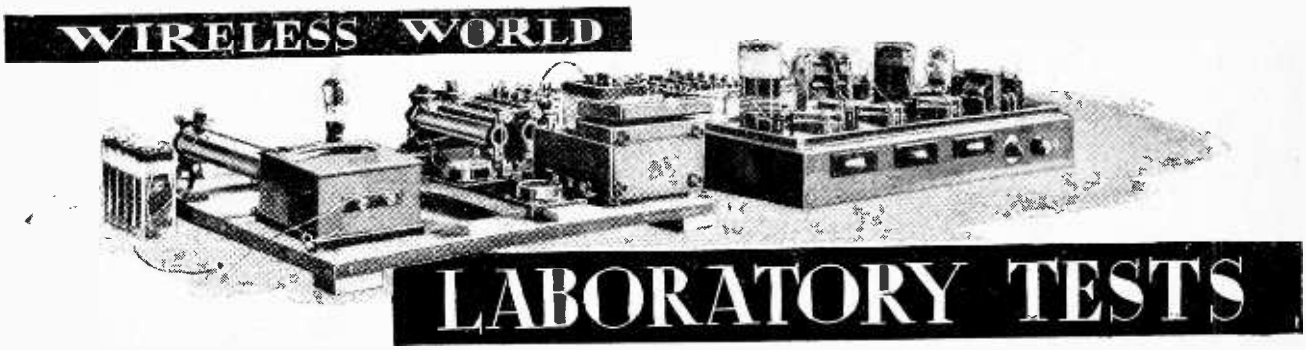


Fig. 10.—(a) Vectors representing the individual currents denoted by curves (1) and (2) of Fig. 9. (b) The resultant current is given by OI, the diagonal of the parallelogram of vectors.

be added together, the sum must be found by the method of the parallelogram of vectors. The corresponding vectors are drawn at the necessary angle to each other (for the phase difference *must* be known), the parallelogram is completed, with the aid of a pair of compasses, as in Fig. 10 (b), and the length of the diagonal which passes through the axis of rotation is measured [or if the parallelogram is not drawn to scale the length of the diagonal can be calculated from the well-known formula $I = \sqrt{I_1^2 + I_2^2 + 2I_1I_2\cos\phi}$ amperes, where I_1 and I_2 are the R.M.S. values of the two currents to be added and ϕ is the angle of phase difference between them].

[1] By calculation $OI = \sqrt{6^2+4^2+2\times6\times4\times\cos60^\circ} = 8.72$ amperes.



A Review of Manufacturers' Recent Products.

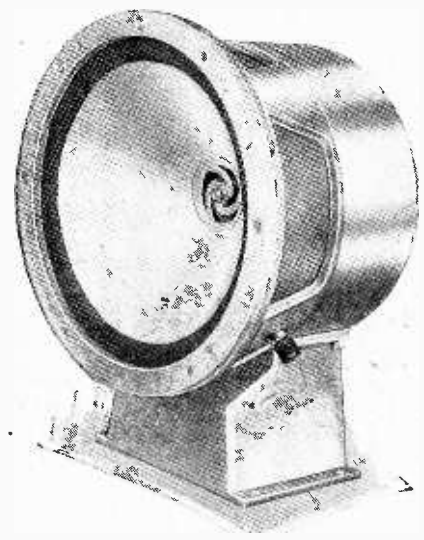
PARMEKO PERMANENT MAGNET MOVING COIL LOUD SPEAKER.

The permanent magnet is totally enclosed in die-cast aluminium body, and produces a flux density in the gap of 9,000 lines per sq. cm. The cone, which is .6¾in. in diameter, is constructed of selected material of less than the usual thickness, and is centred by a flexible "spider" giving ample freedom of movement. A low-impedance coil is employed, and in the model tested a double-ratio transformer giving alternative effective impedances of 2,000 and 8,000 ohms was incorporated in the base.

The unit has an excellent frequency response from below 50 to approximately 7,000 cycles, the upper register from 4,000 to 6,000 cycles being exceptionally good—so good, in fact, that with a well-designed amplifier some form of tone-compensating device would seem to be desirable. In the majority of cases, however, the high-frequency response will do much to compensate for sideband cutting and deficiencies in gramophone pick-ups. We were able to detect a suggestion of resonance at about 1,250 cycles, but the lower register proved to be commendably uniform, and gave ample volume and body of tone without obtrusive booming. Speech was clear and natural, and music crisp and bright in tone.

The workmanship throughout is first class, and the unit as a whole is a thoroughly sound engineering job.

The price of the loud speaker without transformer is £6 10s., the extra cost of the built-in double-ratio transformer being 30s. The makers are Messrs. Partridge and Mee, Ltd., Leicester, and 74, New Oxford Street, London, W.C.1.



Parmeko permanent magnet moving coil loud speaker incorporating a double-ratio output transformer.

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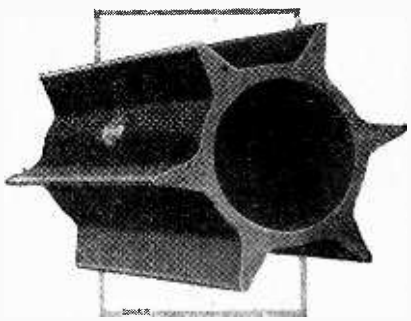

New Becol 6-ribbed coil former with deep wings.

DEEPWING BECOL FORMER.

A new Becol former officially designated the type No. 13, measuring 3in. outside diameter and 1⅝in. inside diameter, and having six wings ½in. deep, is a recent addition to the wide range of moulded ebonite coil formers made by the British Ebonite Co., Ltd., Nightingale Road, Hanwell, London, W.7. This is available in three standard sizes, namely, 3in. long at 1s. 5d.; 4in. long at 2s.; and 6in. long at 3s.

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S.R.S. SHORT-WAVE ADAPTOR.

By the aid of this adaptor any battery type of broadcast set can be easily converted into a short-wave receiver. It makes use of the detector and L.F. stages in the set only, and must not be confused with those units which function on the superheterodyne principle. The unit consists of a Hartly-type regenerative circuit with capacity-controlled reaction.

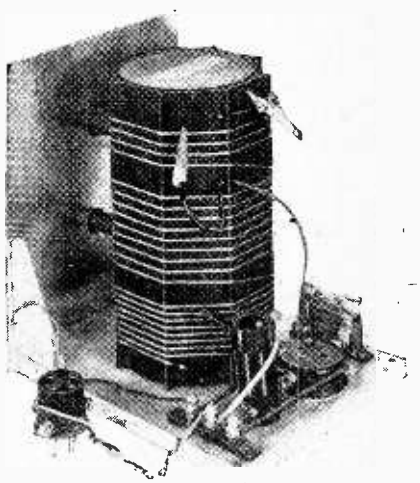
The tuning condenser and reaction condenser are mounted inside the large ribbed ebonite former carrying the coil, an arrangement which appears to be satisfactory in this case, although perhaps not strictly correct from the theoretical point of view, owing to the fact that the mass of metal comprising the condensers is in the field of the tuning inductance.

The coil former measures 4in. in diameter and 7in. high and carries but a single winding consisting of 22 turns of stranded bare copper wire. Of these, seven turns are permanently employed as reaction, while the grid lead can be tapped in at any point between the eighth turn and the top of the coil. The aerial lead is normally connected to the top of the coil.

It can thus be seen that a certain number of dead turns will be present when receiving on the shorter wavelengths, but their presence does not seem to have any serious effect, although the reaction control becomes a little fierce as the wavelength is shortened.

Oscillation can be obtained over the whole waveband covered, with the exception of a small portion of the tuning condenser when the grid tap is connected to the extreme top of the coil. This condition represents a wavelength of approximately 120 metres.

The effective wave range covered by the



Stonehouse ultra short-wave adaptor kit assembled.

unit was found to be from 110 metres down to a little below 20 metres. Tuning on 20 metres was possible with three turns in the grid circuit and the condenser at minimum. It is possible to tune lower than this, but reaction is rather fierce, although quite controllable with the exercise of a little care. Slow-motion dials can be fitted with advantage, as the tuning is very critical.

The makers are Stonehouse Radio Supplies, 54, Union Street, Stonehouse, Plymouth, Devon, and the complete kit of parts costs £1 8s. 6d.

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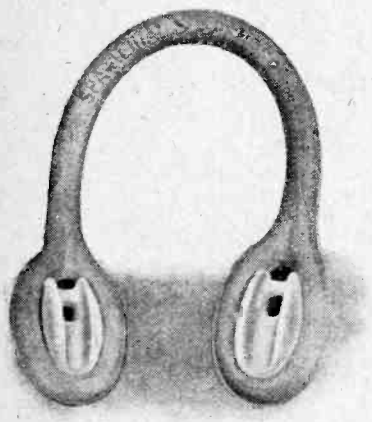
SPA AERIAL SUSPENDER.

This device has been developed to relieve the aerial wire of undue strain if it is attached to a tree or exposed to high



Spa flexible aerial suspender with porcelain insulators.

winds. It consists of two porcelain "egg-" type insulators linked together with a length of india-rubber, which will withstand exposure to all kinds of weather for a very long period without perishing. This useful device is made by F. E. Harmer and Co., Ltd., Knowsley House, Bolton, Lancs, and the price is 2s. 6d.

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WUFA BALANCED ARMATURE LOUD SPEAKER.

This chassis is of foreign origin and incorporates a 12in. diaghragm driven by a balanced armature movement. The workmanship and finish are of a high standard, and the unit is of exceptionally rigid construction. An unusual feature of the design is the method of adjusting the air gap. A long U-shaped permanent magnet carries laminated pole pieces which are forced apart by a carefully graduated cam, mounted between the legs of the magnet on a pivot attached to the die-cast frame of the unit. The cam is operated by a lever which can be unscrewed when the correct setting has been found. The method is unconventional, but appears to work well.

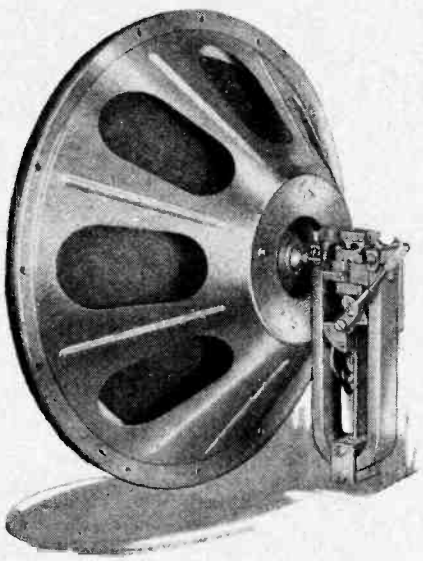
The speech coils are tapped, and, by suitable interconnection of the terminals provided, no less than six alternative impedances are available. Tests were made with the connections giving a nominal resistance of 500 ohms, and the following impedance figures were obtained:—

Frequency (Cycles).	Impedance (Ohms).
50	855
100	1,400
200	2,260
400	3,630
800	5,800
1,600	8,550
3,200	12,700

The sensitivity is well up to the average for this class of unit, and an input of 1,000 milliwatts failed to produce any signs of chattering.

The acoustic output is greatest in the region of 150-200 cycles and between 2,000 and 6,000 cycles. The latter region is characterised by a number of closely adjacent resonances, the most prominent being at 2,500 and 5,000 cycles. In the middle register between 400 and 1,500 cycles the response is uniform, but at a lower level, while below 100 cycles the output falls off rapidly. There is, however, a noticeable output at 50 cycles.

The reproduction of speech is excellent, and there is no trace of hollowness. Generally speaking, music is well reproduced, particularly in the upper register, but the quality of the bass is coloured by the rather prominent resonance in the region of 150-200 cycles.



Wufa balanced armature loud speaker, showing cam adjustment of air-gap.

The price of the complete chassis is 40s., and of the unit alone 27s. 6d. Supplies are obtainable from Messrs. M. Lichtenberg, 4, Great Queen Street, London, W.C.2.

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"KONE KAP" GRID LEAK.

This is a new component introduced recently by Graham Farish, Ltd., Masons Hill, Bromley, Kent, to meet the demand for an inexpensive grid leak of the familiar cartridge pattern. The resistance element is enclosed in a bakelite tube fitted with brass-end caps of generous size. These caps are forced on under pressure affording complete sealing, which is very necessary in grid leaks of this particular type.

The price is 1s. each for all standard sizes.

Standard "Kone Kap" grid leak made by Graham Farish.

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Catalogues Received.

Radio Instruments, Ltd., "Madrigal" Works, Purley Way, Croydon.—Forty-page illustrated catalogue dealing with the range of receivers, eliminators, and components made by this firm.

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Tannoy Products, 1-7, Dalton Street, West Norwood, London, S.E.27.—Illustrated folder and price list of Tannoy receivers and mains units.

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The Saxonia Electrical Wire Co., Ltd., Roan Works, Greenwich, London, S.E.10.—List No. 31931, dealing with the range of flexible cords and cables manufactured by this firm.

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Fuller Accumulator Company (1926), Ltd., Woodland Works, Chadwell Heath, Essex.—Folder dealing with the care of "Sparta Non Spill" jelly acid type accumulators. Also list of types recommended for the majority of portable sets now on the market.

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Robert Fletcher and Son, Ltd., Kearsley Paper Works, Stoneclough, near Manchester.—Twelve-page booklet dealing with condenser tissues and insulating papers made by this firm for embodying in the construction of paper-dielectric condensers. It gives a summary of the results of tests carried out to determine the dielectric strengths of various substances suitable for this purpose.

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Mullard Wireless Service Co., Ltd., Mullard House, Charing Cross Road, London, W.C.2.—Descriptive leaflet dealing with the Mullard Pure Music Speaker, Type "M." Also revised characteristics of the Mullard P.M.2 D.X. valve.

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Igranic Electric Co., Ltd., 149, Queen Victoria Street, London, E.C.4.—Twelve-page booklet, "The Elimination of Pong," describing some experiments made to determine the best way to combat the objectionable effects of microphonic valves.

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Grosvenor Electric Batteries, Ltd., 2-3, White Street, London, E.C.2.—Illustrated folder giving particulars of the various sizes of H.T. batteries made by this firm.

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Watmel Wireless Co., Ltd., Imperial Works, High Street, Edgware.—Blue print of the Watmel T.31 S.G. Imperial Three-valve receiver.

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.

SUNDAY BROADCASTS.

Sir,—As a very keen broadcast *listener*, I feel that I must join issue with your correspondent, Mr. J. H. Hum. Reading between the lines, it is obvious that Mr. Hum's ideal would be no transmissions at all on Sunday.

Is your correspondent aware of the number of listeners in this country? I suppose he does know the number of amateur transmitters still working. Which should come first?

Most real listening enthusiasts are, like myself, toilers for six days a week. Along comes Sunday, the day of recreation, but not with the radio set. In my opinion, Sunday ought to be the longest broadcasting day of the week. Yes, I have heard the argument about work on Sundays. The same remark applies to restaurants, transport services, cinemas, petrol stations, and public services of every kind.

Finally, I must deal with the astonishing statement that "hams'" researches have brought about the present-day high technique of radio. This is untrue. The broadcasting companies, the Government, and the big commercial firms are the only people who have made radio what it is to-day.

No, Mr. Hum, the B.B.C. will consider its clients, not you. Better Sunday programmes are a long time on the way, but come they will.

F. G. KAY.

Hampstead, N.W.3.

GOOD REPRODUCTION—THE B.B.C.

Sir,—The letter in the Correspondence columns of your issue of May 6th over the signature of "H. A. Hartley," touches a number of matters, all of which seem to require airing.

First of all, I agree with him as to the superb quality of a fair proportion of the B.B.C.'s transmissions and the general excellence of most of the remainder.

Next, with regard to the inadequacy of the average set with moving iron speaker and output to suit. Circumstances make me live in a small hotel in the Midlands during the business part of each week, and I considered my lot to be a happy one (the great stuff being available at all hours to a resident) until a traveller of one of the gramophone companies which has recently entered the radio market took to using the same hotel and "planted" a five-valve portable and a two-station two-valve set in the lounge. In spite of a genuine effort on my part to be sociable, I find it quite impossible to live with these sets, and now rarely return to the hotel until late at night. A humorous side of the matter is that the portable stands on top of, and has ousted, a table model exponential horn-type gramophone of another make, which, with all its lack of fundamental bass, is infinitely more desirable as a musical instrument.

I am with Mr. Hartley in his dislike of the Wireless Military Band and the B.B.C. Dance Orchestra for precisely his reasons.

It is in his condemnation of the present-day moving-coil loud speaker that I am most heartily in agreement with him, and crave this opportunity to point out what appears to me to be the root cause of the stagnation.

The moving-coil loud speaker fundamentally requires constant current regardless of frequency for constant volume of sound output at varying frequencies, but the impedance of the speech coil varies by at least 3 : 1 over the working range of frequencies, being lowest and sensibly constant between 150 and 500 cycles. The only rational way to ensure this constancy is to feed the coil from a source having an impedance about three times its own minimum value, thereby sacrificing efficiency. (If the coil behaved as a pure resistance, this ratio would have to be increased to about six times.) It is essential that there shall not be a metal ring on the coil, as has sometimes been advocated, and it is desirable that the pole tips of the field system be laminated to prevent the flow of eddy currents induced by the speech coil to the detriment of the speaker's ultra high-frequency performance.

The pentode forms an ideal source of constant current power for the foregoing conditions, and my own output stage for the past fifteen months has consisted of four P.M.24A.s in parallel push-pull (biased to mid-points and not to bases).

Some people, not surfeited with broadcast reception, on hearing the set worked at proper intensity, have been astounded at the results. Others, used to inferior sets, have stated that it is all top and bottom with no middle (as if such an output were possible with simple apparatus). Personally, with a fairly constant experience of first-hand orchestral music, I know it to be more accurate than any other set I have heard, in spite of a serious resonance in the speaker in the region of the sibilants.

Three years ago, in conjunction with an engineer who runs a small wireless business, I got down to a number of problems affecting loud speaker performance, and we developed an instrument that had a number of promising features, such as :—

(1) A suspension which would give several inches axial movement at the expense of slight radial movement of the diaphragm, but without dropping on the pole tips, and having a natural open circuit period of about five cycles per sec.

(2) A diaphragm which would not focus the sound appreciably and would not have the characteristic resonance in the region of 3,000 cycles per sec. which one associates with moving-coil speakers.

(3) A large square coil (of aluminium wire), so applied to the diaphragm that impulses reached a number of representative points on the front face of the diaphragm simultaneously.

I believe several patents have since been taken out by my collaborator, but as he has his living to make in matters radio I have never felt myself at liberty to publish any of the designs arrived at, and I have not personally found time to follow the matter up experimentally. I mention the foregoing as directions in which development might occur, and will conclude by stating that, in my opinion, real progress in moving-coil speakers will not be made until the relative impedance of the output stage to the speech coil has been raised in the manner suggested. A fundamentally perfect speaker would work correctly only from a source of many times its own impedance, the exact number of times (above a certain minimum) affecting the efficiency but not the quality of reproduction.

D. KINGSBURY.

Sir,—Your correspondent, Mr. Hartley, is quite correct in stating that the matching of the valve and speech coil impedances is of primary consideration, but I think Dr. McLachlan's letter in the issue of May 6th, and also his last article on M.C. speakers, rather bears out my remarks as to wire gauge and flexibility.

On the question of input, his statement that 500 milliwatts is the maximum that can be tolerated in a moving iron speaker makes the average M.C. speaker seem very insensitive if it requires an input of 5 watts.

Personally, I think an input of 1 watt into a M.C. speaker with a flux of 10,000 lines/cm.^{2} in a gap 1.2 mm. long $\times$ 10 mm. deep, with a mean diameter of 38 mm., gives more than ample output for a normal room, and if Mr. Hartley requires 5 watts either his hearing is not of the best or his loud speaker is so much reinforced to overcome peaks, etc., that it is hopelessly inefficient. Incidentally, according to Dr. McLachlan, if the suppression of resonances is carried to its logical conclusion, the output of the speaker will be nil.

In the course of my work, which deals largely with magnets and magnetic testing, I find that, unfortunately, some manufacturers are calling for magnets for loud speakers which are hopelessly inefficient, and probably Mr. Hartley refers to one of this type when he quotes 5 watts as a suitable input.

As an example, using Bg^2Ag as a factor for comparison, one of the magnets I am using has a figure of 8.4×10^6, whilst another magnet which enjoys great popularity with the radio public gives 0.8×10^8.

In conclusion, I wonder if any of your readers have noticed that, if two magnets are taken with the same gap dimensions, but of different flux density, say 6,000 lines and 10,000 lines, and an assembly is fitted first to one and then the other, apart from the increase in volume, a most marked increase in bass response will be noticed on the more powerful magnet.

Sheffield. RICHARD HOLT.

Modern Terms Defined

Recent Additions to the Radio Vocabulary.

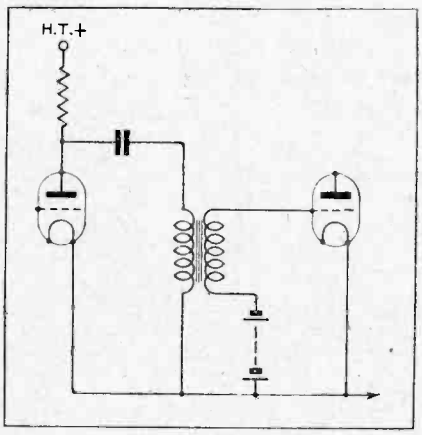
(*Concluded from page 491 of the May 6th issue.*)

Compensated Pentode.—The tendency of the pentode valve to over-emphasise the higher audio frequencies is already a matter of common experience. The effect is most marked when the pentode is used in conjunction with a moving-iron type loud speaker, since the pentode is able to maintain a much higher current in the windings at high frequencies than is the ordinary three-electrode power valve.

Where necessary, this effect can be compensated for by shunting the output circuit with a condenser and resistance in series. The impedance of this combination falls as the frequency rises, and so diverts the excessive current at high frequencies without appreciably affecting the current in the loud speaker windings at low frequencies. Where a choke-filter circuit is employed to couple the loud speaker to the pentode output valve it is customary to connect the compensating resistance and condenser in parallel with the choke, and the average values usually assigned are 25,000 ohms (generally variable) and 0.01 mfd. respectively.

Parallel-fed Transformer.—A system of low-frequency intervalve coupling in which the primary of the transformer is resistance-capacity fed instead of being connected directly in the anode circuit of the valve. Not the least of the many advantages of this system is that the D.C. component of the anode current is diverted, only the A.C. component passing through the feed condenser to the transformer primary. This enables valves with high average anode currents to be used with nickel-iron core transformers which would otherwise be saturated by the heavy direct current.

The principle of operation of the filter-fed transformer differs fundamentally from that of the conventional transformer circuit, for the feed condenser in series with the primary of the transformer and the resistance of the valve forms a closed circuit. By careful design this can be turned to useful purpose; indeed, the filter-fed transformer under favourable conditions is capable of giving a better frequency characteristic than the more usual direct transformer coupling.[1]



Filter-fed L.F. transformer coupling.

Decibel.—In dealing with the overall gain in amplifiers, variations in the acoustic output of loud speakers, etc., it is convenient to express the result in decibels. This unit is one-tenth of a "transmission unit," which has been renamed the "bel" in honour of Graham Bell, a pioneer of telephony. The "bel" is the logarithm of the ratio of two powers. Thus the power gain in an amplifier in "bels" would be log. $\frac{P_1}{P_2}$, where P_1 is the input power and P_2 the output power, the logarithm being to the base 10.

In wireless work ratios of current and voltage are of more frequent occurrence than ratios of power. In comparing currents and voltages the expression is multiplied by 2, since the power is proportional to the square of either of these quantities.

The "bel" is, however, too large a unit for convenience, and results are generally expressed in decibels, since a change in acoustic output equivalent to 1 decibel is just detectable by a sensitive ear. To summarise, the ratios of power, current and voltage may be expressed in decibels, as follows:

$$\text{Power, } 10 \log. \frac{P_1}{P_2}.$$

$$\text{Current, } 20 \log. \frac{I_1}{I_2}.$$

$$\text{Voltage, } 20 \log. \frac{E_1}{E_2}.$$

The use of the decibel confers many advantages. For instance, curves drawn on this basis do not alter their form if the general level is raised or lowered. Further, in estimating the overall gain of an amplifier it is only necessary to add the separate stage gains in decibels.

Lumen.—In descriptions of new photo-electric cells for television and sound-film work this term is sometimes used in connection with the sensitivity, which is then expressed in microamps per lumen.

The lumen is the unit of luminous flux through a given solid angle as distinct from luminous intensity, the unit of which is the candle-power. Thus the lumen takes into account not only the intensity of the source, but also the solid angle which the exposed area of the photo-electric cell makes with the source. Assuming that the source radiates light equally in all directions, the number of lumens (L) falling in a cell of area A at a distance r from the source is given by $\frac{L_0 \times A}{4\pi r^2}$ where L_0 is the total number of lumens radiated from the source. In other words, the luminous flux falling in the cell is proportional to the ratio of the area of the cell to the area of a sphere of radius r. But since the total number of lumens radiated from the source is 4π times the candle-power (C), the formula can be re-written $L = \frac{CA}{r^2}$

[1] See *The Wireless World*, December 11th, 1929, page 644.

IN PREVIOUS ISSUES.

March 4th.—Band-pass Filter. Pre-selection. Peak Separation. Ganging. Differential Condenser.

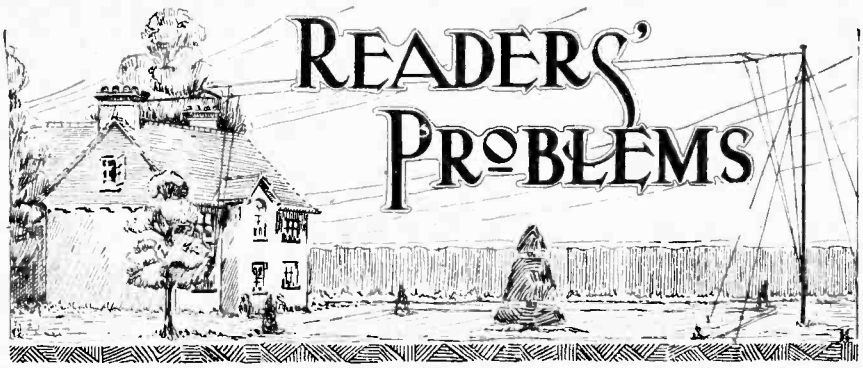
March 11th.—Cross Modulation. Beat Interference. Modulation Distortion.

March 18th.—Secondary Emission. Grid Emission. Contact Potential. Residual Capacity. Dynamic Resistance.

April 8th.—Load Line. Power Triangle. Optimum Loud Speaker Impedance. H.F. Stopping Resistance.

April 22nd.—Input Impedance. Working Capacity. Shot Effect. Parasitic Oscillation.

May 6th.—Back Coupling. Decoupling. Non-inductive Condenser.



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.

An Extra Loud Speaker.

My receiver embodies a built-in moving coil loud speaker of the low-resistance type, which is fed through a step-down transformer: terminals are provided so that an external loud speaker may be connected. I should like to obtain a second instrument for mounting in another room, but hesitate to do so, as it seems impossible to buy one of exactly the same type as that in the set. I suppose the matching of the output valve and loud speaker will be adversely affected unless this is done?

There is no particular advantage in using an external loud speaker of exactly the same characteristics as that already included in the set. The "matching" to which you refer will, in any case, be upset to some extent by the connection of an extra instrument. In practice it might well be best for this loud speaker to have a speech coil of considerably higher impedance.

In giving this reply we assume that the extra loud speaker terminals are, as is usual, connected in parallel across the output transformer secondary.

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An Alternative.

In spite of the fact that the decoupling resistances used in my receiver are as high in value as they can be without unduly reducing anode voltage, it is found that there are distinct traces of L.F. instability. If a greater surplus of H.T. voltage existed, it would clearly be possible to use larger and more effective resistances, but this cannot be managed without substituting a new power transformer. I am sending you a circuit diagram in the hope that you may be able to suggest some alternative and less expensive plan.

Your circuit arrangement (not reproduced) shows that the decoupling resistances are of anything but generous value, and no doubt this is responsible for instability. Fortunately, it should be possible to effect a cure without going to the length of increasing H.T. voltage. We think you have overlooked the fact that the efficiency of the decoupling devices may be increased by fitting larger by-pass condensers than at present. Needless to say, this plan does not involve any further sacrifice of anode voltage.

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Advantages of a Pentode.

Is there any real advantage in using a pentode output valve in an "All-D.C." mains-operated receiver? I have been told that there is, but, for the new receiver that I am planning, I am tempted to use a super-power triode already in my possession. This valve works very satisfactorily in conjunction with my loud speaker, and gives an adequate output.

The outstanding advantage of a pentode valve in a D.C. mains set is that for a given power output a valve of this type requires very much less grid bias than a triode. If automatic bias is to be used, this can only be obtained by sacrificing H.T. pressure. When dealing with A.C. supplies, this is not a matter of any great importance, as by choosing a suitable power transformer, the mains voltage can be stepped up to any desired extent. With D.C. supplies, there is no economical and trouble-free way of increasing voltage.

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Extra H.F. Stages.

The practice of adding an H.F. stage to a set already embodying this form of amplification is generally discouraged, but is it not a fact that there is not the remotest chance of trouble in such cases if the extra valve is made up as a separate screened unit, with its own eliminator for the supply of anode and heater current?

A unit made up in the way you describe would in almost every case work satisfactorily, but it would be wrong to say that there would be no possibility of instability.

In spite of the most careful screening, there remains the possibility of a certain amount of interaction. For example, due to increased overall magnification, any trace of H.F. energy that might be allowed to get through to the loud speaker leads and to interact with the aerial system would probably cause trouble which would not be evident with a single stage of H.F. amplification.

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Excessive Voltage Loss.

In order still further to simplify the single-valve D.C. mains set discussed in the "Hints and Tips" section of your issue for May 3rd, I should like to use a centre-tapped resistance as a combined smoothing and output device, following the plan adopted in the design of the "Radio Reading Lamp." Would this be satisfactory?

I know from experience that my D.C. mains supply (240 volts) is exceptionally free from irregularities, and a minimum of smoothing is necessary.

We fear that this scheme is quite impracticable, as a pentode valve used in the manner you suggest consumes a high anode current. The insertion of a resistance sufficiently large to function efficiently as an output device would involve an altogether excessive loss of voltage, to say nothing of the question of the value of resistance necessary for smoothing purposes.

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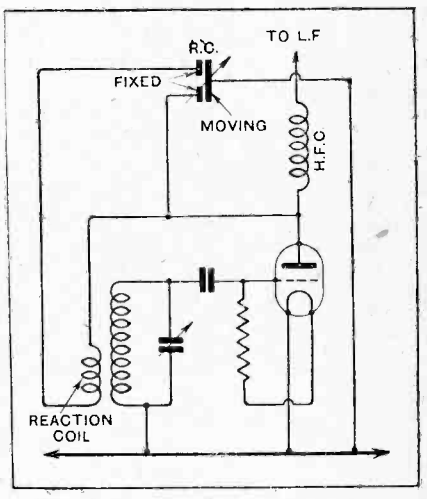

Fig. 1.—By connecting a differential condenser in the manner shown it may be mounted directly on an earthed metal panel.

Earthed Condenser Spindle.

I believe you have described a method of connecting a differential reaction condenser in such a way that the spindle may be earthed, thus avoiding the necessity for "bushing" the one-hole fixing when the component is mounted on a metal panel. I cannot trace this information in my back numbers, and should be obliged if you would give me a rough diagram, provided the plan is one that can be recommended.

The required connections are shown in Fig. 1. A differential reaction condenser connected in this way functions quite normally; the arrangement is one that is used in a number of receivers with excellent results.

Variable Ratio Coupling.

I have a two-valve gramophone amplifier in which the output pentode is coupled to the first valve by means of a parallel-fed transformer arranged in the conventional way to give the highest possible step-up.

Unfortunately, there is an obvious tedency towards L.F. oscillation; further, magnification is distinctly greater than I need. It seems probable that matters could be improved by altering the coupling so that less overall magnification is obtained. Will you please show me how this may be done?

Various forms of connection, each of which affords a progressive reduction in amplification, are shown in Fig. 2. In this diagram, primary and secondary sections are drawn as short and long windings respectively, and the various terminal points are marked in the conventional way. Connections to the anode of the preceding valve are indicated by an arrow in each case.

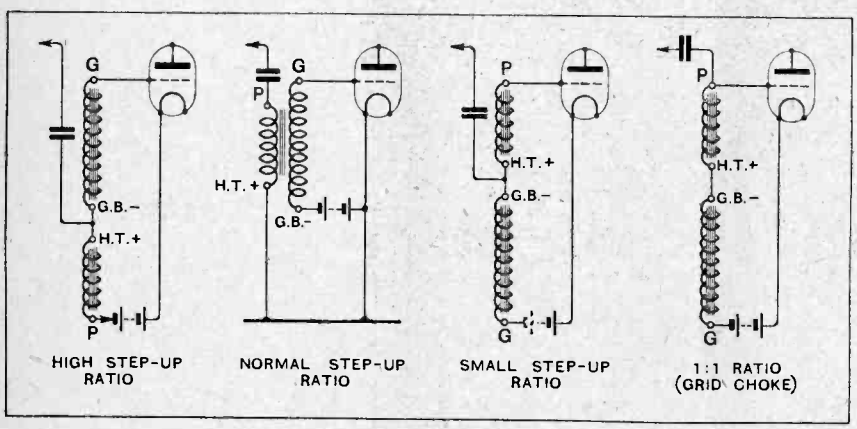

Fig 2.—Methods of connecting a parallel-fed L.F. transformer so that different ratios—and consequently various degrees of amplification—may be obtained.

Two Sets: One Licence.

As it seems uneconomical to use my long-range "two-H.F." set for local-station reception, I am thinking of setting up a two-valve circuit embodying most of the refinements recently discussed in your journal. Will it be necessary to obtain another licence for the second receiver?

No; both sets will be covered by your existing licence.

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Testing a By-pass Condenser.

(Referring to previous correspondence) . . . . *You say that H.F. instability might be due to an ineffective by-pass condenser associated with the H.F. or detector valve decoupling circuits. Is there any way, without apparatus, of making a rough-and-ready test to ascertain whether these components are in good order and suitable for the purpose? I should perhaps add that all the condensers actually used have a capacity of 1 mfd.*

It is not easy to make a really conclusive test of the H.F. resistance of a large by-pass condenser, but some idea as to its suitability for the purpose in question can be formed by connecting it in series with any tuned circuit of a receiver. If the inclusion of the condenser makes a noticeable difference to signal strength, or if its presence alters tuning to any great extent, one can form a strong suspicion that it is unsuitable.

Tests of this sort should be made when listening to an extremely weak but constant signal.

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Affecting Loud Speaker Characteristics.

I am not quite satisfied with the bass response of my receiver; would it be worth while to add another condenser of the same size (2 mfds.) in parallel with the component used in my loud speaker filter-feed circuit? This will give a total capacity of 4 mfds., which, it is noticed, seems to be favoured by the majority of sets intended to give reproduction of especially high quality.

Theoretically, it is desirable that the feed condenser of a loud speaker filter should have a reactance over the usual band of audio-frequencies that is low in comparison with the impedance of the loud speaker. This condition will probably be more nearly satisfied if you add to your existing capacity, but, without knowing all the circumstances, we cannot say definitely whether this addition will produce any noticeable improvement in bass reproduction. Probably it will not, but no harm can be done by trying it.

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Simpler Automatic Bias.

So far as I can see, the easiest way to arranging for automatic bias in a set with indirectly heated valves is to insert the necessary resistance between the cathode of the valve concerned and the H.T. negative bus-bar. As this simple plan does not seem to be generally adopted, I should be glad of your opinion as to whether it has any serious drawbacks.

By connecting the bias resistance in the way that you describe, a difference of potential is created between the cathode and heater of the valve. When indirectly heated valves were first manufactured this was found to be undesirable, but the valves now produced may be treated in this way without any undesirable effects.

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When Reaction Fails.

My ——— receiver, after working well for some time, seems to have developed a fault. Over the majority of the two waveranges covered, reaction control is poor, and it is almost impossible to receive distant stations. The various voltages have been checked as accurately as possible, and other valves have been tried. Can you tell me where the fault is likely to be found?

The most likely explanation for this trouble is that the grid leak has developed a fault; in all probability its resistance is very much higher than it should be. We advise you to try a new leak of the right value.

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L.F. Transformers in Series.

The L.F. transformer at present in use in my receiver does not give quite enough magnification for my needs, and I am wondering whether it would be possible to improve matters by obtaining another component of similar type and connecting each primary and secondary winding in series. By doing this, I presume that the step-up ratio will be doubled?

It is wrong to assume that the ratio will be doubled by connecting the two transformers in series; actually it will remain unchanged. For reasons that cannot be entered into here, the question of transformers connected in series is fraught with considerable difficulty, and we cannot advise you to adopt this scheme.

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FOREIGN BROADCAST GUIDE.

TALLINN *

(Estonia).

Geographical position: 59° 24′ N., 24° 45′ E.

Approximate air line from London: 1,112 miles.

Wavelength: 296.1 m. Frequency: 1,013 kc. Power: 10 kW.

Standard Time: Eastern European (one hour in advance of B.S.T.).

Standard Daily Transmissions.

09.25 B.S.T., German sacred service (Sun.); 12.00, concert (Sun.); 17.30, news, gramophone records and dance music; 18.30, main evening concert; 20.00, dance music (Sun.); gramophone records or concert (week-days); 21.00, dance music (Sat.).

Man and woman announcers.

Call: *Allo! Allo! Tallinn.*

Opening and interval signal: Gong.

Relay: Tartu (Dorpat), 465.8 m. (644 kc.), 0.5 kW.

**Will be found in pre-war maps under name: Reval (Russia).*