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

Selling Wireless Sets by the Valve.

IF we were asked to state in a few words the outstanding difference between receivers of British and American design we should probably at once make the comparison that American sets are far more generous in the use of valves than our own receivers, although we should no doubt add that the efficiency per stage in the American sets is not nearly so high as in the case of the British.

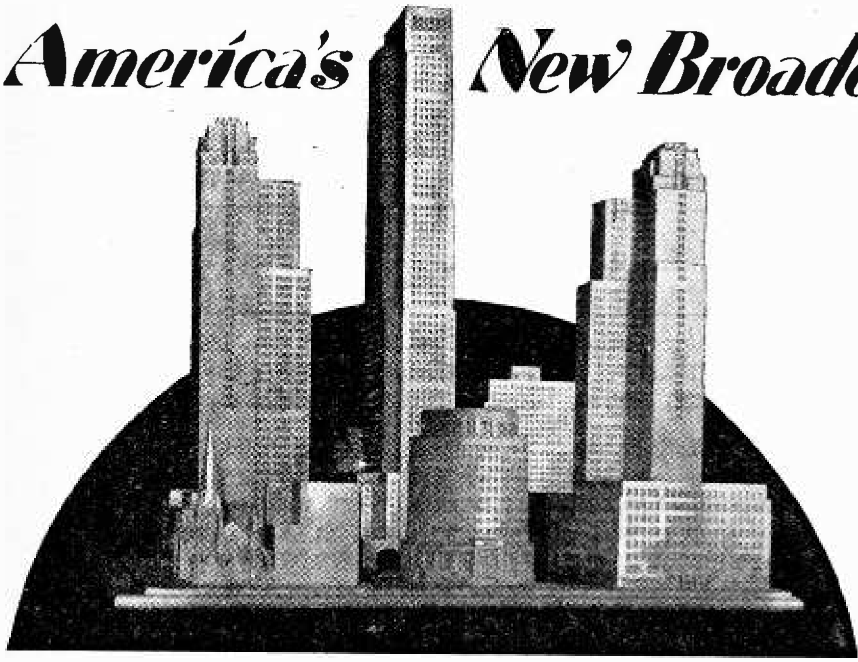
In this country when a member of the public contemplates the purchase of a radio set he is almost invariably asked, as the first question by the salesman, how many valves he wants, whether it is to be a two-, three-, or four-valve set. In America, on the other hand, we believe it would be no exaggeration to suggest that the vast majority of users of the bigger American sets would be unaware of the number of valve stages incorporated; their sets have been bought for their performance, irrespective of the number of valves, and it would be almost as unusual in America to treat the valve stages as an indication of the performance as it would be for a British purchaser to buy his set according to the number of fixed condensers included.

If a valve could be honestly used as a means of defining the equivalent of "horse power" of a set, or as a unit of selectivity, then there would be every justification for selling sets "by the valve" just as other commodities may be sold by the pound or the yard. But the number of valves, unless we have details of the circuits with which they are associated, is really no indication of the performance of a receiver either from the point of view of quality, amplification, or selectivity, so varied are the conditions under which the valves may be used. Is it not high time that the valve was relegated to its proper position, merely as a component in the set, and that receivers in this country should be classified more intelligently and in a way which would convey useful information to the prospective purchaser?

The reason for selling sets in this country "by the valve" dates from the unfortunate terms under which sets were licensed by the Marconi Company when the manufacturer began to pay a royalty per valve stage. This at once made the number of valves the excuse for the price of the set; the excuse was handed on to the public, and the classification has stuck. Had the royalty on sets been assessed on the basis of the selling price of the receiver, selling sets "by the valve" would probably never been come about. The importance of getting away from this classification has become much more apparent of late, the need for selectivity being uppermost in the minds of British set designers. An increase in the number of valves would also, we believe, help in solving the problem of too frequent breakdowns in sets, because it would no longer be necessary to design the receiver to get the last ounce out of every valve. It is not too late now to effect a remedy, and we would like to see a change introduced before next season's sets are on the market.

In This Issue

America's New Broadcasting Centre



The First Description given in this Country of "Radio City," New York.

By Our New York Correspondent.

ABOUT nine months ago it was announced that the National Broadcasting Company, the Radio Corporation of America, and Radio Keith Orpheum, in association with John D. Rockefeller, jun., planned to build a gigantic entertainment centre in New York at a cost of $250,000,000. Few concrete details of the scheme were published at the time, nor has much information been forthcoming in the interim.

Now, however, plans are beginning to assume a more definite aspect, and I have just attended an exhibition of plans, drawings, and a large plaster model of the entire project at the offices of the architects. The development, referred to on the plans as "Metropolitan Square," but popularly known as "Radio City," is the largest single-unit ever contemplated in New York. The site extends east to west from Fifth Avenue to Sixth Avenue, and south to north from 48th Street to 51st Street, an area of roughly 1,150ft. by 1,500ft.

The central feature will be a 68-storey building, which will house the executive offices of the R.C.A., R.C.A. Phototone, R.C.A. Victor Co., and N.B.C., while the lower floors of the building will accommodate some thirty-six N.B.C. studios, some of which will be three storeys high. These studios will be designed and wired with an eye to the requirements of television. Another studio feature will be an adaptation of the revolving stage idea, control rooms being located at the point of intersection of the dividing walls of four studios, so that when a programme terminates in one studio the control room may be revolved to face the studio in which the next programme is due to start. This will assure minimum delay between one programme and the next, and facilitate the change-over of studios.

Other Buildings of "Radio City."

Flanking the central building on either side will be two office buildings, identical in design, and each forty-five storeys in height.

On the corner of Fifth Avenue and 48th Street there is already a church, which will remain—very much dwarfed. On the corner of Fifth Avenue and 51st Street there will be a large department store building, but the present occupants of part of the site have a lease until 1940 which they refuse to sell, so the new building will be built around it, with the steel work so arranged that when the lease expires the entire structure can be completed according to the present plans.

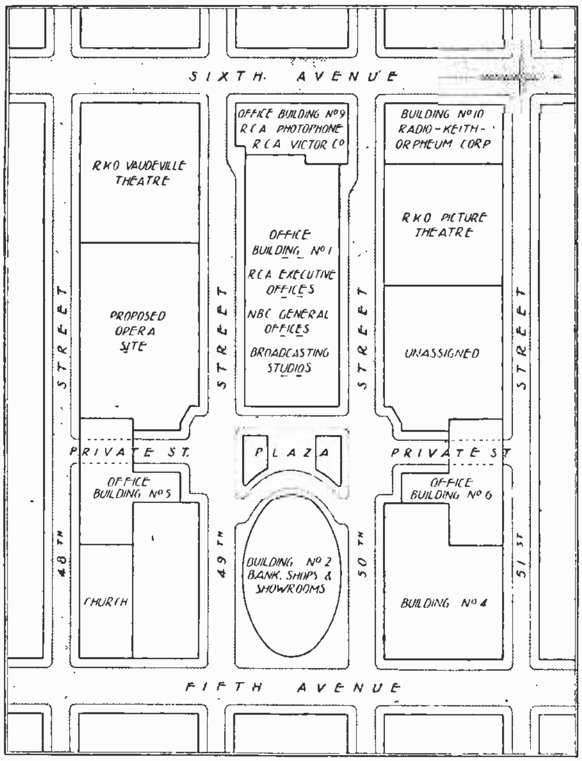
In the centre of the Fifth Avenue side the appearance of the entire site will be relieved by an oval building, fourteen storeys high, which a newspaper writer described as being "as delicate and graceful in comparison with the sharp angles and sheer walls of the buildings surrounding it as a jewelled powder-box on a dressing-table." The lower storeys of this building will be occupied by a bank, while the upper storeys will be occupied by shops and showrooms. In this connection it should be remembered that the site is situated in the fashionable mid-town region, New York's Regent Street.

In the middle of the 48th Street side a site 350 feet long by one block wide has been reserved for the Metropolitan Opera House. This space is amply sufficient for all the requirements, including scenery storage space, of a full-sized opera house. Negotiations between the sponsors of the project and the Metropolitan Opera Company have been going on for some time, but at the time of writing no agreement has been reached, so it is uncertain whether the Opera Co. will avail themselves of the site. The sponsors want the opera there, and it would perhaps be very fitting that it *should* be situated there.

At the Sixth Avenue side, at the 48th Street corner, will be the R.K.O. vaudeville theatre, and at the 51st Street corner there will be built the R.K.O. picture theatre and offices of the corporation. Hiram Brown, President of R.K.O., would not commit himself to describing just what types of entertainment would be given at these theatres; he merely promised to provide "what the public wants."

All goods will be delivered to these buildings through subways, and underground parking space will

America's New Broadcasting Centre.—be provided for motor cars. There is even a possibility that the 51st



Plan of the "city" indicating the proposed allocation of space.

Street office building may be converted into a tower for parking cars.

Gateways through the buildings will lead into a central plaza of fountains and shrubbery, an island of restfulness in the midst of the city.

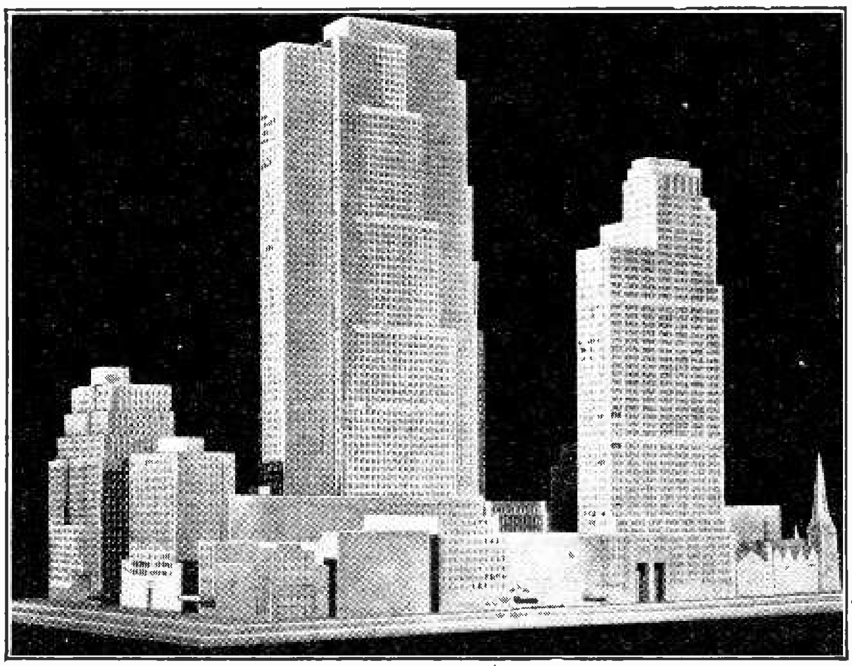
On the subject of television M. H. Aylesworth, President of the N.B.C., was very guarded, but from his careful statements I gathered that some commercial form of television receiver is expected to emerge from the R.C.A. laboratories by the time the new buildings are ready. Asked about the nature of the television broadcasts, and if all programmes would be televised, he declared that not all programmes are suitable for televising, that some programmes are best left to appeal to the ear alone. He also gave a strong hint that the first television broadcasts would consist of talking films.

There is another point about combined sight and sound broadcasts. American listeners to-day leave their radio sets on all day, and listen subconsciously while occupied with something else. If a television accompaniment were to be broadcast as well, listeners would of necessity have to drop everything else and concentrate with two senses, sight and hearing, on the programme. Few people care, or are able, to do this indefinitely. So it looks as if only carefully selected and short programmes will be chosen for combined sight and sound broadcasts.

And now for a few facts and figures. The work of clearing the site for the new entertainment centre has already begun, and construction work on the central broadcasting building will commence in June of this year. The building will be complete and ready for occupancy on May 1st, 1933. The entire project is expected to be complete by 1934-35. The nine separate buildings will have 28,000 windows and 125,000 tons of structural steel will go into their skeletons. The central building will contain 2,000,000 square feet of usable floor space, which is 150,000 square feet more than the Empire State Building, at present the world's tallest building. The entire centre will house 50,000 people.

The plaster model illustrated on these pages can scarcely be described as a thing of beauty. Although the plans are not in their final form, they are described by the architects as being "near enough." Skyscrapers such as these have to be designed with due regard to intricate and rigid building laws and with regard to light and air. Once these considerations have been met, the beautification of the exterior is proceeded with, so we may expect that the buildings, in their final form, will look somewhat more pleasing.

For some months past, conflicting rumours have prevailed concerning the possible future connection with the new centre of S. L. Rothafel ("Roxy"), the popular broadcaster. Rumours have at last been set at rest by the announcement that "Roxy" will start work on April 1st next as major-domo of R.K.O. theatres. This sounds anomalous, since the theatres are not yet built, but it is explained that "Roxy" will "have plenty to do" in the interim.


View of the proposed "Radio City" seen from 48th Street. The existing church appears on the right.

Unbiased — by "FREE GRID" —

A Word to Inventors.

I HAVE just been going through my postbag, which consists for the most part of letters from inventors either asking me for financial assistance or seeking the names of firms likely to take up their pet ideas. Sometimes would-be inventors, with a simple faith which is quite embarrassing, submit their efforts to me for criticism without troubling first to take out a provisional patent. In many cases parents with young hopefuls anxious to "ride to riches on radio," as the advertisements of certain American radio training institutes put it, seek my advice. To all these correspondents I must regretfully but firmly refuse advice, partly because I have not the necessary time and partly because I do not feel that, even if I had the time, I could do justice to the many and varied requests received. I feel, however, that I should like to warn the would-be inventors to trust nobody with their ideas—not even their maiden aunts—until they have taken out a provisional patent. I speak from bitter experience.

Financial assistance required.

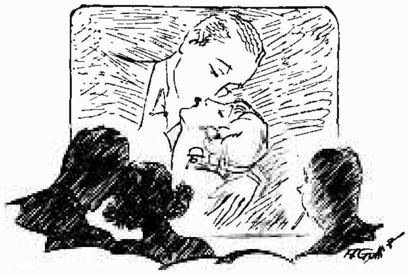
Among other quite unanswerable questions which are constantly being put to me direct by "friends," relatives and other enemies, and through the post by strangers, is "which is the best receiver, loud speaker, or gramophone pick-up, as the case may be, of all those upon the market?" To such questions I can truthfully reply that there is no "best" in wireless, any more than there is in any other walk of life. There is no single set upon the market which embodies all the good points to the exclusion of all the bad ones, and even if I were to venture to pick out a loud speaker, for instance, which I thought to be the best, it would be merely by personal choice, and there are thousands, I feel sure, who would heartily disagree with me.

Another perennial question relates to the type of receiver which I most favour and which I myself use. To this I would reply that apart from the remote-controlled family receiver to which I have previously referred in these columns, I have a large number of experimental sets, but my favourite instrument is an all-mains superheterodyne with all the latest improvements which I completed about a month ago.

At the Cinema.

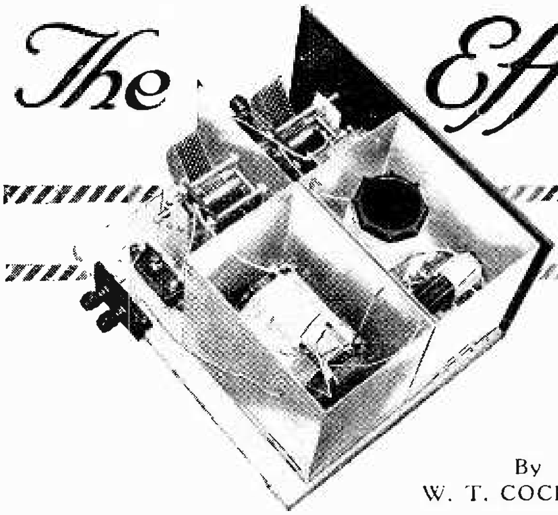
It is seldom that I have the time or inclination to patronise the talkies, but having a little time to spare the other evening and being persuaded by the importunities of one of the little Grid Leaks, I eventually found myself inside the local "hot house." The item in progress was the "News Gazette," and I therefore made due allowances for the fact that all the characters on the screen who opened their mouths appeared to be suffering from a cleft palate, as I fully realised the difficulties under which such films have to be recorded. What did surprise me, however, was to hear the gentle rhythmic throbbing which experience teaches one to recognise as a peculiar form of motor-boating. Surely, I thought, it is high time that even the most out-of-the-way cinemas installed proper apparatus if they are to cater for talking films at all. I had dismissed the matter from my mind when it so happened that on the following afternoon I found myself in one of the most up-to-date West End cinemas in company with one of the proprietors in order to give him my opinion upon the performance of a new type of amplifier which had been installed.

As we took our seats the fade-out kiss of a typical American sob-stuff piece accompanied by the usual sloshy noise from the back-screen loud speakers was taking place. After a brief intermission, as the Yanks call it, the same "News Gazette" which I had seen the previous evening in the old home town flashed up on the screen, and to my immense astonishment the amplifier feeding the loud speakers commenced to motor-boat gently. I was about to remonstrate with my acquaintance and point out that his


The fade-out kiss with moving coil effects.

"last-word" apparatus was behaving no better than the amplifier in my local cinema when, as certain lady novelists are fond of saying, the scales fell from my eyes with a resounding clatter and the horrid truth dawned on me. It was, of course, the *recording* amplifier and not the reproducing amplifier in the cinema that was doing the gentle motor-boating. Consequently all the cinemas throughout the length and breadth of the land would have this abominable noise inflicted upon them. My companion told me that unfortunately the occurrence was not entirely uncommon.

Enquiry among those of my friends who are cinema habitués has confirmed the fact that this strange noise, as they term it, often appears in certain news features. For my own part I think that it is monstrous that such a state of affairs should exist, and I intend to make a strong protest about it to a young friend of mine whose job in life it is to drag celebrities to the microphone and make them ejaculate a few platitudes into it. Perhaps he can persuade his directors to try and get hold of a copy of the now scarce and precious "New Readers' Number" of this journal.



The Efficiency of the MIXED FILTER

Making the Most of Fixed Inductance-Capacity Coupling.

By W. T. COCKING.

THE advantages of the band-pass filter over the single tuned circuit are by now well known to readers of THE WIRELESS WORLD. By adopting this method of pre-selection, not only are better quality and higher selectivity secured, but trouble from cross-modulation and beat interference is greatly reduced. The mixed filter, lately described in this journal, overcomes the majority of the faults encountered with simple capacity or inductive coupling, and, furthermore, has the advantage that signal strength is hardly sacrificed at all for selectivity. Calculations of the relative efficiency of various filters are made and advice is given as to the best method of ganging when the mixed type of coupling is used.

THE normal filter which employs either inductive or capacitative coupling has certain faults, the chief of which is the variation of band-width with tuning. When inductive coupling is used, the peak separation increases as the circuit is tuned to higher frequencies, and the selectivity, therefore, becomes low in the neighbourhood of 1,500 kc. to 1,000 kc. (200-300 metres). With capacity coupling, on the other hand, the band-width varies in the opposite direction; the selectivity is then very high at the higher frequencies, but the double-peaked tuning curve is lost, and the efficiency becomes very low. This was pointed out in a recent article by the present writer[1] in which it was shown that the efficiency of a capacity-coupled filter may be as high as 70 per cent. of that of a single-tuned circuit at 1,000 kc., but that it falls to only 25 per cent. at 1,500 kc. It was further shown that this is due to the use of a fixed value of capacity for the coupling.

The Mixed Filter.

Now it has been indicated in a recent article[2] that a combination of capacity and negative mutual inductance for the filter coupling offers decided advantages over either of the more common and simpler couplings. The band-width can be maintained more nearly constant over the tuning scale, and this leads to an improvement in both selectivity and quality. It becomes of importance, therefore, to determine the efficiency of such a filter at various frequencies throughout the broadcast band.

The circuit of this type of filter is shown in Fig. 1, and it should be emphasised that the inductive coupling must be *negative*. Any attempt to use positive mutual inductance will lead to a less efficient filter than either of the simple capacity or inductive circuits. The exact values for the coupling condenser C_m, and the mutual inductance M_m, depend not only upon the inductance and resistance of the tuning coils, but upon the manner in which the latter varies with frequency. This has been explained in the article already referred to, but the values for any given case are readily calculable from the usual peak separation formulae, since the common reactance consists of the *sum* of the reactance due to the mutual inductance and the reactance due to the coupling condenser.

When the tuning coils have an inductance of 200 μH., and their H.F. resistances vary in accordance with the figures given in the table, the best calculated values for the coupling components are 0.05375 mfd. for and condenser and 2.375 μH. for the negative mutual inductance. The inductance, of course, can readily be made to have any desired value, but a condenser of this capacity would be difficult to obtain. Fortunately, however, the values are not critical; and it is quite satisfactory, in practice, to use the nearest standard value of capacity, and to alter the inductance appropriately. Normally, therefore, we should choose a condenser of 0.05 mfd. and a mutual inductance of about 2.5 μH. It should be noted, however, that the curves which illustrate this article have been obtained using the theoretically correct values.

The peak separation to be expected with this type of filter is shown by curve B of Fig. 2, while curve A shows the band-width in the case of a pure capacity coupling by a condenser of 0.015 mfd. The difference between the two filters is most marked, and although the values chosen for the mixed filter do not give perfectly constant peak separation, it is obvious that a great improvement has been made. Indeed, it is not altogether desirable to maintain constant band-width up to 1,500 kc. for the reason that the tuned circuits themselves are rather unselective at these high frequencies,

[1] "Correct Aerial Coupling," *The Wireless World*, Feb. 4th, 1931.
[2] See "New Band-pass Filter" by W. I. G. Page, *The Wireless World*, Feb. 18th, 1931.

The Efficiency of the Mixed Filter.—

and that this fault can be remedied by decreasing the the filter coupling. Between 550 kc. and 1,200 kc. (550-250 metres) the peak separation does not vary more than 1 kc., but for frequencies higher than this, it falls off rapidly until the two peaks coalesce at 1,400 kc., instead of at 950 kc. for the capacity-coupled filter.

Magnification.

It is this rapid decrease in peak separation which makes the capacity filter so inefficient above 1,000 kc., and we should expect to find, therefore, that the inductive-capacity filter is considerably more efficient at the higher frequencies. The magnification at any frequency can be calculated from the formulae given in the Appendix to an earlier article[1] by substituting for $1/\omega C_m$, the total common coupling reactance, and the curves of Fig. 3 show this for two different degrees of coupling to the aerial. Curve A is for a mutual inductance to the *aerial* of 8.9 μH., and curve B for 19.35 μH.; in each case the filter coupling has the values mentioned earlier, and the coils an inductance of 200 μH. It may be mentioned that a mutual inductance of 8.9 μH. is obtained with the usual coil when the aerial winding has about six or seven turns, and a mutual inductance of 19.35 μH. when it has about 12 turns.

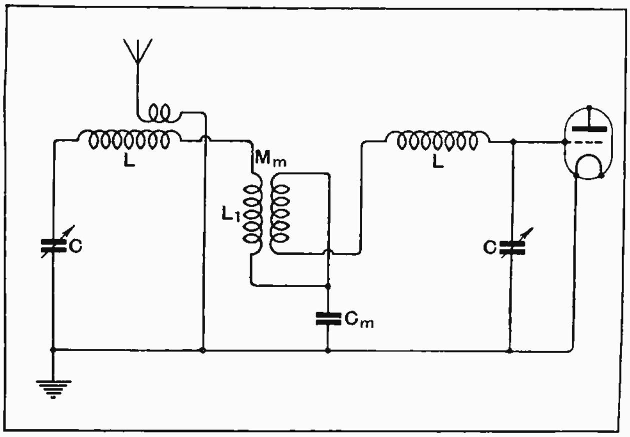


Fig. 1.—The requisite mixture of negative mutual inductance and capacity coupling is most easily obtained as in the above circuit. It should be noted that the coupling coil consists of two sections wound in the same direction, but connected in circuit in the opposite directions.

It will be seen that curve B is considerably better than curve A, since the magnification is not only higher, but it varies less as the circuit is tuned over the waveband. Over the range of 1,500 kc. to 1,000 kc. the magnification is very nearly constant, varying only between 8.2 and 9; but it falls off at the lower frequencies, until at 550 kc. it is only 2.1. This is a normal effect, however, and is due to the combined effect of a large number of factors; it is not due to the filter coupling, for it is found in nearly the same degree with the single-tuned circuit.

Perhaps the greatest single cause of this lack of efficiency at low frequencies is that the aerial coupling is insufficient. If the coupling be made larger, however, it is then too great at the high frequencies, causing a loss of efficiency and selectivity. There appears to be no simple method by which the coupling can be varied electrically, as is the case with the filter coupling, and mechanical means are out of the question in a ganged receiver. Even optimum aerial coupling at all frequencies does not keep the efficiency constant, however, owing to the fact that the circuits themselves are inherently less efficient at the low frequencies, due to the lower ratio of inductance to capacity. At present, the only satisfactory method of overcoming this universal fault is to change the values of tuning inductance for the different ends of the waveband; that is,

Coil Inductance = 200 μH,

Frequency (kc.).	H.F. Resistance (ohms).
550	5.3
750	7·5
1,000	12
1,200	16
1,500	27.5

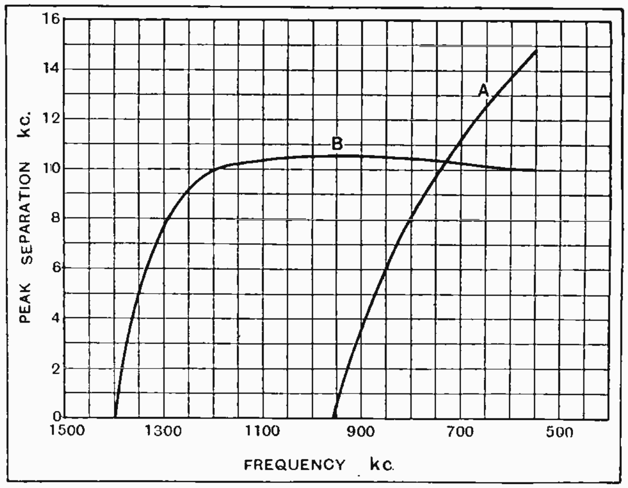


Fig. 2.—The variation in band-width over the broadcast band can be seen from these curves. Curve A is for a coupling capacity of 0.015 mfd. and curve B for the inductive-capacity filter in which the condenser has a value of 0.054 mfd. and the negative mutual inductance is 2.375 μH.

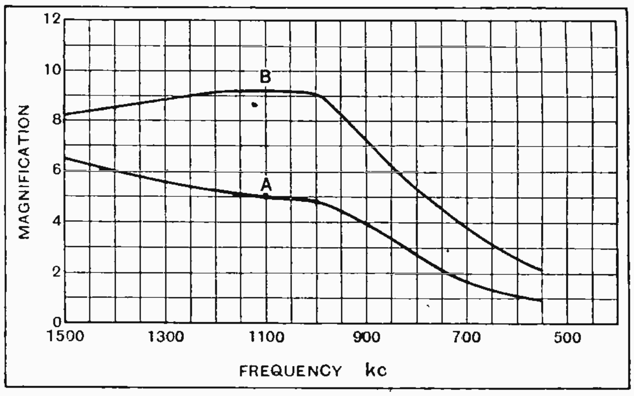


Fig. 3.—Curve A shows the magnification of the inductive-capacity filter which is coupled to the aerial by a mutual inductance of 8.9 μH. and curve B when the mutual inductance is 19.35 μH. Note the even magnification in the latter curve between 1,500 kc. and 1,000 kc.

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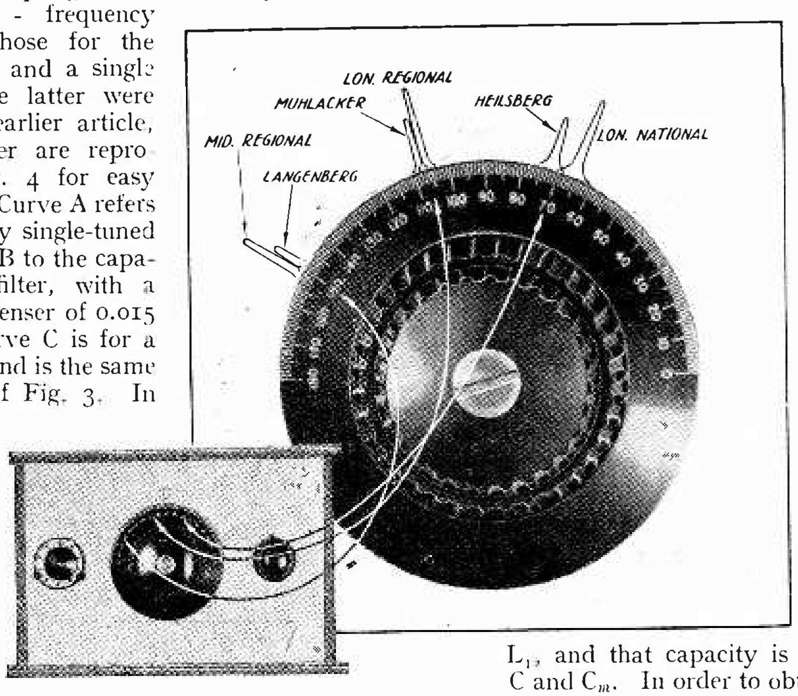
to split the waveband into two sections of 1,500 kc. to 1,000 kc. and 1,000 kc. to 550 kc. This complicates a receiver and is unlikely to become general.

In order to appreciate the full advantages of the mixed-filter coupling, it is necessary to compare its magnification - frequency curve with those for the capacity filter and a single circuit. These latter were given in an earlier article, and a number are reproduced in Fig. 4 for easy comparison. Curve A refers to the ordinary single-tuned circuit, curve B to the capacity-coupled filter, with a coupling condenser of 0.015 mfd., and curve C is for a mixed filter, and is the same as curve B of Fig. 3. In every case the coupling to the aerial is the same, and consists of a mutual inductance of 19.35 μH.



The aim of the mixed band-pass filter is that of providing uniform selectivity across the tuning range.

It is interesting to note that in the region of 1,000 kc. the inductive-capacity filter is very nearly as efficient as the single circuit. This, of course, is due to the filter being operated with its optimum aerial coupling at this frequency, whereas the single circuit aerial coupling is a little below its optimum. The point of particular interest, however, is the marked difference between curves B and C, for the capacity and mixed filters respectively. It is obvious that the latter is by far the superior; indeed, it is 3.2 times as efficient as 1,500 kc. Even at 550 kc. the magnification is greater by some 40 per cent., due to the narrower band-width obtained at this frequency. It is only at the low-frequency end of the range that the magnification falls much below that of the single circuit. When the added advantage of nearly constant peak separation is taken into consideration, it will be seen that the inductive-capacity filter is very much superior to the simple capacity circuit.

Practical Considerations.

In addition to these definite facts, it has been observed that the trough between the peaks is less than that with the simple couplings. When the filter directly precedes a power grid detector without reaction the double-humped curve is not obtained, due to detector damping; it is found, however, that over a range of 5 kc. on either side of resonance the tuning curve is quite flat, with a very sharp cut-off outside this range.

This type of tuning curve is a distinct advantage in a simple receiver, since it eliminates any difficulty in tuning occasioned by the necessity for tuning midway between two points of maximum strength. Reaction on to the secondary circuit may be used with a more beneficial effect than with plain capacity coupling; indeed, it behaves far more normally, and is often quite useful.

The ganging of the two condensers in a mixed filter is no more difficult than with the simpler types; difficulty may be experienced, however, when an attempt is made to use it preceding a tuned H.F. amplifier. In this case the inductances and capacities of the various circuits will not usually be identical. Any intervalve couplings following the circuit of Fig. 1 will normally employ coils of the same inductance as L, and condensers identical with C. The filter, however, has not these effective values, because the inductance consists of the sum of L and L_1, and that capacity is the series connected value of C and C_m. In order to obtain perfect ganging in a multi-stage set, therefore, it may be necessary to connect in series with each intervalve coupling a small coil of the same value as L_1 and a condenser of the same capacity as C_m.

This is shown in Fig. 5, which also indicates how this condenser which may be necessary for ganging can be made to serve a useful purpose as a decoupling component. Although these balancing conditions are theoretically essential, it will often be found, in practice, that they are unnecessary. Sufficiently accurate gang-

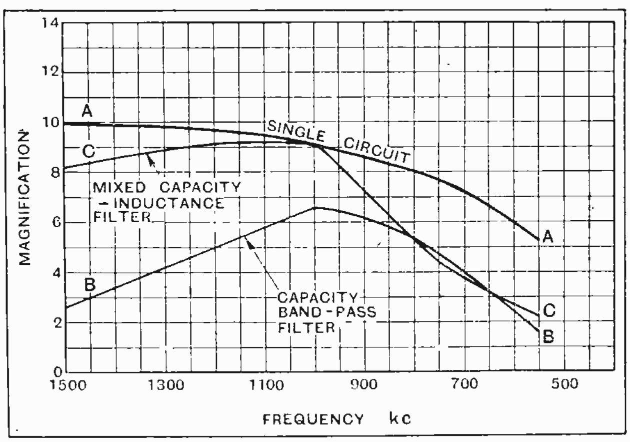


Fig. 4.—The magnification obtainable with three different types of pre-selector, in each case the mutual inductance to the aerial is 19.35 μH. Curve A refers to the single tuned circuit, curve B to a capacity-coupled filter with a coupling condenser of 0.015 mfd. and curve C, which is the same as curve B of Fig. 3, to the inductive-capacity filter.

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ing can often be obtained without them, since the variation in inductance will only be about 1 per cent.

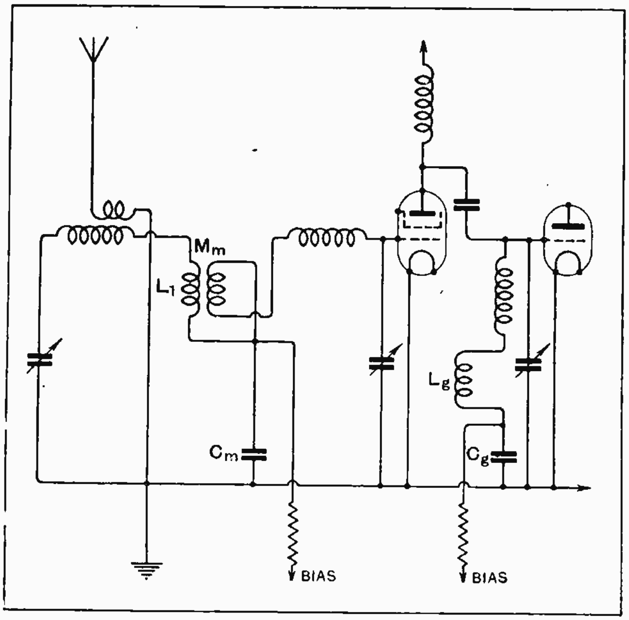

Fig. 5.—The method of ensuring perfect ganging in a multi-stage set when a mixed filter coupling is used. The small coil L_g and the condenser C_g match the coil L_1 and condenser C_m in the filter. Note that the condenser C_g is also used as a de-coupling condenser.

Any method by which the required degree of negative mutual inductance can be obtained, however, will give the desired results, and so we find that there are several alternatives to the circuit of Fig. 1. This particular method is the best where only a single waveband is to be covered, for it enables adjustments to the coupling to be readily effected, but it becomes too complex where waveband switching must be included. In this case it is necessary to adopt one of several alternative methods; these alternative methods have a coil construction which is somewhat more critical, but have the very decided advantage that the switching is no more complex than with the ordinary capacity-coupled filter. In addition, it is possible so to arrange matters that no ganging difficulties, due to a disparity in the inductances, are met with in a multi-valve receiver. It will be seen, therefore, that the circuit of Fig. 1 has definite uses, but that an alternative method may prove better in a multi-stage receiver.

The Choice of Filter.

In conclusion, it may be said that although the inductive-capacity filter has been shown to have very superior characteristics to the simpler types, this must not be taken to mean that it can always replace other filters. In a simple set, where the filter is the sole tuning circuit, it is definitely superior, but in a multi-stage set, where filters and single circuits are used together, its indiscriminate use is not advised, for it is necessary to consider it in conjunction with the other tuned circuits which a receiver may possess.

NEWS FROM THE CLUBS.

Pick-Ups for Fivepence.

A radio-gramophone pick-up which cost 5d. to construct was demonstrated by Mr. Gowing at the meeting of the Gloucester and District Radio Society on March 18th. Good reproduction was provided on a moving-coil loud speaker.

Several interesting discussions took place on a variety of topics, special attention being given to short-wave work. Captain G. Courtenay Price (G2OP) gave some useful hints for budding short-wave "hams." The Hon. Secretary discussed the problems of 10-metre reception, referring to the receiving of harmonics on this wavelength. The R.S.G.B. 28 mC. trophy was on view, together with the winning receiver.

The Society is planning an ambitious programme for the coming months, with provision for several field-days.

Hon. Secretary, Mr. J. W. Hamilton, Upper Parting, Sandhurst, Gloucester.

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For Liverpool Amateurs.

The latest receiver developments were discussed at the recent monthly meeting of the Liverpool Wireless Society. Selective tuning devices—band-pass filters, super-heterodynes, and the stenode radiostat—came under review. Much interest was aroused by the statement of a member that he was receiving the American short-wave stations on the 30-metre channel with an early *Wireless World* short-wave set which had been out of use for several years.

The next meeting of the Society will be held on April 9th, and all interested are invited to communicate with the Hon. Secretary, Mr. G. Miller, 1, Rosedale Avenue, Great Crosby, Liverpool.

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New Society for Portsmouth.

A new amateur organisation—the Portsmouth and District Wireless and Television Society—has been formed, and it is hoped that many enthusiasts in the Portsmouth area will quickly enrol as members. Mr. Albert Parsons, who presided over the inaugural meeting, mentioned that the aims of the Club included an annual exhibition, the tracking of oscillators, a local wireless magazine, field-days in the summer, and activity in the interests of all listeners in the district.

Full particulars can be obtained from the Hon. Secretary, Mr. H. E. Christie, 94, Suffolk Road, Southsea.

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A.C. Mains Operation.

A fascinating lantern lecture on "A.C. Mains Operation," prepared by the Marconiphone Co., was delivered at a recent meeting of the Tottenham Wireless Society. Slides were shown giving diagrams and curves relating to A.C. voltage rectification, smoothing and voltage dropping circuits. Detailed descriptions were given of the 8v. directly heated valves, as well as the Marconi M54, MHL4 and ML4 indirectly heated types, and finally a description of the latest Marconiphone all-mains receiver.

An interesting discussion followed the lecture on the subject of relative efficiency of valve and metal rectifiers.

Hon. Secretary, Mr. W. B. Bodemeaid, 29, Pendennis Road, Tottenham, N.17.

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Catford and District Radio and Television Society.

We welcome the formation of the Catford and District Radio and Television Society, which held its first public meeting on Friday, March 20th. Enthusiasts in the district are cordially invited to apply for particulars to the Hon. Secretary at 69, Englebert Road, Catford, S.E.6.

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Talking Systems Compared.

A member of the Bristol and District Radio and Television Society—Mr. C. L. S. Cooper, of Messrs. Philips Lamps, Ltd., and also the operator of the transmitter G.6YN of the Society—gave the weekly lecture on "Talkie Sound Production." He discussed the relative merits of the synchronised disc method with the sound on film system of sound recording, problems of reproduction in the theatre, and the use of either selenium or photoelectric cells.

The lecture was followed by many questions from members.

Hon. Secretary, Mr. S. T. Jordan, 1, Myrtle Road, Cotha, Bristol.

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Developments in Intervalve Transformers.

Three organisations—the Thornton Heath, Whitgift Middle School and South Croydon and District Radio Societies—joined forces at a recent meeting, at which Mr. Shaw, of Radio Instruments, Ltd., lectured on "General Development in the Design of Inter-valve Transformers." The lecturer simplified his talk by means of blackboard diagrams, and the many problems in transformer construction were dealt with.

Turning from the theoretical to the practical, the meeting heard an "R.I." Madrigal receiver at work, and it was much appreciated. Despite a very small indoor aerial, more than a whisper of Europe was heard, but particular attention was paid to the receiver's quality of reproduction.

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

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Television Society for Rochdale.

Television enthusiasts in the Rochdale district will be interested to learn that a television society is being formed by Messrs. T. Whitworth and A. Kay. Enquiries should be addressed to Mr. T. Whitworth, 48, Miller Street, Rochdale.

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April 1st Feature.

A feature at the meeting this evening (Wednesday) of the Gloucester and District Radio Society will be a demonstration of a "Heath Robinson" loud speaker. The meeting will be held at 7.30 p.m. at the Wessex Hotel, Gloucester.

From Aerial to Loud Speaker

No. 5.—The Output Stage.

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

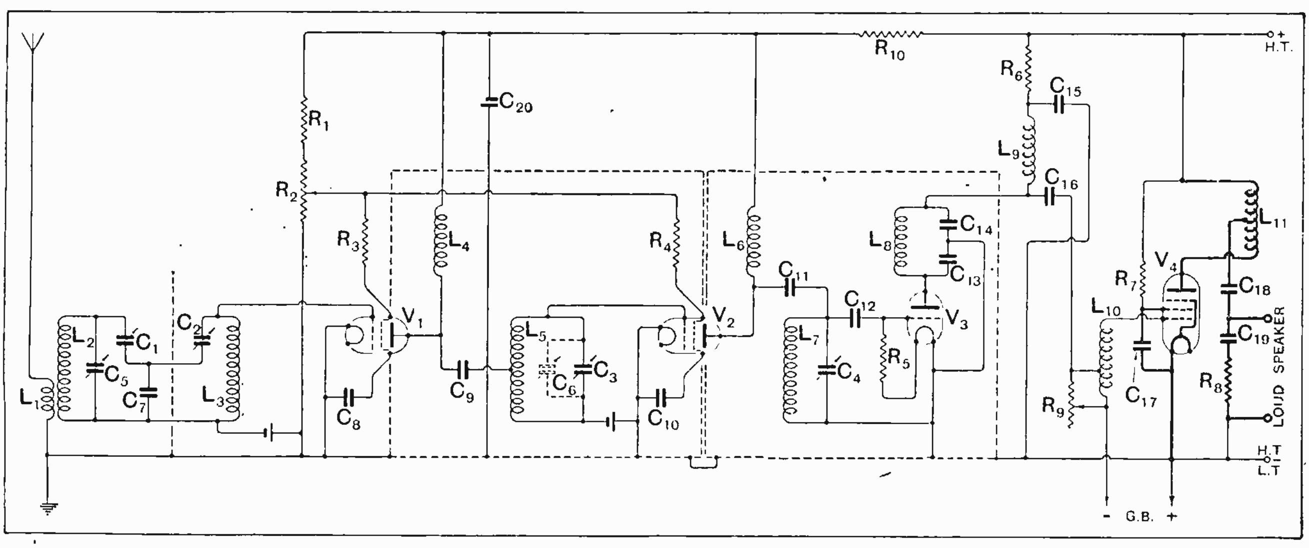
THE fifth article of this series, describing the function of every component in a modern four-valve receiver, deals with the last valve and its coupling circuit. The fundamental difference between the pentode and the three-electrode valve and the conflicting requirements of quality and volume are explained in simple terms.

THE sub-title over which the reader's eye has just glanced may, perhaps, seem to some a little odd. Why not "The L.F. Stage"? It may be that this title would have been more usual, but with all respect to those who would have preferred it, the writer submits that it would have been wrong. There *is* no L.F. stage at all in the set we are discussing—unless we choose to depart so far from precedent, and to approach so near to reality, as to describe the detector valve and the components that are coupled in its anode circuit in those terms.

It will be remembered that, in discussing the components immediately following the detector, we saw that they had to amplify and pass on, without distortion or omission, the low-frequency impulses resulting from rectification. It was from this point of view, taking the characteristics of the detector valve into consideration, that the choke and transformer were chosen. This part of the circuit is, in fact, designed exactly like a low-frequency amplifying stage, for the very good reason that the work it has to do is exactly the same.

The last valve, V_4, has quite a different function. Instead of delivering a voltage to a succeeding valve, which, by virtue of taking no grid current, absorbs no power, it has to provide the energy necessary for operating the loud speaker. That it cannot be classed as an amplifying valve in the ordinary sense becomes clear if we remember that when using a low-resistance loud speaker the voltage across it may be much less than the voltage delivered to the output valve by the secondary of the transformer from which it derived its signals.

The object of all this discussion is simply to convince the reader that if he regards our set as having "a transformer-coupled L.F. stage," he is taking a point of view which will mislead him hopelessly in matters of design. [And yet it is completely correct to speak of "a transformer-coupled H.F. stage." Paradoxical?—

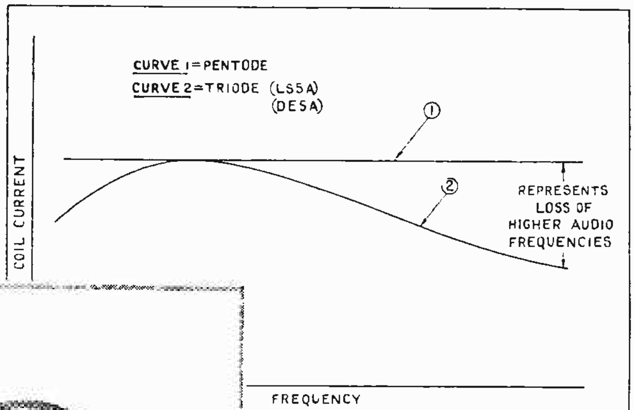


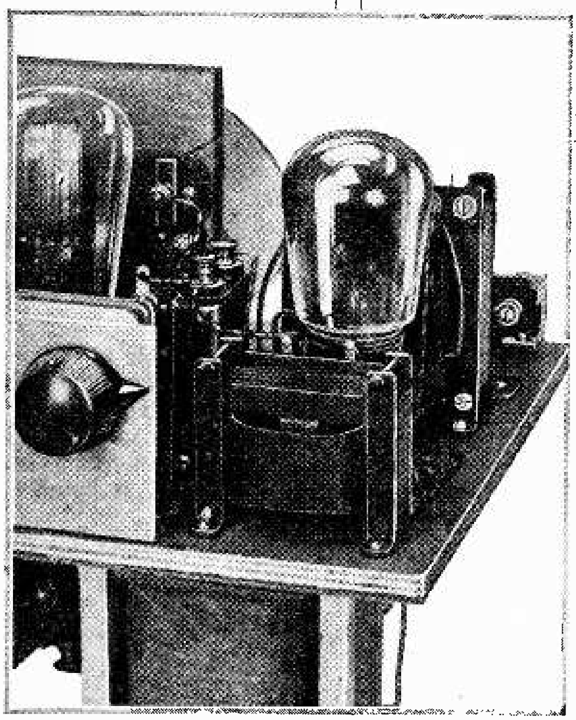
The four-valve circuit which is taken as typifying modern practice. The function of each component of the output stage is considered in this instalment.

From Aerial to Loud Speaker.—

not at all: the transformer *follows* the H.F. valve.] Instead, he must think of the set as containing "a detector transformer-coupled to the output stage." This connects the transformer, not with the output valve at all, but with the detector—in choosing the transformer did we not have in mind the characteristics of the detector valve? And was the output valve so much as mentioned?

Agreeing, then, that the output stage *is* an output stage, we will proceed to discuss it. The first point that leaps to the eye is that a pentode, and not a triode has been chosen. There are several good reasons for this choice, and, except for the slightly greater cost both of the valve and its associated components, the writer knows of no disadvantages to counterbalance them.





(Above) Showing the superiority of the pentode over the triode when a moving-coil speaker is used. These curves are taken from an article entitled "The Output Stage and The Pentode," by Dr. McLachlan. (Left) The pentode output stage of "The Pre-Selection A.C. Three" receiver.

In the first place, the pentode requires a much smaller input of signals than a triode capable of producing the same volume of sound without distortion. If the station being received is coming in well, this extra sensitivity of the output stage will not be usable, because the pentode will be overloaded if the detector is supplied with the strong signal that it requires for distortionless rectification. In receiving the local station, and all the more powerful foreign ones, the volume control R_9 will have to be so adjusted as to cut down the available signals to an amount small enough for the pentode to accept—we might just as well have used a triode, for the signals necessary to operate it are there. But for the fainter and more distant programmes, where even two stages of efficient high-frequency amplification will not suffice to build up the feeble signal to the large value that the detector likes best, the extra sensitivity of the pentode will be very acceptable. Owing to underloading the detector, quality will not be up to "local-station standard" when the volume-control is turned right up, but there will always be a certain number of stations which will be heard, at least fairly well, with a pentode in the output socket, whereas with the less sensitive triode they would not be heard at all.

Apart from choosing a pentode with the idea of providing a small reserve of power for the stations nearly out of range of the set, it has other points in its favour. In certain quarters the pentode has a reputation of being greedy of anode current; but anyone who cares to investigate the matter will find that the truth is exactly the opposite. For the same consumption of power in its anode circuit, the pentode will supply a little more power to the loud speaker than will the triode. Putting the same thing differently, if a pentode and a triode will give the same volume of sound before overloading begins, then the pentode will consume, in anode and screen-circuits combined, a few milliamperes less than the triode. The economy is, perhaps, small, but in the case of receivers worked from batteries it is well worth having.

There has been a belief that the pentode does not give reproduction of so good a quality as that yielded by a triode. With certain speakers, and if no precautions are taken to ensure good quality, this is undoubtedly the case; but if the valve is intelligently handled, the reproduction it gives will never be less good than that from a triode, and will in certain cases be better, especially with a moving-coil speaker.

When the Pentode Behaves as a Triode.

Certain components are needed with a pentode that have no place when a triode is used. One of these is shown in the diagram of our set as C_{17}. The purpose of this condenser is much the same as that of C_8 and C_{10}, which serve to short-circuit to earth the signal voltages appearing on the screening grids of the high-frequency valves. In the case of the pentode it is desirable to take this precaution, not so much for the sake of stability as on account of the fact that the valve only acts as a true pentode when the screening grid is earthed. The writer has even heard of a case in which the voltage for the screening grid was obtained by connecting it directly to the anode; in this case the full signal voltage is developed on the screening grid, and the pentode behaves exactly like an ordinary triode.

From Aerial to Loud Speaker.—

Since C_{17} has to pass low-frequency currents, it must have a large capacity. In practice, it is found that 2 mfd. is very suitable, even in the presence of a decoupling resistance (R_7 in the diagram), which naturally tends to assist the development of signal voltages by offering an obstacle to their passage through the high-tension supply.

The Purpose of the Choke Filter.

A larger capacity than this will do no harm at all, while the choice of a much smaller capacity will tend to lower the amplification given by the valve. If C_{17} becomes disconnected entirely, signal strength will fall away to a very noticeable extent; if an eliminator is being used, motor-boating may result. Where H.T. accumulators, or a dry battery in good condition, are being used, both C_{17} and R_7 may be omitted without harm, for there will still be a low-resistance path to earth through the battery. If a short-circuit should develop in C_{17}, the screening grid of the pentode will be connected to earth, so that signals will cease. In addition, the high-tension supply will be virtually short-circuited.

To the resistance R_7 will be allotted a value which will depend upon the valve chosen for V_4; discussion of this component will therefore be postponed until we consider valves and working voltages.

The choke L_{11}, in conjunction with the condenser C_{18}, forms a choke-filter output circuit. The purpose of this arrangement is two-fold; the more obvious and less important advantage being that the steady anode current of the output valve is diverted from the loud speaker. The modern balanced-armature speaker will usually tolerate the passage through it of even quite heavy anode currents, but one cannot allow a steady current to pass through the coil of a high-resistance moving-coil speaker. It would tend to drive the coil violently out of its gap, either towards or away from the magnet (depending on the direction of flow of the steady current), and would result in tightening the leather surrounding the cone to such an extent that free movement would no longer be possible.

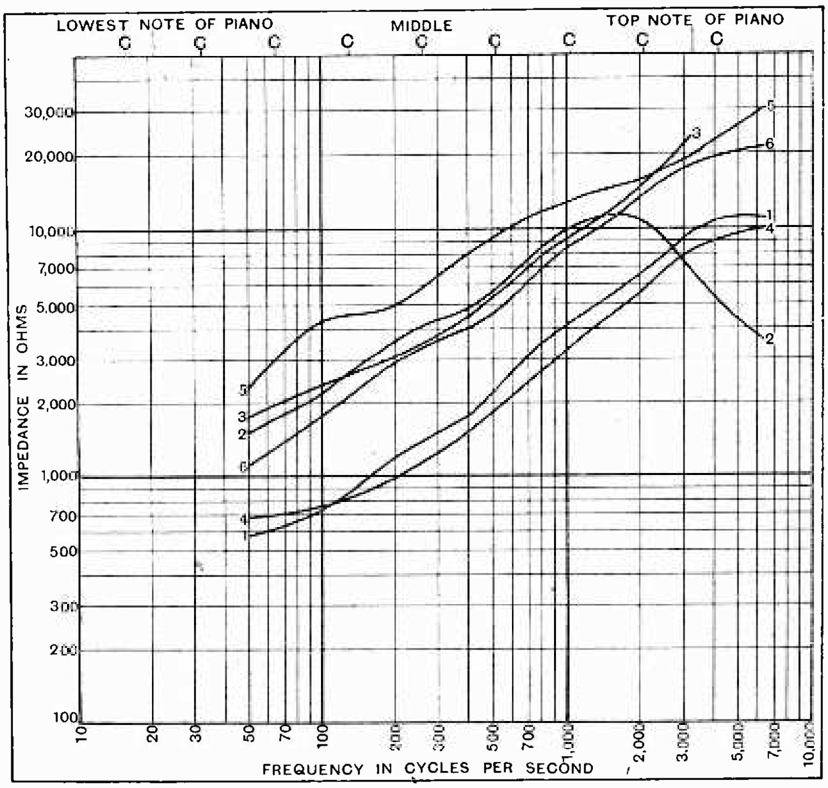
The more important advantage of the choke-filter is that the bulk of the speech currents run through the speaker directly to earth, and do not pass through the source of anode-current supply. It is thus an absolutely invaluable aid in the prevention of motor-boating and allied troubles; so much so, indeed, that to omit the choke filter in a set that is to be driven from an eliminator is extremely unsafe.

The choke, L_{11}, has a tap at its mid-point in order that it may act as a step-down transformer which, with the majority of speakers, is necessary if the bass notes are to be fully reproduced when a pentode is used. An alternative, and perhaps better, scheme is to have a choke with several tapping points, so that the step-down ratio may be adjusted to suit the individual loud speaker and valve in use. The inductance required for this choke is fairly high; a value not less than 50 henrys should be chosen, this inductance to be effective when the steady anode current is flowing. The bass response will suffer if a choke of too low an inductance is used, but a higher value will be harmful only in so far as it implies a higher direct-current resistance, and so a greater loss of voltage across the choke.

If L_{11} should become disconnected, signals will cease owing to the cessation of anode current in V_4; if it should become short-circuited, silence will again result, since signal currents will take the easier path through the high-tension unit instead of passing through the loud speaker.

The condenser C_{18} is a feed condenser, allowing the speech currents to pass through to the speaker while protecting it against direct current. This protection will be withdrawn if the condenser should develop a short-circuit, with probable dire results to the loud speaker; a disconnection, on the other hand, would do no more than cut the loud speaker off from the set.

The condenser C_{18} is required to offer an impedance low compared with that of the loud speaker to currents of even the lowest audible frequency; this condition is not very completely met by the usual 2-mfd. condenser,



Variation with frequency of the impedance of six typical moving-iron speakers. The components C_{19} and R_8 are used to smooth out these variations to which the pentode is extremely sensitive.

From Aerial to Loud Speaker.—

which has a reactance of some 1,600 ohms at 50 cycles. Nevertheless, the addition of a further 2 mfd. in parallel makes a difference barely great enough to be detected by ear, so that in practice 2 mfd., or 4 mfd. at the most, proves perfectly satisfactory. If a much smaller capacity is used, the bass will suffer rather severely.

Tone Control.

The resistance R_8 and the condenser C_{19} connected in parallel with the loud speaker terminals form a tone control, essential whenever a pentode is used to supply signals to any speaker other than one of moving-coil type. In its absence, high notes are badly over-accentuated, overloading sets in at a comparatively low signal strength, and the pentode is liable to be damaged by the development of excessive anode voltages. All these things happen because the impedance of the loud speaker rises very rapidly with frequency, as the curves of a number of typical loud speaker movements show. The pentode tries to drive the same current through the speaker whatever its impedance may be—behaviour quite different from that of the triode, which tends to develop the same voltage across the speaker at all frequencies. The cure is evidently to keep the impedance of the anode circuit more or less the same at all frequencies; the resistance R_8 does this quite satisfactorily.

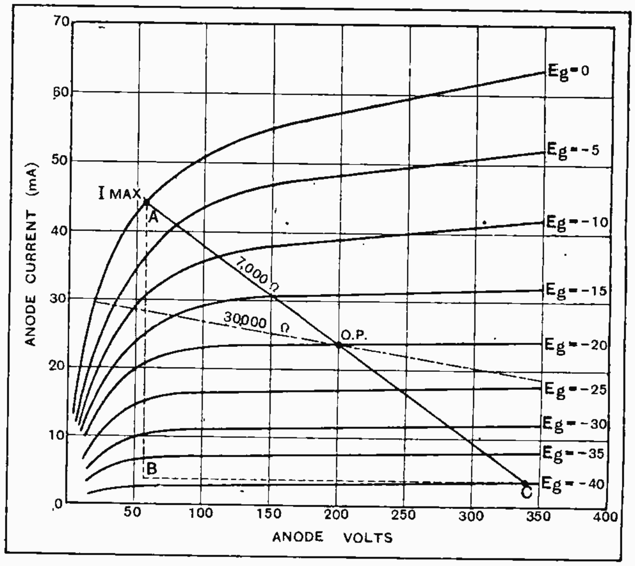
The impedance of the loud speaker, if it is of the moving-armature type, may be taken to be some 5,000 ohms at the middle musical frequencies; the same value should be chosen for R_8. If a variable tone control is looked upon with favour (and it is sometimes very useful), R_8 may be a variable resistance of maximum value about 10,000 ohms. In order that the alternative path offered by the resistance shall not absorb any appreciable power at frequencies below the higher notes for which the correction is primarily required, the condenser C_{19} is inserted. The impedance of this will be high for the low notes, and low for the high notes, so that R_8 will only come into effective action over the upper ranges of music—which is what we require. The largest capacity likely to be needed for C_{19} is 0.05 mfd., which offers a reactance of about 5,000 ohms at 600 cycles. Smaller capacities, down to 0.01 mfd., may be preferred with many speakers. It is largely a matter to be settled by ear, after the receiver is built.

Choosing the Speaker.

A short circuit in C_{19} will throw R_8 into action for all frequencies; a weakening of low notes will result. The same fault in R_8 will put C_{19} directly across the loud speaker, so that all high notes will vanish completely. If either is disconnected, the tone control will become inoperative; signals will, therefore, become shrill and distorted.

The choice of a loud speaker, the last component in the receiver proper, is one that can very well be left to the taste and the means of the user, so far, at least, as instruments of the balanced-armature type are concerned. All that is necessary in adapting this variety of speaker to the output valve has already been discussed.

There must, however, be just a word or two for those who would choose a moving-coil speaker. If this is of the low-resistance type, incorporating a step-down transformer, the primary of this should be connected to the normal loud speaker terminals of the set. The transformer will then be working under the best possible conditions, as the steady anode current of the valve will still be passing through the choke. A high-resistance speaker, fitted with a coil suited to a triode output valve, should also be connected to the existing terminals with-



Anode volts-anode current curves of a high-voltage pentode. If the curves were truly horizontal the voltage across the speaker would be exactly proportional to its impedance. This condition is seen to be closely approached.

out alteration to the set, but it is even better to use a speaker with a special high-impedance coil designed to follow a pentode. In this case, the lead to C_{18} must be removed from the centre tap of L_{11}, and joined directly to the anode of the valve.

Owing to the fact that the loud speaker of moving-coil type does not change its impedance with frequency to anything like the same extent as the moving-iron speaker, the control circuit (C_{19} and R_8) may usually be omitted without detriment. This is particularly the case when the cone is made of a material softer than the average cone, and so does not unfairly accentuate the higher notes. If, however, experiment shows that high notes are too pronounced, the control circuit may be restored.

In the next and concluding instalment consideration will be given to the choice of valves and their operating voltages.

TONE AND VOLUME CONTROL OF GRAMOPHONE PICK-UPS.

The second instalment of this article will appear in our issue dated April 8th. In the first instalment on page 315, second column, the "equals" sign should be deleted from the denominator of the fraction in line 2. In line 13, 1.5 should read 1.3 and the expression in the last line then becomes:

$LC = 140 \times 1.2^2 \times 1.3 \times 10^{-8} = 2.63 \times 10^{-6} = 1/(2\pi f)^2$.

Current Topics.

THE OLD COMPLAINT.

Radio Paris has suspended its afternoon transmissions owing to a shortage of funds.

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YES, BUT HOW?

"It is hoped that one day the laws will be revised in such a manner as to make it impossible for people to pirate their broadcast amusement."—*Indian Wireless Magazine.*

oooo

THE ROYAL SET BUILDER.

H.R.H. the Duke of York, who is the "wireless" member of the Royal Family, has recently completed the construction of a two screen-grid receiver in his workshop at 145, Piccadilly, and uses it to receive the majority of the European broadcasting stations.

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RUSSO-RUMANIAN POWER WAR?

More than a spot of bother seems to be developing in Eastern Europe in regard to the opening of Russia's new relay station at Bogorodussja which will work on a power of 100 kilowatts and disseminate the Moscow programmes over the neighbouring countries. Preparations for a counter-offensive are reported from Roumania, who will probably erect a powerful propaganda station close to the frontier. Meanwhile Poland is ready for all-comers with her 160-kilowatt transmitter at Rasin.

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WHERE LISTENING IS EXPENSIVE.

The Budapest newspaper "Voice of the People," has started a campaign to lower the cost of wireless licences, declaring that, judged on the basis of the working man's wage, the Hungarian licence is the most expensive in the world. The annual fee is 24s., or 2½ pengos per month.

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TECHNICAL RIVALRY IN FRANCE?

A mild sensation seems to have been created in French wireless circles by a *communiqué* issued by the Minister of Public Works outlining a national network of broadcasting stations. Our Paris correspondent remarks that the popular surprise is due to the fact that the officials are actually approaching the problem from a technical angle instead of *via* the usual political route. The officials are warned, however, that a technical broadcasting commission is already sitting under the presidency of General Ferrié, and that if rival plans are evolved the last state of things may be worse than the first.

To us it seems that the best intentions of the French authorities will be stultified until listeners are effectively taxed.

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R.N.V.R. SIGNALS AND WIRELESS SECTION.

Naval wireless veterans will meet at the re-union association's annual dinner in London on Cup Final day, April 25th. Full particulars from the hon. secretary, Mr. W. S. Finlayson, Northwood, St. Michael's, Liverpool.

GERMAN TELEVISION INVENTION. One of Herr Mihaly's former assistants is seen with his new "mirror screw," used in the Tekade system of television, which permits of some 100 lines per picture while dispensing with an unwieldy disc. Postcard-size pictures are obtained without magnification.

EIGHTEEN YEARS OLD.

To-day (Wednesday) marks the eighteenth anniversary of our birthday. "The Wireless World" made its first appearance in April, 1913.

HONOUR FOR VALVE INVENTOR.

All wireless amateurs will warmly endorse the action of the Physical Society in choosing Sir Ambrose Fleming, F.R.S., to be the recipient of the Duddell Medal for 1931.

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ALL ROADS LEAD TO SPA.

In order to be quite up to date, the big international trade exhibition in the Kursaal, Spa (Belgium), opening on April 4th, will contain a wireless, television, and gramophone section.

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ON TAP.

No fewer than 173,000 of Holland's 460,000 licence holders listen on communal sets operating relay systems.

oooo

AT THE LEIPZIG FAIR.

Few band pass sets and no "superhets" were to be found at the Leipzig Fair, according to a correspondent who recently visited this most important European trade festival. Although the radio section is only a "side show" it provides some useful indications of the trend of German radio designs. To an English visitor interest naturally centres round the method of tackling the quality-selectivity question, and it is at once apparent that the Germans are preferring triode H.F. valves to the S.G. type. The 2HF-v-2LF type is extremely popular for long-range working. Exceptions are the A.E.G. 2SG-v-1 set without preselection or band pass and the Siebt long-range set with four screen-grid stages.

Most amplifiers shown fell very definitely into the "power" class. It was quite usual to find a moving-coil speaker giving considerable volume and fed by a 10-watt amplifier; exhibitors showing speakers working on 2-watt apparatus referred to their wares as sensitive and economical.

Almost all the condenser firms stressed the value of their products as interference quenchers, and it would seem that the interference bugbear is regarded more seriously in Germany than in Britain.

Despite the vogue of the "week-end habit" in Germany, portables were conspicuous by their absence.

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SCIENCE TALKS FROM THE VATICAN.

"A whole corps of editors," according to our Turin correspondent, is combining to make a success of the "spoken journal" which is to be inaugurated by the new Vatican wireless station in a fortnight's time. Luminaries of the Pontifical Academy of Science will tell the world of their researches and discoveries week by week in the realms of astronomy, electrotechnology, geophysics, and biology.

The Vatican station does not transmit daily, but operates as occasion may arise on wavelengths of 19.84 and 50.7 metres, using either telephony or telegraphy.

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"THE WIRELESS WORLD" QUALITY AMPLIFIER.

It is regretted that in the photograph on p. 309 of our last issue the output and rectifier valves were shown in their wrong sockets. They should have been interchanged.

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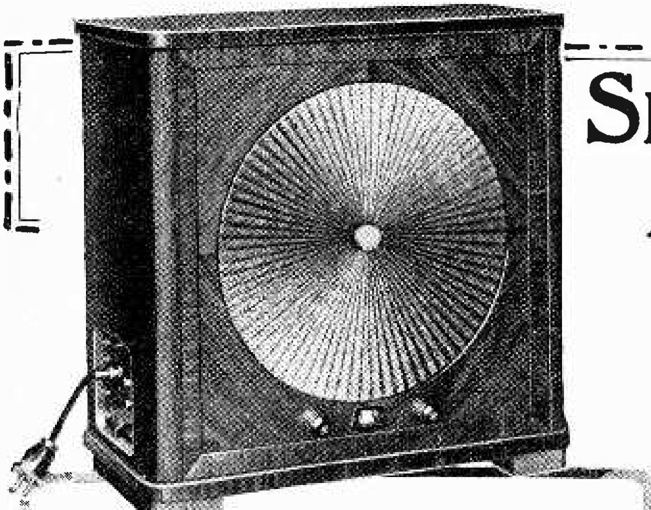
PCJ'S THREE AERIALS.

PCJ, the famous Dutch short-wave station, is now using three aerial systems. Aerial A is an ordinary non-directional aerial, while B is a new directional aerial radiating east-west for service to the Dutch East Indies. C is directional south-west with the object of reaching South American countries.

The wavelength is 31.28 metres, and we understand that, subject to minor changes, the present schedule is as follows:—

Wednesday, 17—20; Thursday, 14—18, 22—02; Friday, 18—20; Saturday, 02—06. Times given are G.M.T.

Reports of reception will be welcomed by Philips Lamps, Ltd., 145, Charing Cross Road, London, W.C.2. Envelopes should be marked "PCJ Reception Report"



Loewe Type EB100.

SELF-CONTAINED ALL A·C· SET

Employing a New Metal-coated Multiple Valve with Increased Power Output.

LOEWE products have always been noted for their originality and simplicity of design, and the latest product from the British factory at Tottenham maintains the distinctive features which have come to be associated with this name. A three-stage multiple valve is again the nucleus of the receiver, and the resulting economy of associated components has enabled a particularly neat design to be evolved at a very reasonable price.

The receiver is entirely self-contained, and includes a four-pole balanced armature loud speaker. Indeed, at first sight the instrument might be taken for a loud speaker, so neatly have the various components and controls been disposed in and on the cabinet. It would be quite easy at first sight to overlook the small recessed tuning dial and the two controls for tuning and reaction at the bottom of the front panel. The remaining controls, including the aerial coupling, wave range switch, and mains "on-off" switch, are neatly disposed out of sight in a small recessed panel at the side of the case. Inside, the few components such as tuning coils and mains equipment which are not already included in the multiple valve are arranged in a metal tray at the bottom of the cabinet.

The type 3NFW multiple valve comprises a reacting detector and two L.F. stages with resistance coupling throughout. The first two stages are indirectly heated, and the valve as a whole is screened by an earthed metallic covering sprayed on the surface of the glass. The tuning coils are of the honeycomb type, and variable magnetic coupling is provided between the aerial and tuned-grid coils.

High-tension current is provided by a half-wave valve rectifier, and smoothing is entirely by resistances and condensers. Grid bias is also derived from the H.T. circuit, and the whole of the feed system is decoupled.

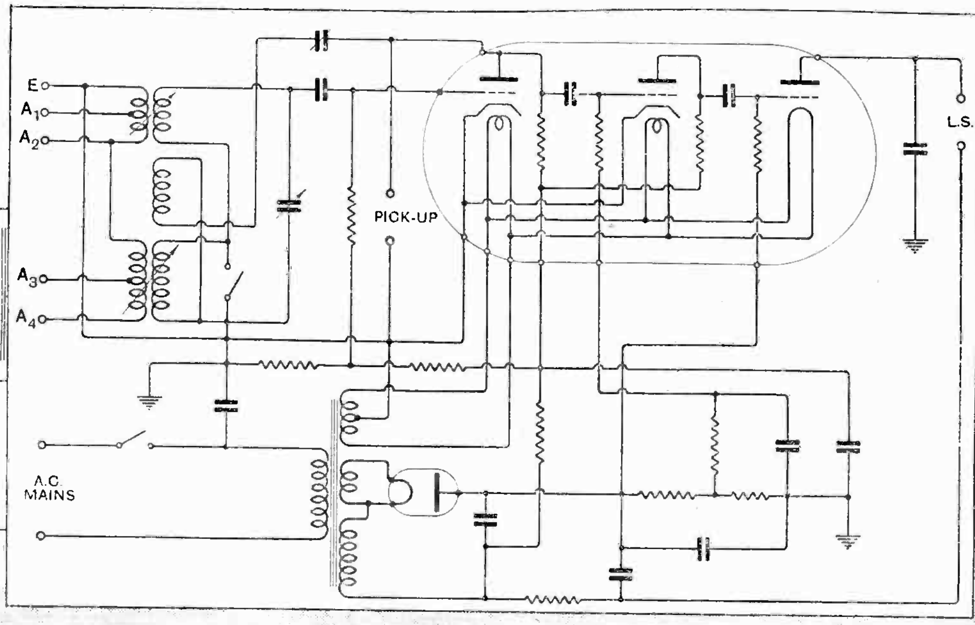
On switching on the set for the first time one is at once favourably impressed by the improvement in the power-handling capacity of the output stage over earlier types of multiple valves produced by the Loewe Company. The volume can be increased well beyond the level that can be tolerated in the average room before provoking aural evidence that the valve is overloading. The reproduction of music was very good indeed, and the response in the upper register was much better than the average cone unit. When listening to speech, however, it was found advisable to cut down the volume slightly to avoid a tendency to boom. This defect developed only when the volume was excessive.

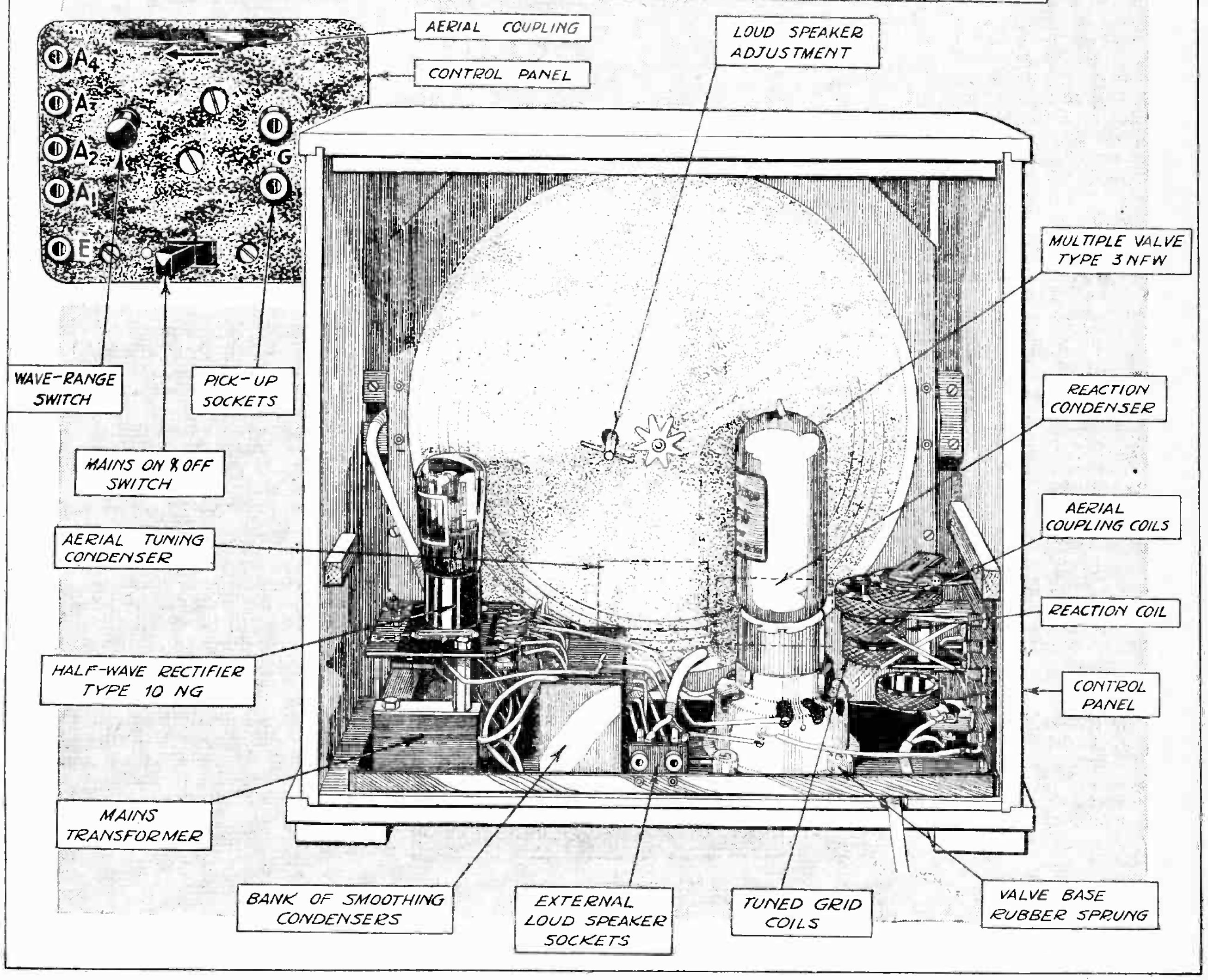
The tuning controls are simple to operate, and reaction is smooth and free from backlash. The combined selectivity and volume control (aerial coupling) had an unusually wide range, and there is little doubt that a satisfactory compromise between range and selectivity could be obtained in any conceivable circumstances. At a distance of only five miles from Brookmans Park with a 50ft. outdoor aerial no difficulty was experienced in separating the twin transmitters with the aerial connected to A_1 and the volume control coupling about midway between minimum and maximum. Numerous carrier waves of foreign stations were picked up between the two local transmitters, but any attempt to resolve them by increasing the aerial coupling resulted in interference from the strong local transmissions. On Sunday evening, however, before the commencement of the B.B.C. transmissions about ten stations were well received, showing that in more favourable circumstances foreign stations could be received in addition to the B.B.C. stations on short waves. On long waves five stations in addition to 5XX were well received.

The Loewe EB100 receiver can therefore be relied upon to give satisfactory reception of the B.B.C. regional stations, without mutual interference, under the most unfavourable conditions. Further, the range of the set is capable of giving excellent reception from the principal European stations provided it is not worked too near to one of the high-power stations.

SPECIFICATION.

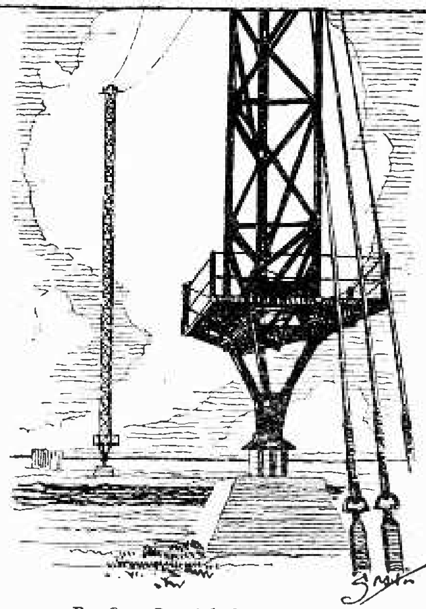
GENERAL: Self-contained, including loud speaker. For use with external aerial.
CIRCUIT: Three-stage multiple valve (metal coated). Reacting detector and two L.F. Variable magnetic aerial coupling. Half-wave valve rectifier. Provision for pick-up and external L.S.
MAKERS: The Loewe Radio Co. Ltd., 4, Fountayne Road. Tottenham, London, N.15.
PRICE: £10 10s. 0d, including valves.





Layout of components and controls in the Loewe type EB100 receiver. The dust covers have been removed from the bottom half of the cabinet.

BROADCAST BREVITIES



By Our Special Correspondent.

Well Done, Slaithwaite!

To say that a transmitter is up to B.B.C. standard is high praise, and we can say it of Northern Regional. Listening in London to the nightly tests of the past week I have been impressed mainly by the uniform quality of the transmissions. Fading is certainly more noticeable than one might expect on the comparatively high wavelength, but if Northern listeners fail to observe it there is no reason why a Londoner should grumble.

oooo

Favourable Reports.

Although at the time of writing many reports are being received at the B.B.C. Northern headquarters in Piccadilly, Manchester, no attempt has been made to collate them, and I am unable to say more than that the general impression is highly favourable.

oooo

A Talks Time-table.

No riots have ever been caused by the publication of the B.B.C. Quarterly Talks Syllabus, and none need be feared in regard to that for the coming April-June period, despite the fact that the explanatory booklet is issued free. Though excellent in its way, this Bradshaw of broadcasting carries the defects of every time-table, viz., sameness and inelasticity.

oooo

Where to Go.

Many listeners will be sorry that Mr. Harold Nicolson is discontinuing his "People and Things" talks at the end of April. Apparently, like the pussycats, we shall then become attached more to places than to people, for several authorities are to talk to us about ideal holiday centres in England, Scotland and Ireland.

oooo

Ways of Escape.

Those of us who sigh for emancipation from the common round may find it in "Escape," a series of talks by adventurers who are determined to make our flesh creep on Saturday evenings. Among the speakers, it is hoped, will be Major F. Yeats Brown, Mr. A. J. Evans, author of *The Escaping Club*, Mr. E. H. Jones, author of *The Road to En-Dor*, and some who have burst their bonds in lands across the sea.

oooo

Russia Again.

The usual weekly features on new books, plays, music, etc., remain. For the rest it can be said that there is plenty of nourishment for the thoughtful listener, while a certain section of the Press will find a succulent meal in the shape of eight talks entitled "Russia in the Melting Pot."

oooo

Pro-Russian Bias Denied.

Speaking of Russia, the B.B.C. seem anxious to clear themselves of the charge of a pro-Russian bias, but I am assured that the sudden withdrawal of the play, "'Krassin' saves 'Italia,'" must not be associated with the criticisms which Savoy Hill has recently had to face in connection with international politics.

oooo

The Real Reason?

It is impressed upon me that the main reason for holding up this play when it had reached an advanced rehearsal stage was the inclusion of many phrases and exclamations which might easily have given the impression to people who had just switched on that some great disaster was actually occurring. In the course of the play there are several S O S's and announcements that "all stations will now close down," and, with memories of Father Ronald Knox's famous broadcast hoax, the B.B.C. wished to avoid alarming the more sensitive listener.

A NEW MICROPHONE. The Lord Mayor of Munich is here seen with one of the new "Bandchen" speech microphones recently introduced in Germany. Sound waves set up vibrations in a thin band of aluminium suspended in the field of a permanent magnet.

oooo

Queer.

All one can say in the face of such an explanation is that it is a pity the B.B.C. did not discover these inappropriate passages at an earlier stage. Mr. Cecil Lewis, the able producer, has secured plenty of publicity for his postponed effort.

The play, when it has been watered down, will probably be produced in June.

oooo

Talk by Chief Engineer.

Mr. Noel Ashbridge, the chief engineer of the B.B.C., is to give the first of a series of talks on the "Progress of Broadcasting" from the National transmitters on Monday next, April 6th.

oooo

The Unsuccessful Applicant.

With a queue of would-be broadcast artistes stretching (metaphorically) from Land's End to John o' Groats, the B.B.C. are hard put to it to invent new ways of turning away the "also rans" without appearing unjust and unkind. Possibly the Blattnerphone will be of some assistance.

oooo

The Blattnerphone Arrives.

One of these instruments has now been delivered at the Corporation's research department in Clapham. As readers are aware, the Blattnerphone records by Dr. Stille's magnetised wire system. By those who have heard the instrument working at Clapham I am told that the results are surprisingly good—comparable, in fact, with good gramophone reproduction.

oooo

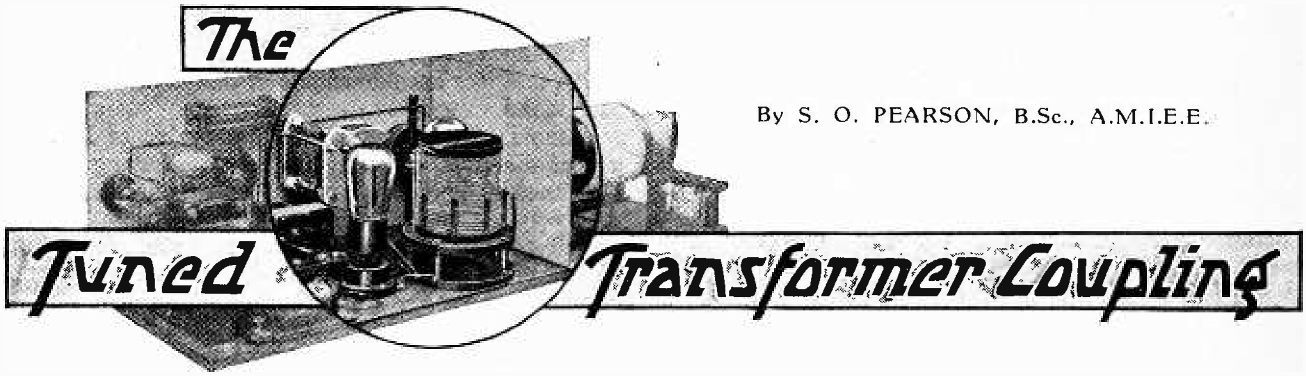
Secret Records?

There is now a scheme on foot—diabolical, perhaps, from the artiste's point of view—whereby candidates for microphone fame will be secretly recorded and cinematographed during their audition. This is already done in America, and is said to save much tiresome explanation when Miss Florrie Largelungs protests at being "turned down" because her voice wobbles. She denies the allegation and defies the "alligators," whereupon she is shown the visual and audible record of her misdeeds and is then led away crying.

oooo

Constructive Uses.

Something of the same sort may eventually be necessary in this country, though the B.B.C. hope that the Blattnerphone will be useful in a more constructive manner by indicating to artistes just how they can correct minor faults in their delivery.



The Tuned Transformer Coupling

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

Theoretical Calculation of Stage Gain.

THE behaviour of a high-frequency transformer depends not only upon its own design and constants, but also upon the nature of the load connected to its secondary circuit and on any external impedance or resistance which may be connected in series with its primary winding.

As a high-frequency intervalve coupling a transformer is normally connected as shown in Fig. 1. The primary winding is in the anode circuit of the first of the two valves to be coupled, and so carries the direct or feed current to the plate of the valve. The secondary winding L_2 is tuned by a variable condenser C_2 and has its ends connected between the grid and cathode (or filament) of the second valve, a suitable grid-bias battery G.B. being included in the position shown to ensure that the second valve shall function properly.

Since the H.F. transformer has no iron core, its action is not in any way affected by the presence of the direct-current component in the primary winding, and therefore the intervalve circuit of Fig. 1 can be replaced by an equivalent A.C. circuit, as shown in Fig. 2, the batteries being eliminated because they have no influence on the alternating components of current. The same procedure was adopted in dealing with other types of intervalve coupling in previous articles in *The Wireless World*. Stray capacities are ignored for the time being.

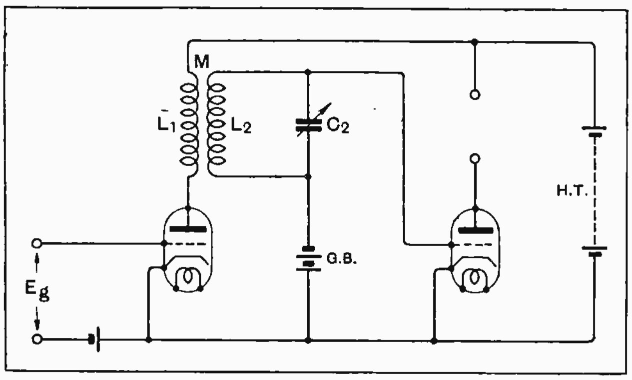


Fig. 1.—Simple circuit diagram showing how a high-frequency transformer is normally used for coupling two valves in an amplifier.

Let μ be the amplification factor of the first valve, and suppose that an alternating high-frequency voltage E_g is applied between the grid and cathode. Then an alternating voltage μE_g will, in effect, be set up in the anode circuit, this voltage being in series with the internal A.C. resistance R_a of the valve. So, in the equivalent A.C. circuit, the source of voltage μE_g, the A.C. resistance R_a of the valve, and the primary winding of the H.F. transformer constitute a closed loop as indicated on the left-hand portion of Fig. 2.

Influence of the Secondary Circuit.

The alternating component of current produced round this closed circuit is obtained by dividing μE_g by the effective impedance of the circuit. Now it was shown in the preceding article on the theory of the H.F. transformer that the current in the secondary winding exerts a considerable influence on the effective impedance of the primary circuit, and the nature of this influence was fully explained. If the secondary circuit is tuned to resonance its effect is to produce an apparent increase of primary *resistance* without affecting the reactance. For instance, if M is the mutual inductance between the windings in henrys, it was shown that the apparent increase of primary resistance caused by the tuned secondary circuit is given by

$$R_1' = \frac{(\omega M)^2}{R_2} \text{ ohms,} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

where $\omega = 2\pi \times$ frequency and R_2 is the high-frequency resistance of the secondary circuit.

So if R_1 is the actual resistance of the primary winding, the total effective resistance of the complete primary circuit will be $R_T = R_1 + R_a + R_1'$ ohms. Let L_1 henrys be the inductance of the primary coil; then ωL_1 ohms is its reactance, and the total effective impedance of the primary circuit will be $Z_T = \sqrt{R_T^2 + (\omega L_1)^2}$ ohms. The primary current is then $\frac{\mu E_g}{Z_T}$ amps.

Numerical Calculation.

To explain the actual performance of a high-frequency transformer as an intervalve coupling in the simplest and most practical way, a complete numerical calculation is given for a specified transformer. For optimum results the transformer must be designed to suit the valve in whose anode circuit the primary winding is connected; or, for a given transformer, the valve preceding it should be correctly chosen. It will be explained subsequently that the maximum signal strength is

The Tuned Transformer Coupling.—

obtained when the effective impedance of the primary winding (with the secondary tuned) is approximately equal to the A.C. resistance of the valve.

Suppose, then, that the secondary winding has an inductance value of 200 microhenrys and a high-frequency resistance of 10 ohms. Let the self-inductance of the primary winding be 100μH and the resistance also 10 ohms, and assume that the coefficient of coupling between the windings is 50 per cent., that is to say, $k=\frac{M}{\sqrt{L_1L_2}}=0.5$, from which the mutual inductance is $M=0.5\sqrt{100\times 200}=70.7$ microhenrys, or 70.7×10^{-6} henrys.

When receiving a station on a wavelength of 300 metres the frequency will be 1,000 kilocycles per second, or 10^6 cycles per second. The secondary winding of the transformer is tuned to this frequency by a suitable variable condenser, but the exact value of the capacity required cannot be calculated until we know precisely the effect of the primary winding on the secondary under normal conditions.

At 10^6 cycles per second the value of ω is $2\pi\times 10^6=6.283\times 10^6$, and ωM is therefore $6.283\times 70.7=444$ ohms. Thus, from equation (1), the effective increase of primary resistance is $R_1'=\frac{444^2}{10}=19{,}700$ ohms. The total effective resistance of the primary winding is therefore $19{,}700+10=19{,}710$ ohms. It is obvious that the actual resistance (10 ohms) of the primary winding is so small compared with the resistance effect occasioned by the action of the tuned secondary that only a negligible error would be introduced by omitting it altogether. For this reason there is no object in designing the primary winding to have a low ohmic resistance, and therefore the thinnest wire compatible with mechanical strength may be used, and where a single-layer winding is employed the spacing of the turns reduces self-capacity to a minimum.

The primary reactance, being unaffected by a *tuned* secondary circuit, is merely $X_1=\omega L_1=6.283\times 100=628.3$ ohms. Combining this in the usual way with the effective resistance, we have for the effective or apparent impedance of the primary winding (not the complete primary circuit): $Z_1'=\sqrt{19{,}710^2+628.3^2}=19{,}720$ ohms. A single coil of this impedance would take the same current, for a given applied voltage, as the actual transformer primary with the secondary tuned to resonance.

Choosing a Valve to Suit the Transformer.

For satisfactory results with this transformer the valve chosen to precede it should have an A.C. resistance of the same order of magnitude as the effective primary impedance of the tuned transformer, that is to say, about 20,000 ohms. Such a valve, of course, would be one of the three-electrode type. For use with a screen-grid valve the transformer would have to possess an effective primary impedance, under operating conditions, of a very much higher order.

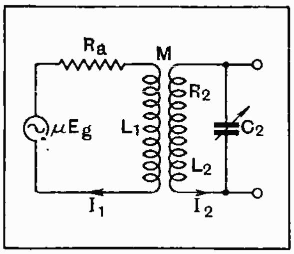


Fig. 2.—Simplified A.C. circuit equivalent to the transformer coupling of Fig. 1. Stray capacity effects are neglected and batteries are excluded because these do not influence alternating quantities.

The present arrangement, involving the use of a simple triode, has been chosen specially to clarify the underlying theory, but it should be realised by the reader that it is usual to choose or design the transformer to suit the valve.

Assume, therefore, that the first valve of Fig. 1 is one of the A.C. indirectly heated type having an A.C. resistance of 20,000 ohms and an amplification factor of $\mu=35$. The effective resistance of the complete primary circuit will thus be $R_T=10+19{,}700+20{,}000=39{,}710$ ohms, including the valve resistance and the effective increase in primary coil resistance due to the action of the secondary circuit. The 628 ohms of reactance of the primary coil is negligibly small compared with this high resistance and may be neglected, so that the total effective impedance Z_T of the complete primary circuit is approximately 39,710 ohms.

Now, suppose that a signal E.M.F. of 0.1 volt (R.M.S.) is applied to the grid of the first valve. Then the resulting equivalent electromotive force μE_g set up in the anode circuit will be 3.5 volts, and this, in turn, will drive an alternating current of $\frac{\mu E_g}{Z_T}=\frac{3.5\times 10^6}{39{,}710}=88$ microamps round the circuit. The voltage actually developed between the ends of the primary winding is therefore the product of this current, and the effective primary impedance Z_1', namely, $88\times 10^{-6}\times 19{,}710=1.74$ volts.

Special Nature of Secondary Resistance Variation.

In the previous article, already referred to, it was shown that both the resistance and the inductive reactance of the secondary winding are affected by the untuned primary circuit. The apparent increase of secondary resistance was found to be dependent on the actual impedance and resistance of the primary circuit as a whole, according to equation (6) of that article. But here we must be careful to make sure of the manner in which this apparent increase of secondary resistance manifests itself. With oscillations of constant amplitude, for instance with the unmodulated carrier wave of a received signal, the current in the tuned secondary circuit is, in truth, given by dividing the E.M.F. induced in the coil L_2 by the actual high-frequency resistance R_2 of the secondary circuit, and so, under these conditions, there does not appear to be even an apparent increase of secondary resistance.

But any decrease in amplitude of these oscillations will be accompanied by a simultaneous transfer back to the primary circuit of a proportion of the energy stored in the magnetic and electrostatic fields of the secondary circuit. Thus, with an unmodulated carrier wave, there is a steady flow of energy from the primary circuit to the secondary, just sufficient to make good the losses in the actual secondary resistance R_2, but when the wave is a modulated one there is, besides this steady flow of energy, a passing backwards and forwards of energy between the two circuits as the amplitude of the oscillation rises and falls.

The Tuned Transformer Coupling.—

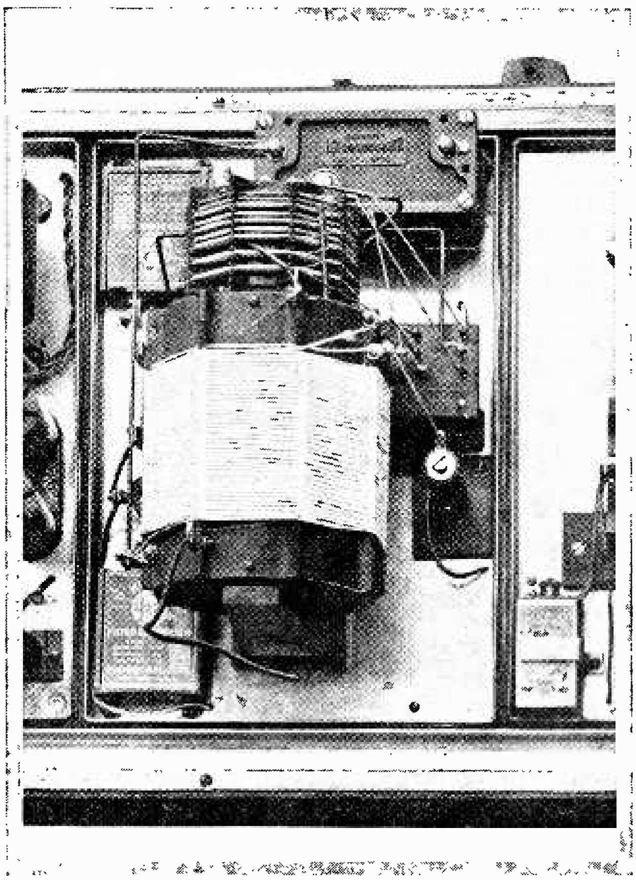
It is in terms of this transient energy alone that the secondary circuit manifests an apparent increase of resistance, that is to say, there is an effective increase of resistance only in respect of variations of amplitude, and not as regards a steady wave. Consequently, in determining the voltage amplification only the true resistance R_2 must be taken into account, but, in computing the selectivity of the coupling, the apparent increase of resistance R_2' must be added.

Calculating the Stage Gain.

Returning, then, to the numerical calculation, the E.M.F. generated in the secondary winding will be $E_2 = \omega M I_1 = 444 \times 88 \times 10^{-6}$ $= 0.039$ volt. The current in the tuned secondary is therefore $I_2 = \frac{E_2}{R_2} = \frac{0.039}{10}$ $= 0.0039$ amp., or 3.9 milliamps.

The next step is to determine the voltage developed across the tuning condenser, but before we can do this we must know the value of the capacity. The inductance of the secondary coil alone is 200 μH, and to tune this to resonance at 1,000 kilocycles per second we should require 127 micro - microfarads, *provided the primary circuit exerted no influence.* This, however, is not the case, and we must therefore first determine the effective change of secondary inductive reactance due to the effects of the primary circuit, and decide whether this is large enough to be taken into consideration.

The apparent change of secondary coil reactance is obtained from equation (7) of the previous article, being $X_2' = \left(\frac{\omega M}{Z_1}\right)^2 X_1$ ohms, where Z_1 is the *real* impedance of the primary circuit, including the valve resistance R_a and the primary reactance ωL_1 ohms. Now, $\omega L_1 = 628$ ohms, and the total resistance is 20,010 ohms, and therefore the primary circuit impedance is $Z_1 = \sqrt{20{,}010^2 + 628^2} = 20{,}020$ ohms. Thus if we neglect the reactance and resistance of the coil altogether and take the A.C. resistance of the valve to represent the impedance, the error introduced is only 1 in 1,000. Hence we shall take $Z_1 = 20{,}000$ ohms. So the apparent change of secondary reactance is



A measured stage gain of about 500 was obtained with the highly specialised H.F. transformer of "The Wireless World" "Record III" receiver.

$$X_2' = \left(\frac{444}{20{,}000}\right)^2 \times 628 = 0.31 \text{ ohm (approximately).}$$

Since the primary circuit reactance is inductive, this represents a *decrease* of secondary coil reactance. The actual reactance of the secondary winding is $X_2 = \omega L_2 = 6.283 \times 200 = 1{,}257$ ohms. We therefore see at once that the effective change of secondary reactance in the present instance is negligibly small and that, for this reason, the tuning is not upset to any noticeable extent. The tighter the coupling between the coils and the lower the valve resistance, the greater will be the effective reduction of secondary coil reactance.

Since the primary circuit has such a small effect, the tuning condenser will, after all, have to be set to approximately 127 $\mu\mu$F., giving a capacitative reactance of 1,257 ohms at 1,000 kilocycles.

The voltage developed across this condenser is therefore $1{,}257.I = 1{,}257 \times 0.0039 = 4.9$ volts, this voltage being applied to the grid of the second valve. The voltage applied to the first was 0.1, and therefore the theoretical stage gain works out to 49. This figure is the result of a valve amplification of 17.4 and transformer step-up effect of 2.83 times, the product being 49.

The calculation has been made chiefly with the object of showing the detailed actions which occur in such an arrangement. In practice, the measured results would quite likely differ considerably from those calculated, due to the effects of reaction or feed-back, and of stray capacity and the damping occasioned by the grid circuit of the second valve. In the next instalment the design of a transformer will be worked out to fulfil specified conditions.

(*To be continued.*)

THE STENODE.

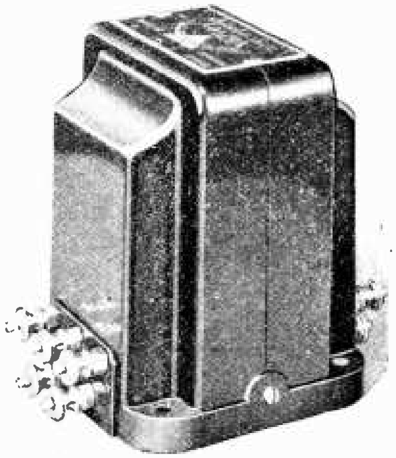
RADIO INSTRUMENTS, LTD., have just issued a little brochure entitled "The Stenode Radiostat Receiver as Designed and Produced by R.I., Ltd."

The brochure gives a good deal of information on the principle of the Stenode and includes illustrations of the very handsome instrument produced by R.I. which, complete with moving-coil speaker, is priced at £75.

Laboratory Tests on New Apparatus.

VARLEY OUTPUT TRANSFORMER. Model D.P. 20.

To obtain the best results from small output valves, they must feed into an impedance equal to twice their A.C. resistance, measured under working conditions. In many cases this state can be attained by suitably choosing the valve and the loud speaker. But this is not always practicable, since often the special nature of the amplifier demands a certain type of valve and one particular type of loud speaker may be favoured. Quite possibly their respective impedances will not offer the best combination for maximum power output, but the interposition of a transformer of suitable ratio will effect a balance.



Varley impedance-matching output transformer for use with high-resistance loud speakers.

The Varley impedance matching output transformer, type D.P.20, has been designed for use on such occasions as this, and offers the choice of five ratios—0.75 to 1, 1 to 1, 1.5 to 1, 2 to 1, and 3 to 1.

The D.C. resistance of the primary is 148 ohms, and when passing 25 mA. has an inductance of 6 henrys. The maximum current the primary will carry is 50 mA.

The makers are Varley (Oliver Pell Control, Ltd.), Kingsway House, 103, Kingsway, London, W.C.2, and the price is 22s. 6d.

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LAMPLUGH "SILVER GHOST" LOUD SPEAKER.

The principle of the "inductor" loud-speaker movement is already well known to our readers; it was fully described in connection with the Radio Show at Olympia. We have now had an opportunity of testing a production model of the Lamplugh "Silver Ghost" unit, which was the first loud speaker to be made in this country under Farrand patents.

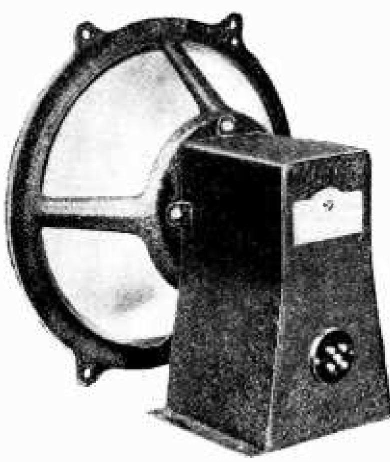
The response is exceptionally good for a moving-iron instrument, and the ear cannot detect any deviation from a uniform output from 5,000 down to 200 cycles. Below 200 cycles the characteristic rises considerably, and at 100 cycles the amplitude developed is greater than that of a moving coil. At 50 cycles the response falls off slightly, but is still greater than the average moving coil. The performance in the bass suggests a fundamental resonance just below 100 cycles.

In the particular specimen tested a slight buzz was detectable in the frequency tests between 200 and 600 cycles, probably located in the metal casing, and there was also some tendency to focusing of the high frequencies. These slight defects, however, are not noticeable under working conditions, and the reproduction of both speech and music should satisfy the most hypercritical ear.

Terminals are provided for low- and high-impedance output valves, and the windings are centre-tapped for direct connection in the anode circuits of push-pull output valves. The impedance values are as follows:—

Frequency (cycles).	Impedance (ohms). Low.	High.
50	965	2,085
100	915	1,720
200	1,680	2,940
400	2,190	4,700
800	5,270	9,220
1,600	9,700	17,300
3,200	18,400	34,500
6,400	19,500	27,800

The unit is made by Messrs. S. A. Lamplugh, Ltd., King's Road, Tyseley, Birmingham, and the price is £3 10s.



Lamplugh "Silver Ghost" inductor loud speaker chassis.

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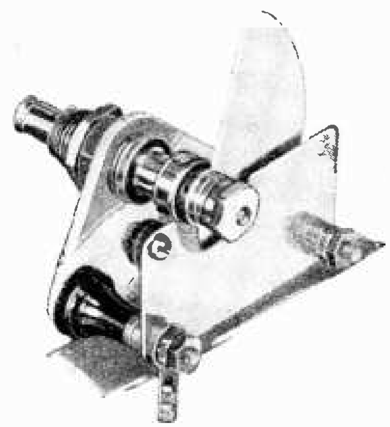
"PRE-SELECTION A.C. THREE" TRANSFORMER.

It should be pointed out that the Bayliss power transformer used in the "Pre-Selection A.C. Three" receiver, as described in *The Wireless World* for February 25th and March 4th, has the following rated secondary outputs: 135 volts, 50 milliamps.; 4 volts, 2-3 amps., centre-tapped; 4 volts, 0.25 amp., centre-tapped. This is a standard product of William Bayliss, Ltd., Sheepcote Street, Birmingham, and, with a primary winding to suit any normal voltage, costs 21s. A similar transformer for 25-cycle supplies is available at 30s.

oooo

UTILITY COUPLING CONDENSER.

When the "Pre-Selection A.C. Three" receiver was designed there was not available any commercially made variable condenser of suitable type for use as a variable coupling capacity between the circuits of the "constant width" input band-pass filter. In consequence it was necessary to dismantle and rebuild a ready-made condenser in order to obtain the right direction of rotation, and also the necessary capacity to give correct tuning peak separation over the tuning scale.



"Utility" 10-μμf. condenser for filter circuits with automatically controlled capacity coupling.

There is no longer any need for the amateur to undertake this work as the manufacturers of the "Utility" component chosen for the original receiver (Wilkins and Wright, Ltd., Utility Works, Holyhead Road, Birmingham) are now supplying a coupling condenser modified in accordance with the published instructions, both with regard to plate separation and spindle length. No extra charge is made for these alterations, as the price remains unchanged at 2s. 6d.

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Catalogues Received.

Stanjack Wood Products, Ltd., 8, Branston Street, Birmingham.—Illustrated folder dealing with the comprehensive range of finished and ready-to-assemble cabinets manufactured by this firm.

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The Automatic Coil Winder and Electrical Equipment Co., Ltd., Winder House, Douglas Street, London, S.W.1.—Illustrated catalogue dealing with automatic coil-winding machines and the coil-winding services available to manufacturers.

Letters to the Editor.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

"A WARNING TO THE POST OFFICE."

Sir,—With reference to your excellent Leader under the above heading in your issue for March 18th, there is a further important point in connection with the provision of broadcasting relay services in so far as the Post Office regulations stipulate that the maximum H.T. to be used is 150 volts, and if this regulation is strictly adhered to it is obvious that to operate an installation of 200 or 300 speakers presents very considerable difficulties if it is to be done reasonably well.

Notwithstanding the fact that this provision is in the Post Office regulations, it is pretty well known that many of these services actually do use higher voltages, and, further, that they put over gramophone records, which is also contrary to the regulations. W. BAGGS.

Manchester.

IS THE B.B.C. A PUBLIC SERVICE?

Sir,—Mr. C. W. Oliver's letter under the heading "Is the B.B.C. a Public Service?" in the issue of March 4th, 1931, arouses my indignation to such an extent as to cause me to write this letter.

Is there anybody in this country who can justly criticise the service which the B.B.C. presents to us at the present time when bearing in mind the small revenue they receive?

Mr. Oliver criticises the Regional scheme, which offers listeners over a wide area a choice of at least two programmes; he goes on to say that he himself has not benefited. He may be right for himself only, but not everybody can live so close to London as New Barnet. This view appears to me to be the height of selfishness, and, remember, other people's money is as good as his. I am sure thousands of listeners have benefited under the scheme. He goes on to say: "The service is, if anything, worse, as the alternative is often on the other station within a day or so." Is this not a step in the right direction? Mr. Oliver must remember that members of the listening public are not always all at home to hear the item on the first evening, so that a repetition gives them a chance to avoid missing it.

We must remember that the new buildings of which he complains are paid for in the form of rent, not in a lump sum at the time of erection.

I myself, and many others whom I know, think the B.B.C. gives us a very fine service for our 10s. a year, and I am sure this fact is reflected by the licence figures, which always have, and still are showing, a very rapid, steady increase. This would not be the case if listeners were dissatisfied.

Forest Gate, E.7. F. W. STURCH.

HEAT DISSIPATION.

Sir,—In reference to the Reply to Readers' Problems headed "Heat Dissipation," on p. 162 of the February 11th issue of *The Wireless World*, it may be of interest to your correspondent, and to the many users of D.C. mains sets, to know that the standard practice of my firm is to use resistance nets made by The Cressal Engineering Co., of Birmingham, for voltage reducing purposes.

We find that these nets, the area of which is about 48 square inches, easily carry the required currents—we regularly pass 1 amp. through them—without an undue rise in temperature. They consist of resistance wire interwoven with asbestos string, and have a selvedge by which they may be secured in place. Lastly, the price per net is ridiculously low, being little above the actual cost of the wire used.

Until we met these resistance nets we had never found a satisfactory solution to the problem of voltage-reducing resistances for D.C. sets.

With the usual disclaimer. F. E. GODFREY.

Hampstead, N.W.3.

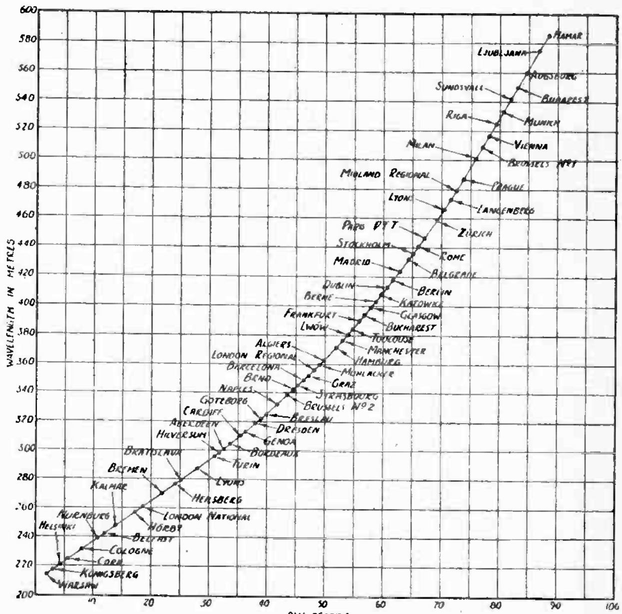
[These nets are already in use in certain commercial receivers for the purpose suggested.—Ed.]

"THE WIRELESS WORLD" BAND-PASS SUPERHET.

Sir,—We have great pleasure in forwarding you a copy of graph (reproduced) taken from readings of the oscillator condenser. This is confined to stations at loud-speaker strength, and taken in one night. Many others appeared at fair to good telephone strength and might be expected to be loud-speaker strength under other and more suitable conditions.

We certainly consider that the set is in a class of its own for sensitivity, selectivity, quality and general simplicity of handling, even by a novice; further, we believe that it will also be free from the many irregularities that often appear in other circuits; in other words, it is foolproof.

We found that it selects and handles Muhlacker even better than your articles lead us to believe. We also consider that the secret of obtaining the very best results is in the correct setting of all the pre-set condensers, and that if this is once accomplished no further trouble may be anticipated.



The set, in brief, is a brilliant justification of the revival of the superheterodyne principle, which had been abandoned for several years, and we should like to compliment the designers on their perseverance and success, and we feel that they have not yet said their last word, and look forward to hearing from them again with great confidence.

We might respectfully suggest that, for the further guidance of those who are ignorant of the various points in handling this receiver, they favour us with a special article dealing with the massed experience received from those who have constructed it. This might prove a great stimulant to others who are more or less afraid that their ignorance would prevent success. Personally, we found it very easy to construct, and were agreeably surprised in this respect. Of course, every point must be strictly adhered to. (For Bowyer and Co.) JOHN P. HALL.

RADIO DEALERS AND RADIO SOCIETIES.

Sir,—Many members of this Society have read with interest the letter of Mr. J. Baggs in your issue of February 11th, the leader in the following week's issue, and the comments of your correspondents, from which we are unable to differ, in the issue of February 25th

One is tempted to digress on an occasion like this, but, having stated that we are unable to differ from the apt observations of your correspondents, and realising the need for brevity, we will confine our further remarks as far as possible to the suggestion of Mr. Baggs and its implications, viz., that new societies should be created with a membership mainly from radio dealers and those associated with the industry.

We rather scent danger in the adoption of Mr. Baggs' suggestion, inasmuch as new societies so created might conceivably become trade advancement or protection societies with competitive rather than co-operative tendencies.

There is little doubt that the majority of radio societies fortunate enough to be alive are of amateur origin, and exist to-day by virtue of this amateur status. The co-operation of the trade in many instances could prove of immense advantage to these societies, provided their normal activities were not subordinated to the requirements of the trade, and their headquarters made to serve too often as a retailers' demonstration room.

Apart from pecuniary profit, how many retailers are really concerned with or informed about the wares they sell to the public? There is the difficulty of getting them interested in a live radio society. If it is possible to enlist their support do so by all means, it cannot but be of mutual advantage. We are pleased to acknowledge the services of as many as five members of the retail trade, but members in spite of their connection with the trade.

To avoid any misconstruction of our views, we take this opportunity of adding that we have yet to find that radio societies can be more welcomed by manufacturers. During the nearly nine years we have been organised—and we meet every Tuesday evening throughout the year—we have always found ready help from manufacturers, and demonstrations and discussions by their representatives have always proved of the greatest interest and value, and have been, with perhaps one exception, conducted in a perfectly candid manner. We owe much to the courtesy of manufacturers, and hope that contact has been healthy and mutually advantageous. It is the practice of this society to endeavour to obtain at least one manufacturer's programme during each of the winter months—we often get more.

We are also mindful of our indebtedness to amateur friends for not infrequent demonstrations and talks. Interchange of visits with a local society is also a feature of our programmes.

In conclusion, the primary aim of any successful society must be "mutual help," and with this as our slogan we find little to dismay as the years pass. It is certainly no small task to cater for the very different needs of the novice, the "hard-boiled enthusiast," and the purveyor of radio goods, but much is possible with that necessary spirit of toleration and the will to succeed. This society has always been blessed with diligent officers and many willing helpers. It is holding its sixth annual dinner-dance next week. The wonder is in such a populous district our membership is not greater. However, our vitality is strong, and we look forward to even better days for this and other societies, with the co-operation of manufacturers as hitherto and the increased support of the local radio dealers.

C. H. PIPER, Hon. Sec.,
The Thornton Heath Radio Society.

Headquarters, St. Paul's Hall,
Norfolk Road, Thornton Heath.

THE STENODE.

Sir.—As one of Dr. Robinson's assistants in his recent demonstrations of the Stenode in America, may I be allowed to reply to some of the points raised by Mr. Cocking in his recent letter, in which he compares the Stenode performance with that of the R.C.A. Radiola superheterodyne?

I was delighted to see that Mr. Cocking has been successful in receiving modulated signals on a receiver incorporating a quartz crystal, in spite of the fact that all published circuit diagrams of the Stenode are seriously out of date, and do not represent the present state of progress.

It is unfortunate, however, that Mr. Cocking's figures do not agree very well with the official curves taken by the Crosley Radio Corporation, and which Dr. Robinson is allowing me to publish in the immediate future. Presumably, he has taken his data from a rough sketch of the response curve published in the American *Radio News*, which was only intended to be of a comparative nature, and considerable error has crept in during the conversion from percentage response at 400 cycles to decibels and back again. The original curves show that the response of the Stenode at 5,000 cycles was nine per cent., and the highest point of the curve near 1,600 cycles was only 135 per cent., and not 2.5 per cent. and 250 per cent. respectively, as Mr. Cocking mentions.

Setting aside this inaccuracy in the data available to Mr. Cocking, I am afraid that I cannot agree to the statement that frequencies below 400 cycles are unimportant in a comparison of this nature, or that the rise of 250 per cent. constitutes an "enormous peak." A peak of this magnitude, even if it had been present, is not objectionable to the average listener, owing to the well-known fact that the corresponding increase in apparent audible intensity is much less; and, moreover, this peak happens to correspond to a pronounced trough in the curve of the speaker used, a fact which had been borne in mind in designing the set.

Mr. Cocking states: "It is upon frequencies higher than 2,000 cycles that we rely for faithful reproduction," and it is significant that he shows the output of the two sets to be equal at 3,000 cycles, in spite of the fact that the Stenode receiver is enormously more selective and capable of separating a transmission from two others 5 kc. on each side of it, a feat which no receiver employing band-pass methods has yet accomplished.

The statements that "the loss in the higher frequencies shown by the curve of the R.C.A. receiver can be attributed to a partial deficiency in the filter couplings," and "that an approach to perfection can be obtained by a combination of filters and single-tuned circuits such as that used in the Band-Pass Four," can only be accepted when it is realised that such methods of improving high-note response are accompanied by a further loss in selectivity, and can in no case separate stations closer together than 10 kc.

Whilst Mr. Cocking's curves may explain the cutting out of a heterodyne whistle of a frequency above 5,000 cycles, they throw no light on the separation of two stations 5 kc. apart by the Stenode. This would appear at first sight to demand a curve cutting off at 2,500 cycles if band-pass filters could be employed to give such a result. Incidentally, the Stenode under discussion was an early one not designed to reproduce above 5,000 cycles, and has since been greatly improved upon.

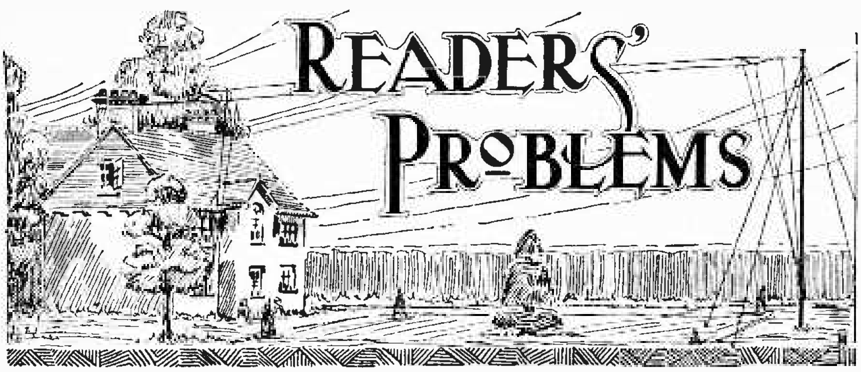
It is quite wrong to assume that the high degree of L.F. correction demanded by the Stenode necessarily implies "an inefficient and expensive L.F. amplifier." The output from the second detector at low audio frequencies is considerably higher than in an ordinary receiver, owing to the build-up effect due to the very low decrement of the selective circuits. Hence no great amplification is needed at these lower frequencies, and the design of the amplifier presents no great difficulty in practice. An amplification as high as 5,000 times at 5,000 cycles is quite unnecessary.

I was interested to see that in certain of Mr. Cocking's experiments with his Stenode he was unable to separate Muhlacker from the London Regional Station. Particular care is necessary when working with an outdoor aerial, since the very strong carrier of the local station may overload the earlier valves of the receiver. Also stray couplings of various kinds may easily upset the perfect operation of the quartz crystal, and a reasonable amount of experience with the circuit is essential before the design of such a set can be correctly worked out.

The practical difficulty in obtaining absolute constancy of the oscillator has long ago been overcome in the British Radiostat Corporation's Laboratory, and now offers no difficulty. A receiver having such great selectivity as the Stenode will naturally exhibit great sharpness of tuning, but ease of adjustment can readily be obtained by the use of a small vernier tuning condenser fitted with a good slow-motion drive, provided, of course, that the set is well designed and stable in other respects.

I fail altogether to see the force of Mr. Cocking's concluding paragraph, in which he says "that the compensating difficulties are enormously increased in the case of receivers employing a series of cascade resonant circuits." This statement is not borne out by experiment, and I know of no theoretical reasons for it. Surely the effective resonance curve of a receiver is the deciding factor, and the method by which this is obtained will not alter the degree of correction required.

45, York Avenue, London, S.W.14. E. L. GARDINER.



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 Official Document.

As a sufferer from interference from tramway power circuits, I read with interest a paragraph in your issue of February 25th, in which mention was made of a Post Office report dealing with tests carried out jointly by the B.B.C. and the G.P.O. at Blackpool. Can you tell me where a copy of this report may be obtained?

The publication to which you refer is for official use only, and we fear that you will be unable to obtain a copy. In any case, the report deals only with remedial measures that may be applied at the source of interference—on the tramcars, etc.—and does not deal with palliatives that may be applied by the listener himself.

oooo

For Battery Feed.

Will you please tell me if the "Pre-Selection A.C. Three," as described in the issues of "The Wireless World" for February 25th and March 4th, could be modified without any great difficulty for use with ordinary battery valves?

This receiver is quite suitable for battery feed, and no alterations are necessary beyond the obvious modifications to filament, cathode and grid bias circuits.

oooo

How Voltage Rises.

have an eliminator rated to give 130 volts and 30 milliamps., but wish to obtain from it a total current of 20 milliamps. at 150 volts. If I can obtain a circuit diagram of the internal connections of the instrument do you think it likely that you would be in a position to tell me how its voltage output might be increased?

In all probability it will be unnecessary to alter your eliminator—at any rate if its rating as quoted is actually correct. It can always be assumed that the voltage output of these instruments is dependent on the current taken from them; in your case, current consumption will be less than the rated maximum, and so it is likely that the voltage will rise to roughly the extent required.

Free Bias Without Complicated Switching.

I believe that, when converting a grid detector to act as an amplifier for gramophone reproduction, it is possible to make the necessary alteration of grid bias without the need for an extra pole on the change-over switch. Will you please show me how this may be applied to my own A.C. set, in which automatic grid bias is provided?

There is no difficulty in arranging matters so that the correct operating bias will result automatically when the grid circuit is switched over from "detection" to "pick-up." Suitable methods of connection are shown in Fig. 1. The first diagram (*a*) illustrates the method applicable when the valve is biased by inserting a resistance in the cathode lead, while the second (*b*) indicates the appropriate connection when bias is obtained from a potentiometer in the common H.T. negative lead. In these diagrams the necessary by-pass condensers are marked C, while the decoupling resistance that is advised with the second method is marked R.

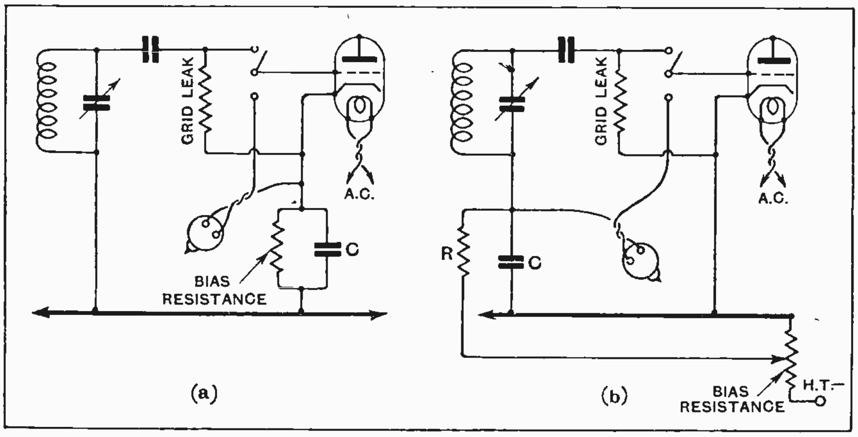


Fig. 1.—Alternative methods of obtaining negative bias for a detector valve when converted to act as an L.F. amplifier.

It will be observed that the grid voltage of the valve when acting as a detector is determined by the connection of the low-potential end of the grid leak in either case.

oooo

A.C. to D.C.

I have an "all-mains" four-valve D.C. set, and, now that our electricity supply is shortly to be changed to A.C., I am wondering what will be my best method of procedure. If possible I should like to avoid any alteration to the set itself, and suppose that it will be necessary to obtain a rotary converter. Is it possible to obtain one of these instruments to convert A.C. to D.C.?

It is certainly possible to obtain a rotary converter or motor generator that will give a D.C. output when connected to A.C. mains, and, as you say, the use of one of these appliances affords the only possible solution to your problem, provided that the set itself is not to be altered.

oooo

Effect of Strong Signals.

My H.F.-det.-L.F. set includes anode bend detection, with a meter for indicating change of anode current due to signals. Results are quite good, as long as current is not allowed to exceed a value of about 0.5 milliamp, but when it rises to anything appreciably greater than this violent motor-boating takes place. It is quite impossible to work with an anode current of about 1 milliamp, which has been suggested in your journal as correct for a valve of the type that I am actually using. Can you make any suggestions?

We think that the receiver is suffering from incipient L.F. oscillation, which brings about actual motor-boating when a strong signal is applied to the detector. It is suggested that the anode circuit of this valve should be decoupled; if this precaution has already been observed, then we advise you to decrease the values both of the decoupling resistance and of the associated by-pass condenser. It would also be wise to pay attention to the separation of H.F. and L.F. components in the detector anode circuit

Filter-detector Set.

Would the type of input band-pass filter in which a small condenser, joined between the high-potential ends of the coils, is used as a coupling, be satisfactory for a simple detector-L.F. set with reaction and one L.F. stage; the proposed receiver is to embody power grid detection, and is to be used almost exclusively for short-distance reception? If so, I should be obliged if you would give me the circuit diagram of a suitable arrangement.

This type of filter coupling is as suitable as any other for a set such as you describe; the limitations of reaction control (which have been discussed in this journal) will apply to this circuit, but no more than in the case of a filter with any other form of coupling.

A suggested circuit arrangement is given in Fig. 2.

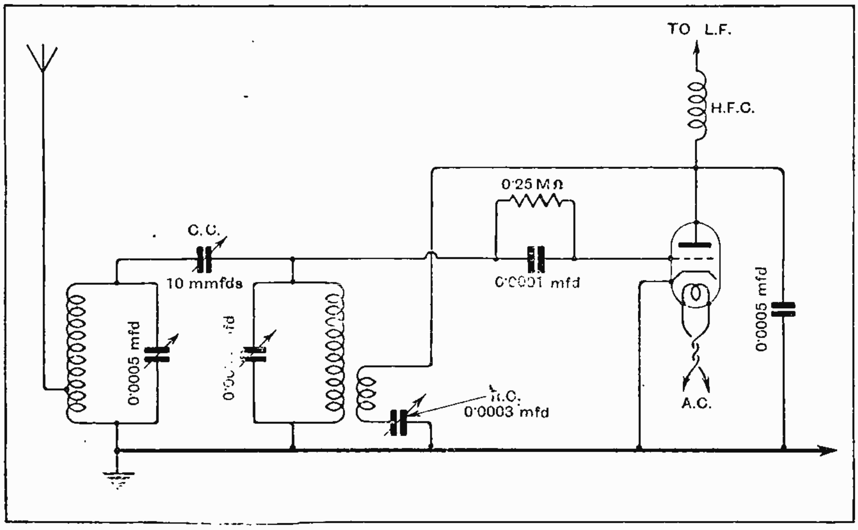


Fig. 2.—Filter circuit with automatically controlled capacity coupling in conjunction with a power grid detector.

Induction Motors.

I notice that a large number of radio-gramophones are fitted with induction motors; can you tell me if motors of this type are available in a form suitable for operation on a 220-volt D.C. mains supply?

Induction motors are essentially for operation on A.C. supplies, and in your case you must use a motor of the commutator type.

Low-capacity Loud Speaker Extensions.

Comparative tests show that the quality of reproduction of my loud speaker is definitely impaired when it is connected at the end of a long extension lead. A choke filter output is fitted, and it would not be a difficult matter to arrange to use a single-wire extension with an earth return. Do you consider that the reduction in capacity would be sufficient to be worth while?

By running the single-wire extension lead at a reasonable distance from earthed objects, such as water-pipes, electric lighting conduits, etc., it should be possible to keep down its capacity to earth to a value that is very low in comparison with that of the usual twin-wire extension. Provided reasonable care is taken, we think you would be well advised to make the change.

H.F. Couplings and Quality.

In a receiver with a single H.F. stage, which form of coupling—tuned anode, tuned grid, or transformer—do you recommend from the point of view of good quality reproduction?

On the score of quality there is no real difference between these methods of H.F. coupling. Admittedly, the use of the tuned-anode system permits L.F. voltages to be fed back to the detector grid, and thus may be indirectly responsible for L.F. reaction, which may impair quality; however, even this possibility may be entirely avoided by proper decoupling.

Grid Circuit Wiring.

I have a commercial H.F.-det.-L.F. three-valve set, and, now that a battery eliminator has been fitted, find that there is a good deal of spare room in the base compartment, in which batteries were originally accommodated. Do you consider that it would be wise to use this space for a band-pass input filter, for which there would be ample room? The only possible drawback seems to be that a fairly long lead to the grid terminal of the H.F. valve would be necessary.

No serious difficulty need be anticipated in making the alteration proposed, particularly if the H.F. valve anode circuit components are fairly well screened. It would be wise completely to screen your filter unit, and the difficulty of the long grid wires should be overcome by running both "go" and "return" leads side by side, and with a spacing of about $\frac{1}{4}$in. throughout the greater part of their length.

Insufficient Power.

I am sending you a circuit diagram (with values marked) of my detector-2 L.F. receiver; can you tell me why it is impossible to obtain proper reaction control?

The detector anode resistance, which is shown as being of 0.25 megohm, is certainly too high, but you might be able to improve reaction by shunting it with a condenser of about 0.0003 mfd. This alteration, however, will introduce a certain amount of high-note loss, and we think it would be better to use a resistance of much lower value.

A Noisy Transformer.

My newly constructed detector-2 L.F. mains set seems to be lacking in stability, as motor-boating occasionally takes place. Do you think that this might be due to the use of a faulty power transformer? I notice that this component becomes warm after extended use, and that a distinct hum or vibration seems to emanate from it.

It should be pointed out that it is an extremely difficult matter to get two stages of L.F. amplification into a state of satisfactory operation when modern A.C. valves are used, and it is for this reason that such an arrangement is seldom advocated nowadays.

We do not think that your trouble is due in any way to the transformer; the noise you describe is probably due to loose-core laminations, and it may possibly be prevented by tightening up the clamps.

FOREIGN BROADCAST GUIDE.

BRESLAU

(Germany).

Geographical position: 51° 5′ N., 17° E.

Approximate air line from London: 743 miles.

Wavelength: 325 m. Frequency: 923 kc. Power: 1.7 kW.

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

Standard Daily Transmissions

07.15 G.M.T., gramophone records (Sun.); 08.15, chimes (Sun.): choral concert; 09.00, sacred service (Sun.); 10.35, gramophone records; 11.00, relay of Berlin (Sun.); 12.10, concert, then continuous programme until 20.00, main evening entertainment; 22.00, relay of "Talkie" film (Fri.): frequently relays dance music from Berlin after 21.30.

Man announcer. Call: *Achtung! Achtung! Hier Schlesische Funkstunde Breslau und Gleiwitz.*

Interval signal: Metronome (240 beats per minute).

Closes down with usual German formula, followed by *Deutschlandslied* (German National Anthem).

Relay: Gleiwitz: 253 m. (1.184 kc.), 5.6 kW.

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Policing the Ether.

A CORRESPONDENT in this week's issue suggests that definite action should be taken to bring the radiation of man-made static within the reach of the law.

The B.B.C. are licensed by the Postmaster-General —who has a statutory monopoly of the ether—to provide broadcast programmes. The listener is induced by the offer of this service to install a receiving set and to pay a yearly fee of ten shillings, part of which goes into the coffers of the B.B.C., whilst the remainder is a tribute paid to the P.M.G. For this, it is argued, the listener should, in equity, be protected either directly by the P.M.G., who is the big policeman of the ether, or by his licensee, the B.B.C., from all *avoidable* interference with the peaceable enjoyment of that for which good money has been paid. There are few listeners who will quarrel with this argument. The difficulty is to find a way to give it full legal effect.

The Legal Position.

Our correspondent's letter refers to the Public Utilities Act, which we are unable to identify, though it is possible he means the Public Works Facilities Act of 1930, which modifies and simplifies the procedure under which special orders made by the Electricity Commissioners under the Electricity Supply Acts are given what amounts to the force of law.

There are more ways than one of creating new laws. For instance, various Government Departments may for certain purposes make special administrative orders, which do not require confirmation by Act of Parliament to bind the general public. In fact, the local bylaws under which wireless retailers are from time to time prosecuted for making undue loud speaker "noise" fall under this head.

Powers of the Electricity Commissioners.

In the Electricity Supply Act, previously referred to, powers are given to the Commissioners to make administrative orders regulating electricity supply services. These orders may contain any "consequential, incidental, and supplementary provisions which appear to be expedient" (Section 6). Also under Section 8 general authority is given over the supply within each district, as regards the construction of "generating stations, main transmission lines, and other works."

In the case of private generating stations, the owners must conform with any regulations made by the Commissioners as to the "type of current, frequency, and pressure to be used" (Section 11).

Somewhere within the extensive area of these powers there may well be found an opportunity for the Commissioners to protect the broadcast listener from certain definite forms of avoidable interference.

Whether this be so or not, it seems desirable that the P.M.G. should exercise more vigilance against those who wantonly trespass on his monopoly of the ether. The Treasury and he are willing to cull the flowers (to the tune of

In This Issue

Policing the Ether.—

£525,000 last year), but nobody seems to want the job of keeping down the weeds—though the one may well smother the other unless checked in time. In fact, the present situation makes one regret that the Wireless Telegraphy Bill of 1925 was allowed to drop instead of being forced through on to the Statute Book.

Section 7 of that Bill read as follows:—

"The provisions of this Act shall apply to the installation and working of apparatus for utilising etheric waves for the purpose of the sending or receiving of *energy* without the aid of any wire connecting the points from and at which the energy is sent and received, in the same way as they apply to apparatus for wireless telegraphy."

Since the main purpose of the Bill was the control and regulation of wireless transmission and reception, this Section would have given the P.M.G. full authority to control and regulate the radiation of etheric energy of any kind or description. It was no doubt at the time intended to apply to the wireless transmission of *power*, but the wording was as set out above.

Radiation of Energy.

The origin of all "man-made static" is the radiation of *energy*, so that the users of all forms of electrical apparatus capable of disturbing the peace and quietness of the ether could have been held liable under the terms of this Section (a) on conviction to twelve months hard labour or to a fine not exceeding £100, or (b) on summary conviction to three months hard labour or a fine of £50.

One may be sure that the manufacturers of any appliance likely to bring the user within the reach of the pains and penalties set out above would scarcely find a market unless their goods were guaranteed to be free from blame in this respect. Necessity is the mother of invention, and an efficient "anti-static" device fitted to each appliance would soon have been the order of the day.

It is interesting to recall that at the time the 1925 Wireless Telegraphy Bill was before Parliament, objection was raised to the Post Office seeking powers to strangle the development of "ether power transmission at its very birth." "Surely," said one prominent critic, "the proper course to adopt would be to prosecute any offender if and when he hinders the general transmission or reception of wireless messages."

These are indeed words of wisdom—though their significance was not, perhaps, wholly realised at the time they were spoken. Events may still make it possible to resuscitate the Bill, and to place it on the Statute Book. Once there, it could be used, with discretion, to relieve a situation that is steadily growing more and more burdensome, and which is definitely prejudicial to the development of the wireless industry.

Flashing signs: a prolific source of interference.

Alternative Long-Wave Programmes.

It is now many months since *The Wireless World* first proposed that an endeavour should be made by the B.B.C. to establish a claim for a second long-wave channel in order to enable the Regional scheme, with alternative programmes, to be applied also to the long waves. Daventry, 5XX, is still regarded to-day as the transmitter which covers the largest area of the country, even though the more densely populated districts are now supplied by local transmitters of medium wavelength.

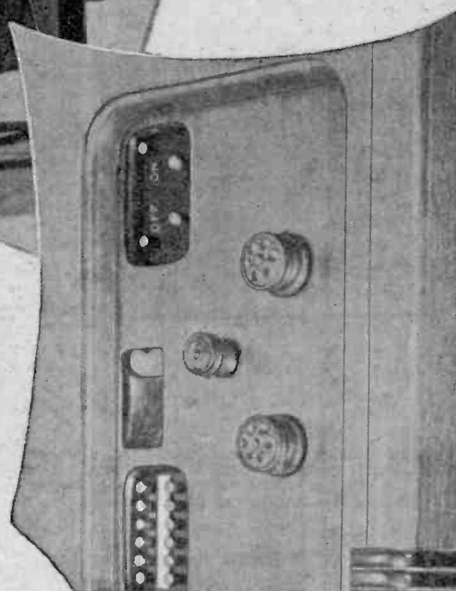
To establish an alternative long-wave transmitter would, as we have already pointed out, not take very long if once the wavelength could be fitted in, and then the alternative programmes on long waves would serve the whole of the country not already supplied with two programmes from local transmitters, and would bridge the period of time which will be required to develop the Regional scheme as a whole on medium waves throughout the country.

Rumours have reached us from time to time to the effect that the B.B.C. are interesting themselves in the question, but the need for haste in staking a claim for a second long wavelength is now urgent, by reason of the insatiable appetites of the Continental countries for additional broadcasting channels.

Attention should be paid, too, we think, to the type of programme at present being transmitted from 5XX, for as things stand now, this programme is merely a duplication of the National transmissions, whereas we feel that it should be an independent programme, embodying all that is best in British broadcasting.

Something New in Cabinet Design

An American "Break-away" in Radio Furnishing.



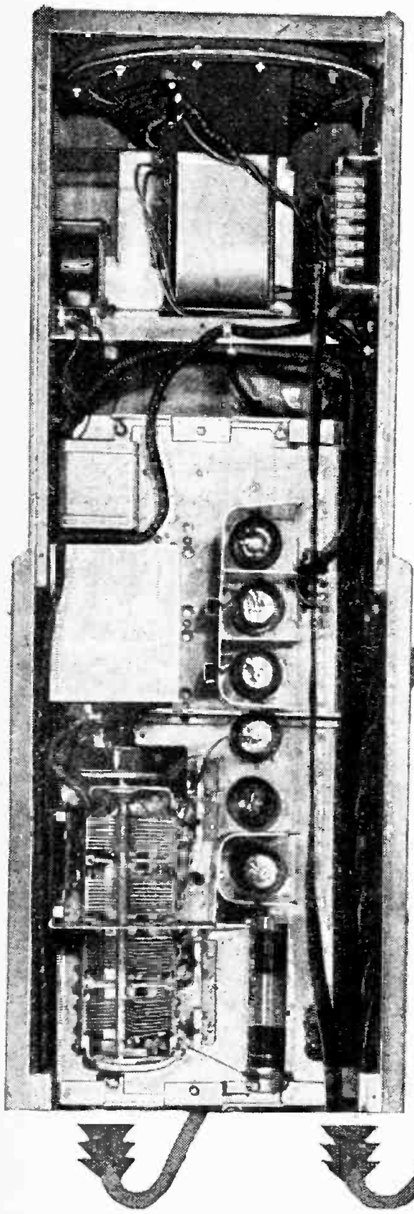
The grandfather clock de luxe containing a complete A.C. superheterodyne receiver and moving-coil speaker. Inset is shown the control panel situated at one side of the cabinet.

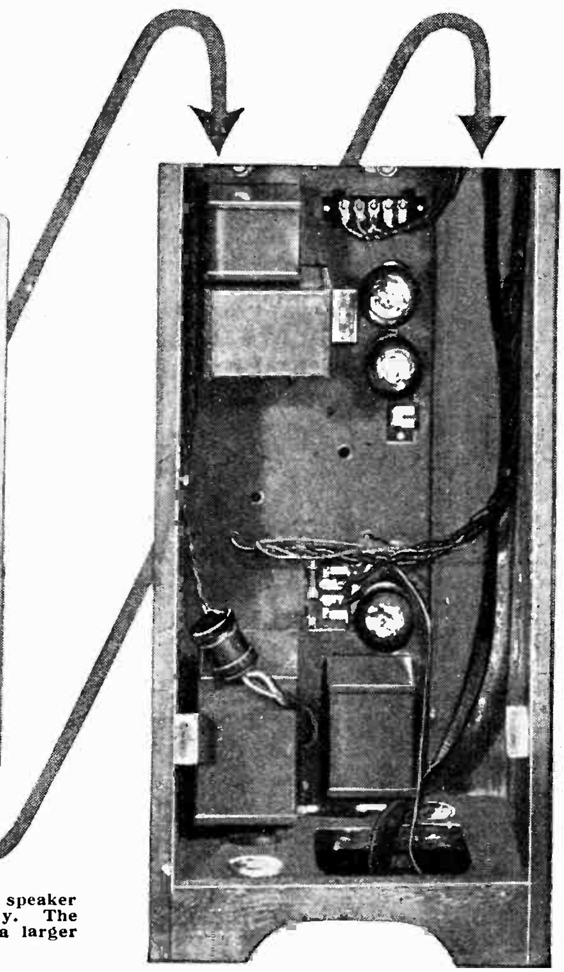
THERE is, of course, nothing new under the sun, and the cabinets which house radio sets have been stereotyped pieces of furniture for so long that the news that one manufacturer has at long last broken away from tradition and put his set in a really different kind of cabinet comes as somewhat of a shock.

The new set, pictured here, is called the "Columaire," and is the product of the Westinghouse Electric and Manufacturing Company of Pittsburg, Pa. The essential feature of the set is that it has been built vertically instead of horizontally, and housed in a case similar to a grandfather clock. This design has been produced in response to a public demand for radio sets which take up less floor space. The actual floor space occupied measures 10 × 12in., and the cabinet is 59in. high. Thus, it is particularly adapted to the needs of small houses or flats.

There are many unique features in this newest design in

Something New in Cabinet Design.—
radio receivers. Perhaps the most radical and important one is the elimination of the speaker grill from the front face of the cabinet and the placing of it vertically so that the sound is directed upward through the top of the cabinet. This arrangement provides a 5ft. column of air under the speaker, from which comes the name of the set, "Columaire," and this, it is claimed, allows the acoustic engineer, for the first time, to exercise the full scope of his knowledge in providing practically perfect reception.





Showing the interior of the receiver, loud speaker equipment and remote control assembly. The cutting of the picture was only to enable a larger view of the interior to be printed.

Another important and novel feature is the provision of a plug of scientifically designed shape above and within the cone of the speaker. This plug not only results in the better performance of the speaker than if it were absent, but it also eliminates any effect due to ceiling height. In other words, the set will perform equally well whatever the height of the room in which it is installed. Another advantage of the new speaker position is the elimination of the so-called "beam effect," due to which the volume of sound directly in front of the speaker is greater than it is in other positions, and this arrangement also eliminates interference due to wall reflection at the side and behind the set. The back of the set is closed except for openings which are introduced at scientifically determined positions to enable the speaker to reproduce with unimpaired accuracy the original broadcast.

The net result of the combination of the vertical column of air, the sound plug, and the position of the speaker, is an even distribution of sound throughout the room, and clearer and more pleasing reproduction.

All controls and dials are flush mounted on the sides of the instrument, and are readily usable from a standing or sitting position, whilst remote control can be fitted if desired. The circuit used in the set is a 9-valve screen-grid superheterodyne, with tone control. The back of the cabinet is easily removed for the placing of valves or the servicing of the set, and the vertical arrangement of the chassis makes these operations unusually simple. This cabinet design also does away with the unsightly appearance of aerial, earth, and power-socket connections.

Another innovation is the inclusion on the front face of the set of a Westinghouse electric clock. As time is now so very closely identified with radio, the inclusion of a timepiece in the radio set is considered a necessity. Electric clocks of the type fitted operate from 110-volt 60-cycle A.C. mains, and consist essentially of a small synchronous motor to which the hands are connected through gears. Since the power companies maintain their frequency with extreme accuracy (they have to, on account of the extensive "tying-in" of remote plants), it follows that the clock keeps accurate time, and it needs no winding or other attention.

The new set shows the influence of skyscraper design. When ground space becomes scarce and it is impossible to build outwards, buildings increase in height.

TONE AND VOLUME CONTROL

of Gramophone Pick-ups

Obtaining a Uniform Level of Reproduction.

By JOHN HARMON.

(*Continued from page* 316 *of previous issue.*)

IN the last instalment the various causes of resonance in a pick-up were examined, and an equivalent electrical circuit was found which represented the pick-up at low frequencies.

In Fig. 10 a needle point is shown travelling from left to right as a grooved section of a record rushes past it. The linear velocity of the point is evidently the sum of the velocity of the pick-up and the velocity of the point relative to the pick-up. It is preferable to deal with *angular* velocity instead of *linear* velocity, since in the electrical analogue it is the former which is represented by current.

Mechanical.	Electrical.
Torque.	E.M.F.
Moment of inertia	Inductance
Compliance	Capacity
Damping	Resistance
Angular Velocity	Current.

When the mechanical system is replaced by its electrical equivalent, the corresponding quantities are given in the table which is shown above.

Thus in Fig. 10 (*a*) if the pick-up is held immovable, the needle point will appear (to an eye placed at the needle clamp P) to move with a certain angular velocity, which is, in fact, the angular velocity with which the groove appears to sway to and fro when viewed from P. If now we release the pick-up it will move to the right with an angular velocity, as seen from the fixed point Q, while simultaneously the armature rotates with its own angular velocity; and, as shown by the equation at the top of Fig. 10, the first velocity is the sum of the other two.

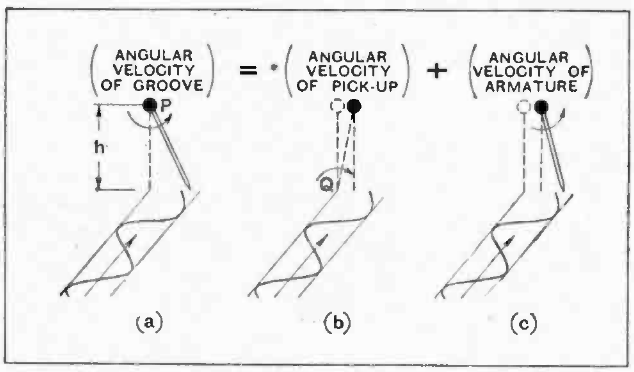


Fig. 10.—If the pick-up is held fast at P the needle point moves with an angular velocity as seen by an eye at P. This is the angular to-and-fro velocity of the groove. When the pick-up is free it oscillates as in (b) and the armature also oscillates as in (c).

Hence the analogous electrical system (Fig. 11) is driven by a constant current generator, and the currents in the two branches are as shown.

Thus, if the inertia of the pick-up is extremely large, no current flows in that branch—that is, the pick-up has no oscillatory velocity. On the other hand, if the armature spring is very stiff, i.e., if the compliance is very small, no current flows in the armature branch, and Fig. 11 then shows that the pick-up velocity equals that of the undulation of the groove, the needle acting merely as a rigid connecting link.

When the exciting frequency is such that resonance occurs, though the supply current remains constant, a large current surges round the tuned circuit, i.e., the armature movement is large, and a peak occurs as in Fig. 9, given in last week's issue.

Resonance at High Frequencies.

Many pick-ups show a resonance occurring in the region between 1,000 cycles and 5,000 cycles. This effect cannot be predicted from the circuit of Fig. 11, and we must conclude that some factor, hitherto omitted, plays a part at high frequencies. This factor is, in fact, the bending of the needle, which acts as a spring and is capable of tuning with the inertia of the armature to form a resonant system at high frequencies. It is easy to see how the needle compliance should appear on the diagram, and we may set it down without further ado in Fig. 12. C_N, the needle compliance, is much smaller than C, the armature spring compliance; often it is about one-tenth of C when loud-tone needles are used. Resonance occurs when L_A (moment of inertia of armature round pivot) is tuned to C and C_N in series, or, if we neglect the impedance of C in comparison with C_N, resonance occurs when $L_AC_N = 1/(2\pi f)^2$.

Fig. 13 shows the effect of using different needles upon

Tone and Volume Control of Gramophone Pick-Ups.—the position of the high-frequency resonance peak, the highest frequency corresponding to the stiffest needle. Evidently the quality of reproduction can be altered considerably by a change of needle. In some types of pick-up this peak is displaced to very high frequencies (higher than any which occur on the record) by reducing the inertia of the armature to the smallest possible amount; this is done by using the needle itself as an armature. The B.B.C. uses this type largely for its transmissions, but for domestic use a rising characteristic in the treble is often preferable in order to correct defects in the amplifier and loud speaker.

Needle and Groove.

An unworn needle fits snugly into the groove, as shown in Fig. 14, which is an accurately drawn profile of an H.M.V. groove and H.M.V. loud-tone needle. The Parlophone groove has a similar profile, but it is noteworthy that the Columbia records have a much deeper groove, and should not be used with H.M.V. needles. The force exerted by the groove on the needle is shown by the sloping arrow, and may be resolved into horizontal and vertical components, which are equal if the slope be taken as 45°. The horizontal component serves to drive the needle and armature, while the vertical component tends to lift the pick-up against its own weight, and, if large enough, may cause the needle to chatter, or even to jump the groove. Since the sloping arrow, when reversed, gives the force of reaction of the needle against the groove, it measures the wear of the record, which thus goes in hand with the driving force.

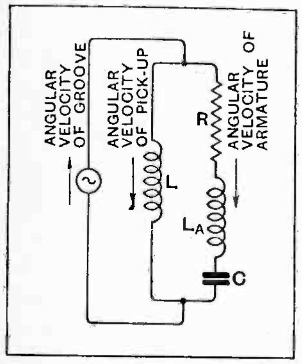


Fig. 11.—Electrical analogue of a pick-up driven by a record. The velocities shown in Fig. 10 reappear as currents.

The driving force F (Fig. 14) exerts a torque round the armature pivot. This torque acts on the mechanical impedance of the pick-up, and imparts angular velocity to each part of it. Accordingly, in the electrical analogue of Fig. 12, it is represented by the voltage which drives current through the various impedances; it is, in fact, the p.d. at the terminals of the constant-current generator. At frequencies where this p.d. rises to a peak we get large currents (loud reproduction), record wear, and a tendency to chatter.

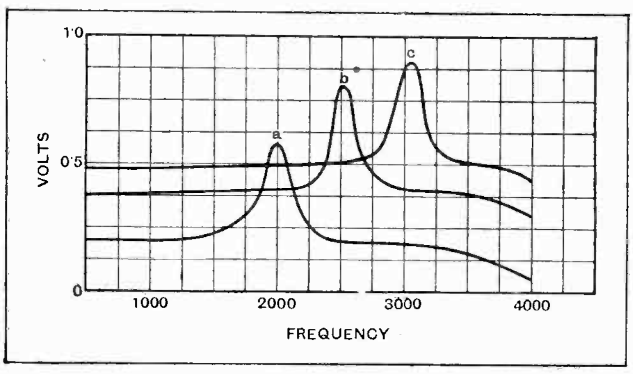


Fig. 13.—Variation of position of a high-frequency output peak due to change of needle. (a) soft tone. (b) medium tone. (c) loud tone.

At low frequencies the current through C_N is negligible, and resonance occurs when L is tuned to C (L_A may be neglected in comparison with L). Thus, the system acts as a rejector circuit, and the p.d. across it rises to a high value. At high frequencies the current through L is negligible, and when L_A is tuned to C_N (the impedance of C being negligible compared with that of C_N) a rejector circuit is formed by the two right-hand branches. Thus the rising characteristics at extreme frequencies typified by Figs. 9 and 13 have their advantages offset by increased record wear and a possibility of needle chatter.

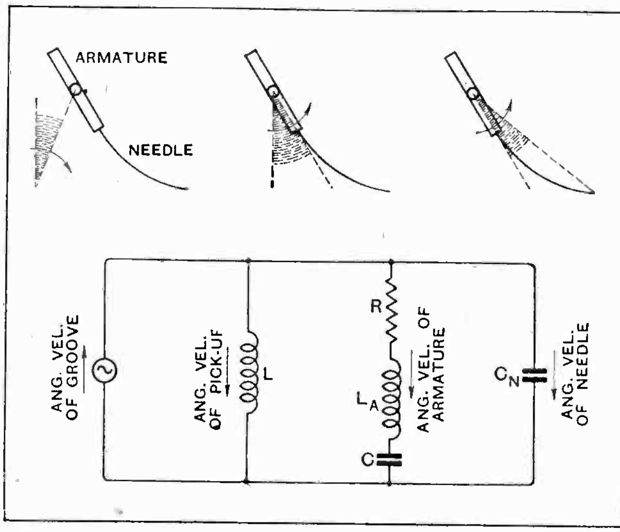
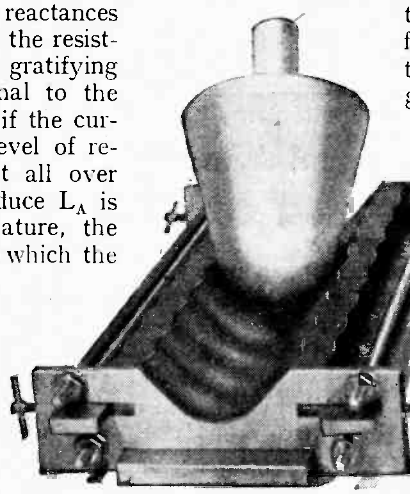


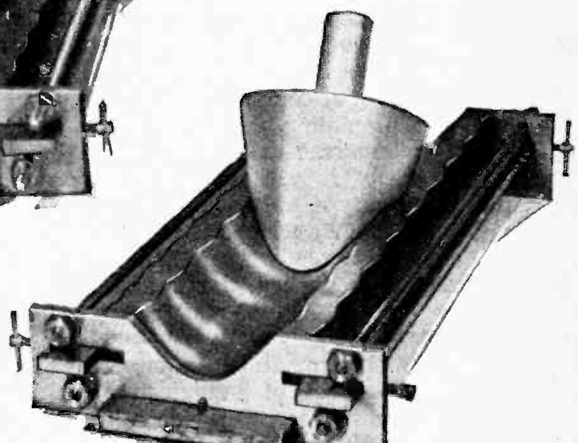
Fig. 12.—Electrical analogue of a pick-up including needle compliance. L (in henrys) = moment of inertia of pick-up round needle point = Mh². L_A = moment of inertia of armature round its pivot. C (in farads) = compliance of armature spring. C_N = compliance of needle. R (in ohms) = damping resistance. The various currents (in amperes) have the values of the angular velocities shown at the top of the figure.

Record Wear.

Readers have no doubt been puzzled at times by remarks such as: "record wear is accentuated when the armature contains a reactive component," or "wear is a minimum when the needle load is purely resistive." The meaning of these statements, which, by the way, are somewhat misleading, becomes clear in the light of Fig. 12. Since the p.d. across the constant-current generator represents the torque imparted by the record to the armature *via* the needle, it is proportional to the corresponding reaction of the needle on the record, and hence to record wear. Accordingly, we try to keep this p.d. down to a low value when endeavouring at the same time to get as much current as possible

Tone and Volume Control of Gramophone Pick-Ups.—
through the armature branch (i.e., maximum possible armature velocity). This involves reducing the impedance of this branch to the lowest possible value; and if this can be done by making the reactances of L_A and C small compared with the resistance R, we have, in addition, the gratifying result that the p.d. is proportional to the current at all frequencies, so that if the current remains constant (uniform level of reproduction), the wear is constant all over the record. The only way to reduce L_A is to use the smallest possible armature, the limit being reached in pick-ups in which the needle itself serves as armature, while the impedance of C reaches its minimum when the armature spring is weakened till it only just prevents the armature from sticking to the magnet.





The photograph on the left shows an enlarged view of a new loud tone steel point in a 4,000 cycle groove. A badly worn steel point is illustrated below.

Needle Wear.

The length of a complete undulation of the groove corresponding to any given frequency increases from beginning to end of a record, since the inner grooves have a smaller circumference. Thus, at a frequency of 5,000 cycles the wavelength at the start of a 12in. record is 0.0097in. (Fig. 15), while at the end it is only 0.004in. The needle point is able to follow the track at the start, but by the end of the run its section is worn to an elliptical shape which cannot follow the curvature of the groove faithfully. Talkie records are made with the spiral running outwards instead of inwards, and have the decided advantage that the steeper undulations of the inner grooves are negotiated by the needle while it is still unworn.

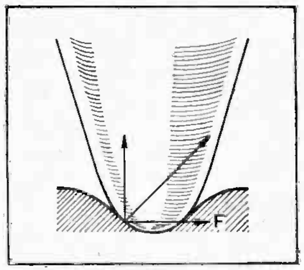


Fig. 14.—Diagram on left shows profile of needle and groove. The force exerted by the record on the needle is along the sloping arrow, and its vertical and horizontal components are shown.

Flexible Needles.

Claims are sometimes made that the use of very flexible needles is advantageous in reducing record wear, and to a certain extent this is true, since C_N is thereby increased to a degree where most of the current is shunted through it, and so the p.d. across the generator is kept down to a low value. But this advantage is illusory, for the current is thereby diverted from the armature branch (thus diminishing the general strength of reproduction). In other words, the needle, but not the armature, is being driven by the record. Moreover, the frequency at which L_A and C_N form a resonant system is displaced to a lower value, so that a peak occurs in the middle of the audio region.

The arguments brought forward in this instalment and the preceding one lead to the conclusion that it is quite feasible to produce an electrical pick-up which will give practically uniform reproduction over the range from 50 to 6,000 cycles, and which will also give rise to uniform wear at every point of the record. Indeed, several types of pick-up now on the market substantially fulfil these exacting conditions. But on the other hand, it is unfortunate that records themselves have not yet reached the stage of perfection where they can do full justice to such excellent pick-ups, since the amplitude of the undulation of the groove is insufficient at frequencies below 250 cycles, and the surface noise, which is due to the abrasive action of the record, destroys the value of reproduced sounds at frequencies above 5,000. A grindstone is out of place in an orchestra. Accordingly, in view of these defects and further deviations from the uniform level of reproduction due to loud speakers, recourse is frequently had to the production of mechanical resonances in the pick-up system, and by introducing one such resonance at the low-frequency end and another at the high-frequency end of the scale, the drooping level of reproduction can be straightened out. But at a price—the price of unequal wear and consequently shorter life of the record.

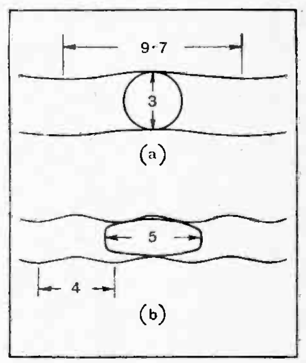
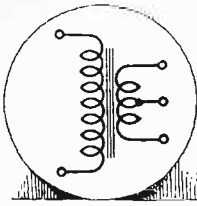
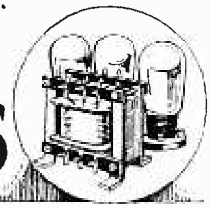


Fig. 15.—Needle in undulating groove of frequency 5,000 cycles on a 12in. record. (a) Unworn needle in an outer groove. (b) Worn needle in an inner groove. The dimensions are in thousandths of an inch.

The next instalment will deal with various forms of tone correctors which can be constructed by the amateur and inserted between the pick-up and the grid of the first valve. (*To be concluded.*)



Filament Transformers



Constructional Details and Winding Data.

By H. B. DENT.

SOME time back the writer was asked by a friend if it was possible to construct a filament transformer of small size with an output sufficient to supply a three-valve set consisting of two indirectly heated A.C. valves and a directly heated output valve. Two stipulations were made, the transformer had to be reasonably efficient and comparatively cheap.

The occasion promoting this request was one that quite possibly many readers of this journal have had reason to consider. It was desired to modify a set fitted with battery type valves but deriving its H.T. from an A.C. eliminator which, after many months of experiment, had eventually been converted into a highly satisfactory accessory giving a very generous output.

Alternative Secondary Windings.

The only additional apparatus required to make the set entirely independent of batteries are A.C. valves and a suitable transformer. Incidentally, a transformer could have been purchased, but the individual concerned had a flair for constructional work, a characteristic which is doubtlessly shared by many who read these pages. Thus a few notes on the construction of this transformer might prove of interest to those contemplating a similar modification to their sets.

Provision is made for two separate output voltages, one giving 4 volts at 2 amps., and the other 6 volts at 0.5 amp. The former is for two indirectly heated A.C. valves, while the latter provides filament current for a directly heated 6-volt output valve. Both windings are centre-tapped. These voltages may not meet all requirements, since many will probably prefer to employ the indirectly heated valves throughout. In this case one secondary winding, designed to give 4 volts at 3 amps., would suffice. It is advisable to mention at this stage that the space available is strictly limited, and even with the exercise of the greatest circumspection in winding it will be impossible to accommodate more than two filament windings at the most.

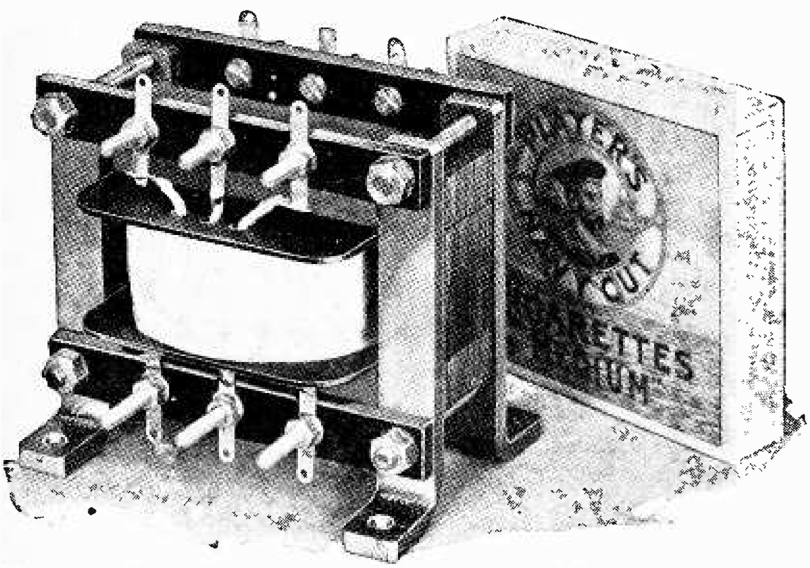
TABLE I.

Design No.	Secondary Voltage.	Secondary Current.	Wire Gauge. (S.W.G.).	Turns.	Quantity. (Approx.).
1	(a) 4	2 amps.	No. 20 D.C.C.	32	10 yds.
	(b) 6	0.5 amp.	No. 22 D.C.C.	46	15 yds.
2	(a) 4	2 amps	No. 20 D.C.C.	32	10 yds.
	(b) 4	0.6 amp.	No. 22 D.C.C.	32	10 yds.
3	4	3 to 4 amps.	No. 18 D.C.C.	32	10 yds.

The material required comprises some six dozen pairs of No. 34 size transformer stampings (Savage) or No. 30 (Sankey), one bobbin, No. 34F (Savage), 8 oz. of No. 30 S.W.G. enamel copper wire for the primary, and D.C.C. copper wire of a gauge suited to the nature of the filament windings decided on. Table I gives the gauges of wire, and the quantity, for a few selected combinations of secondary windings.

In addition, there will be required 18in. of $\frac{1}{2}$in. × $\frac{3}{16}$in. mild-steel strip for the clamps, 12in. of $\frac{1}{2}$in. paxolin strip for the terminal buttons, 9 4BA countersunk screws $\frac{1}{2}$in. long, 18 4BA nuts, some soldering tags, 12in. of 2BA screwed rod, 8 2BA nuts and a strip of Empire cloth 36in. long and 1in. wide.

On paper this looks a formidable list, but with the exception of the stampings, bobbin and wire, which will cost approximately 7s., the remainder can be acquired at an expenditure of about 2s., and probably less if purchased in the right market.



Terminal strips are carried on the ends of the bolts used for clamping the core together.

Filament Transformers.—

For a component that might well be classed as a high-grade article, so far as its electrical qualities are concerned, the price is exceedingly reasonable.

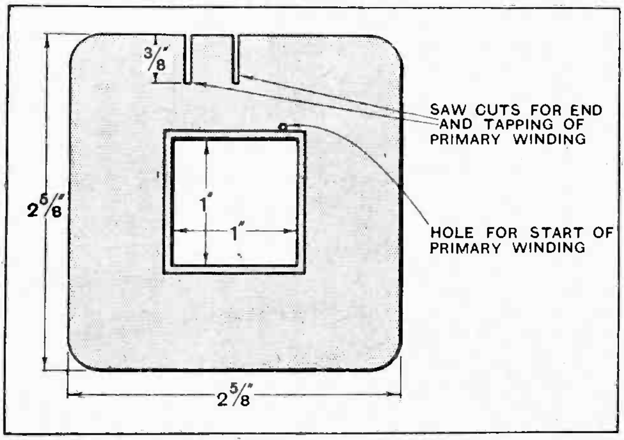
Perhaps before we proceed farther a few words regarding the above table of secondary windings will not be out of place. Take the case of Design No. 1, which has two filament coils, one of 4 volts, the other of 6 volts. The former will supply two indirectly heated A.C. valves and the latter a 6-volt battery type output valve, taking up to 0.5 amp. of current. Design No. 2 has the same 4-volt winding, but the second coil gives 4 volts at 0.6 amp., and is intended to supply current to a valve of the Marconi and Osram P.X.4 type, or a 4-volt directly heated pentode could be used if desired.

THE varying requirements with regard to the current supply of mains-operated valves often makes it desirable for the constructor to assemble small transformers. Making such transformers is by no means difficult, and by carefully perusing the details given here transformers may be quickly put together according to needs.

The third design submitted will provide current for three, or four, indirectly heated A.C. valves, but owing to the gauge of the wire demanded there will be no space to accommodate a further winding.

Primary Winding.

Having collected the material, the first job to tackle is the winding of the bobbin. The primary is wound on first, and for this the No. 30 S.W.G. enamelled copper wire is used. The number of turns required depends on the supply voltage and the periodicity. In the present case we are concerned only with those supplies of 40 cycles per second and over. The primary turns can be calculated by multiplying the supply voltage—marked on the meter—by 8. Thus for a 240-volt main 1,920 turns are required, for 220 volts 1,760 turns, and so on. The model here illustrated was wound so that it could be used on both 220 and 240 volts; to achieve this the primary was wound with 1,920 turns, but tapped at the 1,760th turn.



Details of the end of the former showing the provision made for bringing up the leads.

The No. 30 gauge wire specified is suitable for all mains voltages from 200 up to 250, but it cannot be used for supply voltages of the order of 100 or so. In these cases No. 28 enamelled copper wire is the correct gauge to employ. The same quantity, by weight, will be required.

Before commencing to wind, drill a small hole through one end cheek—it is immaterial which, since the former is square in side elevation—to pass the beginning of the primary winding, and make two saw cuts in the same cheek to bring out the tapping and the finish of the coil. The reason that holes are not advised for the tap and the finish of this coil is that provision must be made here to meet all voltage conditions. Drilling these holes after winding the bobbin is quite impracticable, since the point of the drill will most likely damage the wire. The small sketch shows clearly the relative positions of the hole and the saw cuts.

Having completed the primary winding, a layer of insulating material, consisting of three or four turns of the 1in. strip Empire cloth, should be put on. Care must be taken to cover the primary completely so that the wire cannot possibly come in contact with the following coil.

Three holes, to pass the beginning, tap and finish of the filament coil, can now be drilled, after carefully marking off the correct depth. The insulated covering will protect the primary during this process, but even so the operation must be carried out with caution.

The filament windings have, relatively speaking, only a few turns, and no difficulty is likely to be experienced in this direction. If two secondaries are to be put on, one or two turns of Empire cloth will give adequate insulation, since the only difference in potential between these windings is of the order of the difference between the grid-bias voltages applied to their respective valves.

With the windings completed, the tedious part of the constructional work is over and it only remains to assemble the core, fashion the clamps, the terminal strips and solder the ends of the windings to their respective terminals.

The stampings consist of "U"- and "T"-shaped pieces, one of each forming a pair. Each pair is arranged opposite to adjacent pairs so as to avoid longitudinal air gaps in the core. With the bobbin standing on the bench so that the end cheeks are vertical and pointing towards the constructor, insert one "T" piece from the right, and follow this by a "T" piece put in from the left. Next assemble a "U" piece from the right, then a "T" piece from the right and a "U" piece from the left. Thus, as the core is built up, the joints will fall first on the right, then on the left, and so on.

The stampings must be packed as tightly as possible so that when the core is clamped up the bobbin is absolutely rigid. If there is any tendency towards looseness one or two extra stampings should be added, even if it necessitates tapping home the final pieces with a hammer.

Finally, the core and clamps should be coated with enamel to prevent rust.

Unbiased

by Free Grid

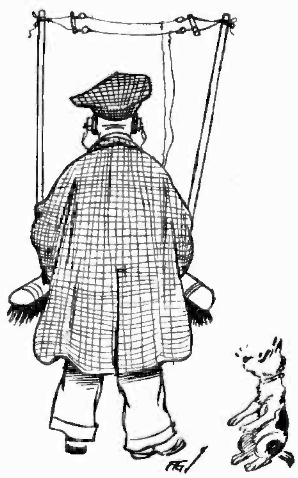
Wobbly Organs.

I HAVE never pretended to have a vast knowledge of things musical, and least of all do I understand fully the intricacies of the organ as a creator of pleasant sounds, and there is one thing about this instrument concerning which I desire to be enlightened. Why is it that when a cinema organ is doing its stuff, as the Americans say, it nearly always sounds all wobbly like a B.B.C. soprano, whereas this effect appears to be lacking in the case of a church organ? Perhaps it is due to a defect in the acoustic properties of cinemas, or perhaps it is intentional, but at the risk of being classed as an out-and-out Philistine by high-brow musicians I am going to record my opinion that to me it resembles nothing so much as an aged Scotsman attempting to play the Haggis—as I believe the national anthem of that country is called—on a superannuated set of bagpipes.

Take Your Portable.

I suppose that there is a large number of *Wireless World* readers who are interested in the broadcasting of national events, such as the Boat Race, Grand National, Cup Final, Derby, etc.; I took advantage this year of an invitation to follow the two boat crews in a launch, and, although they were in view all the time, I must confess that the thrill that I have always experienced in other years when I have taken up my stance on Hammersmith Bridge was completely absent. The reason was that I missed the advantage of my pocket wireless set which I invariably carry on such occasions in order to listen-in to the expert description given by the official commentator.

This apparatus is actually a development of the special portable receiver described by a writer in this journal a year or two ago. I remember that it was his description of the excellent service it had rendered him at the Derby which first induced me to experiment with it. I have found it possible to reduce its dimensions and, when equipped with it and wearing my ordinary hat over the special headphones, I am no more conspicuous than a deaf person wearing an aid-to-hearing device. I have found the apparatus invaluable even at such functions as the Cup Final where the players are



At the Cup Final.

in view all the time because, unless you are a real expert, you cannot always spot who it is who has the ball and what exactly is happening at any particular moment, and the friendly voice of the commentator right in your ear is very helpful. I have always found that folks near me are intensely interested, and I remember that this interest nearly lost me the set at Wembley Stadium a couple of years ago. I had lent the headphones to the man on my right, and his interest was so great that the man on the other side of him was prompted to ask for the loan of the 'phones for a moment. As the cord was not long enough, I was compelled to pass over the whole apparatus. My attention was withdrawn for a few seconds to the field of play, and when I looked round again I was dismayed to see my receiver being eagerly passed from hand to hand and fast receding into the distance. It was actually nearly half an hour before I managed to get it back again. Since that incident occurred I have always equipped myself with one or two spare earpieces having very long leads, and have never let the receiver out of my grasp. In such instances as the Boat Race and the Derby, of course, if one happens to be standing midway between the starting and finishing posts, one naturally receives the official result long before the remainder of the crowd, and at last year's Derby an acquaintance of mine who had borrowed the thing nearly got lynched at Tattenham Corner, so eager was the crowd to get the result from him. I intend to be present at this year's Cup Final on April 25th, and so if you see anybody in the crowd with a pocket wireless set and earpiece sticking out from under his hat you will immediately guess his identity.

The Coil Bogy.

The time is ripe, I feel, for me to scotch a very hoary old superstition, and that is the mythical direct pick-up on the tuning coils of a receiver which necessitates their being enclosed in a sardine-tin if the local station is to be cut out! Good screening is essential in a modern set, of course, in order to prevent interstage reaction, but if you wish to prove how small is the direct pick-up from the local station *when you are not tuned in to its transmissions,* disconnect your aerial and earth system and bring all circuits of your set into resonance at a frequency just above or below that of the local station. Just try the experiment. Of course, if you tune in the local station you will naturally hear it, and, indeed, if your set has an H.F. amplifier worth its salt, you ought—provided that all coils are not completely screened—to be able to bring in (on the 'phones at any rate) several other stations without aerial or earth.

Two New Low Voltage Power Valves

The Marconi and Osram P.2 and L.P.2

IN spite of the fact that the all-electric type of receiver has attracted considerable attention on the part of both set designer and valve manufacturer, the latter has, nevertheless, not overlooked those listeners who, compelled by force of circumstances or desire, employ batteries as a source of high and low tension. Proof of this is to be found in the introduction by both the Marconiphone and the General Electric Co. organisations of two new two-volt power valves operating with a maximum of 150 volts on their anodes. These are officially designated the L.P.2 and the P.2 valves.

In appearance, and also in construction, these valves have much in common. The electrodes are of the familiar "flattened" variety, inclined at an angle within a bulb of comparatively small size. The filament consists of two inverted "V"-shaped elements connected in parallel, the current taken being 0.2 amp. at two volts in either case. The only real difference between the electrode construction of the L.P.2 and the P.2 is that in the former valve a closer mesh grid is employed.

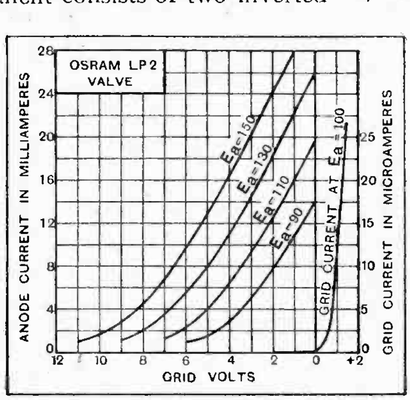


Fig. 1.—Anode current-grid voltage curves of the Osram L.P.2 valve. Average values under working conditions: A.C. resistance, 3,540 ohms; amplification factor, 13.2; mutual conductance, 3.7 mA/volt.

The L.P.2 is the smaller valve so far as power output is concerned, as it has been designed mainly for economy, and, as a consequence, should find favour in the eyes of portable set users. The rated characteristics of the valve are:—

*A.C. resistance, 3,900 ohms.
*Amplification factor, 15.
*Mutual conductance, 3.85 mA/volt.
Maximum anode volts, 150.

*Taken at 100 volts H.T. and zero grid bias.

To attain an amplification factor of 15 with what is indisputably a power valve is no mean achievement. In some respects the L.P.2 can claim kinship with the pentode, since it has a rather limited grid swing, and, consequently, it should follow immediately after the detector. Its working impedance is very much lower, of course, being of the order of 4,000 ohms.

Finding the Load Line.

The first set of curves prepared were those familiar to all readers, namely, anode current-grid voltage curves shown in Fig. 1. As will be seen, grid current starts at zero grid bias, so that the useful portion of the curve necessarily lies to the left of the zero line.

With the maximum anode voltage of 150, a grid-bias of −6 volts will be required by this particular specimen, the steady anode current being of the order of 9.5 mA. According to the makers' recommendations, the average values appear to be −4.5 volts grid-bias, under which conditions the anode current is 11.5 mA. approximately, with 150 volts H.T. In the case of the valve under discussion, an Osram specimen, the anode current would rise to 14.5 mA. with this order of grid bias, and as will be shown later, the actual undistorted power output is lower with the smaller value of bias than by adopting the operating conditions given here.

Of course, samples may vary slightly in production, calling for an adjustment of the bias to attain the best working conditions. As a matter of interest, another specimen, L.P.2., but of the Marconi range, was available, and curves prepared from this valve showed that with a grid bias of −6 volts and with 150 volts on the anode, the steady current was 11.4 mA. At −4.5 volts bias the anode current increased to approximately 16 mA.

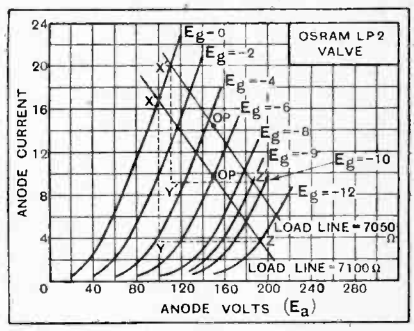


Fig. 2.—Anode current-anode voltage curves of the L.P.2 valve. Two power triangles are shown, X'Y'Z' for $E_g-4\frac{1}{2}$ and XYZ for E_g-6. The larger area of the latter proves the advantage of the higher grid bias.

This evidence would appear to justify the adoption of the higher value of grid bias.

It now remains to ascertain whether this conclusion offers any real advantage from the point of view of output power, and for this purpose the set of curves connecting anode current with anode voltage for equal increments of grid bias, and shown in Fig. 2, was prepared.

Two New Low Voltage Power Valves.—From these we can determine the most suitable loud speaker impedance, and also the maximum undistorted A.C. power output for the two operating conditions discussed above.

Let us take first the working conditions afforded by a grid bias of –4.5 volts and draw the optimum load line for this case, which is

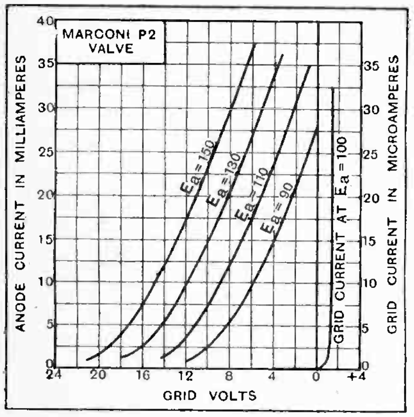


Fig. 3.—Average values under working conditions: A.C. resistance, 2,250 ohms; amplification factor, 6.9; mutual conductance, 3.1 mA/volt.

shown as X′Z′, and gives a load line of 7,050 ohms. The power triangle X′Y′Z′ gives the maximum A.C. output $\frac{X'Y' \times Y'Z'}{8}$, which, if X′Y′ is expressed in mA., will represent milliwatts. In this case we obtain 103 milliwatts, allowing 5 per cent. of second harmonic.

Now the second condition, with –6 volts grid bias, gives a load line only very slightly higher, namely, 7,100 ohms, and from the power triangle XYZ we can obtain an A.C. output of 150 milliwatts, also allowing 5 per cent. second harmonic. Obviously, the second case is far more favourable than the first. In practice the power drawn from the valve will have to exceed this amount to operate a loud speaker of average sensitivity at comfortable volume, but the slight distortion thereby introduced should not be serious, since the ear of the average person is a very accommodating organ. Furthermore, the available power rules out moving-coil loud speakers and restricts the listener to the use of reed-operated devices.

In some respects this is an advantage, as the impedance, at mean speech frequency, of the reed type is generally more in keeping with the requirements of this valve.

H.T. Economy.

Where the need for strict economy in H.T. current is not of paramount importance, the P.2 valve offers a means of obtaining a fairly good power output without imposing an excessive drain on the battery. Its rated characteristics are:—

A.C. resistance, 2,150 ohms.
Amplification factor, 7.5.
Mutual conductance, 3.5 mA/V.
Maximum anode voltage, 150.

These values are taken at 100 volts H.T. and zero grid bias. Measured under the same conditions, the Marconi specimen exhibited the following characteristics:—

A.C. resistance, 2,060 ohms.
Amplification factor, 7.2.
Mutual conductance, 3.5 mA/V.

An Osram sample of the P.2 valve gave sensibly the same values, so that the following remarks with regard to the one apply in equal measure to the other. In Fig. 3 is shown a set of curves connecting grid voltage and anode current for some selected values of anode voltage. These are the usual style of curves supplied by the manufacturers, and enable the familiar characteristics cited above to be determined under the selected operating conditions.

However, their real usefulness ends here, since they do not enable the essential information, such as optimum loud speaker impedance and power output, to be extracted. Thus it is necessary to prepare a further set of curves in this case connecting anode current with anode voltage for equal increments of grid bias, but carried far beyond the usual range. These are given in Fig. 4. With operating conditions set at $E_a = 150$ volts, and $E_g - 12$ volts, the optimum load line, or loud speaker impedance, to give the maximum undistorted A.C. power output, allowing 5 per cent. second harmonic, is shown to be 4,500 ohms. The power output is a shade over 300 milliwatts.

With these working values, the A.C. resistance of the valve is 2,250 ohms, the amplification factor 6.9, and the mutual conductance 3.1 mA. per volt. The average anode current is approximately 17 mA. Only the larger sizes of dry cell H.T. batteries will cope satisfactorily with this order of current, and where mains are available it might be worth while to consider the installation of a battery eliminator, or accumulators and a trickle charger.

The available undistorted A.C. power output is more than sufficient to operate a reed-type loud speaker at comfortable room volume, and satisfactory results should be obtained from the moving-coil variety, provided the instrument is reasonably sensitive. A large acoustic output cannot be expected when using an output valve of this class, operating as it does with a comparatively low anode voltage.

It must be borne in mind that this valve is intended primarily for battery operation—consequently, the power that can be drawn from it will

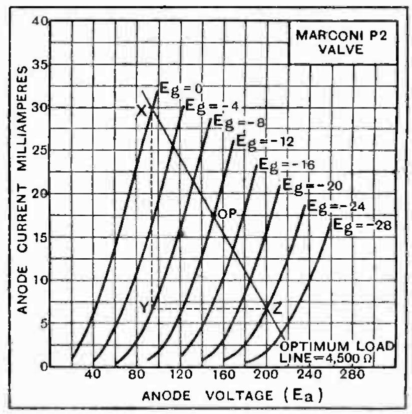


Fig. 4.—Anode current - anode voltage curves of the Marconi P.2 valve. A grid bias of –12 volts gives the largest undistorted power output and the most suitable load line.

be inadequate for any but average domestic requirements, which function it should fulfil in a very satisfactory manner.

CURRENT TOPICS

Events of the Week in Brief Review.

UNSANITARY?

An application to erect a wireless relay system was strongly opposed at a meeting of the Bristol Sanitary Committee.

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AMERICAN RADIO SLUMP.

While our contemporary, *The Wireless Trader*, reports an increase of £149,624 in British radio exports in 1930 as compared with 1929, the *New York Times* draws attention to a large drop in the wages paid in the U.S. radio industry. In one month recently the total radio "pay roll" decreased by 26.5 per cent.

oooo

LOUD SPEAKERS IN THE OFFICE.

Mr. Stenson Cooke, the secretary of the Automobile Association, is now able to address from his office desk the whole of his headquarters staff, numbering over five hundred, by means of a microphone and loud speaker system installed by Philips Lamps, Ltd.

oooo

SPONSORED PROGRAMMES FOR ITALY?

The radio advertisement germ seems to be biting the Italian broadcasting authorities. According to our Turin correspondent, amateurs all over the country are gravely perturbed by the possibility of this abuse of the microphone, and strong petitions are being addressed to the authorities, pleading for care in the introduction of any propaganda in the transmissions. It is pointed out that one never hears advertising in the British, German, or Austrian programmes; only the Latin countries, like France, Spain, and Roumania, have succumbed to the temptation.

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TEACHING MICROPHONE MANNERS.

How microphone technique must differ with different types of instrument is the subject of lessons now included in the radio speaking course at Illinois University conducted by Prof. W. P. Sandford. The professor illustrates the technique necessary with the carbon "mike," and contrasts it with the methods required when a condenser microphone is used, the lecture being followed by speaking drill with both types.

Professor Sandford insists on the maintenance of a relaxed throat so as to produce smooth, sustained tones when addressing the microphone. Abrupt and explosive utterances must be avoided, while breath control is required to sustain the tone.

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SHORT SHRIFT FOR DANISH PIRATES.

Denmark seems to be the latest country to be "pirate-conscious." The police are joining hands with the Post Office in a wholesale onslaught on the unlicensed fraternity, and anyone caught will be liable not only to a fine of from £2 to £26, but to the confiscation of all his apparatus.

18-CENTIMETRE TELEPHONY.

On Tuesday, March 31st, a demonstration of 18-centimetre telephony across the English Channel was given to a party of British and foreign officials and engineers by the International Telephone and Telegraph Laboratories, of Hendon, in cooperation with the Laboratories of Le Matériel Téléphonique, of Paris.

The demonstration took place on the cliffs at St. Margaret's Bay, near Dover, and our illustration shows the transmitter in the foreground and the receiving equipment in the distance. These installations were duplicated at Calais. Visitors had the opportunity of conversing individually with the engineers in Calais.

This experiment, we believe, constitutes the first demonstration of the practical suitability of waves of this order for commercial purposes, such work as has hitherto been done in this direction having been confined to the laboratory. The possibilities which the new system offers were outlined in a talk given by Mr. G. H. Nash, who, as Executive Vice-President of the International Telephone and Telegraph Laboratories, was responsible for a most successful demonstration. A technical description of the system will be included in next week's issue.

BLOW FOR SPONSORED PROGRAMMES.

The swing of the pendulum is indicated by the announcement that Canadian broadcasters have decided to cut down all microphone advertising to 5 per cent. of the total programme time. No sales talk is to be allowed during sponsored programmes given on Sundays.

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TRAIN WIRELESS EXTENSION.

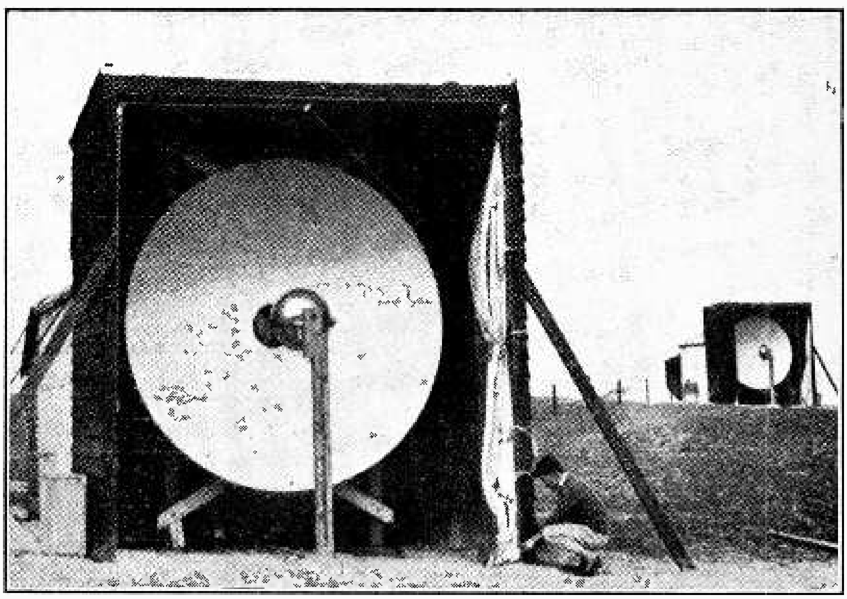
The French State railways are extending their train wireless reception service to the Paris-Dieppe line. Headphones can be hired for 1s. 6d.

It will soon be unnecessary to take a portable to France!

oooo

BAFFLING A SCIENTIST.

After the speech of Sir James Jeans at the British Wireless Dinner Club we wonder whether it is our duty to offer the eminent scientist the services of our Information Department. Sir James, in the course of his speech, admitted that, although he was well primed in the Quantum Theory and felt qualified to discuss such things as Radiation and Atomicity, a faulty grid leak in his wireless set had been known to get him down and necessitate the help of the local electrician.



The apparatus used for reception and transmission of 18-centimetre telephony by the International Telephone and Telegraph Laboratories in a demonstration referred to on this page.

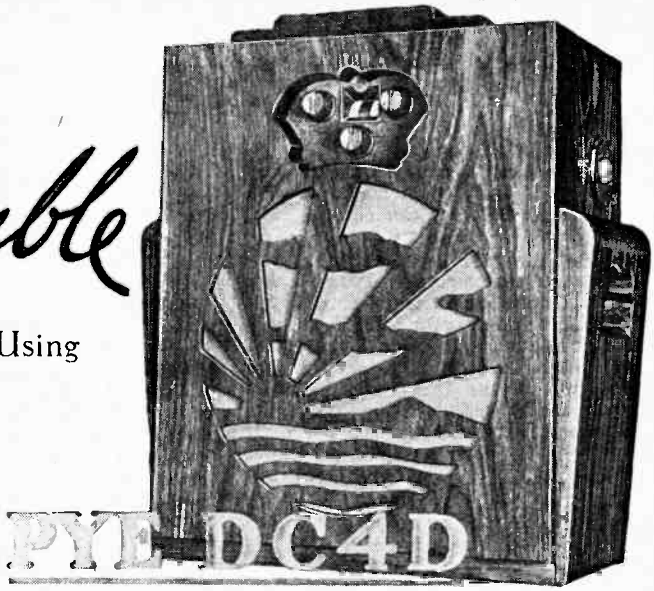
TWO HOURS OF TELEVISION.

Daily television programmes lasting from 3 to 5 in the afternoon (E.S.T.) were inaugurated in New York on Wednesday last (April 1st) by the Jenkin Television Corporation, using their transmitter W2XCR, which works on 147.5 metres with a power of 5 kilowatts.

"SUPERHETS" FOR ITALIAN TRAINS.

The "superhet" is deemed the most suitable set for train reception by the Italian railway authorities, who have installed a receiver of this type on the Milan-Venice express. Excellent results have been achieved.

D.C. Mains Transportable



A Long-range Self-contained Receiver Using the New D.C. Valves.

SPECIFICATION.

GENERAL: A completely self-contained frame-aerial receiver for operation on D.C. mains supplies, 200-250 volts; consumption: 100 to 125 watts.

CIRCUIT: Two H.F. stages, with tuned anode couplings. Power grid detector, transformer-coupled to pentode output valve. Choke-filter loud speaker feed. Indirectly heated series-connected D.C. valves.

CONTROLS: Single-knob tuning control with external trimming condenser. H.F. input volume control; wave-range switch; on-off switch.

ALTHOUGH direct-current mains are likely to exist for many years to come, those with this form of electrical supply have still a somewhat limited choice of mains-operated broadcast receivers. But there are definite signs that the position is improving, and for this the introduction of indirectly heated D.C. valves, with filaments consuming half an ampere, which are intended for series connection, is at least partly responsible. So far as can be ascertained, the Pye D.C.4D. receiver, a specimen of which has been submitted by its manufacturers for review, is the first commercial set in which these new valves are employed.

For this reason, the accompanying circuit diagram will be examined with special interest by all who are concerned with receiver design. Perhaps the most striking feature is the thorough—even lavish—smoothing and decoupling that is provided; no doubt in this matter the makers are playing for safety, realising that some at least of their sets will be operated on "rough" mains.

Separate centre-tapped frame aerials are used for the medium and long broadcasting wavebands, while the two H.F. amplifying stages are coupled on the tuned anode system. The detector, which operates on the "power grid" principle, includes in its anode circuit a filter for disposing of the H.F. component.

Tone Correction in Output Circuit.

An L.F. choke, operating in conjunction with the usual condenser and grid leak, serves as a coupling between the detector and pentode output valve; in addition to the H.F. filter already mentioned, there is an H.F. stopping resistance in series with the grid of the latter valve. The loud speaker is fed through a choke filter; a tone corrector, consisting of a resistance, inductance and condenser, being shunted across the output circuit. Arrangements are made for connecting an external loud speaker without infringing regulations, as feed condensers are interposed in each output lead. The L.F. stage is arranged to have a rising frequency characteristic, in order to compensate for loss of high notes in the H.F. amplifier.

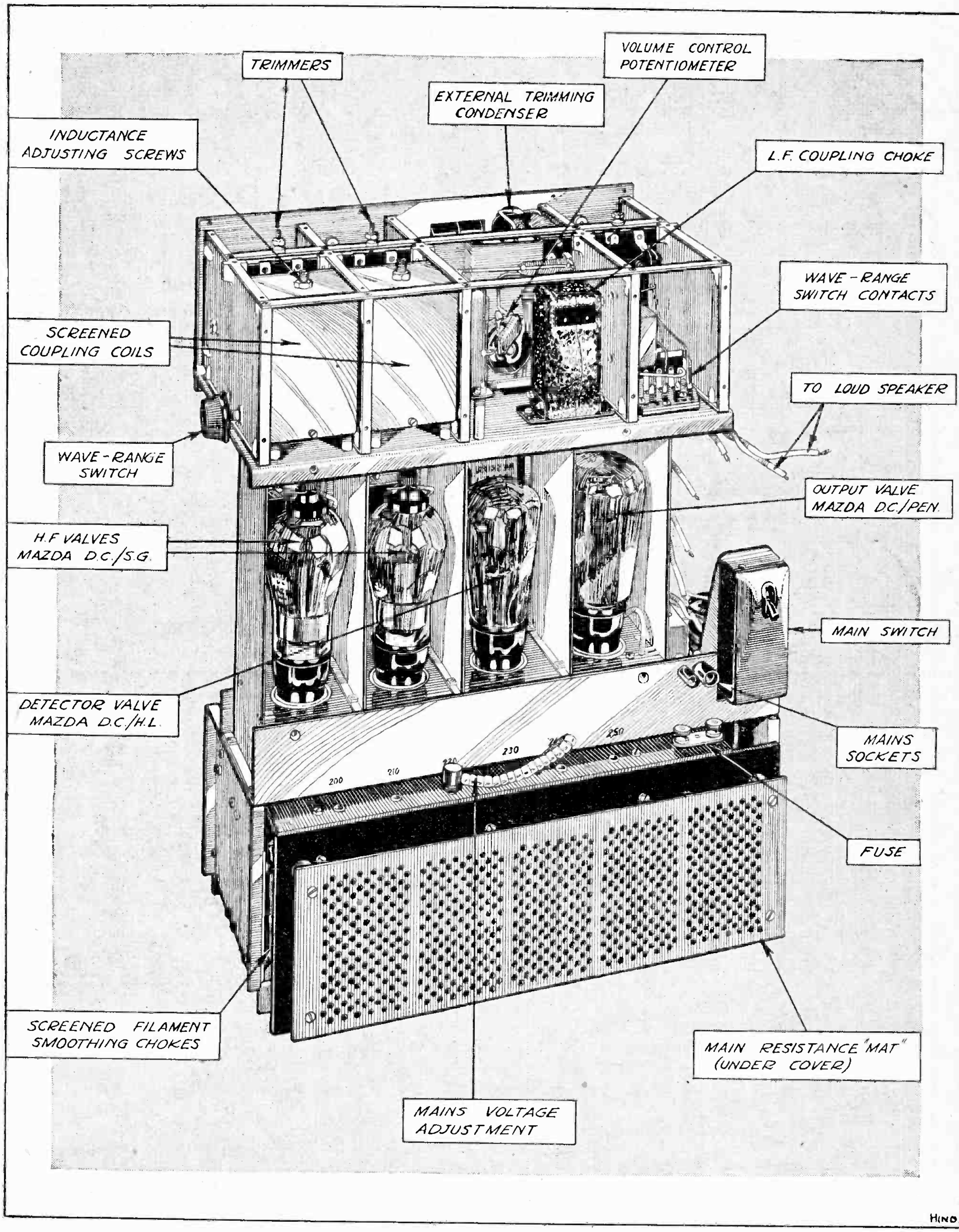
With regard to the power supply circuits, an H.F. choke, with by-pass condensers, is connected in the negative lead. This H.F. filter is followed by a double smoothing circuit, consisting of a low-resistance L.F. choke, shunted by condensers, in each mains lead. In addition to the main regulating resistance, which controls the current flow through the series-connected valve heaters, there is a tapped resistance for adapting the set to various supply voltages. A safety fuse is fitted.

Grid Bias as Sensitivity Control.

Volume control is effected by variation of H.F. valve grid bias, sensitivity being reduced progressively as negative grid voltage is increased by operation of a potentiometer. Under-biasing is avoided by the expedient of connecting a fixed resistance in series with the potentiometer winding, which, electrically speaking, amounts to the same thing as limiting the travel of the contact brush.

Current is supplied to the screening grids through tappings on the main resistance, and it will be observed that the feed lead for the first valve is doubly decoupled. The pentode priming grid is fed through an L.F. choke.

Heat dissipation is always something of a problem in a D.C. receiver, and there can be little doubt that the designers of the Pye set have done the right thing in mounting the main voltage-absorbing resistance so that it projects beyond the back of the containing cabinet, where it can be properly cooled by an induced current of air, which circulates through ventilating slots cut in an aluminium cover. This resistance is actually in the form of a mat woven with resistance wire and asbestos thread; it naturally becomes hot in use, but,



Chassis of the Pye D.C. transportable set, which can be removed from the cabinet after unsoldering a few connecting leads.

D.C. Mains Transportable.—

as the heat is freely dissipated, no harm can be done.

Another problem—that of screening—is fraught with even greater difficulties in a self-contained set, where the tuned intervalve circuit components must of necessity be mounted in the field of a frame aerial. In this case, a solution has been found by building the set in the same way as the Pye "Twintriple" A.C. receiver already described in this journal. The metal chassis is divided into several units; at the top is the receiver proper, sub-divided into a number of screened compartments, containing tuning condensers, coils, and L.F. coupling components. The coils are actually doubly screened, as they are mounted in rectangular brass boxes, through which protrude screws, by means of which their inductance values can be matched. Die-cast cross-pieces serve as screens between the ganged condenser units, and provide an exceptionally rigid construction.

Constructional Details of the Chassis.

Below are mounted the valve screens, under which is the power supply unit, comprising smoothing chokes, resistances, and by-pass condensers, etc. The complete chassis can be withdrawn after unsoldering the loud speaker and frame aerial connections; these accessories, with the cabinet, form a separate unit.

Among other details of construction deserving of special mention are the ganged wave-changing switches, cleverly arranged to avoid long leads, and with self-cleaning contacts. "Pinched" and soldered joints are used in wiring; this has been a feature of Pye sets for some time, and would appear to confer complete immunity from faulty connections, even under the stress of rough usage.

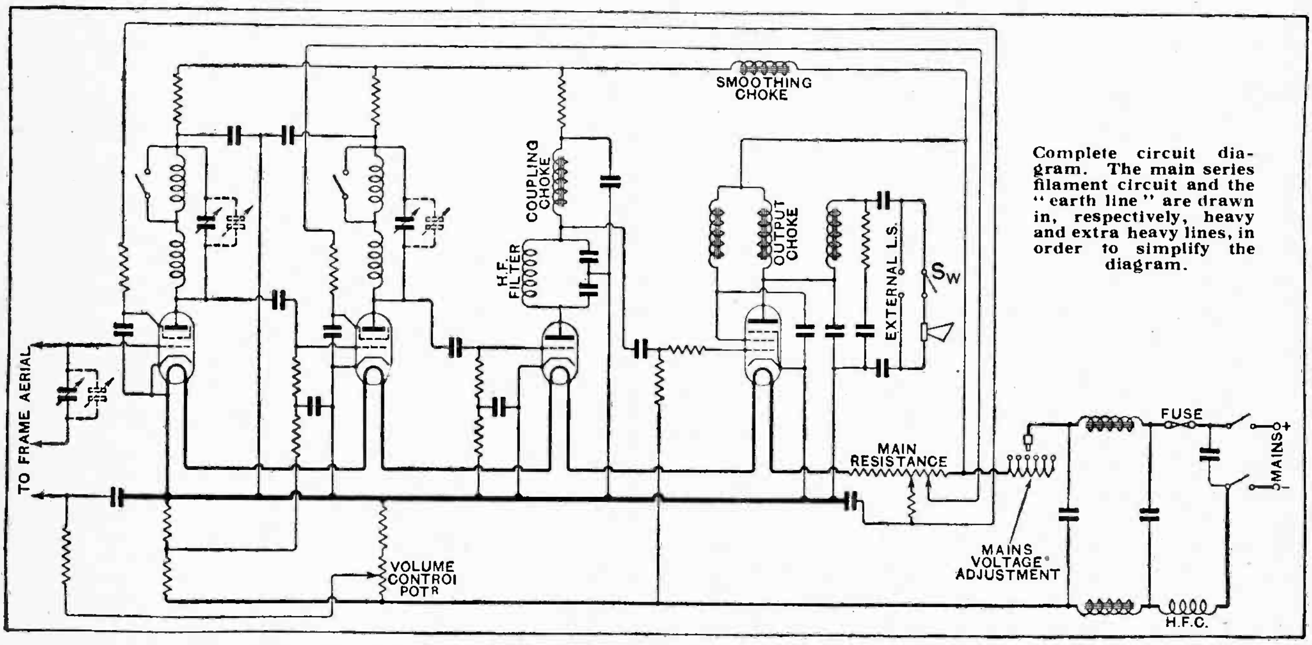
Even if we ignore the fact that the receiver is operating with a built-in frame, and not an outside aerial, its sensitivity and range must be regarded as distinctly good. Thanks to freedom from background noises, distant stations can often be received better than with an "outside aerial" set of similar type. There is a commendable absence of hum and general mains interference; the precautions taken against these troubles seem to be particularly effective on the medium band.

Performance of the Receiver.

All the controls work smoothly and well, although the condenser knob, which is mounted on a recessed panel, might be slightly more accessible. Against this, there is the admitted advantage that the control knobs are thoroughly protected, and are unlikely to be damaged by careless handling. Adjustment of the ganged tuning circuits seems to have been most carefully done, and, once set, there is little need to touch the external "trimmer."

Selectivity is sufficiently high to confer reasonable immunity from interference, even from the powerful local twin transmitters when testing the set in London. It is comparatively seldom that there is any need to make use of the directional properties of the frame.

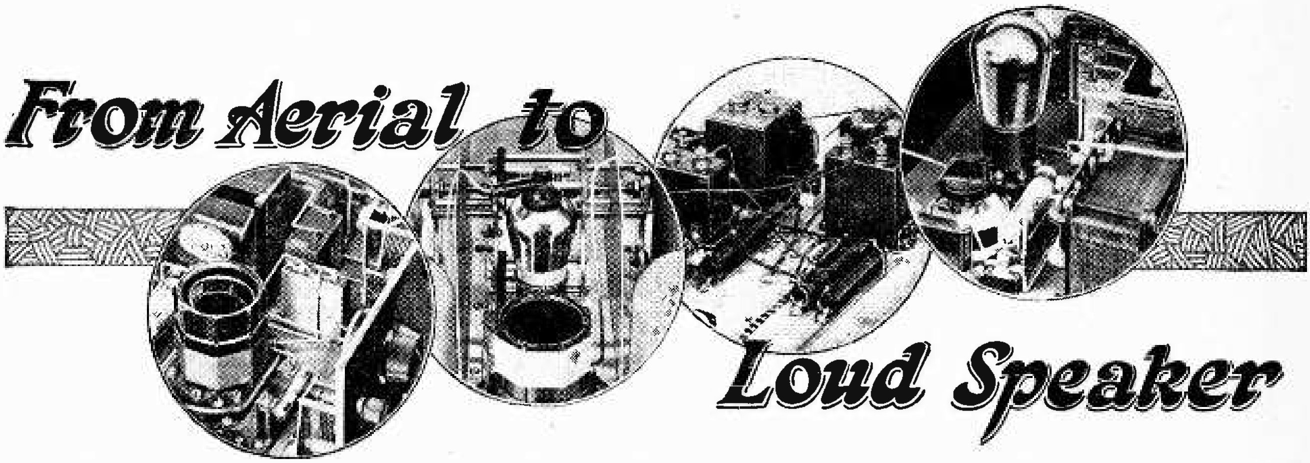
Regarding quality, there is a well-maintained low-frequency output between about 150 and 3,000 cycles; the only aurally detectable resonance that is in any way obtrusive occurs at about 200 cycles. This resonance is low enough not to interfere with the reproduction of speech, which is exceptionally good.



Complete circuit diagram. The main series filament circuit and the "earth line" are drawn in, respectively, heavy and extra heavy lines, in order to simplify the diagram.

Consumption of power from the mains varies between 100 and 125 watts, depending on voltage, and so a single unit of electricity will supply the receiver for from 8 to 10 hours.

Externally, design and finish leave no loophole for unfavourable criticism, and the figured walnut cabinet in which the receiver is mounted will generally be considered as highly attractive. The makers are Pye Radio, Ltd., Radio Works, Cambridge, and the complete receiver, with valves, costs 28 guineas.



No. 6.—Valves and Voltages.

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

SINCE the last instalment of this series brought us to the loud speaker, the reappearance of the title over yet another article calls, if not for an apology, at least for an explanation. Although we have followed the received signal over its full path from aerial to loud speaker we have ignored, for the sake of continuity, certain turnings out of the main road. Some of the more important of these by-ways we must now explore in order to complete the discussion of the receiver.

In the first article of the series it was said that the set was to be used with battery valves and an eliminator giving 200 volts when delivering the current required by the set. The initial step in converting this general statement into definite design data is to decide what valves we shall use, and of these the first to receive attention must be the pentode output valve.

The last valve has to be chosen first, because it is the output valve that will decide the filament voltage to be used throughout the receiver. Reference to *The Wireless World* Valve Data Chart[1] shows that the undistorted output available from a two-volt pentode is decidedly less than that available from one requiring four volts, while the six-volt pentodes give a greater output still. The fact that the biggest outputs of all are given by four-volt valves is no contradiction to this statement; these much larger figures refer to valves built to stand up to high anode and screen voltages.

We have therefore to decide whether we will be content with the comparatively modest output given by a two-volt valve, or whether we will buy ourselves another accumulator cell and have a four-volt pentode.

The writer is inclined to think that the needs of the average listener would be satisfactorily met by the choice of the biggest of the two-volt pentodes, especially as the ability to apply 200 volts to its anode will result in an appreciable increase in available power. As output valve for our set a Marconi or Osram P.T.240 valve is therefore suggested. This valve is rated for 150 volts on screening grid and anode, at which voltages the screen consumes 6 milliamps. and the anode 16 milliamps. when the valve is biased to 9 volts. The output of the valve is then 500 milliwatts.

With 200 volts on the anode this output will be considerably exceeded, rising perhaps to 700 milliwatts. Provided that the voltage applied to the screen is not allowed to exceed the prescribed maximum of 150 volts, the valve is not at all likely to be harmed by the extra anode voltage.

METHODS of decoupling and the calculation of the values of the voltage-dropping resistances form the chief subject of the last article of this series. The distribution of voltage and current in a screen potentiometer for S.G. valves, which always appears rather complicated, is simply explained by means of diagrams.

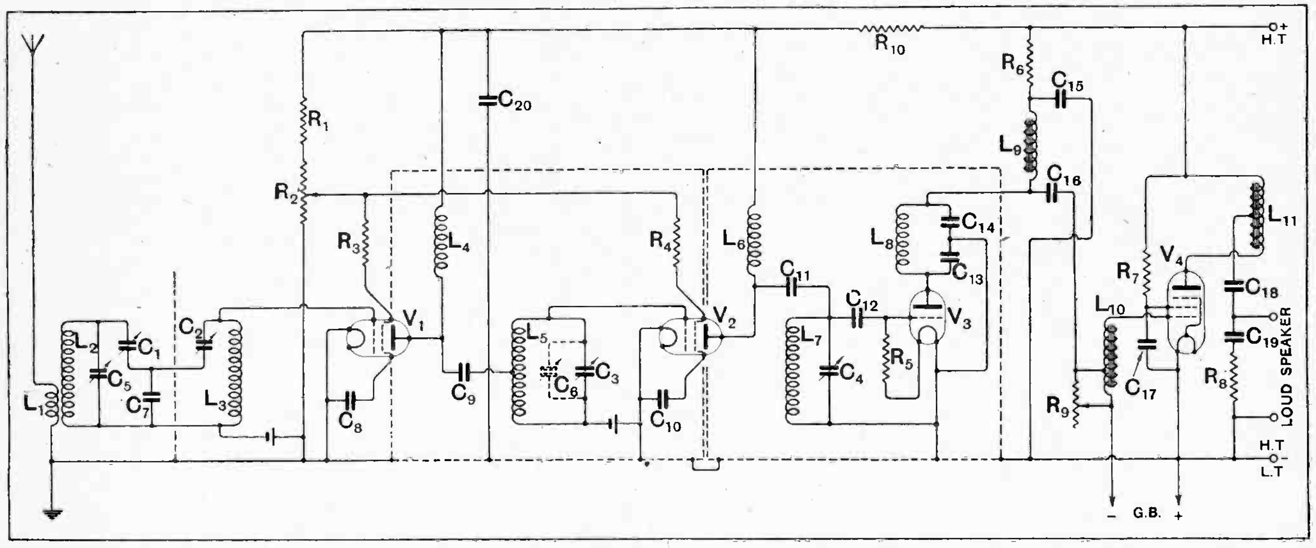
Reference to the circuit diagram of the receiver will show that the screening grid of the pentode is fed, through R_7, from the main anode-current supply at 200 volts. The value of R_7 must be such that, at the current drawn by the screen, there will be a drop of 50 volts across it, so that there will be 150 volts on the screen itself. The increase in anode voltage from 150 to 200 volts will not make any but a very trifling change in anode current, for this depends primarily on screen voltage. The grid-bias, therefore, may remain unaltered at 9 volts. Apart from the anode voltage we shall thus not alter any of the operating voltages to which the data already given refer, but this one change will result in a slight fall in screen current. In place of the 6 mA. quoted, we will assume the value of 5 mA. By Ohm's law, the resistance required to drop V volts at a current of I amperes is V/I ohms; to drop V volts at a current of I amperes will require V/I thousands of ohms. In our case V=50 volts, I=5 milliamperes, so that the resistance required is 10,000 ohms. This,

[1] Supplement to *The Wireless World*, Nov. 26th, 1930.

From Aerial to Loud Speaker.—

then, is the correct value for R_7, which is connected between H.T.+ and screening grid.

A greater resistance than this will decrease the voltage applied to the screen, so reducing the power available and giving rise to distortion on any but very quiet signals. A smaller resistance, or, still more, a voltage the valve consumes 8 milliamps., which is about the right current for a power detector when the anode voltage is approximately 110 volts. This is 90 volts short of the 200 volts available; R_6 will therefore have to drop 90 volts at 8 mA. Using Ohm's law, as in fixing the value of R_7, we find that R_6 should have a resistance of 11,250 ohms. 10,000 ohms, the nearest



A typical four-valve circuit with two stages of screen-grid amplification. The decoupling scheme and the various feed-resistances are considered in detail.

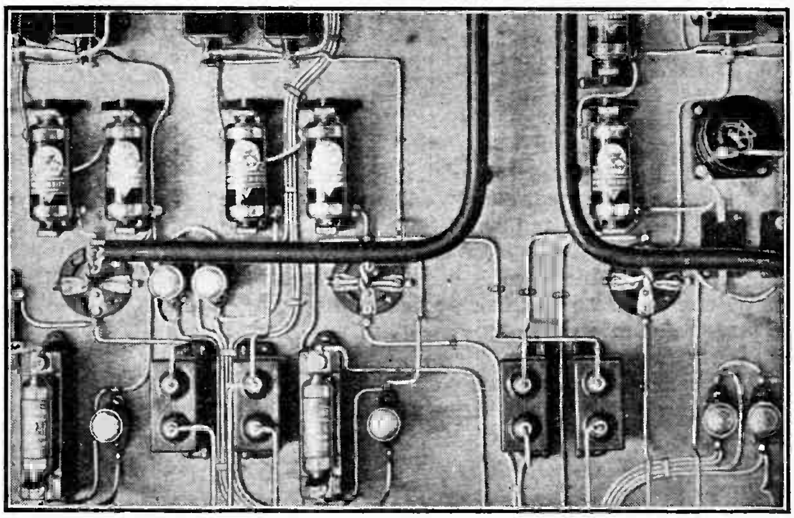
short-circuited resistance, will increase the screen voltage towards, or up to, 200 volts; the anode current will then be excessive, especially as the valve is biased for only 150 volts on the screen, and the pentode will probably resent its ill-treatment by losing emission. If R_7 should become disconnected the valve will cease to work, for it will have no screen voltage at all.

Having settled on a two-volt output valve, we shall naturally choose two-volt valves for the rest of the set. Nor shall we lose anything appreciable by so doing, because two-volt valves are practically as efficient as those of higher rating, except only in the output stage.

Since we have started with the output valve, we may as well work backwards through the set, and take the detector next. In discussing the detector stage we chose the various components associated with it to suit a valve of A.C. resistance some 10,000 ohms, on the ground that such a valve makes the best power detector. The Mazda L.210 is a valve of exactly this A.C. resistance, in conjunction with which it has an amplification factor of $15\frac{1}{2}$. It will therefore make an excellent and sensitive detector.

Reference to published curves of this valve shows that grid current starts at about $\frac{1}{2}$-volt positive, so that if we connect the bottom end of the grid-leak R_5 to L.T. *plus* the grid will set itself at about half a volt positive. At this grid

standard value, will be satisfactory enough in practice. If the resistance were very much too low, or were short-circuited entirely, the anode current would rise to an extent sufficient to saturate the choke L_9, so causing poor quality. The valve, too, would be seriously overrun. Too high a resistance, on the other hand, would curtail the anode voltage supplied to the detector, so that it would no longer be able to handle the strong signals with which, as a power detector, we shall require it to deal. A disconnection in R_6, by



Decoupling apparatus is often best arranged on the underside of the baseboard. The generous decoupling used in the feed circuits of the demonstration receiver installed at the Science Museum.

From Aerial to Loud Speaker.—

breaking the anode circuit of V_3, would result in the complete cessation of signals.

In addition to acting as a voltage-dropping resistance, R_6 has a second function to fulfil. In conjunction with the condenser C_{15} it forms a "decoupling system" for the anode circuit of the detector. While C_{15} allows currents of speech-frequency to pass back, with but little opposition, to the filament of the valve, R_6 acts as a barrier to prevent their passage into the eliminator.

It is possible that the resistance of R_6, which was chosen purely from the point of view of voltage regulation, may turn out to be too low from the point of view of decoupling. If so, motor boating will occur, and it will be necessary either to increase R_6 to 15,000 or even 20,000 ohms, or to increase the capacity of C_{15}. The former cure is inexpensive, since one resistance costs no more than another, but it may reduce slightly the freedom from distortion for which we had hoped. The second course involves buying more

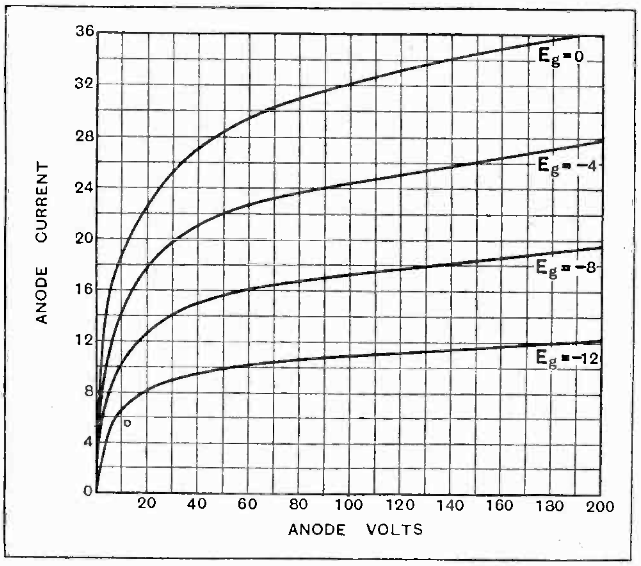


Fig. 1.—Anode-volts/anode-current curves of Marconi or Osram PT240, at screen volts 150. Note that an increase of anode voltage from 150 to 200 volts only adds about one mA. to the anode current.

condensers, for which there may not be room in the space allotted for C_{15}, so that a compromise, involving a simultaneous smaller increase in the capacity of the condenser and in the resistance of R_6 may be made. The exact compromise to be made is a matter for trial, since it depends more on the eliminator than on the set.

A normal value for C_{15} would be 2 mfd.; a smaller capacity is likely to be insufficient to prevent motor-boating, which will also occur if the condenser should become disconnected. A short-circuit in C_{15} will apply the full eliminator voltage to R_6, resulting in the flow of an excessive current. There would then be no anode voltage on the detector, so that signals would cease.

In discussing the high-frequency stages it has already been stated that the screen-grid valves, though for different reasons, are both required to have low A.C. resistance. Although the A.C. resistance of screen-grid

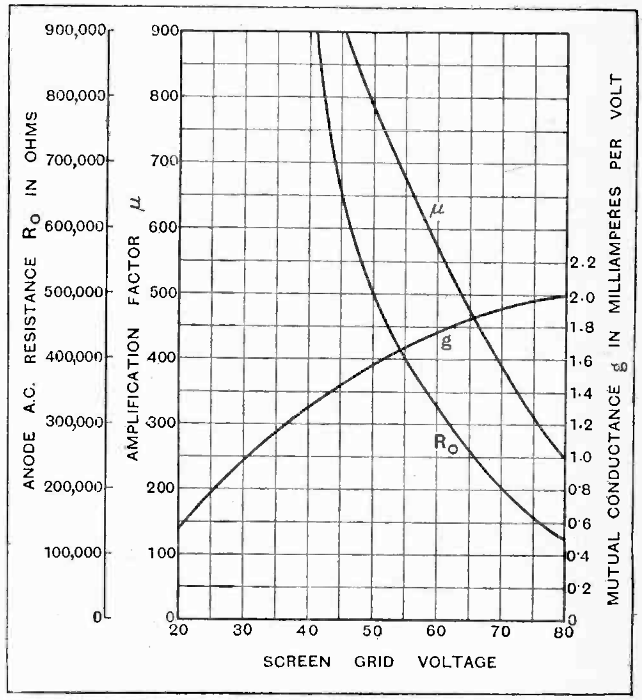


Fig. 2.—Cossor 220 S.G. valve. The variation of A.C. resistance, amplification factor and mutual conductance with changes in screen-grid voltage. These are measured at zero grid bias and anode-volts 150, which give optimum working conditions.

valves is invariably given in manufacturers' catalogues (under the title "impedance"), the figure there given cannot be used as a basis upon which to choose valves, owing to the fact that the A.C. resistance of a screen-grid valve varies over an enormous range, with changes in operating voltages.

The lowest A.C. resistance is always obtained by using the smallest possible grid-bias and the highest possible screen-grid voltage. The latter is limited by the makers' recommendations, which are much the same for all valves, while the minimum grid-bias depends upon the onset of grid current, which usually occurs when the grid of the valve is at approximately the same potential as the negative end of the filament. Our requirement of low A.C. resistance therefore amounts, in practice, to choosing a valve which requires the least possible bias to prevent the flow of grid current.

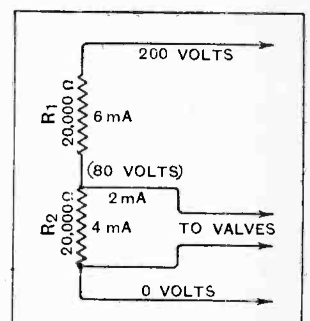


Fig. 3.—The potential divider in detail. The voltage drop on R_1 is $6 \times 20 = 120$ v. and that on R_2, $4 \times 20 = 80$ v. The voltage on the valves is 80 v. when taking 2 mA. The sum of the currents through R_2 and valves is $4 + 2 = 6$ mA., and the current through R_1 is also $4 + 2 = 6$ mA.

As a recent review in this journal shows,[2] the Cossor 220 S.G., in which grid current does not flow until the grid is made half a volt

[2] *The Wireless World*, September 10th, 1930, page 250.

From Aerial to Loud Speaker.—
positive, fulfils our requirements very satisfactorily, since it may be used without any grid-bias at all. On the assumption that a pair of these valves is to be used, the grid-bias cells shown in the diagram may be dispensed with.

With zero grid volts and 80 volts on the screen the A.C. resistance will be about 125,000 ohms, which will suit our tuned circuits admirably. The overall amplification of the two stages, neglecting stray reaction, will be about 7,000 times—an adequate gain for even a small aerial.

The maximum anode voltage recommended by the makers of the screen-grid valves is 150 volts, at which voltage each will consume 8 milliamps. at maximum screen voltage. The resistance R_{10} is inserted to drop the anode voltage from 200 to 150 volts; applying the formula already used for R_6 and R_7, we find that about 3,000 ohms will be needed to drop 50 volts at 16 milliamps. This, then, settles R_{10}.

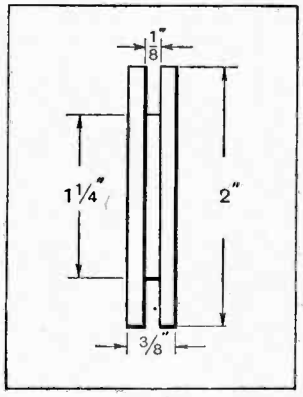


Fig. 4.—Long-wave coil designs. In a former made as shown in the diagram, from three discs of 1/8in. wood or ebonite, 240 turns of 34 d.s.c. wire should be wound. This will give 3,000 microhenrys.

If too low a value is chosen, or if the resistance is short-circuited, the anode voltage will exceed the maker's limit of 150 volts. This is not likely to have any very disastrous consequences. If R_{10} has too high a resistance, the anode voltage of the screen-grid valves will fall, thereby reducing their efficiency. A fall in anode voltage enough to reduce it below the screen voltage may cause spontaneous oscillation, while if R_{10} should become completely disconnected there will be no anode voltage at all, and therefore no signals.

The two resistances R_1 and R_2 form a potential divider, variable over a certain range, for supplying the screen voltage to V_1 and V_2. The variation in screen volts is used as a pre-detector volume control, and is found satisfactory for this purpose in normal circumstances.[3] R_1 and R_2 are so proportioned that when the slider is at the positive end of R_2 the screen voltage applied is the maximum useful value—for the valves chosen, 80 volts. The calculation of the resistances required is not quite as easy as it looks, because we have to allow for the current drawn by the screening-grids, by which the voltage across R_2 is reduced. The valves to be used take 1 milliamp. apiece at 80 volts, so that R_1 and R_2 may each be made 20,000 ohms. The total current drawn will then be 6 milliamps., or three times that taken by the screens themselves. The distribution of voltage and current that results is shown in an accompanying diagram.

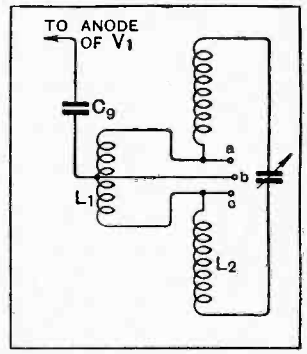


Fig. 6.—Wave-range switching in first intervalve circuit. For long waves the points a, b and c are left open and for medium waves these points are all connected together. L_1 is the long wave coil which is centre-tapped and L_2 the medium-wave coil, wound in two halves.

If a short-circuit should develop in R_1 it will become possible to apply the full 200 volts to the screening grids, which will lead to the early death of the valves. The same fault in R_2 will rob the screens of their voltage, so that the high-frequency stages will cease to amplify. The same result will follow if either R_1 or R_2 should become disconnected.

We have now completed our survey of the set as an instrument for receiving medium-wave broadcasting; a word or two on long-wave coils, and we have finished.

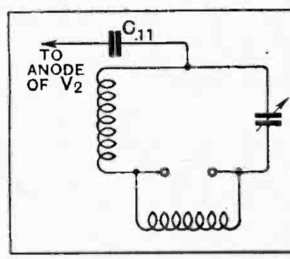


Fig. 7.—Wave-range switching in detector grid circuit. The loading coil is short-circuited for medium waves.

One of the difficulties in designing long-wave coils is that loss of high notes due to cutting side-bands by over-sharp tuning is liable to be very much more marked than it is on the medium waves. In order to guard against bad quality arising from this fact we shall be compelled to use comparatively inefficient coils. There will be, of course, a loss in amplification through doing this, but long-wave stations come in with adequate strength.

The maximum capacity, including stray capacity, is about 0.00037 mfd. in all tuning circuits; to tune up to 2,000 metres coils of 3,000 microhenrys inductance will be needed. A suitable design to give this inductance is illustrated, together with suggested waveband switching circuits.

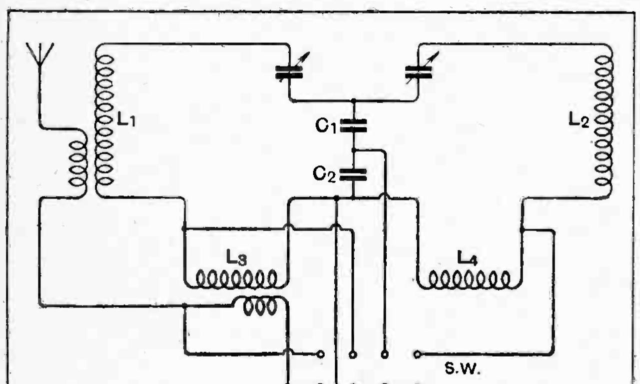


Fig. 5.—Switching for wave-change in a capacity filter circuit. L_1 and L_2 are short-wave coils. L_3 and L_4 long-wave coils and C_1 and C_2, 0.015 mfd. each.

[3] For a criticism of this method, and a discussion of alternatives, see "Controlling Volume," *The Wireless World*, February 25th, 1931, page 202.

BROADCAST BREVITIES

By Our Special Correspondent.

B.B.C.'s Financial Position.

The additional £157,000 which the Postmaster-General has granted to the B.B.C. will ease the financial burden to some extent and pave the way for the erection of Western Regional, the fourth link in the regional chain.

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Additional Annual Grant.

The grant to the Corporation this year is £1,194,500, compared with £1,060,000 for 1930. The Grand Opera subsidy makes a further £22,500. The P.M.G. proposes, before any payment is made, to conclude an agreement with the B.B.C. under which contributions will be made to the Corporation of £5,000 in respect of the quarter ended December 31st, 1930, and at the rate of £17,500 a year thereafter, during the currency of the agreement.

oooo

Expensive Regional Scheme.

But for the development of the regional scheme, the B.B.C. would now be in a flourishing financial condition, for not even the biggest pessimist at Savoy Hill could deny that broadcasting is bringing in the shekels, despite the large proportion of licence moneys still retained by the P.M.G.

oooo

Western Regional.

It is fairly certain, I understand, that Watchet, on the Somerset coast, will furnish the site for Western Regional. The engineers have been continuing their tests with a mobile transmitter in the neighbourhood, and, apparently, are not deterred by the nearness of the Quantock Hills.

oooo

Good for Wales.

From the Welshman's point of view, Watchet should be an excellent site, there being no barriers between the little Somerset town and the Welsh coast, which is only thirteen or fourteen miles away, and yet a sufficient distance to avoid the familiarity that breeds the form of contempt common among dwellers under a regional wireless mast.

oooo

Northern Regional Mystery.

Many Londoners have asked me why Mühlacker, with 75 kilowatts, can burst one's eardrums, while Northern Regional, using only 5 kilowatts less, fades out like an old soldier, and at its better periods is rarely so strong as the German giant.

The answer, of course, is that this is one of those mysteries that make wireless such a fascinating hobby.

oooo

Song and Dance "Plugging."

Listeners as well as music publishers stand to suffer by the practice of song and dance "plugging" which is very prevalent just now, as the B.B.C. themselves are forced to admit. No one seems able to devise a means of preventing an enterprising music publisher from handing a little "baksheesh" to a dance-band conductor on the understanding that particular tunes will be given special publicity, and the result is that listeners continue to miss unsubsidised tunes which may be just as good, if not better.

Abolishing "Outside" Dance Broadcasts.

The most interesting suggestion is that all "outside" dance bands should be divorced from the microphone and that Jack Payne's band should ring the changes with an alternative band, also under the *aegis* of the B.B.C. Whether the idea commends itself to listeners is doubtful; some of the outside bands are very popular.

oooo

Another Talk by the Chief.

"Relays from Overseas" will be the subject of a talk by Mr. Noel Ashbridge, the chief engineer of the B.B.C., to National listeners on April 13.

oooo

Warning.

The one infallible sign that a pastime is achieving popularity and success is the publication of a "doctor's warning." If Harley Street begins to take notice, then the purveyors of cocktails, cigars, ping-pong balls, or whatever is the subject of the warning, can breathe a prayer of thankfulness that their life has not been wasted.

oooo

Too Wonderful.

Thus it is that Savoy Hill has seemed an extraordinarily happy place in the last few days—ever since a doctor has proclaimed that people are sacrificing their opportunities for exercise by over-devotion to the B.B.C. programmes.

oooo

Tyranny of the Microphone.

A few days ago the funny man in a vaudeville turn asked to be excused. He feared that he would not be able to do his part justice in view of the fact that on the following day he was to be principal witness at an inquest into a motor accident. Apparently the B.B.C. officials are psychological experts, for they insisted that the performance would take his mind off the unpleasant subject, and eventually he was persuaded to "carry on." This was fortunate for other than psychological reasons, there being no available understudy.

oooo

Critics in Committee.

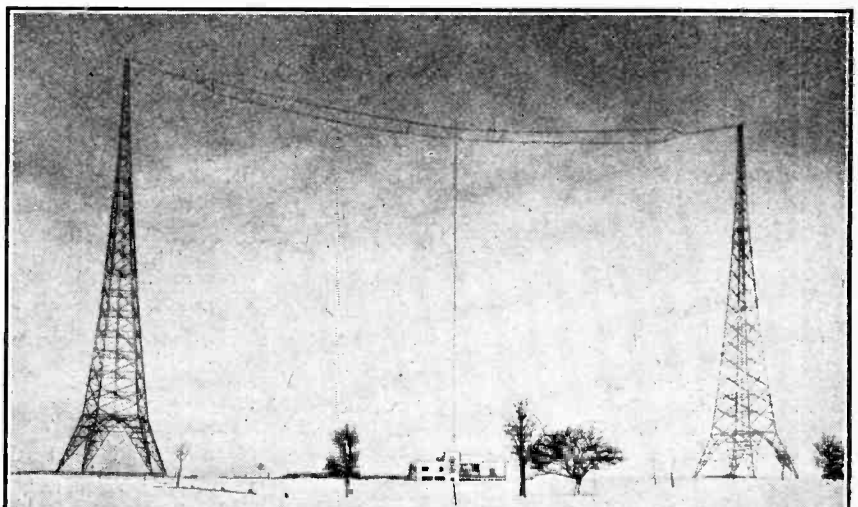
It would be pleasant to think that broadcast criticism was conducted with a firm and jealous regard for independence of outlook, but the recent formation of a Broadcast Critics' Circle suggests that this is not so. With notable exceptions, the critics are now putting their devoted heads together, and we have the possibility that one or more powerful personalities on this self-appointed committee will freeze the genial current of varied and representative opinion on the broadcast programmes.

oooo

For and Against.

The argument for the new organisation is, of course, that a united body of critics will carry more weight with the B.B.C. than any number of units. But will anyone deny that an opinion is likely to be more forceful and more nearly right when it is arrived at by different observers working independently?

If opinions do differ, it is a sign that the **B.B.C.** is at least not displeasing everybody in the same way. Which is a good sign.



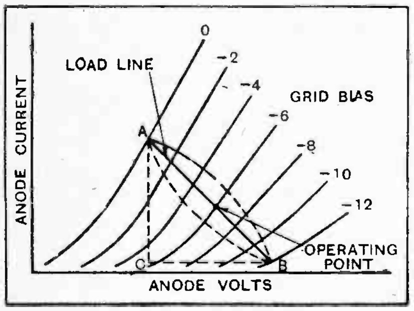
SWITZERLAND'S BRITISH-BUILT HIGH-POWER STATION.—A new view of the Söttens station, near Lausanne, which has just been completed by Standard Telephones and Cables, Ltd. Working on a wavelength of 403 metres with a power of 25 kW., Söttens is regarded as a potential disturber of the peace when Midland Regional changes down to 398.9 metres in a few weeks' time.

Modern Terms Defined

Further Valve Terms, with Special Reference to the Output Stage.

(*Continued from page 297 of March 18th issue.*)

Load Line: The characteristics of modern power output valves are generally plotted to show the relationship between anode current and anode volts for various fixed values of grid bias. On the same scale it is possible to represent the load in the anode circuit of the valve as a line cutting across the family of valve curves. It will be seen that the slope of the line AB represents the rate of change of current (AC) with voltage (BC) in the anode circuit load, i.e., a resistance. If the load is inductive, as it is if a loud speaker is used,



Anode volts/anode current characteristics of a power valve showing load line AB, and power triangle ABC.

the load line is expanded into an ellipse, but in practice it is sufficiently accurate to use the major axis (AB) of the ellipse for purposes of calculation.

Power Triangle: The triangle ABC in the accompanying set of valve curves, from which the undistorted power output of the valves may be calculated. If the length of the load line is limited to the permissible grid swing of the valve, and if the slope of AB is such that second harmonic distortion does not exceed five per cent.,[1] the power output is obtained by multiplying AC by BC and dividing by 8. Then if BC is in volts and AC in milliamperes, the power output will be in milliwatts.

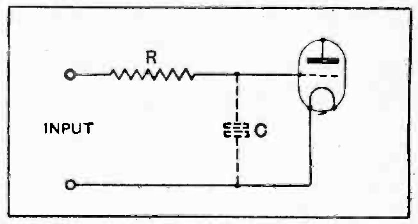
[1] For full details of the method involved, see *The Wireless World*, December 4th, 1929, pages 614 and 631 and December 18th, 1929, page 666.

Optimum Loud Speaker Impedance: The power and quality of the output from the last stage of a receiver are intimately bound up with the relationship between the A.C. resistance of the valve and the impedance of the loud speaker. Before the action of the valve was properly understood, simple calculations based on the assumption that the load in the anode circuit was a pure resistance indicated that this load should be equal to that of the valve for maximum power. Subsequently, it was shown that when the load is inductive, as in a loud speaker, the optimum or best ratio of load to valve impedance was 2 : 1. More refined calculations have pointed to a ratio of 1.6 : 1. In practice it is impossible to calculate the best ratio, since characteristics other than the A.C. resistance of the valve must be taken into account. It is not sufficient to obtain the maximum power output, but the introduction of harmonic distortion must be avoided. The output impedance which gives the highest power output with the minimum harmonic distortion is best found by the graphical method, to which reference has already been made.[1] As is evident from the figures given in the Valve Data Sheet which accompanied our issue of November 26th, 1930, the optimum ratio of valve to loud speaker impedance for the conditions specified is different for each valve. It will be seen, however, that the average ratio is about 2 : 1, and this may serve as a guide for all simple calculations.

H.F. Stopping Resistance: A resistance R, generally of the order of 0.25 megohm, is frequently inserted in series with the grid of a low frequency or power output valve. The object of this resistance is to stop the further amplification of high-frequency currents which may still be associated with the low frequency output from the detector.

Many people have difficulty in visualising the function of this resistance and its selective discrimination between high- and low-frequency currents. This difficulty is understandable, as the average circuit diagram does not show the input capacity (C) of the valve, and it is this capacity in conjunction with the resistance R which brings about the suppression of stray H.F. currents.

To take a concrete example let us assume that the input capacity of the valve under working conditions is 20 micromicrofarads, and that the stopping resistance is 0.25 megohm (250,000 ohms). At 300 metres (1 million cycles per sec.) the valve capacity has an impedance of approximately 8,000 ohms, which is small compared with the stopping resistance. Consequently only a small fraction of the original input (about 3 per cent.) is developed across the valve, the remaining 97 per cent. being dissipated in the resistance.



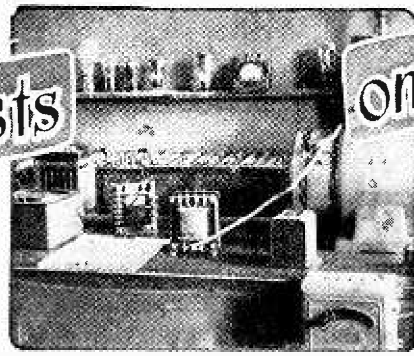
The stopping resistance R in conjunction with the valve capacity C tends to suppress H.F. currents while passing L.F. currents without appreciable loss.

On the other hand at the higher audio frequencies the valve capacity offers a considerably higher impedance. For example, at 3,000 cycles the impedance of C (20 micro-mfds.) would be as much as 2,600,000 ohms, which is large compared with the stopping resistance. Only 9 per cent. of this useful frequency is lost in the stopping resistance, the remainder being available for amplification. At lower frequencies the loss is correspondingly decreased.

(*To be continued.*)

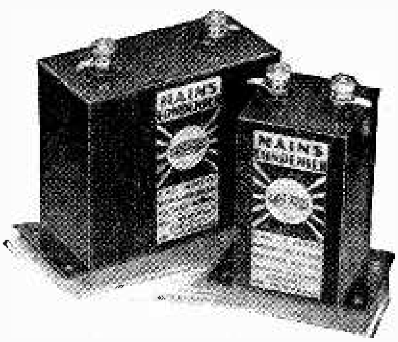
IN PREVIOUS ISSUES.

Wireless World Laboratory Tests on New Apparatus



FORMO MAINS CONDENSERS.

These condensers are intended primarily for use in mains receivers, the working voltage being the satisfactory figure of 400 volts D.C. So far two types are available, the one enclosed in metal cases, as illustrated, and styled type B, is stated to have an insulation resistance of 2,500 megohms per mfd. These are available in capacities ranging from 1 mfd. at 2s. 6d. to 8 mfds. at 10s. 6d. A condenser bank consisting of 14 mfds. tapped at 4, 6, 1, 1, and 1 mfd. for use in eliminators costs 22s.



Formo high-voltage test condensers for use in mains sets and eliminators.

The type A is enclosed in bakelite cases and the working voltage is 300 volts D.C. A lower insulation resistance is shown by this type, being of the order of 1,000 megohms per mfd. They are made in 0.1, 0.25, 0.5, 1.0 and 2.0 mfds. sizes, the prices being 1s. 6d., 1s. 9d., 2s., 2s. 2d. and 3s. respectively.

Supplies are obtainable from Formo (Arthur Preen & Co., Ltd.), Golden Square, Piccadilly Circus, London, W.1.

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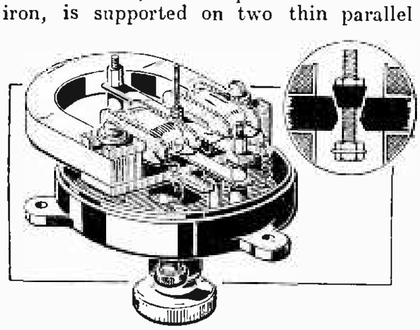
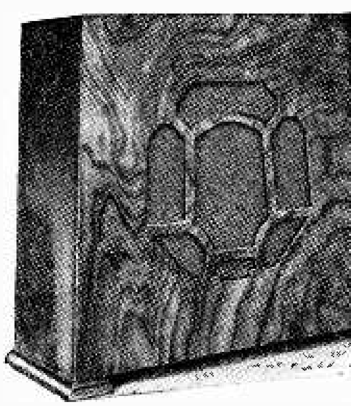
PANADYNE LOUD SPEAKER.

The movement in this loud speaker is of the non-differential moving-iron type. The armature, a V-shaped block of soft iron, is supported on two thin parallel



The Panadyne loud speaker unit.

strips of phosphor-bronze which permit vertical movement at right angles to the pole pieces. The restoring force due to the spring suspension is rather weak, and it is therefore necessary to work with a comparatively large air gap to prevent the armature from sticking to one or other of the pole faces. Consequently the movement is comparatively insensitive. This is our only serious criticism, for the frequency response is good. Apart from resonances at 100 and 3,500 cycles, the output is sensibly uniform from 75 to 4,000 cycles. The reproduction of both speech and music is excellent, and there is no trace of frequency doubling in the base.



Panadyne loud speaker in walnut cabinet.

Measurements of the impedance under working conditions gave the following results :—

Frequency (cycles).	Impedance (ohms).
50	1,350
100	2,250
200	3,120
400	4,630
800	8,080
1,600	13,400
3,200	23,000
6,400	25,900

The makers are Messrs. E. J. Mackintosh & Co., 32, Ernle Road, Wimbledon, London, S.W.20, and the price of the complete loud speaker in walnut-faced cabinet, as illustrated, is £4 10s. The unit alone costs 2 guineas.

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SOME NEW "FARADEX" COMPONENTS.

Recent additions to the "Faradex" components made by Rook Bros., Ltd., 32, Queensway, Ponders End, Middlesex, include an L.F. transformer and a range of semi-fixed condensers. The transformer is made in two ranges 3 : 1 and 5 : 1—the price being 6s. 6d. in each case. By using a special alloy for the core it has been possible to reduce considerably the overall size of the component, the principal dimensions being 2in. × 2¼in. × 2in.

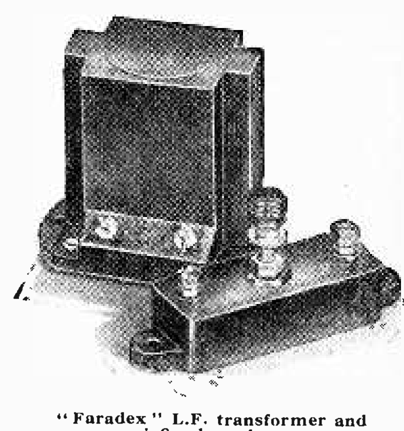
Measurements showed the primary inductance to be on the low side, since at 50 cycles and with no D.C. flowing the 3 : 1 ratio component could only attain some 18.7 henrys. At 2 mA. this falls to 14.7 henrys, and with 5 mA. is down to 11.4 henrys. The A.C. voltage was maintained at 4.5 volts and the A.C. current was of the order of 1 mA.

In the case of the 5 : 1 component it was necessary to reduce the A.C. voltage to 3 volts in order to commence the test with the same initial A.C. current. The inductance values were : 12 henrys with no D.C. flowing, 9.9 henrys with 2 mA. and 8 henrys with 5 mA. of D.C.

The amplification of the lower audio frequencies will be rather poor unless very low impedance valves are used, in which case the parallel feed method should be employed.

The D.C. resistance of the primary on the 3 : 1 component is 560 ohms and that on the 5 : 1 model is 620 ohms.

Four types of semi-fixed condensers are available, viz., F, J, G and H, and each costs 2s. Type F is rated to cover



"Faradex" L.F. transformer and semi-fixed condensers.

from 0.000005 mfd. to 0.0001 mfd., which when measured was found to be from 0.000004 mfd. to 0.000152 mfd. The range of type J is from 0.000025 mfd. to 0.0003 mfd. (nominal), that of G from 0.0002 mfd. to 0.001 mfd., and H 0.001 mfd. to 0.002 mfd. The actual value of type J was found to be from 0.00001 mfd. to 0.000377 mfd.

The values are not marked on the condenser, and it is hoped that the makers will rectify this omission in due course.

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.

AVOIDABLE INTERFERENCE.

Sir,—With reference to your editorial in *The Wireless World* of February 11th, upon the interference of broadcast reception by electrical machinery, a point has occurred to me which may be of interest.

The telephone service, since it is under the control of the Post Office, a Government department, is a public utility, and is therefore covered, I believe, by the Public Utilities Act. Anyone owning electrical machinery, which caused interference with the proper working of the telephone service, would be compelled by law to take steps to stop the interference.

Although the B.B.C. is not exactly a Government department it is under the wing of the Government, and I should imagine that a clever lawyer would be able to prove that the broadcasting service is therefore a public service, especially since the public are compelled to pay for its maintenance indirectly through the receiving licence. (A licence is compulsory for radio reception irrespective of whether the B.B.C. is in existence or not, and so is not issued just for their benefit. The fact remains that the B.B.C. receives a big proportion of the compulsory licence money and is therefore maintained by public money, like the Post Office services.)

It seems to me, therefore, that in a test case it could be proved that British broadcasting is as much a public service or utility as the telephone service, and so should be protected by law under the Public Utilities Act.

I must admit that I am not sure of the exact interpretation of the Utilities Act, and to a legal mind the point I raise may seem foolish.

Comments from legal readers of *The Wireless World* would be of interest. C. HADFIELD GALLOWAY.

Addison Bridge, W.14.

COMPETITIVE PROGRAMMES.

Sir,—In your issue of March 4th you have an admirable leader dealing with the question of competitive programmes. Might I, as the originator of the regional scheme, add a word in support of your contention that there will be no real contrast between two programmes until the control of each is vested in completely distinguishable dictatorships?

I have suggested several methods by which this can be done, but my suggestions have never been acceptable to the authorities. Originally my conception of the regional scheme was to radiate a national programme on one wavelength and a regional programme, contrasting with the national programme, on the other. It was thus suggested that the London committees should make up the national programme very much in the same way as they make them both up to-day. On the other hand, it was suggested that we might revive the authority of local station directors and give them the power they possessed when the B.B.C. was founded. One of the programmes at each of the regional stations could then become the responsibility of one man —the station director. He was to be given (within obvious limits) complete control of the programme, which as far as possible would reflect local culture and deal with regional matters. Thus the Manchester station director would have his own orchestra and would experiment with broadcasting as he thought fit. There would have been under my scheme a friendly, if very definite, rivalry between those responsible for the two different programmes, and the popularity of the one or the other would be the measure of the success of the rival organisations.

It was not suggested that any of the Postmaster-General's rulings should be waived or that the general policy of the B.B.C. (if such can be said to exist) should not be followed, but it was suggested that there was a great opportunity for men of culture and enthusiasm to advance the art of broadcasting by being given independence or, if they failed, dismissal.

The failure to impress the authorities with the desirability of such a scheme resulted in my suggestion just before leaving the B.B.C. that it might be possible to arrange private enterprise programmes on one wavelength and leave the B.B.C. to continue their transmissions upon the other. This, again, would give a true contrast between programmes.

Many disadvantages can be cited against my proposals, but no scheme can ever be ideal. It is a great pity that the regional scheme has degenerated into a mere convenience for the listener to dodge what he does not like instead of choosing the thing that he does.

I hope that you will continue to press this point, because the large amount of money that has been spent on the technical side of the regional scheme would seem to be wasted if the real objects of the scheme, to give truly *alternative* programmes, are never achieved. P. P. ECKERSLEY.

North Acton, W.3.

THE STENODE.

Sir,—I was very much interested to see Mr. Gardiner's reply to my criticism of the Stenode, and I should like to remark on a few of the points which he raised.

In my previous letter I criticised the overall fidelity curve of the Stenode, which was published in the March, 1931, issue of *Radio News*, and I now note that Mr. Gardiner states that this curve is inaccurate and represents an out-of-date receiver. Since the curve in question illustrated an article by Dr. Robinson, and was referred to by him in answer to the criticisms of certain American radio engineers, one would have expected it to be both accurate and representative of the latest technique.

It is very unfortunate that all the published data on the Stenode is "seriously out of date, and does not represent the present state of progress." I shall await with interest an article dealing with the latest practice and giving the characteristics of a modern receiver. Without such details, of course, criticism is impossible.

Mr. Gardiner states, however, that he would not consider the *Radio News* curve poor, even if it were accurate, since the average listener would be unable to appreciate its deficiencies. The average listener may, or may not, be as critical as those who are accustomed to the reproduction of the finest apparatus available, but this is surely no reason for depriving him of a high standard of fidelity. In my own experience, the average listener is quite capable of appreciating high quality.

With regard to the last paragraph of his letter, I would assure him that it is readily demonstrable, both in theory and in practice, that cascade resonant circuits require far more compensating than does a single circuit of low decrement. I quite agree that the amount of compensating is determined by the overall resonance curve, and that the manner in which this is obtained is immaterial. The point, however, is that the resonance curve of a number of cascade circuits, each of normal decrement, is quite different from the resonance curve of a single low decrement circuit.

As an example, if a 5,000-cycles note be attenuated to the same extent with both types of circuit, a 50-cycles note will be attenuated to no appreciable extent with a series of cascade circuits, but it will be very greatly attenuated with a single low decrement circuit. Hence the ratio of 50-cycles to 5,000-cycles notes will be much greater in the case of cascade circuits. A few minutes' work with pencil and paper will convince anyone of the truth of this statement. W. T. COCKING.

Southgate, N.14.

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.

Mixed H.F. Couplings.

In order to avoid the need for buying new components, I propose to use tuned-anode and tuned-transformer couplings for the two stages of an H.F. amplifier. I suppose that it does not matter very much in which order these couplings are used? Will you please give me your opinion on this matter?

It will be best to use the tuned-anode coupling in the first stage, thus avoiding the risk of feeding back L.F. impulses to the detector-grid circuit.

If you adopt the alternative plan, it will almost certainly be necessary to "decouple" the second H.F. anode circuit more lavishly than would otherwise be the case.

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Modulated Hum.

My H.F.-det.-L.F. receiver, with indirectly heated valves and a full-wave valve rectifier, is of conventional design, and works quite satisfactorily, except that when it is accurately tuned to the local transmission a loud hum is produced. Can you suggest anything that I could do in order to prevent this?

We advise you to try the effect of connecting a condenser of 0.1 mfd. between each anode terminal of the rectifier valve and the centre point of its filament heating transformer. This will probably effect a cure; if it does not, please write to us again, sending a complete circuit diagram of your set.

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By Trial and Error.

Will you please describe a method of determining experimentally the correct value for an automatic grid-bias resistance with the help of a milliammeter and a tapped-grid battery?

The value of anode current flowing when correct bias is applied from the battery should first be noted. Next, a variable-bias resistance should be inserted in the correct position, and the circuit connections altered to those applicable for automatic bias. The variable resistance should now be adjusted until the original anode-current value is restored, when it can be assumed that the voltage developed across the bias resistance is equal to that originally obtained from the battery.

Superheterodyne Modifications.

Will you please give me a circuit diagram showing how to connect a pick-up to the "Band-Pass Superheterodyne" receiver, described in your issues of November 5th and 12th, 1930?

The pick-up should be inserted in the grid circuit of the oscillator valve V_3, which becomes the detector when the switch S_2 is set for local-station reception (with three valves only in use). The necessary alterations are shown in Fig. 1, from which you will see that an extra single-pole change-over switch is required.

Do not forget that the existing switch S_2 must be in the "local station" position when the pick-up is in operation.

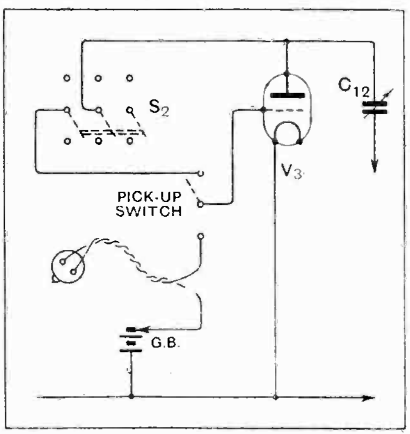

Fig. 1.—Adding a pick-up to the "Band-Pass Superheterodyne."

Testing an Oscillator.

Will you please tell me how to determine whether the oscillator valve of a superheterodyne receiver is working properly? A milliammeter is available for making the tests if necessary.

If the valve is oscillating, everything is probably in order; this point can be determined by connecting your milliammeter in the anode circuit. Normally, there should be a change in current as the variable tuning condenser is rotated from minimum to maximum. Similarly, an appreciable change in current should be produced when the oscillator grid coil is short-circuited.

Home-made L.F. Choke.

A 30-henry L.F. choke was described in your issue for January 28th last year. I have made this up, but find that its D.C. resistance is over 350 ohms, which is considerably higher than the value specified, although I have followed the published instructions implicitly. Can you suggest an explanation, and also say whether the inductance of my choke is likely to be much lower than it should be?

It seems certain that you must have used wire of too fine a gauge. However, the resistance value you mention is not unduly high for the purpose for which a choke of this sort would ordinarily be used, and, provided you have wound on the correct number of turns, the inductance value of the choke will not be changed.

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A Common Fault.

I have just completed a two-circuit aerial tuner unit for use with my existing receiver. The gain in selectivity is not as great as I had expected, particularly over the lower half of the medium wave band, in spite of the fact that the small coupling condenser, which is joined between the two coils, is set at minimum. It is noticed that when receiving wavelengths of under 300 metres there are two tuning positions at which a given transmission can be heard. What do you think is likely to be wrong? It should be added that the coils and tuning condensers are thoroughly screened.

It seems certain that your coupling condenser is unsuitable; it should be emphasised that a component with a minimum capacity of not much more than two or three micro-microfarads should be used as a coupling between the high-potential ends of the tuned circuits. We advise you either to modify your existing condenser by removing plates, if possible, or else to obtain a new one of more suitable design. Attention should also be paid to the wiring, and matters should be so arranged that incidental capacity between the circuits is kept down as much as possible.

Grid Bias Volts.

I have read that it is generally permissible to fit a pick-up in the grid circuit of a "leaky grid" detector by merely joining it, in series with a suitable bias battery, directly between grid and filament. To avoid the necessity of fitting a switch, I propose to adopt this arrangement in converting my own commercial receiver, of which the detector-grid circuit, with the proposed addition of a pick-up, is shown in the accompanying diagram.

You will see that, in order to obtain a positive grid voltage for detection, the tuned circuit is returned to L.T.+. Does this mean that, to offset the voltage applied from the L.T. battery to the grid—in this case two volts—I must, when determining the proper value of grid bias, add this voltage to that which would be normally applied?

No; when the pick-up is connected in circuit, it may be considered that the working grid voltage will be solely that due to the bias battery.

This matter will be made clear by a consideration of Fig. 2, in which your own diagram (a) has been redrawn (b) in such a way that the operating conditions are more easily appreciated. Ignoring for the moment the bias battery, and imagining that the pick-up is directly connected to the filament, it will be seen that the greater part of the L.T. battery voltage will be "dropped" across the grid leak, and that an insignificant proportion of it will be set up across the pick-up, and consequently across the grid circuit, as the latter has a comparatively negligible resistance.

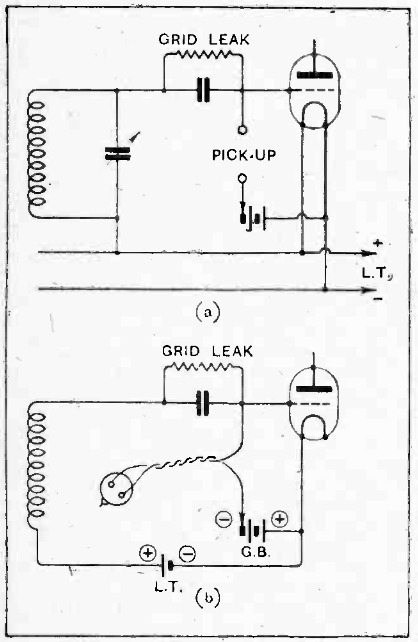

Fig. 2.—Showing how grid bias voltage is affected by connecting a gramophone pick-up.

Testing a Filter.

I have just completed an H.F.-det.-L.F. set with input band-pass filter, and am not quite satisfied that everything is working as it should. In order to eliminate uncertainty as much as possible I intend, in the first place, to concentrate on the filter itself, and to do this it will be necessary temporarily to replace the H.F. valve by an anode bend detector, so that the behaviour of the circuit may be checked by inserting a meter in series with the anode. Do you think tests made in this way will afford a reliable indication as to the way the filter will behave under normal operating conditions?

There is a risk that the damping imposed on the filter circuit by the anode bend detector may be much greater than that due to the screen grid H.F. valve which is normally connected across it. We suggest that a by-pass condenser of about 0.0005 mfd. should be connected between the anode of the temporary detector valve and earth; this will largely prevent reversed reaction feed-back, and should enable you to simulate normal working conditions with sufficient accuracy for all practical purposes.

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Tapped Power Transformer.

My A.C. supply is at present 110 volts, but this is shortly to be changed to the standard voltage. Would it be satisfactory to obtain a power transformer designed for the new voltage, but with a tapping to be used as a temporary measure until the change takes place?

It should be realised that the current through the primary winding will be very much greater when it is used on low-voltage mains than with a standard supply. There is accordingly the danger that overheating may take place, but if the first section of the primary is wound with a suitable gauge of wire, there is no reason why your proposal should not be adopted.

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Constant Band-width Filters.

Do you consider that the newer type of band-pass filter, which gives sensibly constant peak separation, is definitely better than the older system, in which fixed-capacity coupling is used. I am about to construct a unit for addition to an existing set, and am uncertain as to which of the various systems you have described recently is likely to be best for my purpose.

"Constant-width" filters are slightly more complicated than the older type, but they offer very definite advantages, particularly in sets with a single H.F. stage. A filter with fixed-capacity coupling tends to give excessively broad tuning at the upper end of the wave-range scale, while at the lower end coupling falls below the optimum value, and consequently there is a noticeable loss of signal strength. Inductively coupled filters suffer in a similar way, except that the position is reversed, and tuning becomes broad at the lower end of the tuning scale.

FOREIGN BROADCAST GUIDE.

MARSEILLES (PTT)

(France).

Geographical position : 43° 17′ N., 5° 21′ E.

Approximate air line from London : 624 miles.

Wavelength : 316 m. Frequency : 950 kc. Power : 1.5 kW.

Time* : Greenwich Mean Time.

Standard Daily Transmissions.

13.00 G.M.T. (Sun.), relay of PTT Paris (Ecole Supérieure); 12.30, gramophone records; 14.30, 18.30, 20.30 (Sun.), relay of PTT Paris; 17.30, gramophone records; 20.30, concert or play; opera (Fri.).

Man announcer. Details of items in programme are sometimes given in Provençal dialect. Call: *Allo! Allo! Ici Marseille-Provence.*

Opening Signal: gramophone records of a Provençal folk-song from Bizet's incidental music to *L'Arlésienne.*

Interval Signal: two bells (struck alternately).

Closes down with usual French formula.

*(*France adopts British Summer Time.)*

Reaction as Volume Control.

It appears from articles that have been published in your journal that some form of input volume control is almost always desirable when band-pass tuning is used; do you consider that it would be necessary to add this refinement to a detector-L.F. set (with filter input) which is to be used mainly for reception of the local station at a distance of 20 miles?

Acting on advice given to another reader in the "Readers' Problems" section, reaction is to be fitted.

We think that, in the circumstances you describe, an input volume control would almost certainly be unnecessary; adjustment of reaction should provide sufficient variation in signal strength.

○ ○ ○ ○

Magnetic Sense of Windings.

I am winding some sectional coils for use as intermediate-frequency couplings in a superheterodyne, and have come up against a minor difficulty with regard to the interconnections of the sections. It is realised that, in order that the magnetic sense may be correct, the end of one coil should be joined to the beginning of the next, provided they are all wound in the same direction. In my case, it is inconvenient to make the interconnections in this way: would it be in order to wind alternate coils in opposite directions, and to join together the inner and outer ends of adjacent windings?

Yes, if you find it convenient to do so, there is no reason why the coils should not be joined together in this way. This applies to any inductive winding.

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

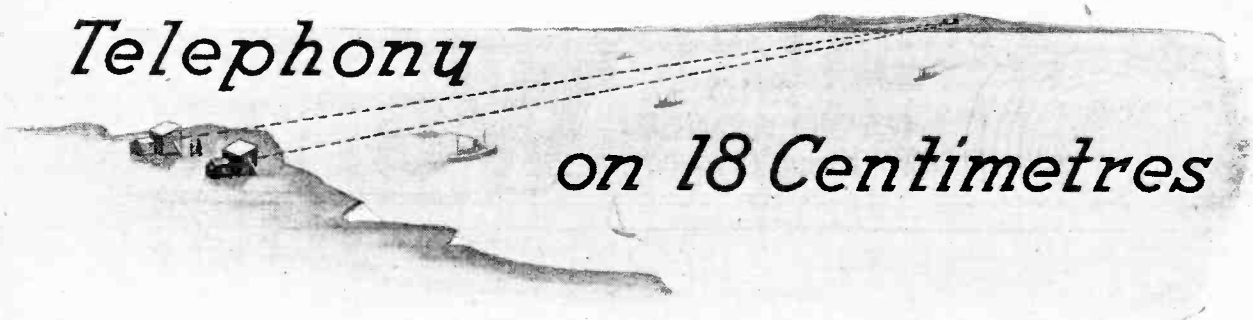
Broadcasting is no Longer a Monopoly.

WHEN the introduction of broadcasting was first discussed in this country, whatever may have been the differences of opinion and variety of ideas on how broadcasting should be conducted, those responsible for its introduction were unquestionably unanimous that broadcasting must be controlled, so far as the nature of the programme matter was concerned, by some central authority, which, in turn, would be subject to the Government. On this understanding our B.B.C. came into existence and was allowed substantially a free hand, but the Government retains authority to check anything which might be regarded as in the nature of misuse of the microphone. We have had numerous examples to illustrate how impossible it is for the B.B.C. to err from the paths of impartiality without being pulled up by some section of the public, for, in the very nature of things, the programmes broadcast can be heard and criticised by all.

But a new situation has arisen to-day; the monopoly of broadcasting is no longer the monopoly which it formerly was, and many listeners are participating in broadcasting originating in this country not all of which emanates from the studios of the B.B.C. If the reasons for establishing broadcasting as a monopoly under Government control were sound originally, nothing would appear to have occurred in the intervening period to justify what appears to be a reversal of those views to-day. The Post Office, however, on its own initiative, and apparently without reference to other authorities, has granted permission to all sorts of persons in different parts of the country to set up what is a broadcast relay service in name, but which, in point of fact, may be quite a different affair. In the case of these relay services the Post Office has no convenient means of listening-in to check what is being put out over the wires.

Why do we go to the trouble we do in selecting those who are to guide the destinies of the B.B.C. and censor the broadcast matter, when we give similar power to distributors of relay services with no check on the matter which may be distributed over their circuits? We are not suggesting at the moment that there is any deliberate intention of those who apply for a licence for a relay service to make use of the lines for other than distributing broadcasting, but if we are to safeguard the system which we have so carefully set up, then licensing independent relays is not the way to set about it. It is possible, through a relay service, to pick and choose what should be put over the lines and to intersperse comment between items or to replace the broadcast transmissions entirely by other matter at will. Surely such a state of affairs cannot be allowed to go on without proper investigation, and we are strongly of the opinion that the Post Office has failed to appreciate the responsibility which it has taken upon itself in creating a situation which negatives the original conception of the control of British broadcasting.

In This Issue



Telephony on 18 Centimetres

An Interesting Demonstration of Commercial Possibilities.

ONLY a few years ago wavelengths below 100 metres were regarded as interesting but of no real value for commercial purposes, and, consequently, as congestion in the ether grew, the amateur transmitters and experimenters were pushed out of other wavelengths, and authorised to work on these bands, uncoveted for commercial exploitation. But this state of affairs did not last for long, and, very largely due to the enterprise of amateurs in trying to make the most of their allocation of wavebands, a new era in wireless communication was evolved, embracing world-wide short-wave telephony and the beam systems.

Investigators have since been busy in exploring wavelengths of a far lower order, and laboratory results have been obtained with wavelengths of the order of centimetres; but, until a demonstration given recently by the International Telephone and Telegraph Laboratories, of Hendon,[1] when two-way telephony communication between Dover and Calais was carried out, using a wavelength of 18 centimetres, we believe nothing of this kind had been attempted outside the laboratory, and certainly had not been contemplated for commercial application.

[1] See *The Wireless World*, April 8th, 1931, page 377.

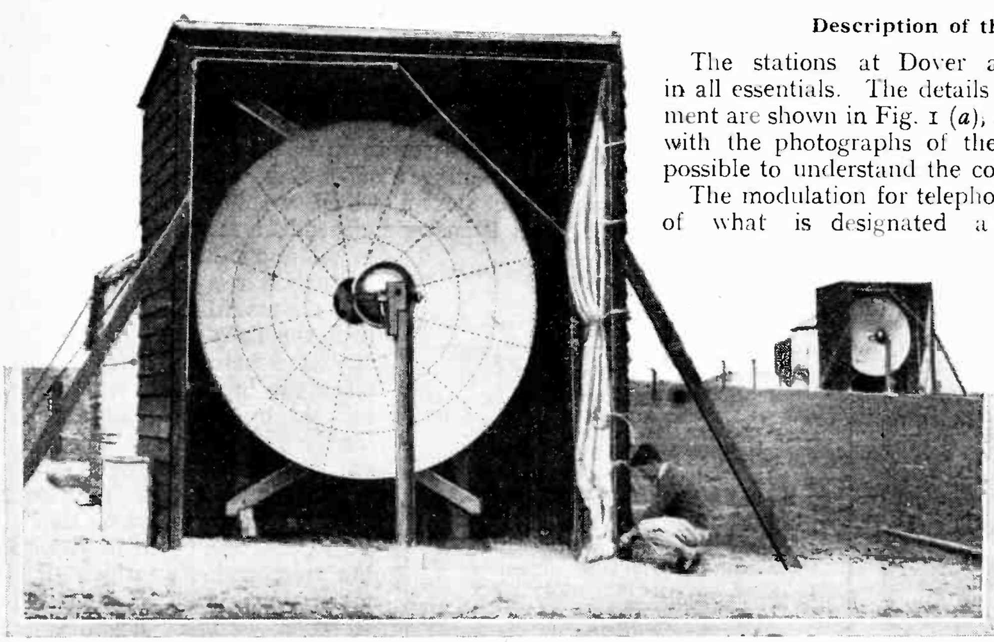
The transmitting and receiving aerials used for this demonstration were less than one inch long, and the power used was only half a watt. These values are in striking contrast to the power to which we are more accustomed in connection with commercial telephony when elaborate aerial systems are generally employed.

The equipment used for the demonstration was largely developed by French engineers in the laboratories of Le Matériel Téléphonique, Paris. A station has been set up on the cliffs at St. Margaret's Bay, near Dover, and another across the Channel at Blanc Nez, near Calais. The two-way radio telephony circuit shows no sign of fading, and the quality is remarkably good. The propagation of the waves is naturally unaffected by climatic conditions, but it is necessary to have virtual optical visibility between the transmitter and receiver, or, at least, conductive obstacles of any length must not be interposed.

Description of the Equipment.

The stations at Dover and Calais were identical in all essentials. The details of the transmitter arrangement are shown in Fig. 1 (*a*), and, studied in conjunction with the photographs of the equipment, it should be possible to understand the construction.

The modulation for telephony is applied to the circuit of what is designated a "micro-radion" valve, which is employed for generating the high-frequency oscillations. This valve, it is understood, is of special construction, and is, in fact, the secret of the efficiency of the system. A short transmission line connects the valve to the radiation system, or doublet, which is about two centimetres in length. The amplitude of the high-frequency current along the doublet at



View of the transmitter (in foreground) and the receiver at St. Margaret's Bay, near Dover.

Telephony on 18 Centimetres.—
any instant is substantially the same. The doublet is located at the focus of a paraboloidal reflector, some 10ft. in diameter, the purpose of which is to concen-

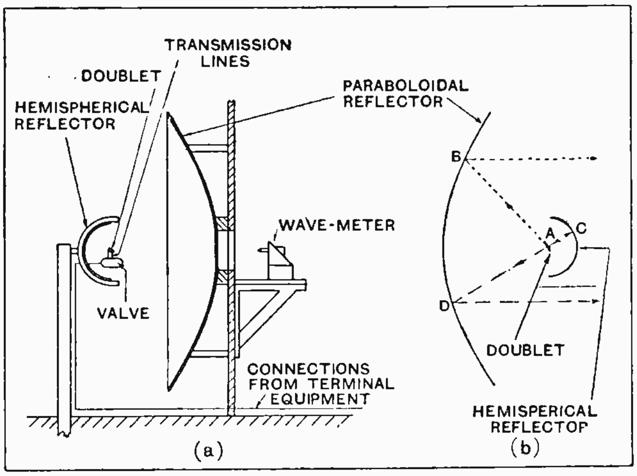


Fig. 1.—Sketches illustrating the purpose of reflectors.

trate the radiated waves into a small solid angle accurately directed on to the distant receiver. The focal length and the diameter of the reflector are so related as to ensure maximum efficiency for the diameter used.

A small hemispherical reflector is also arranged to face the paraboloidal reflector, and embracing the valve and doublet so as to collect all the radiation and reflect it back again towards the source. This smaller reflector is of such a size that when the reflected radiations reach the focus again they are in phase with those being radiated at that instant. The appropriate length of the radius depends upon the wavelength, the relation being that it should be substantially a multiple of half wavelengths, i.e., radius $= N\frac{\lambda}{2}$. The factor N is so chosen that the radius shall be large enough to ensure that the reflector has satisfactory electro-optical qualities, but is not large enough unduly to intercept reflection from the main reflector.

The purpose of the spherical reflector can be seen from reference to Fig. 1(b), although the effect of diffraction would have to be taken into consideration in practice and is neglected in this description. Fig. 1(b) shows that the direct radiations such as A B pass straight to the large reflector and thence to the distant receiver, as indicated by the arrow, whereas waves such as A C are reflected back by the small reflector through A, on to the large reflector D, and thence out to the receiving station. By way of comparison it may be stated that the gain due to the paraboloidal reflectors on one channel is of the order of 46 decibels, and that the small reflector adds to this another 6 decibels.

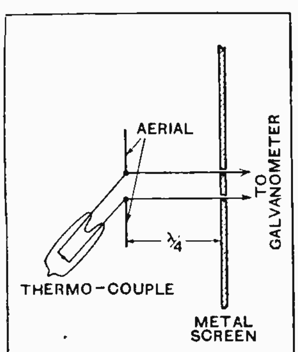
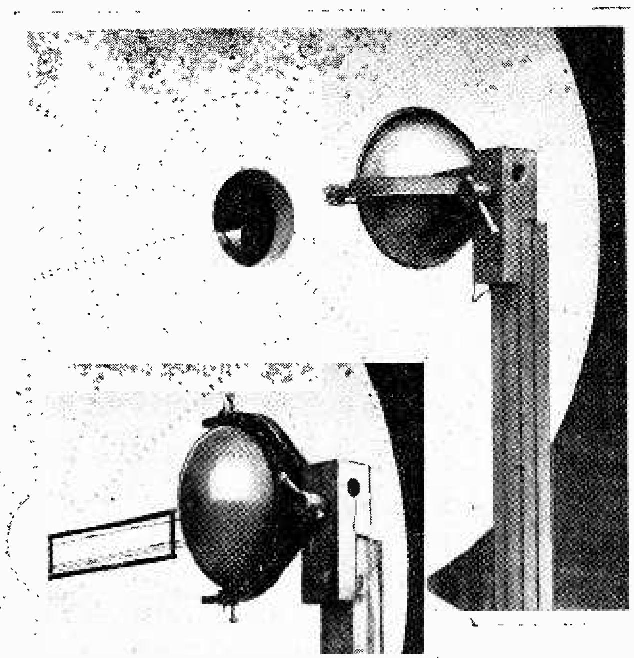


Fig. 2.—Arrangement of the wavemeter.

Reference to the photographs will show that the large reflector associated with the transmitter has an aperture in the centre through which a part of the radiation passes, but by making the diameter of this aperture slightly less than that of the smaller reflector no actual loss of radiated power results. The radiations passing through this aperture are arranged to fall upon a special measuring instrument which can be employed as a wavemeter. This instrument is shown diagrammatically in Fig. 2. This wavemeter is normally calibrated and set to the frequency of the transmitter. It comprises a small collector or aerial, in which the induced e.m.f.



Close-up views of the reflectors on the transmitter (above) and receiver (below).

acts upon a thermo-couple junction. The associated galvanometer indicates the radiated power, whilst the distance between the aerial and metal screen, being adjustable, provides a means of measuring the wavelength; thus, in the demonstration which was given the wavelength used was 18 centimetres, whilst the radiated power was of the order of 0.5 watt.

The Micro-Radion Valve.

The general arrangement of the receiver is very similar to that of the transmitter, except that no measuring device is included, and, consequently, the main reflector has no aperture. As in the case of the transmitter, there is a doublet connected by a transmission line to the "micro-radion" valve, which acts as the detector. The linear distance between the receiver and transmitter comprising one station is about 80 yards, and the reason for this spacing is to avoid possible coupling. The re-

Telephony on 18 Centimetres.—ceiver is so located as to be in the electro-optical shadow of the transmitter. In Fig. 3 the arrangement is illustrated diagrammatically.

Applications.

It would be unwise to attempt any prophecy as to what may be the ultimate applications of this system. There can be no doubt that it provides a dependable and extremely economical intercommunicating system for short distances; whether or not it can be applied to communicate directly beyond the limits of the horizon will depend upon later investigations into the properties of waves of this order. The two outstandingly valuable properties of these waves which are at once obvious are that the very high-frequency band will enable an enormous number of channels of communication to be included, making ether congestion on this band a very remote contingency, and offering great possibilities for television or picture transmission; also, the very marked directional properties of the transmissions indicate the value of the system for secret communication. For navigation purposes, and especially for radio beacons, the simplicity of the apparatus has distinct advantages. It would not appear at first that applications are promising in cases where one point of communication is not stationary; there are, however, enough possibilities opened up where these requirements need not be fulfilled to allow us to leave safely in the hands of the brilliant originators of the system the development of means for overcoming disadvantages which at present may be apparent.

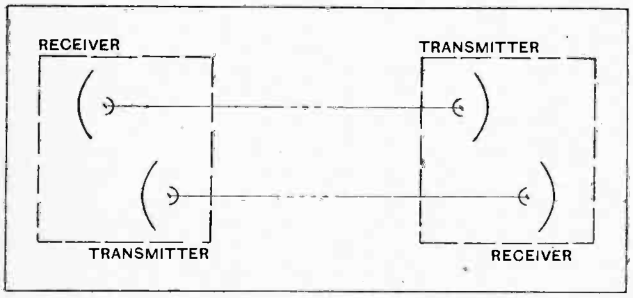


Fig. 3.—Sketch showing the arrangement of transmitters and receivers so that receivers are in the shadows of the transmitters.

NEWS OF THE WEEK IN BRIEF REVIEW.

MORE BROADCAST HOWLERS.

Some eighteen months ago (September 25th, 1929), *The Wireless World* gave several instances of the mutilated titles of items from the Daventry programmes as printed in some of the French broadcast programme journals, and a correspondent sends the following fresh examples:—

In view of the apparent difficulty in finding jazz titles nowadays, possibly some of the following may be genuine: if not, perhaps they may inspire composers:—"My Baby just caress for me," "My seweter tan swett," "Cheer up and mile," which goes nicely in the athletic line with "A sprinting-time idyll," "I'm doring wat I'm doring," "Happy days in Digie" (indigenous, perhaps?) "Hawaiian Sweetheart of Mince," "Sillepy Valley." One likes also the "Stars and Spripes" march, and the selection from the "Shew of Skows."

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A NEW NATIONAL ANTHEM.

With all the new post-War States, one does not like to deny the accuracy of the item "Little wee croodin' doo: *Hymne Nationale*," though one would like to know the country which has adopted it.

Classical and semi-classical items are, however, not neglected. "The Beauty of the Sleeping Cars" continues to appear regularly, "Shepherd Steey" is a newcomer, as also "The sticky worm" (*Ver Gluant* for "Glow-worm").

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A VERY OLD TIMER.

Another title that promised excellently was "*Le vieux Centenaire.*" One hoped for the "old Centenarian's" reminiscences—the Boer War ("Dolly Gray") somewhat confused with Waterloo, and so on, all in his shaky old (saxophone) voice. "Variations on the Old Hundredth" came as a disappointment.

However, by far the best effort was a Walton item which appeared as "*Symphonie Deconcertante*"—obviously the right title!

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WIRELESS FOR THE BLIND.

The Organising Secretary of the "Wireless for the Blind" Fund sends us an extract from the "New Beacon," suggesting the "Radio Adoption" of blind people by suppliers of wireless sets. He gives an instance of a Radio Association of Wholesalers and Retailers, in which it is proposed that each member shall "adopt" two or three blind people, with a view to giving them all possible assistance with their sets, such as the provision of accessories and aid in the event of breakdowns. He will be glad of any information concerning schemes of a similar nature in various parts of the country, which should be addressed to him at 226, Great Portland Street, W.1.

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THE SHORT-WAVE FAMILY.

"Few persons realise that short-wave radio is a new Dove of Peace, silently bringing together the peoples of the world into one big family," says *International Short Wave Radio News.* "In this fascinating field social standings are discarded. High Government officials and millionaires write to poor labourers and exchange ideas; each trying to surpass the other's record and at the same time help one another. We have daily proof of this at headquarters while going over the mail. We know of several Presidents who spend their few leisure moments beside a short-wave receiver and a Sultan who spends several hours each day tuning a powerful set that was rushed him a few thousand miles by airplane."

NEW STATION AT SEVERAC.

The French postal authorities are erecting a station at the Portes de Saint Nazaire, between the communes of Montoir and Severac, which will be one of the most powerful in France, and able to communicate direct with ships in the most distant parts of the Atlantic. The transmitter will be at Severac and the receiver at Montoir. Special devices will be used to avoid interference with the Basse-Landes station belonging to the Department of Marine. The work on this station is progressing rapidly, and it is expected to be working next autumn.

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FRENCH BROADCASTING PROBLEMS.

It will be no easy matter to draft a wireless Bill that will satisfy the French listeners. The Saverne Radio Club, for instance, has passed a resolution asking the State not only to "make known publicly and periodically" the manner in which it spends the money obtained from listeners' licences, but to "recognise the right" of the listener to earmark "an important and well defined percentage" of his licence fee for the transmission station of his choice.

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GOOD LUCK, HIMOPIS!

A tantalising report—tantalising because no wavelength is mentioned—is given in the Allahabad "Pioneer" concerning the first broadcasting experiment in Northern India. The plunge was taken by the Allahabad University Physics Department on March 9th, using their transmitter for a concert supplied by the band of the 1st Batt. 22nd (Cheshire) Regiment and a number of local performers.

Everyone who took part was granted the title "Himopi," i.e., Helper in Matters of Public Interest.

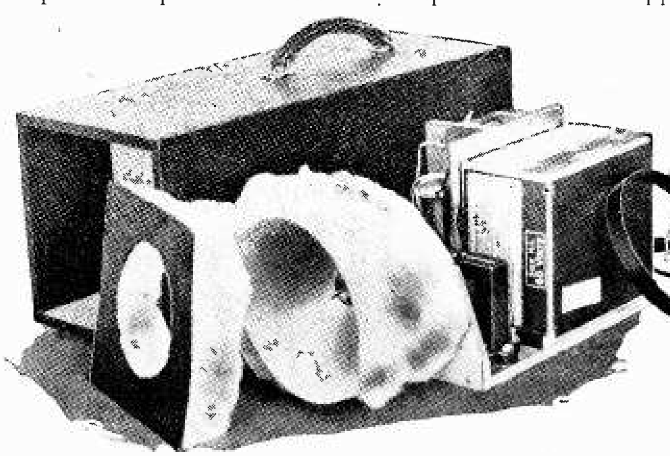
Making a DEAF AID

Portable Microphone and Amplifier.

A NEGLECTED application of the low-frequency amplifier is its use, in conjunction with a microphone, as a means of augmenting the intensity of sounds so as to render them audible to the deaf. By following the simple constructional details given here a speech amplifier is obtained which will prove of great assistance to the partially deaf as well as being suitable for remote listening.

ATTEMPTS to remedy insensitive hearing with the aid of amplifiers have been made since the first introduction of the microphone. More or less successful appliances have long been available combining a microphone, battery and telephone earpiece. Such apparatus gives a greater intensity of sound at the ear than does the original sound, and has proved sufficiently beneficial to be indispensable with mild and certain forms of deafness. Apparatus of this form was in use long before the coming of the valve amplifier, and it is surprising that comparatively few deaf-aid equipments are available making use of the valve amplifier. The small microphone amplifier has the advantage of compactness, modest current consumption and low cost. It is, however, comparatively insensitive and introduces distortion, although not, perhaps, to an objectionable extent. In using the valve as an amplifier we have a much more sensitive equipment, but the complete outfit is more cumbersome. Assuming that one can tolerate the disadvantages of size and weight the simple equipment here described will prove most valuable.

In place of the carbon microphone, as commonly used in the simple apparatus not employing a valve amplifier an electro-magnetic microphone is adopted. This takes the form of a loud speaker movement, for most radio enthusiasts know that a loud speaker will serve as a microphone and that words spoken on to its diaphragm can be heard in a pair of telephones joined across its terminals. No battery is used in this part of the apparatus, the loud speaker movement generating currents as a result of the movement of its armature. Although a loud speaker used as a microphone in this way is less sensitive than the carbon type, it possesses the advantage of freedom from noise, so that it becomes possible to amplify the potentials generated without the speech becoming obliterated by the amplification of noises which result from the ordinary type of carbon microphone. In effect, the simple carbon microphone is only sensitive when spoken into at short distances, while the loud speaker movement used as an electro-magnet microphone, followed by an amplifier, possesses a much greater range. It is not necessary, therefore, to "speak into" the apparatus, and when placed anywhere in the room proves sufficiently sensitive, delivering to the ear a considerably amplified sound.



Easy access is obtained to the components, which are assembled as a unit and arranged to slide into the case.

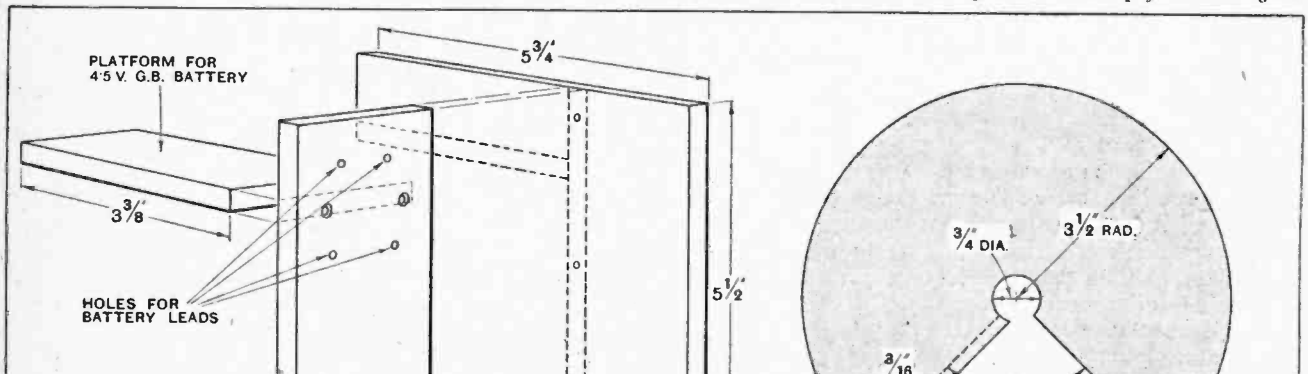
Two stages of valve amplification are adequate to follow the particular loud speaker movement chosen. A two-stage amplifier is very easily built, and no difficulties will be encountered by way of L.F. oscillation, while precautions in the form of introducing de-coupling are unnecessary. Three stages of amplification, on the other hand, bring about considerable complication, and the additional magnification would be mostly lost by the uncontrollable sensitiveness that would result. There would also be considerable increase in intensity of extraneous noise. Thus we have an arrangement which may readily be put together in which the output from the loud speaker movement is fed to the grid of a valve which is transformer coupled to a second valve and the telephone

LIST OF PARTS.

Wood, 5-ply, ⅜in. thick, 24ins. × 36ins.
2 Valve holders (Benjamin Vibrolder).
1 Breakjack, three-spring (Igranic P.65).
1 Plug (Igranic P.40).
1 Transformer, 3½ to 1 (R.I. type GP).
1 Loud speaker unit (Blue Spot 66K).
1 H.T. battery, 60 volts (Siemens H.1).
1 Grid bias battery, 4½ volts (Siemens G.1).
1 Accumulator (Exide "Gel-Cel" JWX5).
Rubber sponge.
1 Leather handle.
Imitation leather paper (F. G. Kettle, 9, New Oxford St., London, W.C.1).

receivers connected in its plate circuit. As the valves deal with only a small signal voltage those of the "H.L." type are used in both stages, so that maximum amplification is obtained while a slight reduction of the lower frequencies which thus results is, if anything, an advantage.

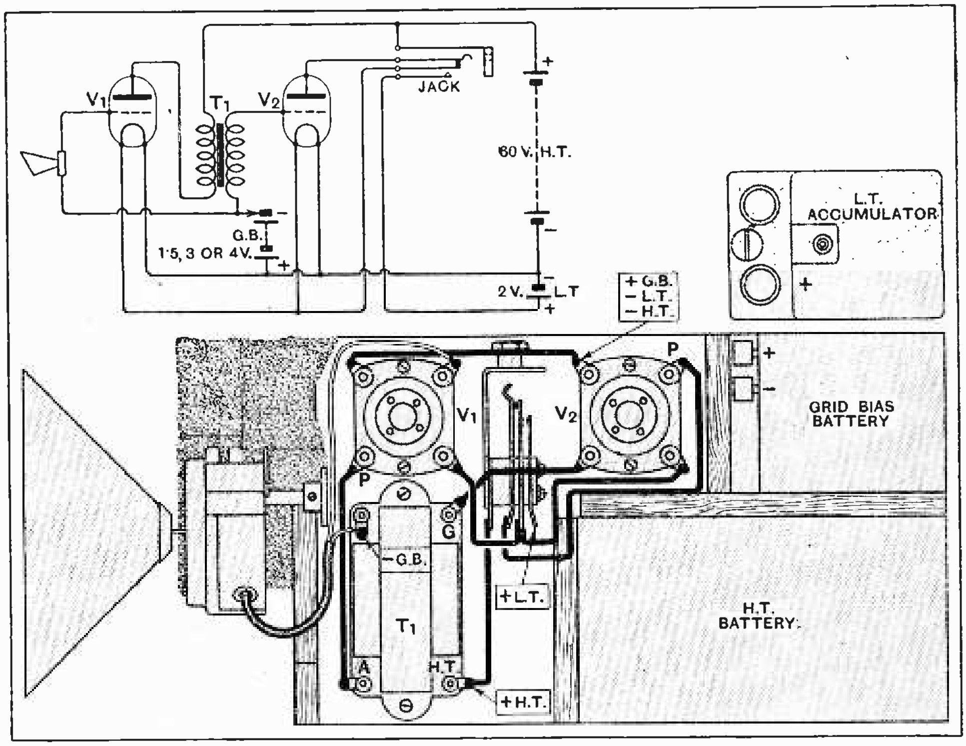
The two valves which are of the 2-volt class require a current of only 0.2 ampere, so that an accumulator measuring only 4 × 3½ × 2½ will give 70 hours' use from a single charge. An H.T. battery potential of 60 volts is adequate, and as the current drawn is less than 1 mA. a very prolonged working life may be expected before renewal is necessary. These batteries, as well as the grid-biasing cells, fit together snugly in the back of the amplifier, and the L.T. accumulator may be readily removed for recharging. In front of the batteries are the pair of valve holders and the intervalve transformer, while the loud speaker movement is clamped between two pieces of sorbo rubber (a sorbo sponge) so as to minimise its response to vibration applied directly to case. A breakjack on the baseboard is arranged to switch on the filament circuits when the telephone plug is inserted. Quite a small diaphragm suffices to pick up the sound, and is constructed in the form of a cone by cutting out a piece of stiff drawing paper to the dimensions given. Five-ply wood, ⅜in.



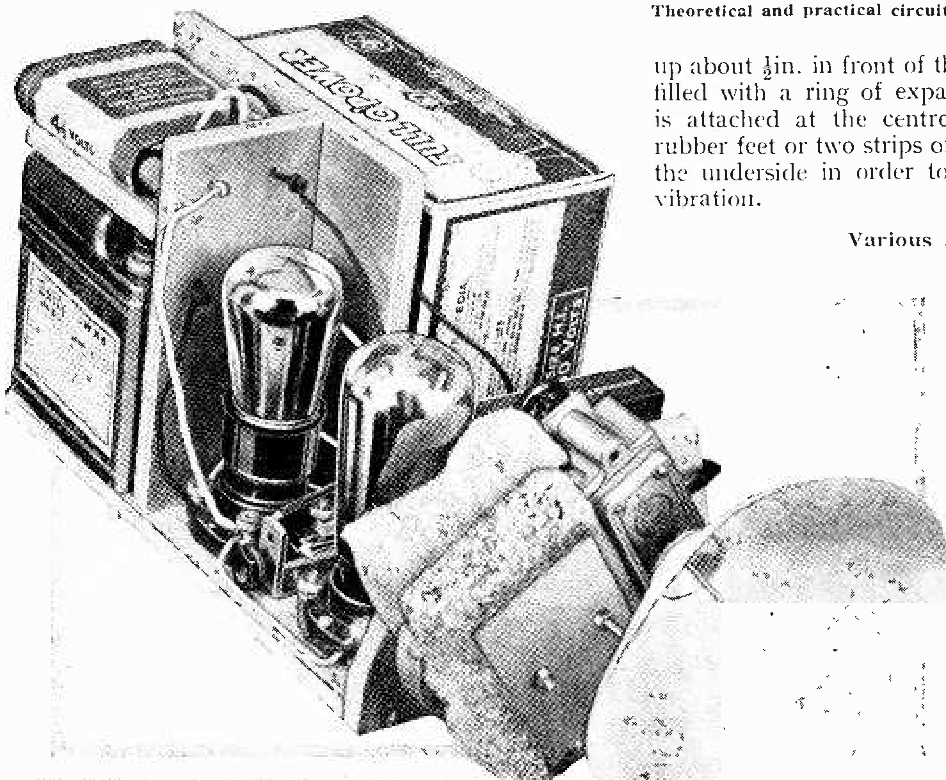
Constructional details of the plywood baseboard and supports also the data for screwing on the various components. The pieces of wood are secured together with glue and screws. The diaphragm is cut out from a sheet of moderately stiff drawing paper.

Making a Deaf Aid.—

thick, is used throughout for constructing the containing box, the baseboard and the battery supporting partitions, all joints being glued and screwed. A black paper or cloth imitation leather covering is easily glued on to the outer faces of the box, using the glue very wet and spreading the paper so as to avoid folds. Wiring up is carried out in the simplest manner with No. 22 tinned wire run in sleeving. Positive connections are made to the H.T., and grid-bias batteries by driving the flexible wire connections home under wood screws in the battery sockets. No trouble is likely to be met with in making up the apparatus which will be found to work at once, using a pair of 2,000 ohm telephone receivers. The mouth of the box is arranged to give the microphone a somewhat directional effect, and a cardboard barrier with a central hole is set up about ½in. in front of the diaphragm, the space being filled with a ring of expanded cotton wool. A handle is attached at the centre of balance, and four soft rubber feet or two strips of sorbo rubber are attached on the underside in order to insulate the apparatus from vibration.



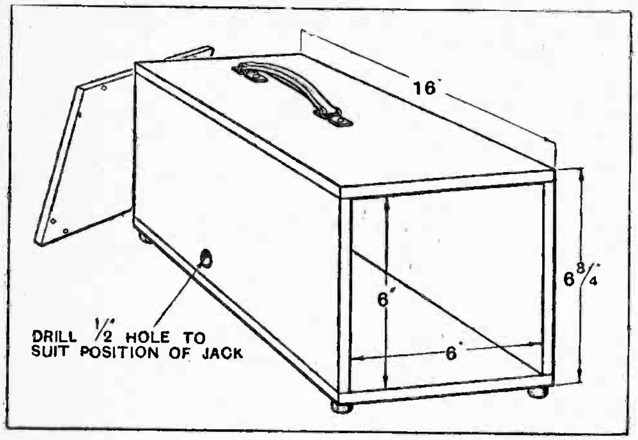
Theoretical and practical circuit diagrams.



The finished unit showing the arrangement of the batteries and the method of clamping the loud speaker movement.

Various Applications.

As to the utility of this "Deaf Aid," it may be said that when used in a room the amplification is easily sufficient to avoid the need of speaking above the ordinary degree of loudness, where otherwise it would be necessary to raise the voice considerably. Again, this apparatus is of considerable assistance when listening to broadcast reception when the sound delivered from the radio receiver is normally insufficient. Another application is that of using the "Deaf Aid" at the cinema, but the drawback here is that the listener may find some difficulty in interpreting the amplified sounds he hears, not owing to their weakness, but in consequence of the considerable background noise that exists.



Dimensional drawing showing the construction of the cabinet. The handle is attached at a position away from the centre so as to balance the outfit when lifted.

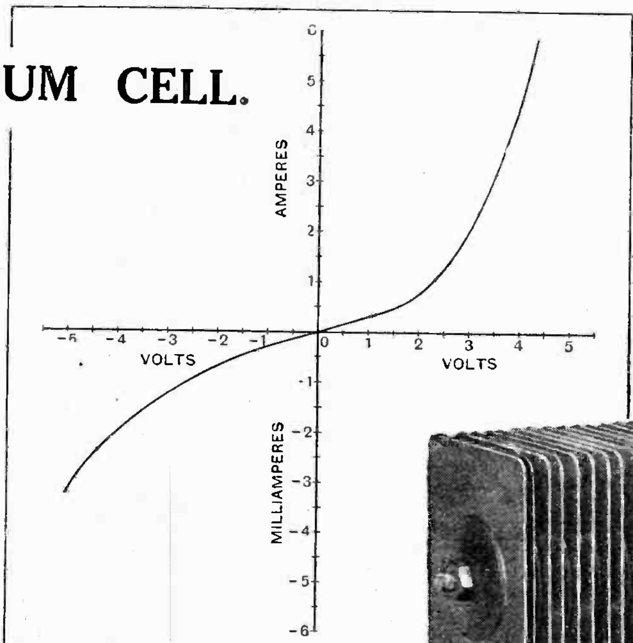
A microphone and amplifier such as this has applications other than its use by the deaf, such as listening in to conversations at a distance and the examination of noises emitted by machinery.

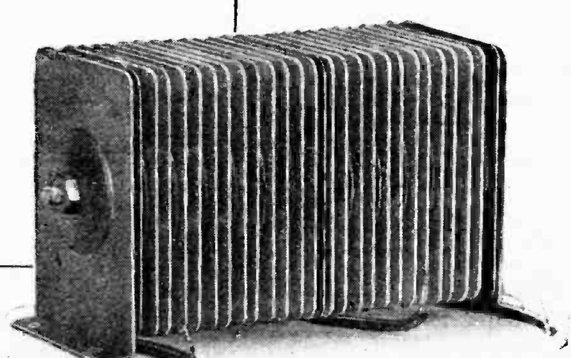
Whilst the design given is of the simplest possible type so as to permit of ready construction, the results represent the most satisfactory obtainable, bearing in mind always that amplification cannot be pushed too far owing to the fact that interfering sounds are so often present. If a volume control is thought desirable this may take the form of a 50,000-ohm wire-wound potentiometer connected across the loud speaker movement, one side being taken to the grid bias circuit and the sliding contact to the grid of the first valve. If he so desires the radio enthusiast will find no difficulty in adding a simple tuned circuit with reaction as an auxiliary unit so that the apparatus may be used for radio reception. Alternatively, it is quite a simple matter to put to the test the details given here by adapting an existing radio receiver connecting the loud speaker leads into the grid of the detector, applying a small negative potential and connecting telephone receivers to the output terminals of the set. High magnification valves will, of course, increase the amplification, and, while not permissible for loud speaker operation, will give the best results on the weak input signal from the loud speaker microphone, and consume but little current from the H.T. battery.

NEW SELENIUM CELL.

A Dry-plate Rectifier with Attractive Properties.

CONSIDERABLE interest attaches to the new selenium rectifier recently brought out by the S.A.F. (South German Apparatus Works) belonging to the class of dry-plate rectifiers or dry valves. Its construction is as follows: an atom thick selenium layer is spread on a metal plate, and has pressed against it a piece of metal foil. Between the two elements—selenium-coated plate and metal foil—the rectifying action takes place, and the current only finds a passage in one direction.





The selenium cell rectifier and its characteristic.

To assist in cooling and to give greater mechanical rigidity, metal plates are inserted between the separate elements. It is claimed that the cells are insensitive both to vibration and to temporary overloading; furthermore, protection against injury is afforded by the fact that a rise of temperature decreases the current passed.

The rectifier would seem to have a vast field of application, as the elements can be connected in series or in parallel to suit various requirements of voltage and current. Units are available for battery charging, anode supply, field-magnet supply, and for building in to measuring instruments.

The selenium valve has a highly efficient rectification characteristic, and allows only 0.1 per cent. of reverse current to pass. To attain this high efficiency the selenium is subjected to a special process which gives it a crystalline structure, and assists it to maintain constant electrical values.

UNBIASED

BY FREE GRID

Truths about Trams.

Those listeners who live in areas where tramcars and trolley buses make life scarcely worth living, speaking from a wireless point of view, will probably remember with some bitterness that a considerable time ago the Postmaster-General announced, in reply to a question in the House of Commons (see Hansard), that his engineering department was co-operating with certain tramway undertakings in special experiments with a view to remedial measures being taken whereby the radiation of man-made static could be prevented, or at any rate reduced. Since then silence has brooded over the land, and letters to the B.B.C. or to the G.P.O. only draw forth what I believe is unofficially known as a sympathetic sob-stuff stock reply (usually abbreviated to reply Type S.S.S.S.). It is generally realised, of course, that there is no law under which owners of trams, face lifters, and other offensive electrical appliances could be prosecuted, but one would have thought that the P.M.G. would have at least published a report on the results attending the G.P.O. experiments so that if they had found a remedy the long-suffering wireless public would have been armed with a few technical facts upon which to found an impassioned appeal to the Government to pass the necessary legislation to make the adoption of such remedial measures compulsory. The silence of the G.P.O., however, is apt to make people think, rightly or wrongly, that no remedy was found.

Pro Bono Publico.

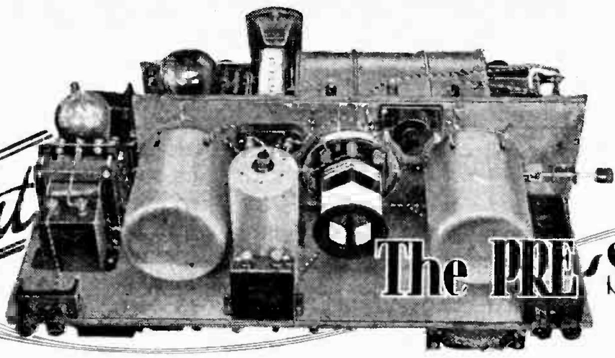
Now it so happens that I maintain a ménage in a municipality which is blessed, or cursed, according to the particular viewpoint taken, with trams of the trackless as well as of the ordinary variety, and although not being sufficiently near to suffer interference myself I have spent a considerable amount of time with various receivers in the houses of friends dwelling along the actual tram routes. In my very early days as an electrical engineer I had a fair amount of experience in electric traction work, and so am not entirely unacquainted with the "innards" of these juggernauts of the streets. Consequently, I have for a long time had certain definite ideas of my own in the matter of possible "cures." Only the basilisk eye of the conductor has hitherto prevented me from tearing up the floorboards of a tram and putting some of my ideas into practice, and now at last comes a heaven-sent opportunity of so doing.

Seeking a static cure.

My opportunity to show the P.M.G. his business is due to the fact that a misguided municipality up north—the name of which for obvious reasons I must not mention—has just appointed a brother-in-law of mine (who is, incidentally, also a keen wireless enthusiast) to have dominion over their trams. He does not take up his appointment until after Whitsun, but has meanwhile lost no time in hopping across to the Continent to study at first hand experiments which have been undertaken in one or two European cities in this matter, and he has already invited me to come up north as soon as he has got well into the saddle in order to co-operate with him in certain experiments which he intends to undertake. I hope, therefore, before long to be assisting him to spend a little of the ratepayers' money for the good of humanity at large, and to have some first-hand information on this all-important subject which I will gladly make public in due course. Incidentally, I may mention that some time ago I approached the tramways engineer of my own home town concerning this matter, but he proved to be one of the old school, and seemed to think that I was trying to put one over on him with what he described as "these new-fangled ideas."

Duplex Television, Please.

Sometimes one is apt to get heartily sick of the sycophantic applause of the studio crowd, who are apparently paid by piece-work. Not only do they annoy by making it difficult to follow the dialogue during a good comedy turn in a variety programme, but they add to their sins by vociferously applauding feeble turns when all the time you are sitting by your fireside longing to heave a lump of coal at the performer. It is unfortunate—or perhaps fortunate for him—that a poor performer cannot see the thousands of people who must jump to their on-off switches or to their tuning dials directly he starts up. In this connection I may mention that I am fervently looking forward to the day when television is perfected, for I shall then press for legislation which will compel the B.B.C. to undertake the expense of providing duplex television working for all their licence holders so that not only can the latter see the performer, but the performer will be able to see the effect of his efforts on his vast audience and take notice accordingly. In those days I trust that the Lord High Programme Panjandrums (or is it Panjandra?) of the B.B.C. will be compelled to have a look-in on Sunday afternoon.



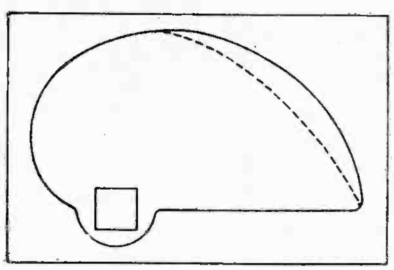
More About The PRE-SELECTION A.C. THREE

Points in Construction and Operation: The Question of Alternatives.

EXCEPT for its capacity-coupled input band-pass filter, which gives sensibly constant broadness of tuning over the medium-wave scale, the "Pre-Selection A.C. Three"[1] does not include any features that are at variance with standard modern practice. Naturally, there was some uncertainty as to whether an innovation such as this new method of automatically variable filter coupling would prove, in the hands of amateur constructors, to be as successful as was hoped when it was originally developed. Although there was no tangible reason for thinking otherwise, it is reassuring to be able to say that this part of the receiver seems to have given no trouble whatever.

Although inter-circuit coupling, as provided by the arrangement actually used and described, is sufficiently correct for most practical purposes, there is a slight broadening of tuning at each end of the medium waveband. So far as the very short wavelengths (a little above 200 metres) are concerned, this is due to stray capacities, including residual capacity of the coupling condenser. At the other end of the scale slight excess coupling is traceable to condenser plate shape. This must not be taken as reflecting on the designers of the coupling condenser, as this component was used for a purpose for which it was never intended.

Those who are not satisfied with anything short of perfection may be interested in the question of modifying the coupling condenser so that an even greater degree of band-width constancy may be obtained. With this object in view, the moving condenser vane may be altered by cutting off a part of it, as indicated in the accompanying diagram. As the coupling condenser rotates with the main tuning spindle, this alteration will reduce coupling to a slight extent on wavelengths over about 450 metres. Minimum capacity is most easily reduced by substituting the metal end-plate by one of ebonite, which can be made accurately by using the original metal plate as a drilling jig.



By cutting the coupling condenser vane along the dotted line, a tendency for peak separation to increase on wavelengths above 450 metres is avoided.

It should perhaps be made clear that, although a "bakelite-dielectric" condenser was specified for coupling purposes, this was only because this particular component was suitable for modification; the bakelite interleaving must be removed entirely.

Operation of the filter for long-wave reception is a debatable subject: although theoretically correct peak separation of some 9 or 10 kilocycles can readily be arrived at by suitable adjustment of the extra coupling condenser CC_1, this control is not altogether an unmixed blessing, and, generally speaking, experience shows that it may be omitted entirely without any great harm being done. True, modulation sidebands will then be "cut" to some extent, but, thanks partly to the use of a pentode, reproduction will not be so lacking in brilliancy as to offend the average ear.

Operating Hints for the Experimenter.

In certain circumstances, and particularly when searching for distant stations, it may be desirable to work with considerably looser filter coupling than that provided for in the original design. This is mainly a matter of selectivity, although there is a slight increase of signal strength as coupling is reduced from normal to that giving optimum transference of energy. Of course, alterations of this sort must inevitably result in impaired high-note reproduction, but losses in this direction can generally be tolerated when long-distance reception is in question. It should be made clear that these adjustments are not essential, and are described only for the benefit of those who are experimentally minded.

Not the least attractive feature of this form of filter coupling is that changes can be introduced as and when required without any difficulty. The obvious way of introducing variations is to slack off one of the nipping screws which secures the condenser coupling disc, and then to set the moving vane at a position found by trial to be suitable for the wavelength to be received. By doing this, one forfeits the advantage of automatic variation of coupling when passing from one end of the scale to the other, and it will generally be preferred to adopt the alternative plan of increasing spacing between fixed and moving vanes of the coupling condenser. If a spring spacing

[1] *The Wireless World*, February 25th and March 4th, 1931.

More about the Pre-Selection A.C. Three.—

washer is fitted on the spindle, behind the moving vane, adjustments can be made in a few moments.

Construction of the receiver is simple and straightforward; experience shows that there are no real pitfalls for the inexperienced, but attention should be paid to one or two minor details. Before mounting the coils, it is wise to assure oneself that the built-in wave-range switches are operating properly. It should be realised that the switch control rod of the second filter coil (L_2, L_3) is "live," and, if it is allowed to touch the metal screening cover or base, the grid bias resistance for the H.F. valve will be short-circuited. To avoid all risk of this, it may be found advisable to widen the cover slots through which it is passed. The foregoing applies to the type of coil used in the original set.

If unduly long screws are used to secure the metal bracket which supports the volume control condenser, there is a risk that an unwanted "earth" may be introduced, as the screws may make contact with the under-baseboard screening plate. Incidentally, the other condenser supporting bracket should be definitely earthed. as shown in the practical wiring plan.

There is no particular reason why the general layout of the receiver should not be modified to suit individual requirements, but particular care must be taken to ensure that all coils and tuning condensers are adequately screened, and also that the leads to the coupling condenser are short, and arranged in such a way that capacity between them is kept as low as possible.

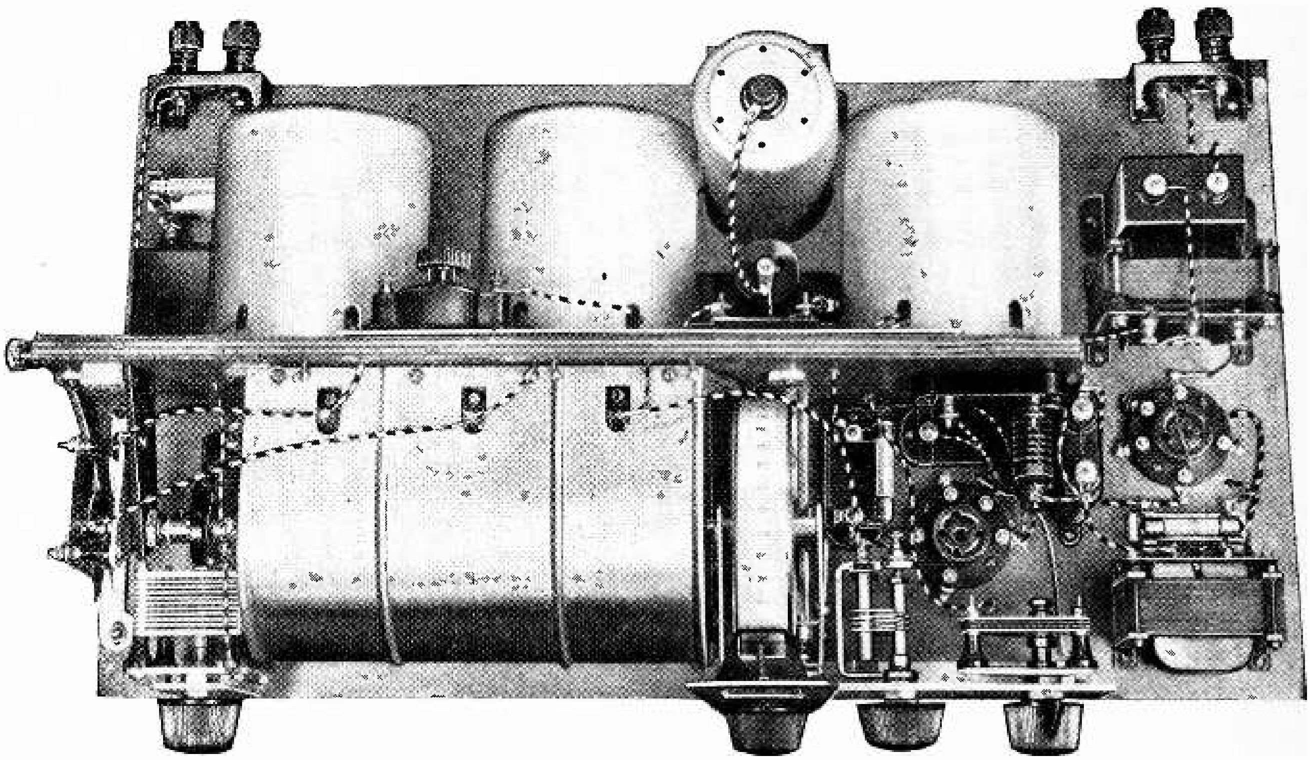
Those who are taking the "Pre-Selection A.C. Three" as a basis on which to rebuild obsolete receivers may, in the interests of economy, consider separate tuning control for the H.F. intervalve circuit. Needless to say, the filter condensers should be ganged.

Little need be added to what has already been said concerning operation of the set, but it may again be emphasised that no attempt should be made to adjust the filter trimming condensers except when inter-circuit coupling is set at minimum. If the aerial is exceptionally short, it may occasionally be found that the trimming capacity of C_2 is insufficient; the remedy is to move the aerial tappings towards the high-potential ends of L and L_1 (in equal proportion) or, alternatively, to add a small external capacity.

Modifications may Necessitate Re-designing.

There remains the vexed question of circuit modification. As the set is basically straightforward, it follows that an almost infinite number of variations might permissibly be introduced, but receiver design is now so involved that it is quite impossible to deal at any length with this subject. Those who wish to use a valve rectifier for H.T. supply are referred to the Readers' Problems section of *The Wireless World* for March 11th. The set is quite suitable for use with a gramophone pick-up, which may be inserted in the detector grid circuit in the manner described in the issue of March 18th.

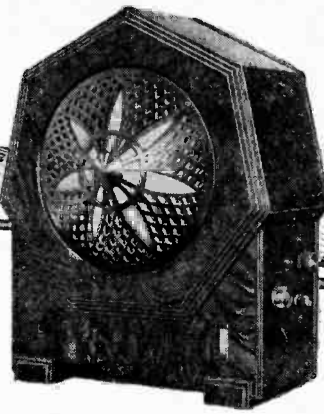
A battery-fed version of the receiver is practical enough, but apart from the obvious alterations necessary, it will generally be preferred to reduce anode current consumption by abandoning high-voltage power grid detection. A transformer may then be used in place of a choke as an L.F. coupling.



Plan view. Components associated with power supply are mounted below the baseboard.

Philips Radioplayer

ALL-ELECTRIC TYPE 2634



A Self-contained Mains-operated Three, having a Generous Output.

IT may still be said that the three-valve set is the most popular on the British market to-day. Three valves give adequate selectivity in relation to the number of stations that can be received. From the listener's standpoint the output stage is far more important than the arrangement of the H.F. amplifier and the range-getting properties of the receiver. It is the output stage that determines quality of reception, and if one can overcome the desire for the novelty of receiving forty continental stations, the reduced number that one will get with the three-valve set are practically free from valve noise, mush, and heterodyning. The three-valve set renders the reception of some ten stations an easy matter, gives an adequate input to the detector, and passes on a signal to the output valve as free of distortion as it is possible to obtain with any other combination of valves.

It is from these considerations that Philips have introduced yet another model in the three-valve range. It has a good single H.F. stage devoid of the defects of cross-modulation, self-oscillation, and the other well-known difficulties associated with two or more H.F. stages. Its detector is the leaky grid arrangement, using the 244V. valve, having values of grid condenser, leak and anode voltage conforming to the requirements of power grid detection, and being distortion-free within wide limits.

In the output stage is the generous power pentode, the PM24A. In comparing receiving sets particular attention should be paid to the type of output valve adopted, for therein largely lies the cost of the set, while the quality of reception is mainly governed by whether or not a generous output valve is fitted. The PM24A delivers a power output of 3,000 milliwatts to the loud speaker, a figure which, by way of comparison, is more than three times that of the average 6-volt battery power valve.

Turning to the details of the circuit, it is to be noted that the aerial is coupled to the first tuned circuit through a small air condenser having a value of 0.00002 mfd., and by this means aerial dimensions have but little effect upon the tuning positions for given stations and the gang operation of the two tuning condensers. An unusual feature is the dividing of the wave range of 200 to 2,100 metres into three sections instead of the customary two. This renders the set more sensitive as greater signal strength is developed across the tuned circuits. Following the H.F. valve, which is an S4V, is a straightforward tuned anode coupling. A generous H.F. filter follows the detector valve, which is transformer-coupled to the pentode.

The construction is particularly compact, which is largely due to the use of tuning condensers having mica dielectric, a practice concerning which there can be no criticism. It is probable that solid dielectric condensers such as these will not lend themselves to gang operation, but here, while the two tuning condensers are on a single shaft in order to render control easy, an auxiliary adjustment is provided for rocking the fixed plates of one of the condensers. Thus, the merits are gained of single-dial control, with the advantage of being able to get the last ounce out of the set by careful adjustment of an individual tuning condenser. The main chassis assembly is carried on a substantial bent iron frame, cadmium-plated to prevent rusting. The wave-change switch has a positive action, and while this fitment is often the cause of trouble in a receiver it is, in this case, owing to its particular form of construction, thoroughly reliable. A powerful snap action indicates the switch positions. Honeycomb-type tuning coils are adopted, and coupling between the aerial and anode coils is avoided by totally enclosing the aerial inductance in a metal compartment.

A new departure is to be found in the mains equipment in the use of a mains transformer suited to supply

SPECIFICATION.

H.F. stage with tuned anode coupling and S4V valve. Power grid detector, 244V valve. Transformer L.F. coupling to power pentode valve, the PM24A.

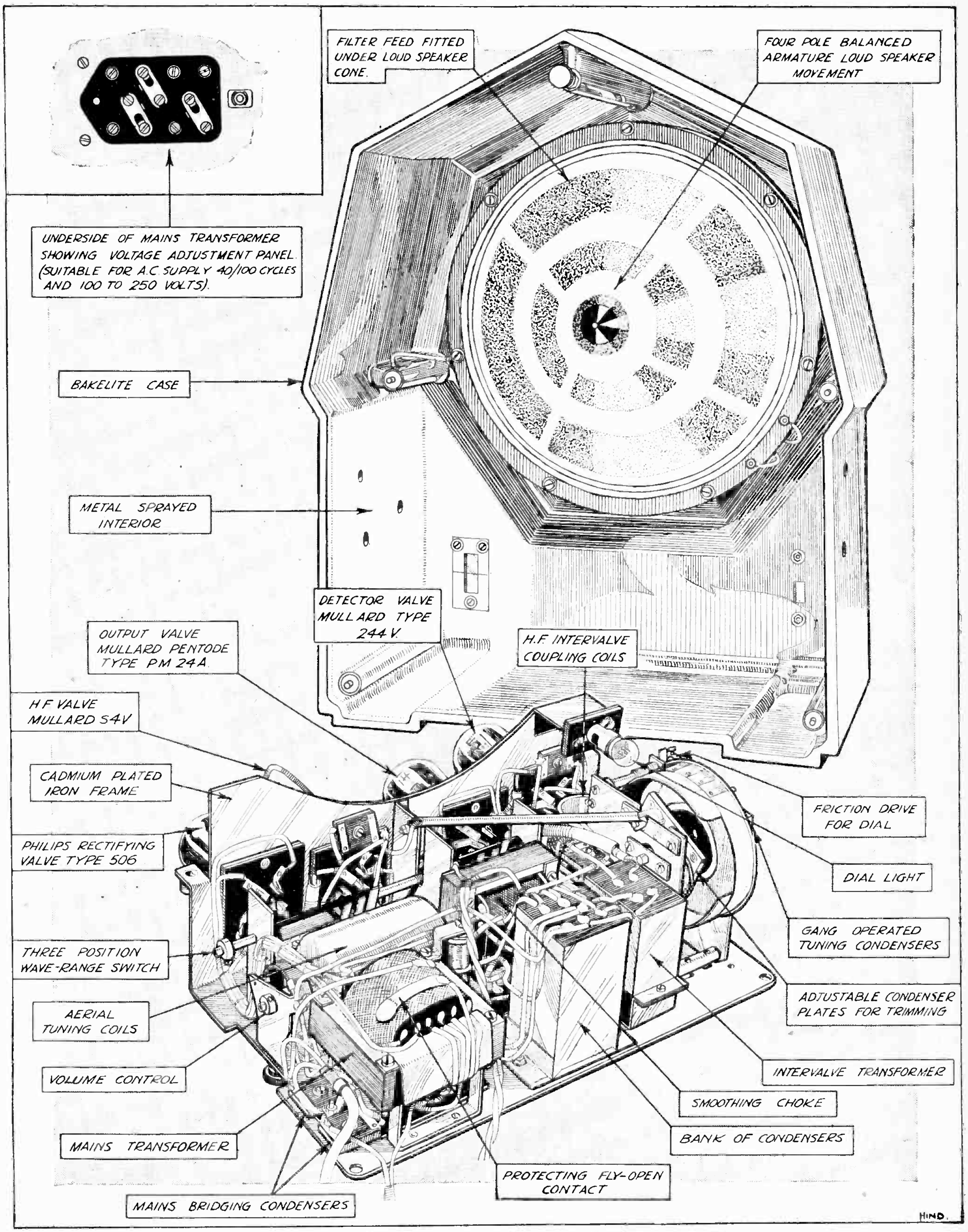
Wave range, 200 to 2,100 metres in three steps. Single-dial tuning with trimmer. Reaction and volume controls.

Provision for gramophone pick-up. High voltage valve rectification.

Adaptable for A.C. supplies from 100 to 250 volts and 40 to 100 cycles.

Cone loud speaker with 4-pole balanced armature movement and incorporating a choke capacity filter.

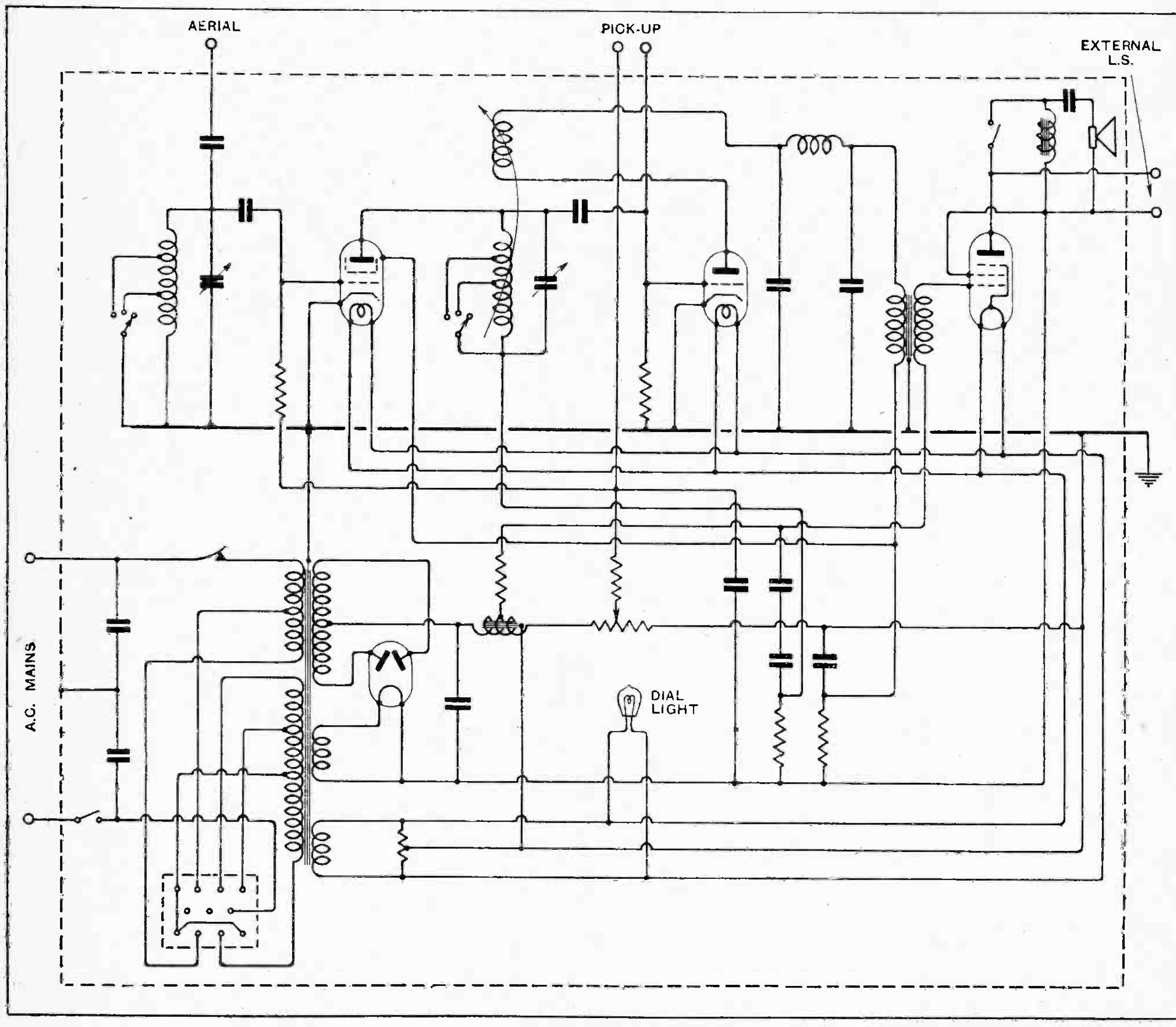
Price, complete with valves, £25.



Internal details of construction. The Philips "Radioplayer," type 2634.

Philips Radioplayer.—voltages between 100 and 250 and frequencies from 40 to 100 cycles, so that one need not specify the mains requirements of particular localities. A feature of all Philips' sets is a fly-open spring contact, held down by a low melting point alloy which breaks the main supply should an error occur in the set to cause overloading and thus bringing about a small rise in the temperature of the mains transformer. The smoothing equipment is generous, using a gapped-core choke which, combined with other small but important details, gives reception entirely free from mains hum.

A bold and original cabinet design with a conical loud speaker grille of oxidised metal, and the cabinet itself of mottled bakelite, produce a set of tasteful foreign programmes were received with strength and quality equal to that of the Midland Regional. By combining the loud speaker with the receiver the manufacturers may take into account the characteristics of both in order to get as near as possible to the desired uniform audio-frequency response. The customary measurement of the output over the frequency range was not carried out in this instance, but as an alternative an aural test was applied which revealed practically no falling off in the ability of the set to reproduce the upper frequencies up to 5,000 cycles, while at the lower end of the scale only a slight weakening was observed as the test frequency dropped below 200. This test revealed also a satisfactory absence of marked resonances. This outfit fulfils the requirements of those needing a set of moderate



Circuit of Philips three-valve A.C.-operated "Radioplayer," type 2634.

appearance. The knob controls being placed at the sides are convenient to operate.

Used in North London, separation of the two Brookmans Park stations presented no difficulty, and many range-getting properties and giving good quality reproduction. It is considerably better than the simple sets of slightly lower price and does not include unnecessarily elaborate and expensive equipment.

Broadcast Brevities

By Our Special Correspondent.

New Western Studio.—More Powerful German Stations.—The "Plugging" Controversy.

The Western Regional.

No site has yet been selected for the Western Regional transmitter, although, as stated last week, it will in all probability be located between Watchet and Minehead. Matters are, however, moving in the west, and the B.B.C. has taken a suite of offices in Queen's Road, Clifton, where a studio will be established.

oooo

Local Talent to be Encouraged.

Bristolians are now assured of a fair representation in the Western Regional programmes when they materialise a year hence. This adjunct to the Cardiff studios conforms with the hint given by the B.B.C. some five years ago that if, and when, the number of transmitters was reduced, a move would be made towards establishing studios in a number of artistic and industrial centres to provide an outlet for local talent.

oooo

Theatre Excerpt.

"Folly to be Wise," which is now running at the Piccadilly Theatre, with Cicely Courtneidge, Nelson Keys, and Mary Eaton in the cast, will furnish a programme item for National listeners on April 18th, when an excerpt is to be broadcast.

oooo

Unpremeditated Asides.

The routine of the studios is now so well organised that it is rarely the listener hears anything in the nature of prompting or unintended asides, so it was somewhat startling, at the conclusion of Field-Marshal Lord Plumer's appeal for the Ypres Settlement, when he was evidently gathering up his papers, to hear the announcer's voice in a loud stage whisper prompting him to "give the name and address for contributions," and after Lord Plumer had inadvertently given the postal district of Baker Street as "W.C.7," instead of "W.1," he was heard, before the line "went dead," asking "was that all right?" The reply was unfortunately unheard, but we can hardly imagine the chief announcer—the very essence of politeness—retorting "no it wasn't!"

oooo

Silent Disapproval.

A pink and grey parrot has been added to the staff of the Midland Regional Children's Hour; but has hitherto proved an unresponsive mascot. The parrot has every appearance of dominating the corner more than listeners perhaps realise. Singers have been heard to remark that they would rather undergo several microphone auditions than sing under the critical stare of this bird, which sits perched in the corner of the studio in (up to the present) stony silence.

oooo

Mühlacker and Other Interference.

In the first of the new series of talks entitled "The Progress of Broadcasting," which was given in the National programme by the Chief Engineer of the B.B.C. on Easter Monday, he seemed inclined to minimise the interference from Mühlacker which, he declared, was only noticeable after nightfall, and in some districts around London. I do not agree with this statement, as the trouble is quite noticeable in the earlier parts of the day. No solution of the problem is likely to be offered for some time to come, and I fear that listeners will find no consoling thought in the German announcement that the power of Königswusterhausen and Langenberg will be raised to 75 kW. in the autumn, nor in the further prospect that the Breslau, Frankfurt and Leipzig transmitters will all be replaced shortly by others of higher power.

The B.B.C. will, no doubt, take these hard facts into consideration before finally completing its Regional scheme.

oooo

Selectivity.

Perhaps the issue of the new B.B.C. pamphlet on "Selectivity" will help listeners to overcome the difficulty of tuning out some of these powerful European stations. I understand that the circulation of this booklet will be limited and confined to genuine applicants.

oooo

All Record Broadcast from Rome.

In the interests of British listeners, The Gramophone Co., Ltd., have arranged for a series of three broadcast concerts from Rome (441 metres) on Sundays, April 19th, 26th, and May 3rd, from 7.15 to 8.15 p.m. English time.

The programmes, which are designed to please as many musical tastes as possible, will be given by star artists who record for "His Master's Voice," including records by Chaliapine, Kreisler, the Philadelphia Symphony Orchestra, John McCormack, Gracie Fields, and Jack Hylton's and Ambrose's dance bands. The concerts will be conducted through the medium of the record by Christopher Stone, whose B.B.C. broadcasts have become one of the most popular weekly items.

As it is not possible for The Gramophone Co. to represent their trade mark visually during their broadcasts, the "His Master's Voice" concerts will be easily distinguished by the bark of a dog preceding each item.

Reports on reception of these concerts from *Wireless World* readers are particularly requested, and should be sent to the Press Department of The Gramophone Company, Limited, 363, Oxford Street, W.1.

oooo

A Curse.

Somebody must announce. It would be a queer day's broadcasting without a single announcement. Yet the other day a character in an American talkie cursed another with the wish that all his children might grow up to be radio announcers.

oooo

Is Radio Popularity Short-lived?

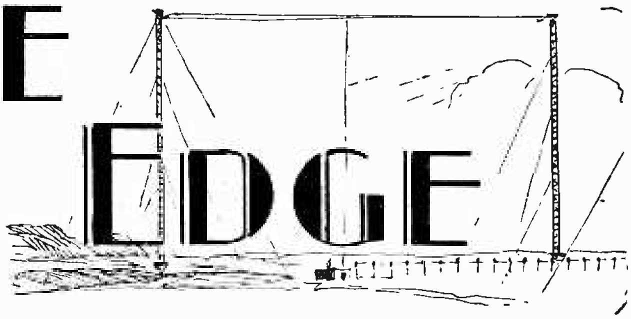
Experience over here hardly supports a conclusion arrived at in America that microphone stars are unable to maintain their positions, and that all radio fame is fleeting and short-lived. Undoubtedly some of our stars have faded, but one has only to mention the names of such pioneers as Ronald Gourley, "The Roosters," Mabel Constanduros, and Edith Penville and many others to realise that the listening public is capable of lasting affection.

oooo

Song and Dance "Plugging."

The controversy over "song plugging" is again revived, as I mentioned last week, but it is difficult to understand why the B.B.C. should disclaim all responsibility for this insidious form of advertisement. It will be remembered that for several months the B.B.C. prohibited the announcement of titles by dance-band leaders and the singing of choruses, leaving it to the announcer to give a bald list of the numbers played, at set intervals during the performance of dance music. This did not altogether meet with approval, and after a solemn assurance from the music publishers that "plugging" should cease, the *status quo* was resumed in November, 1929, and the announcing of titles and the singing of choruses was again permitted, though many listeners would still prefer instrumental music unadulterated with vocal efforts—but this is a matter of personal taste. The B.B.C. disclaims all knowledge of the renewal of the alleged "plugging," but, to my mind, it is up to the B.B.C. to control what is broadcast just as any newspaper editor is responsible for matter published. "Plugging" of wares in the press by contributors would soon become rife if not checked

MOORSIDE EDGE



The North Regional Dual Programme Transmitter Completed.

JUST completed at Moorside Edge, near Slaithwaite, in Yorkshire, is the second high-power dual-programme station to be built in accordance with the Regional Scheme. The change in reception conditions to be brought about by this new high-power transmitter will affect a far larger number of listeners than was the case with the starting up of the London Regional transmitter last year. London, with its single, dense area population, has always been well served, but in the North a greater population is distributed over an enormously larger area, and the substitution of the modest station in Manchester by a pair of 50 kW. transmitters high up on the Yorkshire moors will result in a vast improvement in reception to more than a quarter of the B.B.C.'s total listeners. Even less trouble is anticipated owing to the use of unselective sets than was the case in London, as the station is farther removed from the bulk of its listeners, the nearest town of importance being Huddersfield, some five miles away.

Higher Aerials than at the London Regional.

In the general design and layout of the station no important change has been made from that adopted at the London Regional transmitter, excepting as regards the arrangement of the aerials. In the place of parallel aerials for the two transmitters, we find aerials running out at right angles and supported by three masts, each of which is 500ft. high. They are excited at their centres and connected to the transmitters by feeders. The masts are insulated from earth, and the guy wires are also broken up by insulators to avoid what is termed "mast shadow effect" and asymmetric radiation. As severe weather conditions are experienced in such an exposed position, the aerial system has been designed to withstand a wind velocity up to 100 miles an hour. In addition, a power of about 100 kW., representing a current of several hundred amperes, may be applied to raise the temperature of the aerials to prevent the formation of ice.

Examining the station equipment from the generating of the current to the excitation of the aerials, we start with four six-cylinder Diesel engines which, running at 335 revolutions per minute each, develop a maximum power of 345 h.p. They are each coupled to a direct-current generator giving an output of just over 1,000 amperes at 230 volts. The four generating sets allow one for each transmitter, another for charging the emergency accumulator, and a fourth may, when necessary, be overhauled. A reservoir having a capacity of 200,000 gallons provides water cooling for the engines, and guards against the possibility of shortage of water due to drought. Passing on to the main machine-room, we find three large motor generators, which each deliver anode current of 19 amperes at 12,000 volts to the transmitters. To obtain this high voltage, the generators are built in two sections, and the four commutators with which they are fitted are series-connected. There are no fewer than fifteen motor generator sets in all, supplying, in addition to the main anode current, filament current, grid biasing potentials, and subsidiary anode voltages.

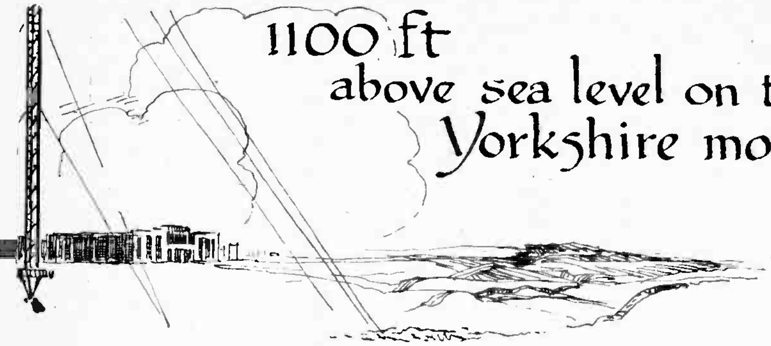
Transmitting Equipment.

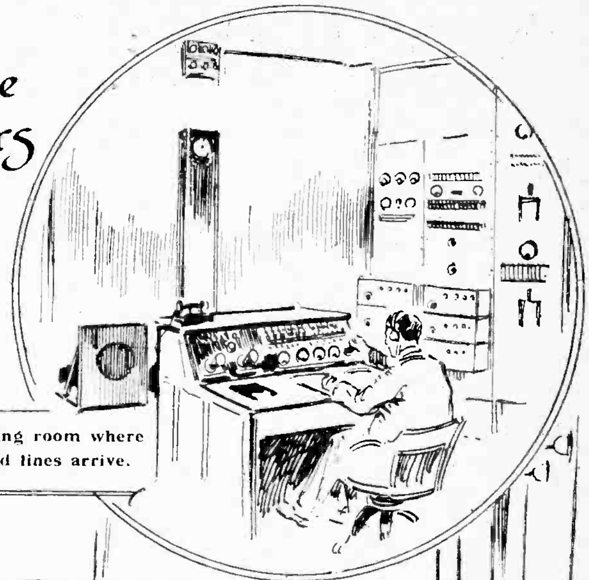
In the transmitter hall the two sets are arranged on the adjacent sides with the switchboard at one end. Observation desks stand in front of each transmitter, where the more important meters from the switchboard are duplicated so that conditions can be closely watched. In circuit arrangement each transmitter comprises a drive oscillator to hold the wavelength constant coupled through a separating circuit to a second oscillator which is anode modulated. A second unit using a push-pull circuit amplifies the modulated oscillations and is, in turn, connected to two large and similar units, each fitted with seven valves and representing the two sides of another push-pull amplifier. Between these last two units stands the tuning equipment associated with the feeders to the aerials. Elaborate precautions are taken to avoid interruptions in the programmes due to failure of valves or other components; spare valves are provided in each circuit which can be connected by the operation of a switch, while other components are not bolted but are retained in position by dowel pins.

The front portion of the building, which has two storeys, contains the control rooms, test studio, quality-checking room, and test room, the latter being equipped with a variable frequency oscillator, a special receiver, and a cathode-ray oscillograph.

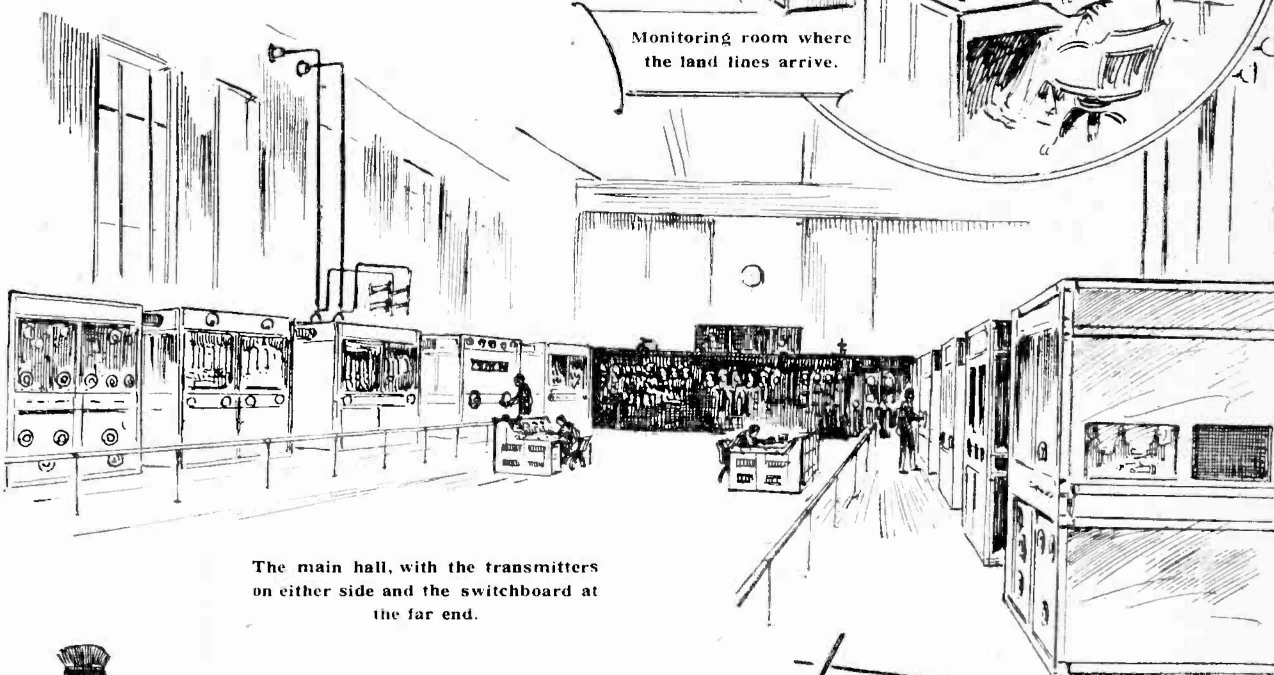
The alternative programme transmitter will relay the National programme on 301.5 metres, permitting of the withdrawal of the existing transmitters at Manchester, Leeds and Bradford. With the bringing into operation of the alternative programme the present experimental transmission on 479 metres will develop a programme distinctively, and in contrast to the transmission on the National wavelength.

1100 ft above sea level on the Yorkshire moors

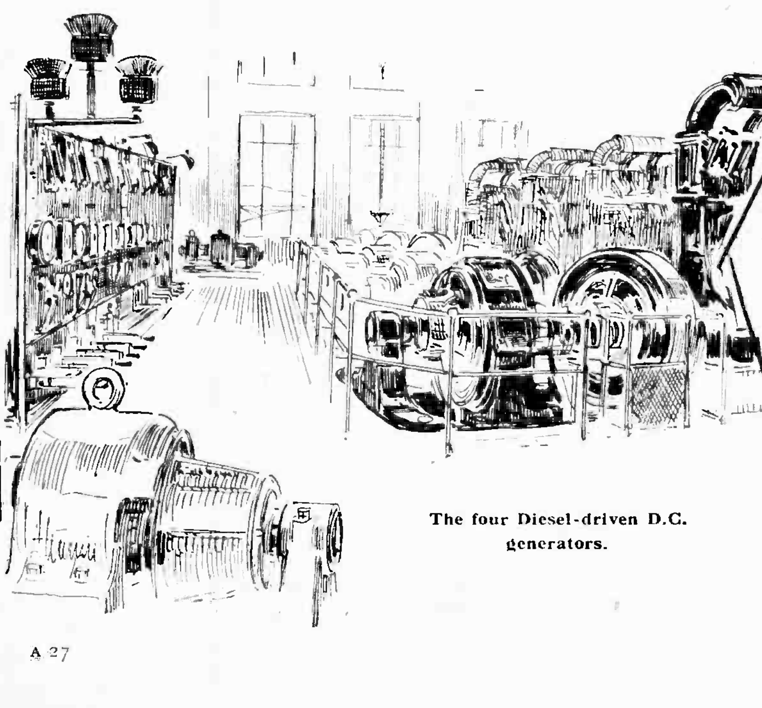




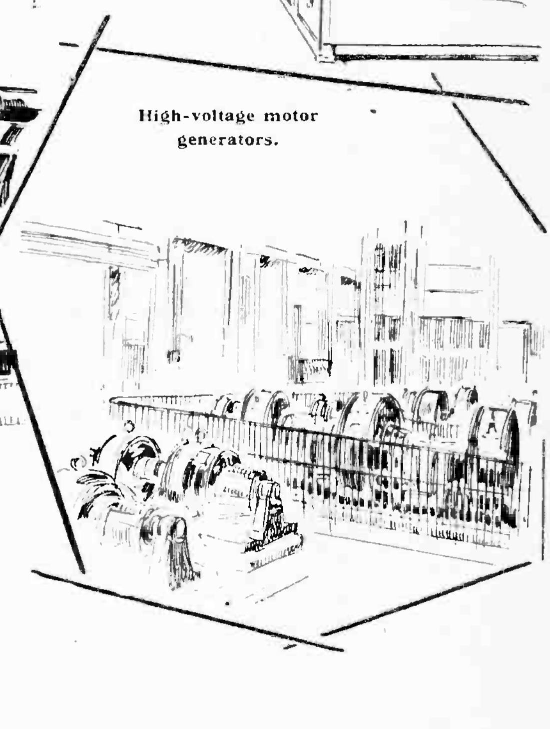
Monitoring room where the land lines arrive.



The main hall, with the transmitters on either side and the switchboard at the far end.

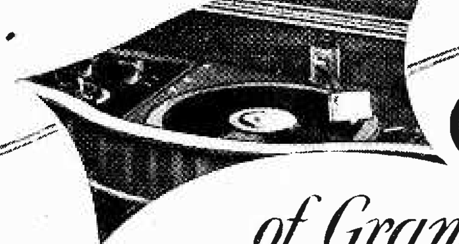


The four Diesel-driven D.C. generators.



High-voltage motor generators.

TONE and VOLUME CONTROL of Gramophone Pick-ups



The Electrical System of the Pick=up.

By JOHN HARMON.

(*Concluded from page 311 of previous issue.*)

IN the previous instalments the mechanical system of a pick-up has been analysed, and it appears that in most cases two principal resonances are to be expected, one at low frequency and one at high. Unfortunately, the user cannot do much in the way of altering the position of these resonance points to suit himself; the only simple variations which can be made in the mechanical system are those due to changing the type of needle or loading the tone-arm in cases where it is practicable.

Before we leave this part of the subject it should be realised that the rubber pads which are often used to stiffen the armature deteriorate in time. Their replacement by new rubber, though a delicate process, is well within the powers of the amateur who is gifted with sufficient patience.

Let us now turn to the electrical system of the pick-up. The coil which surrounds the armature, and is excited by variations of magnetic flux, can be considered as a resistance in series with an inductive reactance, and these quantities can be measured at various audio-frequencies on an A.C. bridge. The results of such measurements are given for some typical pick-ups in Fig. 16. If resistance were independent of frequency the curves would become vertical lines, but actually resistance increases with frequency, due to eddy currents induced in the adjoining iron.

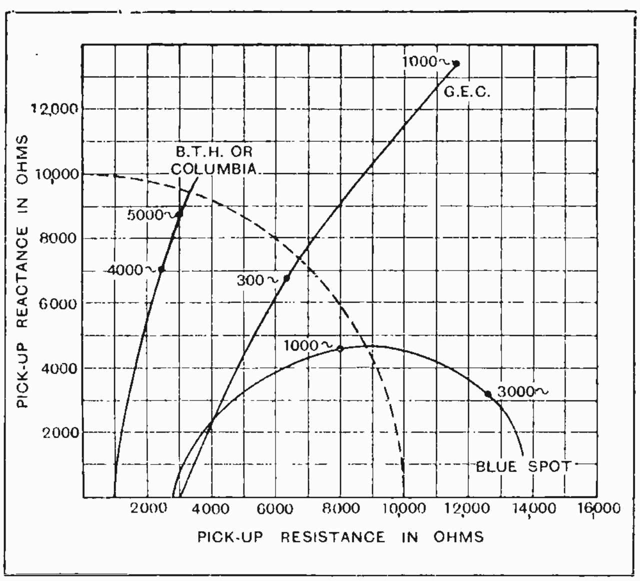


Fig. 16.—Resistance and reactance of pick-up coils at different frequencies.

Since resistance is plotted horizontally and reactance vertically, the impedance at any frequency is represented by the length of a line joining the origin to the corresponding point on the curve. If a pick-up were used on open circuit—that is, with terminals joined directly to the grid and filament of an amplifying valve, the impedance value would be a matter of indifference, but it becomes important when devices are inserted for the control of volume or tone.

Volume Control by Potentiometer.

Suppose a potentiometer of 10,000 ohms total impedance to be placed across the pick-up terminals. This value corresponds to the radius of the quadrant drawn in Fig. 16, and it will be seen that it is comparable to the impedance of the B.T.H. pick-up at 5,000 cycles. Hence at this frequency the response is diminished by nearly 50 per cent. With the G.E.C. pick-up the same decrease occurs at only 300 cycles, and serious attenuation takes place at higher frequencies. (These considerations do not apply to the Blue Spot curve, which owes its peculiar shape to the incorporation of a potentiometer in the tone-arm). Evidently a potentiometer of much higher resistance is required, and since continuous variation is not really necessary good results can be obtained from four resistances of 10,000 ohms each (of the anode resistance type) joined in series and tapped off at the junctions.

A tapped choke of not less than 10 henrys inductance gives an ideal volume control, since its impedance rises in proportion to that of the pick-up as the frequency increases, with the result that the level of response remains constant and independent of frequency.

Tone Control.

The response characteristic of a pick-up can be altered by the insertion of impedances across the terminals with the view of producing resonance at some particular frequency or frequencies. Some of these methods are illustrated in Fig. 17. In each case the pick-up is

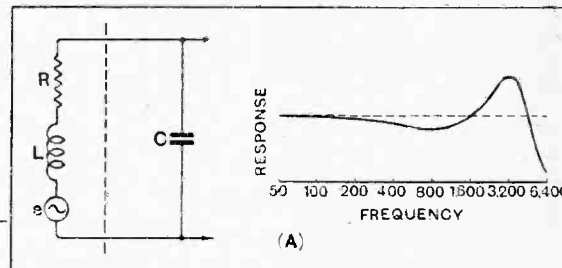
Tone and Volume Control of Gramophone Pick-ups.—represented as an A.C. generator of variable frequency in series with a resistance R and an inductance L, and lies to the left of a dotted line. On the right of this line are the elements which form the correcting device, and the arrows indicate the connections to the grid and filament of the first amplifying valve. It is desirable that the tone corrector should be placed ahead of the first valve and not inside the amplifier, since this ensures that if the first valve is not overloaded the amplifier is working correctly. Moreover, the amplifier is often part of a radio receiving set and its internal arrangements should not be tampered with. The accompanying response curves are drawn with reference to a horizontal dotted line, which is the response given by the uncorrected pick-up on open circuit, reduced to a scale of uniform level. It will be seen that in some cases the corrected curve rises above the dotted line, showing an actual increase in sensitivity due to the corrector. These matters will now be considered under definite headings:—

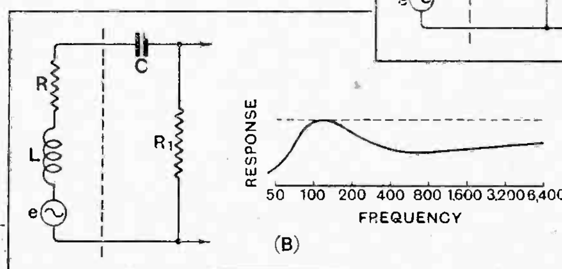
A. Condenser in Shunt.

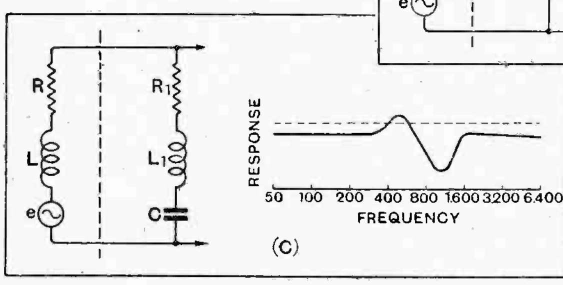
The fraction of the pick-up e.m.f. which appears across the condenser is the ratio (condenser reactance)/(impedance of whole circuit). When the frequency is such that resonance occurs, the coil and condenser reactances tend to annul each other, and a peak occurs in the response. At low frequencies the condenser reactance is high, and the response is much the same as that on open circuit. At frequencies above resonance the reactance of C decreases and the curve falls sharply. This method is excellent for raising reproduction at 3,000 cycles or 4,000 cycles, combined with a fairly sharp cut-off at 5,000 cycles, where needle scratch becomes obtrusive.

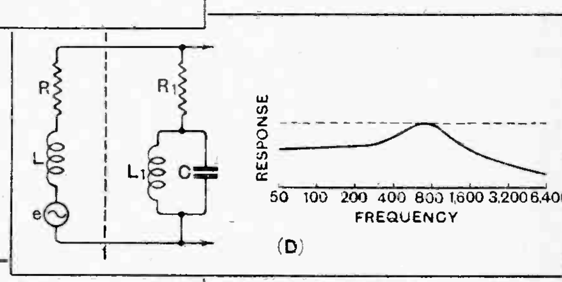
It is worth while to examine the utility of this corrector. Draw a horizontal line OA in Fig. 18 to represent the resistance of the pick-up at any frequency, and let AB be the corresponding coil reactance. Then OB is the pick-up impedance. From B draw BP downwards to represent the (negative) condenser reactance. Then OP is the impedance of the whole circuit. Hence the fraction of the pick-up e.m.f. which appears across the condenser is BP/OP. If this is to be a maximum at the chosen frequency, P must move downward along the vertical line, and it can be proved geometrically that the maximum ratio is BP_1/OP_1, when P_1 lies at the bottom of the vertical diameter.

By comparing similar triangles this maximum ratio is easily seen to be equal to OB/OA, i.e. (pick-up impedance)/(pick-up resistance), so that from curves such as those in Fig. 16 we can predict the response amplification at the frequency where pick-up and condenser are in tune. Thus for the B.T.H. pick-up, when the condenser is varied to give resonance at 4,000 cycles, the amplification is 7.5/2.3 = 3.3 times the response on open circuit. Similarly, for the G.E.C. at 1,000 cycles the figure is 17.6/11.6 = 1.5. With the Blue Spot at 3,000 cycles it can be seen that the effect is so small as to be practically negligible.









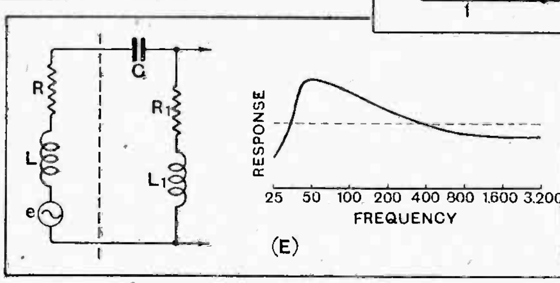


Fig. 17.—Five methods of tone correction. The pick-up is shown as an A.C. generator with an impedance RL in series. The corrector lies to the right of each dotted line. Connections to amplifier are indicated by arrows. The full-line curves show the types of response.

B. Condenser in Series.

Here C is in series and a high resistance R_1 is in shunt. The latter may be tapped to serve as a potentiometer. At low frequencies the reactance of C, and consequently the impedance of the whole circuit, is high compared with R_1, with a correspondingly low response. At resonance the system is equivalent to R_1 shunted across R, and the amplification approaches unity if R is small compared with R_1. At high frequencies the reactance of L becomes large and the response falls off. This corrector is not of much general utility, but may serve

Tone and Volume Control of Gramophone Pick-ups.— to emphasise low tones at the expense of high by putting the resonance point at the lower end of the scale—at about 100 cycles.

C. Acceptor in Shunt.

The shunt system consists of R_1, L_1, and C in series. A slight peak occurs when $L+L_1$ resonates with C, since the impedance of the whole circuit is then minimum, i.e., $R+R_1$. This is followed by a larger depression at a higher frequency when L_1 resonates with C, since

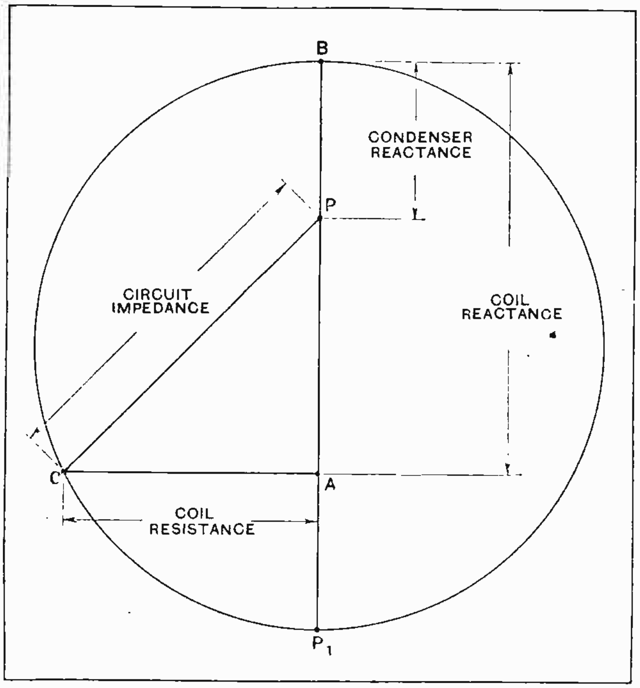


Fig. 18.—To illustrate the circuit of Fig. 17(A).

the impedance of the acceptor circuit falls to the value R_1, and the p.d. across it becomes minimum. This corrector is useful for obliterating a marked resonance in response.

D. Rejector in Shunt.

The parallel system L_1C is placed in series with R_1, and the whole is shunted across the pick-up terminals. The response shows a peak, with a falling away on either side, but more accentuated on the high-frequency side. The greater the value of R_1 the flatter the curve becomes.

A double peak results when a second rejector system is added in series with the first and tuned to a different frequency.

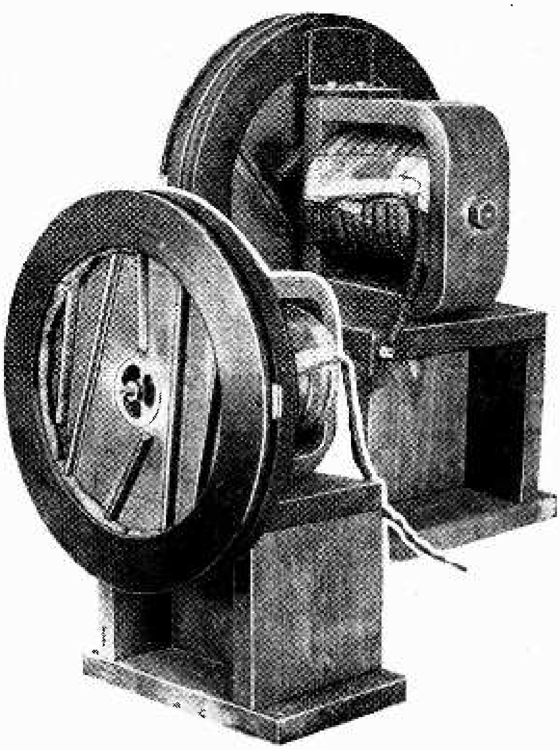
E. Condenser in Series. Choke in Shunt.

When C is tuned to $L+L_1$ the total circuit impedance reduces to $R+R_1$ and the response amplification is $L_1 2\pi f/(R+R_1)$, which can be made much greater than unity. At lower frequencies the curve falls sharply owing to the rise in condenser reactance, but at higher frequencies it need not drop appreciably below unit level if L_1 is large compared with L, the reason being that the increasing impedance of the choke keeps pace with that of the pick-up. Obviously this corrector serves to accentuate low tones without appreciably attenuating the response at high tones. The choke may be tapped for purposes of volume control.

Conclusion.

Of the five methods of tone control just described the 1st and 5th give actual amplification of response at a chosen frequency region with unaltered reproduction over a great part of the remaining scale, and the region of attenuation can be chosen to lie outside the important audio-frequencies. The 2nd and 4th give no amplification, but correct defective tone colour by reducing response over the whole scale outside the region of resonance. The 3rd method serves to absorb the single resonance which often occurs in an otherwise acceptable pick-up. It should be realised that these correcting devices do not give rise to extra record wear since they do not react on the mechanical system of the pick-up. The magnetic coupling between the electrical and mechanical system in all commercial pick-ups is too loose to produce any such reaction. Space does not permit of a detailed numerical examination of the values of resistance, capacity and inductance which give the best results with various types of pick-up, but readers are certain to derive interesting and, it is to be hoped, profitable results from experiments with the five types of corrector described in this article.

VANDERVELL MOVING COIL LOUD SPEAKER.



A new product of the Vandervell Electric Reproducing Co., Ltd., 15c, Clifford Street, London, W.1, employing a reinforced balsa wood diaphragm.

Modern Terms Defined

The Detector Stage.

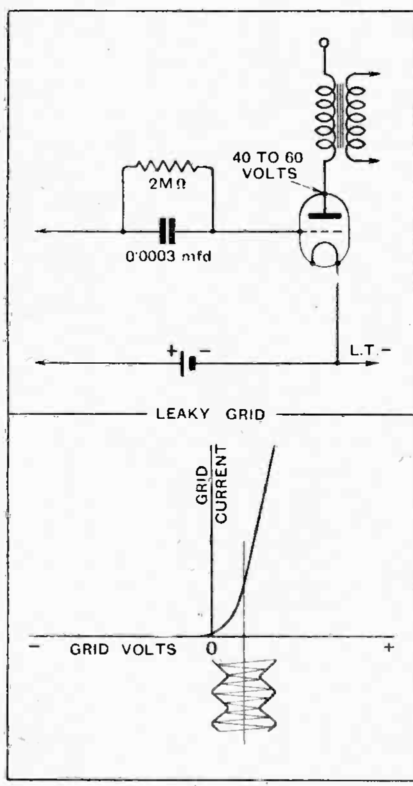
(*Continued from page 386 of April 8th issue.*)

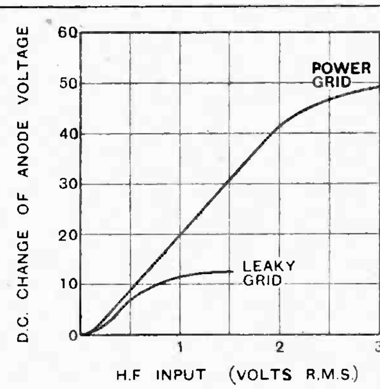
Power Grid Detection.—A development of the leaky grid principle of detection which is becoming increasingly popular in high-quality A.C. mains receivers where a high anode voltage is readily available. Superficially the circuit of the power grid detector bears a strong resemblance to the well-known leaky grid (cumulative grid) detector, and at first sight would seem to differ only in the values chosen for the grid condenser and leak and the voltage applied to the plate. Actually there is a clearly defined difference in the principle of operation. The leaky grid detector is suitable for small inputs only and operates by virtue of the curvature of the grid current characteristic of the valve, a positive bias being applied to bring the operating point to a suitable part of the curve. In power grid detectors, on the other hand, the input voltages are so large that the curvature of the grid current characteristic is ignored, and rectification takes place simply because grid current flows during positive half-cycles, and stops completely during negative half-cycles. The power grid detector is therefore adjusted so that the operating point is at the foot of the grid current curve, i.e., with zero or slightly negative grid bias.

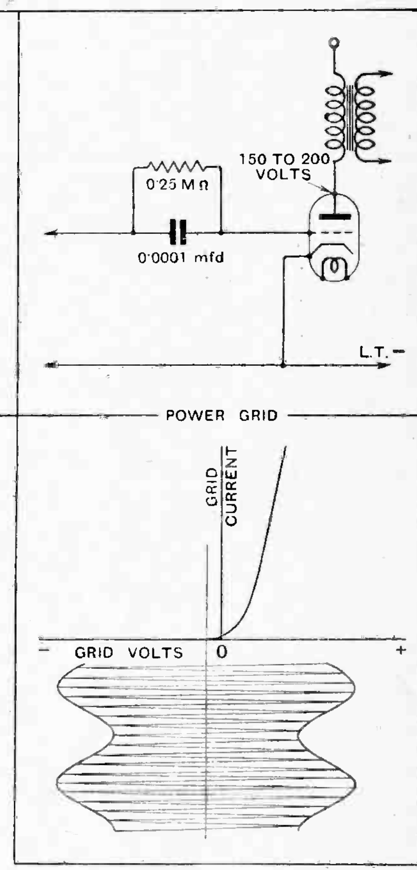
It will be readily understood that considerably higher rectified voltages are developed in the grid circuit under power-detection conditions than with normal leaky grid rectification. It is for this reason that a high anode voltage is necessary if distortion in the anode circuit is to be avoided. In general, these high voltages can only be obtained in A.C. mains receivers, where it is a simple matter to step-up and rectify the mains voltage. The practical difficulties, such as the power dissipation limits of the valve (with zero bias) and problems of decoupling have already been dealt with in detail in this journal.[1]

Nevertheless, these difficulties are not insuperable, and the power grid detector has already proved its worth both from the point of view of efficiency and freedom from distortion. Provided the input is maintained at a sufficiently high value, the quality obtained is comparable to that of the diode rectifier which has hitherto been taken as the standard of comparison. In this connection it is significant that power grid detection has been adopted instead of the diode rectifier in the latest demonstration receiver[2] at the Science Museum, South Kensington.

(*To be continued.*)







A comparison of the circuit values, operating conditions and rectifying characteristics of leaky grid and power grid detectors.

[1] *The Wireless World*, January 8th, May 7th and 14th, December 3rd, 1930.

[2] *The Wireless World*, July 30th, August 6th, 1930.

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IN PREVIOUS ISSUES.

March 4th. Band-pass Filter. Pre-selection. Peak Separation. Ganging. Differential Condenser.

March 11th. Cross Modulation. Beat Interference. Modulation Distortion.

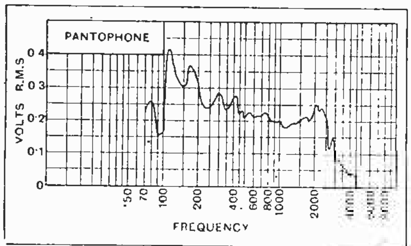
March 18th. Secondary Emission. Grid Emission. Contact Potential. Residual Capacity. Dynamic Resistance.

April 8th. Load Line. Power Triangle. Optimum Loud Speaker Impedance. H.F. Stopping Resistance.

Laboratory Tests on New Apparatus.

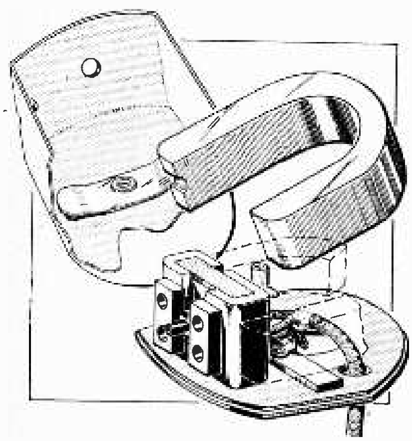
PANTOPHONE PICK-UP AND TONE-ARM.

The armature and pole piece assembly in this component is designed on the well-known differential principle. An unusual feature of the design is that the horse-shoe permanent magnet is not fixed to the pole pieces. It is, however, an accurate sliding fit, and the air gap is consequently small compared with the gap between the pole pieces. The magnet is held in position by a phosphor-bronze spring riveted to the inside of the metal dust cover.



Frequency characteristic of the Pantophone pick-up with H.M.V. half-tone needle.

Rubber damping is liberally applied to the armature, but the movement is not unduly restricted. The pick-up follows the groove in the test records down to 70 cycles, so that record wear is not serious.

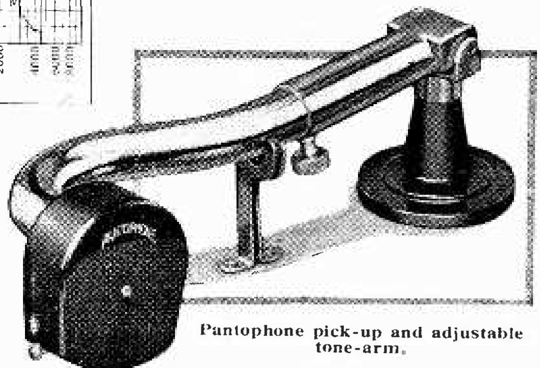


Constructional details of the Pantophone pick-up.

An excellent response is obtained between 100 and 2,500 cycles with a rising characteristic towards the bass. Above 2,500 cycles the output falls rapidly, and no measurable voltage was obtained above 4,600 cycles. The consequent lack of brilliance in the upper register is, however, compensated by an almost complete absence of needle scratch.

The tone-arm is spring-loaded to relieve the pressure on the needle point, and the length is adjustable in order to obtain the best possible needle track alignment.

The price of the pick-up is 30s., and of the tone-arm 10s. 6d. The makers are the Parlophone Co., Ltd., 81, City Road, London, E.C.1.



Pantophone pick-up and adjustable tone-arm.

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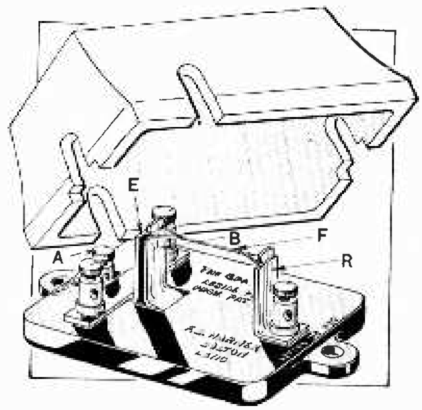
"SPA" AERIAL SAFETY FUSE.

This device is intended to protect the wireless sèt in the event of the aerial being struck by lightning during an electrical storm. Naturally, it will be mounted somewhere outside the building, preferably on a brick wall, and in such a position that it enables a direct lead to be taken to the earth connection.

The aerial downlead is connected to the terminal A, which contacts with the spring arm B, normally held away from the earth contact E by a length of fuse wire F. The other end of the fuse wire, which must be strong enough to take the pull of the spring without stretching, is attached to the support R carrying the terminal to which is connected the lead to the receiver.



"Spa" lightning arrester and aerial safety fuse.

Should the aerial be struck the fuse melts, releases the spring B, which falls back and contacts with the earth member E, and so connects the aerial direct to earth. In the sample examined the temper of the spring was hardly sufficient for the purpose, but no doubt the makers will rectify this in future models.

All parts are mounted on bakelite and protected by a cover of the same material. The makers are F. E. Harman and Co., Ltd., Knowsley House, Bolton, Lancashire, and the price is 5s.

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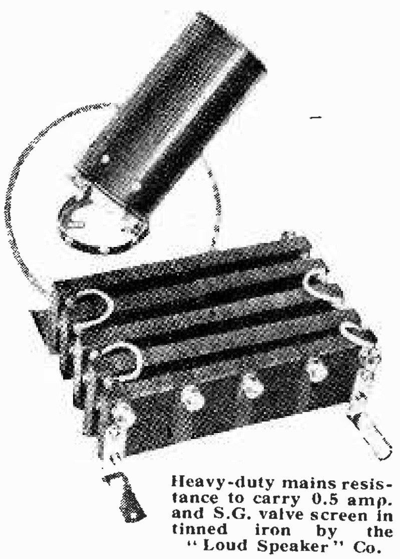
MAINS RESISTANCE FOR D.C. VALVES.

This resistance has been designed especially for use with the new Mazda indirectly heated D.C. valves. It is wound on five slate formers, each measuring 7in. × 2in. × ½in., mounted side by side and with ventilating spaces between them. A heavy-gauge enamel-covered resistance wire is employed which is rated to carry 0.5 amp. Owing to the large area, heat is rapidly dissipated, and after a prolonged run the resistance was only warm.



Heavy-duty mains resistance to carry 0.5 amp. and S.G. valve screen in tinned iron by the "Loud Speaker" Co.

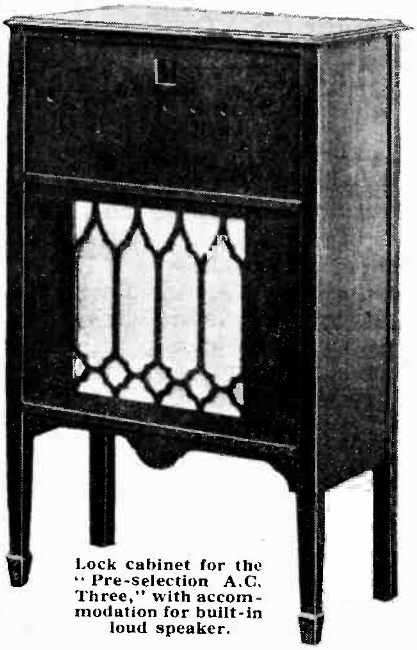
To enable it to be used on all standard supply voltages over 200, five-tappings are provided, the various resistance values being 390 ohms, 405 ohms, 426 ohms, 446 ohms, and 466 ohms.

The makers are The "Loud Speaker" Co., Ltd., Palmer Works, 2, Palmer Street, Westminster, London, S.W.1, and the price is £2 2s.

This firm is marketing also a tubular valve screen in tinned iron, measuring 5½in. high and 2⅜in. diameter, for enclosing screen-grid valves. It has a skeleton base held in position by the valve-holder and an insulated hole at the top to clear the anode terminal. It is finished in blue enamel and the price is 1s. 6d

NEW "LOCK" PEDESTAL CABINET.

The "Pre-selection A.C. Three" receiver, described in *The Wireless World* for February 25th and March 4th, although primarily intended for mounting on a conventional table cabinet, lends itself to assembly as a self-contained unit, complete with loud speaker. Those who are building this receiver will be interested in a well-made pedestal cabinet just produced by W. and T. Lock, Ltd., of St. Peter's Works, Bath. The front panel is ready drilled and cut for the control spindles and tuning condenser escutcheon, and there is space below for mounting a reed-driven cone or moving-coil loud speaker; this compartment is fitted with an ornamental fretted front. Overall height amounts to about 3ft. 5in.; width is 24in.



Lock cabinet for the "Pre-selection A.C. Three," with accommodation for built-in loud speaker.

In oak, the cabinet costs £4 3s. 6d., while 10s. extra is charged for mahogany.

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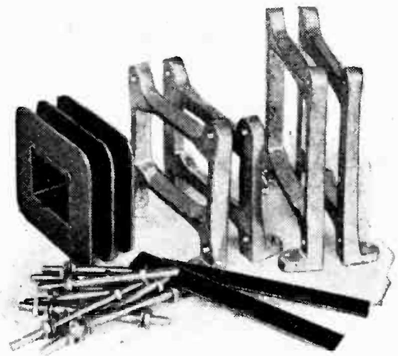
MAINS TRANSFORMER MATERIAL.

Those readers who are interested in the construction of small mains transformers and L.F. chokes will, no doubt, be interested to learn that there are now available specially shaped end-plates for clamping up the core stampings. These are made by the Sound Sales, Tremlett Grove Works, Tremlett Grove, Junction Road, London, N.19, and consist of aluminium castings drilled to take 2 BA bolts and replete with feet for fixing to the baseboard.

So far two sizes are available, the one for the familiar No. 4 stampings in "stalloy," or by Savage, and the other for "stalloy" No. 30, or Savage No. 34. The price is 2s. per pair, including bolts, nuts and washers, for No. 30 size clamps, and 2s. 6d. per pair for the No. 4 size clamps.

There are, in addition, some paxolin terminal strips ½in. wide. 4½in. long, and $\frac{1}{16}$in. thick, priced at 4d. each, and a new bobbin designed to carry the secondary windings only. This is divided into two equal sections, and, when used in conjunction with one of their other



Aluminium end-clamps, special bolts, terminal strips and new two-section bobbin by Sound Sales.

standard bobbins, forms a perfectly insulated three-section former for use with No. 4 size stampings. The price is 1s.

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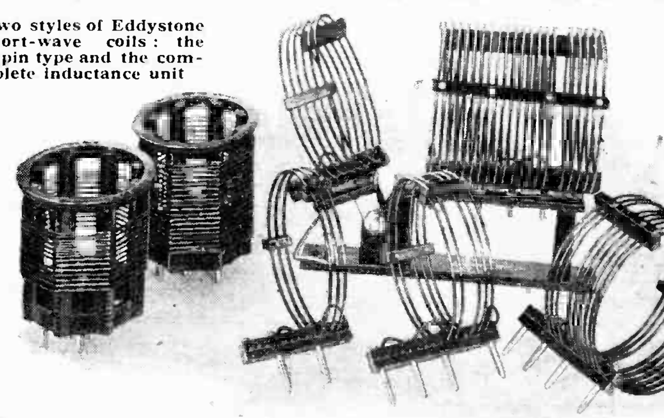
EDDYSTONE SHORT-WAVE COILS AND COMPONENTS.

Coils to meet the requirements of practically every type of short-wave receiver likely to be used are now included in the Eddystone range. One style is wound on 6-pin skeleton moulded formers 2¼in. in diameter. In this class there are coils for all wavelengths extending from 12.5 to 2,000 metres. This class is subdivided into three sections: one section consists of coils for aerial circuit tuning where a stage of H.F. amplification is used; another contains H.F. transformers with reaction windings; and the third consists of coils suitable for use in aerial circuits with reaction or in tuned anode circuits with reaction. The following table gives the type number and the waverange covered by each coil when tuned by a 0.00015 mfd. condenser.

The prices range from 4s. 6d. to 5s. 6d., according to type, and the special 6-pin base costs 2s.



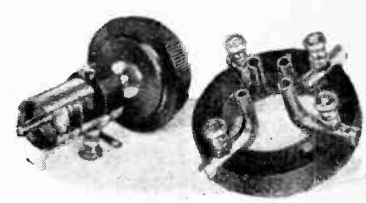
Two styles of Eddystone short-wave coils: the 6-pin type and the complete inductance unit

The other style is primarily for short-wave reception and covers a range of from 14 to 98 metres. Coils for the normal broadcast bands are available if required. The coils are air-spaced and self-supporting, being wound with No. 16 S.W.G. enamelled copper wire. They are mounted on 4-pin bases and each unit consists of a grid coil and a reaction coil fixed in relation to each other. The

Aerial coil without reaction.	L.F. trans-formers with Reaction.	Aerial coil or, tuned anode, with reaction.	Waverange (Metres).
4 L B	2 L B	4 L B R	12.5 to 28
4 Y	2 Y	4 Y R	24 to 50
4 R	2 R	4 R R	40 to 85
4 W	2 W	4 W	80 to 170
4 P	2 P	4 P	160 to 270
4 G	2 G	4 G	250 to 500
4 B R	2 B R	4 B R	490 to 1,000
4 G Y	2 G Y	4 G Y	1,900 to 2,000

aerial coil plugs into the special baseboard mounting, and provision is made for varying the coupling.

Three units complete the short-wave set, and these tune respectively from 14 to 31 metres, 25 to 52 metres, and 46



Eddystone skeleton valve holder and "Midget" variable condenser.

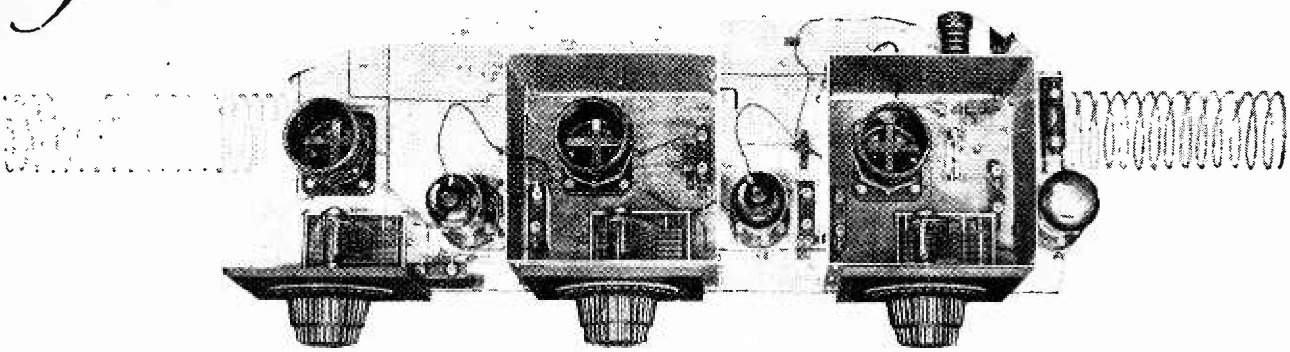
to 98 metres, with a 0.00015 mfd. condenser. The price of the complete inductance unit is 22s. 6d.

A component which should prove useful for short-wave receivers is the low-loss valve-holder of the 4-pin rigid type. The valve socket, fixing lug and soldering tag are fashioned in one piece, and the base is a moulded bakelite ring. The price is 1s. 6d., with or without terminals.

The "Midget" variable condenser, with a minimum capacity of 2.5 micro-mfds. and a maximum value of 8.5 micro-mfds. — measured — should prove very useful as a coupling component for H.F. filter circuits; its price is 2s. 9d.

The makers of Eddystone components are Stratton & Co., Ltd., Bromsgrove Street, Birmingham.

The BEST TURNS RATIO



The Design of a High-frequency Transformer.

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

IN designing a high-frequency transformer for use as an intervalve coupling calculations must be made with the object of fulfilling two main conditions. First, the secondary winding must be designed to tune to the required band of wavelengths when a tuning condenser of normal capacity range is used; and, secondly, the primary winding must be chosen so that the transformer as a whole will operate efficiently in conjunction with the amplifying valve in whose anode circuit it is connected.

As regards the secondary winding, the necessary inductance is calculated from the usual formula $\lambda = 1884\sqrt{LC}$, where λ is the wavelength in metres, C is the tuning capacity in microfarads and L is the desired inductance in microhenrys. For istance, suppose that the maximum wavelength to be received is about 500 metres, corresponding to a frequency of 600 kilocycles per second, and that the maximum capacity value of the tuning condenser is 0.00035 microfarad; then, from the above formula, the coil inductance should be about 200 microhenrys.

The number of turns required to give this inductance depends on the form and dimensions of the coil. For a single-layer cylindrical coil, the inductance is given by the well-known formula, $L = KDN^2$ microhenrys, where N is the number of turns, D the diameter of the winding in centimetres, and K is a number depending on the ratio of the axial length to the diameter of the winding. In the accompanying table the values of K for a single-layer coil are given for various values of the ratio of length to diameter:—

Length / Diameter.	K.	Length / Diameter.	K.
0.1	0.0206	0.8	0.00788
0.2	0.0158	1.0	0.00697
0.3	0.0135	1.2	0.00598
0.4	0.0116	1.5	0.00464
0.5	0.01037	2.0	0.00404
0.6	0.00938	—	—

For multi-layer cylindrical coils the value of K depends not only on the ratio of length to mean diameter but also on the ratio of the radial depth of the winding to the mean diameter. Those whose lot it is to make numerical calculations of this nature could not do better than utilise *The Wireless World* Data Charts by R. T. Beatty, M.A. These enable the user to perform most of the usual calculations relating to wireless receiving circuits by a simple graphical method.

Finding the Number of Secondary Turns.

It will be assumed that the secondary winding of the intervalve transformer is to be a single-layer one with a self-inductance of 200 microhenrys. Now, the table of constants cannot be used until the ratio of the length to the diameter of the coil is known, and this ratio is quite arbitrary. It must, therefore, be decided upon by the designer, and should preferably be somewhat less than unity.

Let us assume, then, that the ratio of length to diameter of the secondary winding is about 0.8. Then, from the table, the value of K is 0.00788, and so for this shape of coil the inductance formula becomes $L = 0.00788\,DN^2$ microhenrys, in which there are still two unknown quantities, namely, the diameter itself and the number of turns. The diameter must be chosen according to considerations of available space, or, if this is immaterial, according to the standard of efficiency required. Fewer turns of thicker wire will be called for on a coil of greater diameter, with adjacent turns wound in contact. For a coil of given dimensions there is an optimum size of wire giving minimum high-frequency resistance, the turns being spaced apart, but in the present instance this refinement will not be adopted.

Suppose, then, that the secondary coil is to be wound on a cylindrical former of 7.5 centimetres (about 3in.) diameter. The winding length will then be $0.8 \times 7.5 = 6.0$ cms.

The number of turns required can now be found

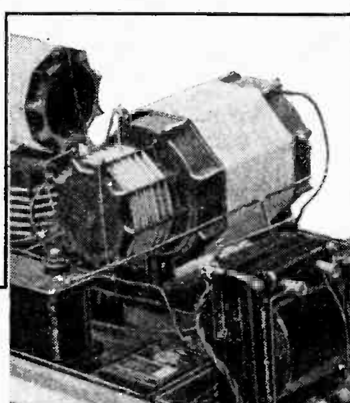
The Best Turns Ratio.—

from the formula $L = KDN^2$, from which $N^2 = \frac{L}{KD} = \frac{200}{0.00788 \times 7.5} = 3{,}380$, whence $N = \sqrt{3{,}380} = 58$ turns. These 58 turns have to be wound into a space of 6 cms., so that there will be, roughly, 9.7 turns to the centimetre. We should then choose a wire capable of being wound 10 turns to the centimetre at least. On referring to wire tables it is found that No. 20 S.W.G. double silk-covered wire winds 10 turns per centimetre with adjacent turns touching, and this is accordingly chosen as a suitable size.

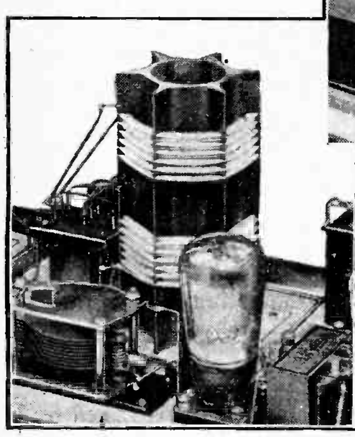
Determination of Secondary Resistance.

Before we can design the primary winding we must know the effective high-frequency resistance of the secondary circuit at a specified frequency. The determination of this is not very simple, as it depends on several factors, the theory being rather too advanced for inclusion in an article of this nature. The reader is, therefore, referred to an article by S. Butterworth in *The Wireless World* of December 8th and 15th, 1926, and to the Radio Data Charts mentioned above. The subject was dealt with in an elementary way by the present writer in "Wireless Theory Simplified" (*The Wireless World*, June 4th, 1930).

The length of wire in the secondary coil is $\pi DN = \pi \times 8 \times 58 = 1{,}380$ cms., and the D.C. resistance of this length of 20 S.W.G. copper wire is 0.356 ohm at 60°F. At a frequency of 1,000 kc., however, the H.F. resistance of the No. 20 S.W.G. wire closely wound, is found to be nearly 11 times this figure (due to eddy current losses), namely, about 4 ohms. But there are other losses in the secondary circuit besides those due to conductor resistance, chief among them being dielectric losses in both the coil and tuning condenser, and those due to the loading effect of the succeeding valve and grid-leak (if any). A grid-leak resistance of 250,000 ohms virtually in parallel with the tuning coil and condenser will increase the effective secondary circuit resistance by an amount equal to the square of the coil reactance divided by 250,000, namely, $\frac{(2\pi fL)^2}{250{,}000} = \frac{1{,}257^2}{250{,}000} = 6.3$ ohms. This is a figure more than one and a half times as great as the H.F. conductor resistance of the coil itself.

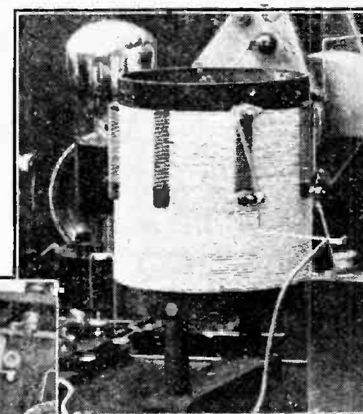


Highly specialised transformer of the "Record-Three" receiver.

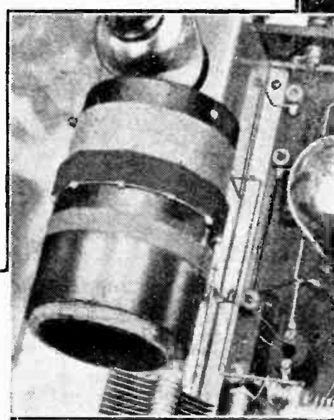


Coupling used in *The Wireless World* Kit Set.

This example has been worked out to emphasise the importance of taking into account all sources of loss, even though they are external to the tuned circuit itself. In the case of the transformer under consideration, it will be assumed that the sum total of all losses over and above those due to conductor resistance accounts for an extra 6 ohms, making the total effective resistance of the secondary circuit about 10 ohms at 10^6 cycles per second—that is, at 300 metres.



H.F. transformer of the "Everyman-Four" type.



Intervalve coupling of the "Europa Three" set.

Conditions for Maximum Output from Valve.

Attention must now be turned to the primary winding. It was shown in the earlier articles dealing with the H.F. transformer that the actual resistance of the primary coil is quite unimportant compared with the extra or apparent increase of resistance occasioned by the action of the tuned secondary circuit. For this reason there is no need to calculate the diameter of wire; it is the most suitable number of turns that must be determined.

It will be assumed that the transformer is being designed to give the maximum stage gain in voltage. This means that we require the highest possible voltage to be developed across the secondary circuit for a given value of signal E.M.F. impressed on the grid of the first valve. Now, the voltage across the tuned secondary circuit is proportional to the current within it, and the power consumed by the circuit is proportional to the square of this current. Consequently, the stage gain will be greatest when the primary winding is so proportioned that the maximum amount of power is transferred to the secondary circuit.

The power expended in the primary coil itself is quite small compared with that in the secondary, and, therefore, it can be assumed, without introducing any serious error, that the whole of the effective output from the valve is transferred to the secondary circuit. Hence the stage gain will be greatest when the output from the valve is a maximum.

Now, the power output from a valve is greatest when

The Best Turns Ratio.—
the external load resistance is made equal to the internal A.C. resistance (differential resistance) of the valve. This can be proved mathematically, but, as it is desired to avoid mathematics here, proof by trial and error will suffice. Assume that the valve has an A.C. resistance of $R = 20{,}000$ ohms, under operating conditions, and that its amplification factor is $\mu = 35$. Then, if a signal voltage of 0.1 (R.M.S. value) is applied to the grid, an alternating E.M.F. of $35 \times 0.1 = 3.5$ volts will, in effect, be set up in the anode circuit. Now, suppose that a plain resistance of $R = 20{,}000$ ohms is connected in the anode circuit, as shown in the diagram (*a*) of Fig. 1, the equivalent A.C. circuit then being as indicated at (*b*). The alternating component of current produced in the circuit will be $I = \frac{3.5}{40{,}000} = 87.5 \times 10^{-6}$ amp., and the power represented by this alternating current in the resistance R will be $P = I^2R = 87.5^2 \times 10^{-12} \times 20{,}000 = 153 \times 10^{-6}$ watt.

If the reader cares to repeat the calculation with any other value of R, either greater or lower than 20,000 ohms, he will find that in every case the power represented in this resistance by the alternating component of current will be less than 153×10^{-6} watt, thereby proving that the power output from the valve is greatest when the anode load resistance is made equal to the internal A.C. resistance of the valve.

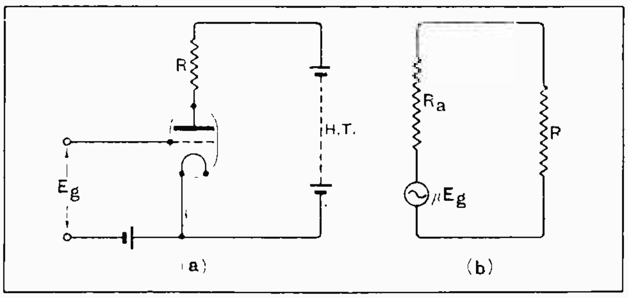


Fig. 1.—(a) Resistance load in anode circuit of a valve. (b) Equivalent A.C. circuit with D.C. components eliminated. The power expended in R due to the alternating component of current only is greatest when $R = R_a$, the valve resistance.

How the Turns Ratio Affects Primary Impedance.

In a previous article it was shown that the total effective impedance of the primary winding of a tuned transformer is very nearly equal to the extra resistance which is apparently added to the primary coil as a result of the action of the tuned secondary, and the magnitude of this extra resistance was found to be

$$R_1' = \frac{\omega^2 M^2}{R_2} \text{ ohms} \quad \ldots \ldots \quad (1)$$

where $\omega = 2\pi \times$ frequency, M is the mutual inductance between the windings, and R_2 the effective H.F. resistance of the secondary circuit. Consequently, the output from the valve, and the stage gain obtained, will be greatest if the mutual inductance M is given such a value that R_1' is equal to the valve's A.C. resistance.

Now, the value of M will depend, among other things, on the numbers of turns of the individual windings, and as it is required to find the number of primary turns it is necessary to convert equation (1) to a form involving the turns ratio instead of the mutual inductance. Unfortunately, this conversion cannot be made without introducing a certain degree of inaccuracy, because, besides depending on the actual numbers of turns, the mutual inductance depends on the relative positions of the two windings.

To obtain the new formula it is necessary to assume that the coupling coefficient between the windings is unity, or, in other words, that the transformer acts like an iron-cored one in which the whole of the magnetic field is assumed to be linked with all of the turns of both windings. The inaccuracy arising from this assumption has to be allowed for subsequently.

For any coil in which all of the lines of magnetic force are linked with the whole of the turns, the self-inductance is directly proportional to the *square* of the number of turns; for if the number of turns is doubled the magnetic flux for a given current will also be doubled, and twice the flux linked with twice as many turns clearly represents four times the inductance.

Consequently, in the case of a transformer where each winding encloses the same magnetic flux, the ratio of the inductances is equal to the square of the turns ratio. If L_1 and L_2 denote the primary and secondary inductances respectively, and N_1 and N_2 the corresponding numbers of turns, we have

$$\frac{L_1}{L_2} = \left(\frac{N_1}{N_2}\right)^2 = N^2,$$

where N stands for the ratio of primary to secondary turns. Multiplying each side of this equation by L_2^2 we get $L_1L_2 = N^2L_2^2$. But, since the coupling has been assumed to be unity, we have $M = \sqrt{L_1L_2}$, or $L_1L_2 = M^2$; and, substituting this value in the last equation, we get $M^2 = N^2L_2^2$, or

$$M = NL_2 \text{ henrys} \quad \ldots \ldots \quad (2)$$

Thus, with 100 per cent. coupling the mutual inductance between the windings is equal to the secondary coil inductance multiplied by the ratio of primary to secondary turns.

Finding the Turns Ratio.

Returning now to equation (1) and replacing M by NL_2, we get $R_1' = \frac{N^2\omega^2L_2^2}{R_2}$ ohms for the extra load thrown into the primary circuit by the tuned secondary. For maximum stage gain, R_1' must be equal to R_a, the A.C. resistance of the valve, and so, substituting R_a for R_1', and rearranging the formula, we have $N^2 = \frac{R_aR_2}{\omega^2L_2^2}$ from which we obtain the optimum turns ratio:—

$$N = \frac{\sqrt{R_aR_2}}{\omega L_2} \quad \ldots \ldots \quad (3)$$

Owing to the fact that this formula is based on the assumption of 100 per cent. coupling, whereas in practice the coupling is always considerably less than unity, the best turns ratio is somewhat greater than the calculated value. However, the results obtained will be sufficiently accurate if the ratio deduced from equation (3) is increased by 10 per cent. when the primary is wound over the top of the secondary winding (with

The Best Turns Ratio.—
spacers between), and by 20 per cent. when the primary is wound at one end of the secondary coil.

The Case of the Screen-grid Valve.

We are now in a position to complete the numerical calculation. For the particular H.F. valve employed, $R_a = 20{,}000$ ohms, the effective secondary resistance of the transformer was estimated at 10 ohms at a frequency of 1,000 kilocycles per second, and ωL_2 was seen to be 1,257 ohms. Putting these values in equation (3), we get for the theoretical ratio of primary to secondary turns:—

$$N = \frac{\sqrt{20{,}000 \times 10}}{1{,}257} = 0.356.$$

The actual number of turns on the secondary coil being 58, we have, therefore, for the calculated number of primary turns $N = 0.356 \times 58 = 20.6$. Assuming that the primary is to be wound over the top of the secondary coil at one end, an extra 10 per cent or so in the number of turns should be allowed, giving a primary winding of, say, 23 turns for maximum voltage amplification at 300 metres.

The actual stage gain obtained can now be calculated in the same way as explained in the article on "Tuned Transformer Coupling," in an earlier issue.[1]

If the valve resistance had been 200,000 ohms (a likely figure for a screen-grid valve) instead of 20,000 ohms, the theoretical turns ratio would have worked out to 1.12, so that the calculated number of primary turns would then be greater than the number on the secondary coil itself. But it must be remembered that the damping effect of the primary circuit on the secondary increases as the mutual inductance between the windings is raised, and in such a case as this it is usual to wind the primary coil with fewer turns than the calculated number, thereby increasing the selectivity at the expense of signal strength. Also, it must be borne in mind that the optimum ratio of turns, as calculated, only applies to one particular wavelength. For a given value of secondary resistance, the optimum turns ratio varies inversely as the frequency or directly as the wavelength, as shown by equation (3); but, of course, the effective secondary resistance will increase as the frequency is raised, and this indirect effect partly offsets the direct influence of a change in frequency. In any case, the calculation is made at a frequency at or near the middle of the tuning range.

[1] See *The Wireless World*, April 1st, 1931.

Letters to the Editor.

The Editor does not hold himself responsible for the opinions of his correspondents.

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

THE LICENCE HOLDER AND B.B.C. EXPENDITURE.

Sir,—My attention has been drawn to a letter in your issue of March 4th from C. W. Oliver, New Barnet, criticising the B.B.C., in the course of which he says: "For this state of affairs I blame the licence holder; he let the Wireless League simply peter out, and to-day he finds himself bound to pay the tax, and has no voice in the expenditure of the fund he helps to create."

As Secretary of the Wireless League you will, I hope, allow me space to correct a statement which may give rise to misconception in the minds of our members and the general public. So far from petering out, the Wireless League is slowly but surely increasing its membership, and continues to place constructive recommendations before the broadcasting authorities. In June last, for instance, the League organised a petition, which was signed by over 21,000 supporters in the North of England, against the proposal to disband the Northern Wireless Orchestra in the following October, with the result, at least, that the orchestra is still in existence.

May I suggest that the most effective way for the licence holder to organise is to join the Wireless League, whose activities are directed from 12 Grosvenor Crescent, London, S.W.1.

London, S.W.1. I. JOSS.
Secretary, Wireless League.

SUNDAY BROADCASTING.

Sir,—The writer of your broadcasting notes has revealed the first signs of an eventuality dreaded by all amateur transmitters, namely, an extension of the B.B.C.'s broadcasting hours on Sundays.

Not so long ago a certain section of the daily Press started an agitation for more Sunday broadcast, though it was fortunately "squashed" by a series of outspoken letters from well-known transmitters.

Surely the B.B.C. should have a little consideration for the amateurs, to whose researches much of the present-day high technique of radio is due. If a "ham" wishes to transmit at any time during the week he has to stay up till unearthly hours—or create possible interference with neighbouring broadcast listeners, which is taboo with all self-respecting transmitters. That anything approaching such a state of affairs should be permitted to exist on Sundays is definitely unreasonable.

I realise that your correspondent states that the whole subject of more Sunday broadcasting is "in the air." Nevertheless, amateurs must defend their interests while they have them, or they will find themselves pushed out of existence altogether by what is at present the thin end of the wedge of Sunday broadcasting.

J. H. HUM.
London, N.10.

WIRELESS SIGNALS AND EARTHQUAKES.

Sir,—Did any reader of your paper who happened to be listening-in to a wireless programme on Saturday evening, March the 7th, between the hours of 5 p.m. and 8 p.m., notice any peculiar type of atmospheric disturbance?

On my own set I noticed a "swishing" noise of about $1\frac{1}{2}$ seconds duration repeated every 8 seconds, both on the high and low waveband. A friend in another part of the district also noticed this disturbance.

I have heard a similar noise a few times in the past six years, and each time it has occurred I have noticed that an earthquake has happened in some part of the world shortly afterwards.

On this occasion the one in Yugo Slavia occurred, and previously a bad one in Japan.

Is this a coincidence, or is there a connection between the two events? If so, it occurs to me that in countries subjected to earthquakes some method of recording this disturbance may enable scientists to foretell an earthquake some hours beforehand with a consequent saving of valuable lives and material.

Merthyr Tydfil. A. B. COUSINS.

VERTICAL OR HORIZONTAL DIALS.

Sir,—May I premise my remarks by saying how I enjoy "Free Grid's" articles in *The Wireless World*? They are a very pleasant leavening to the often highly technical matter in the rest of the paper.

The tiring of your eyes by watching a vertical dial is partly your own fault, "you" being the designers of sets.

Years ago horizontal panels were used, and, I think, if you will turn up your set so that the panel is horizontal you will find tuning less tiring, this because the eyes are depressed instead of being elevated.

This does not make your statement untrue; our eyes and their orbits have been evolved for roaming in a lateral direction.

The extra ocular muscles of the eyes are much stronger for lateral movement than for vertical. A pair of eyes that can overcome a horizontal prism base out of 30 dioptres or base in of 15 dioptres may not be able to overcome 4 dioptres base up cr down, and this is, I think, the cause of your trouble.

You may have noticed that the eyes are closer together when observing an object at close range, and this is another source of strength for lateral movement.

Oxford. W. ALDERSLEY, F.B.O.A.

THE STENODE.

Sir,—The following brief account of a series of experiments with the Stenode may be of interest, not only to Mr. C. H. Crocker and Mr. N. L. Yates-Fish, but also to your readers in general. I should explain that the Stenode set that I have is an experimental model of the simplified type which does not incorporate the crystal "gate." The selectivity is, therefore, not of the knife-edge order obtainable with the crystal gate receiver.

In the anode circuit of the second detector valve is a delicate milliammeter with a finely graduated scale which reads from 0 to 1.5 milliamperes. The output stage of the set is fully loaded by London's or Muehlacker's transmissions when the amplification is adjusted by means of the volume control (ganged potentiometers regulating the screening-grid voltage of the high-frequency amplifier and the first intermediate frequency amplifier), so that the anode current of the second detector is 0.5 milliampere at resonance. When no signal is coming through, the normal anode current of this valve is 0.11 milliampere.

It was found that the condenser settings required for Graz (851 kcs.), the London Regional (842 kcs.), and Muehlacker 833 kcs.) were exactly one scale division apart. The oscillator and the frame tune "in step," and there was no difficulty about adjusting the condensers so that a setting of exactly 40 tuned the London Regional to resonance. Since they have drum dials of large diameter there was again no difficulty in interpolating divisions at 39.25, 39.5, 39.75, and so on.

In the first experiment the amplification was regulated so as to give an anode current of 0.5 milliampere with the London Regional tuned to resonance. Readings were then taken at 40.25, 40.5, 40.75, 39.75, 39.5, and 39.25. The curve shown in Fig. 1 was then plotted.

Though the method is admittedly rough and ready, the results obtained are distinctly instructive. It will be seen that altering the dial reading by a quarter of a division, which is equivalent to taking the tuning approximately 2.5 kcs. off resonance, reduces the anode current from 0.5 milliampere to 0.13 milliampere on one side and 0.14 milliampere on the other. An alteration of a further quarter of a division brings the current to within 0.01 milliampere of the "no signal" level.

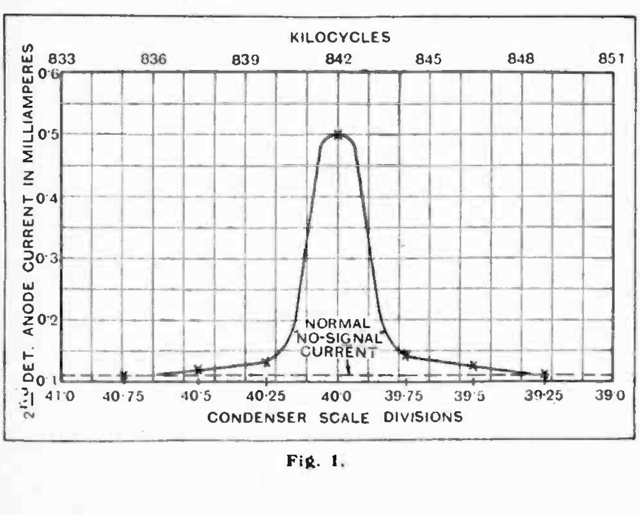


Fig. 1.

For the second experiment a time was chosen when both Muehlacker and the London Regional station were transmitting. The volume control was adjusted so that an anode current of 0.5 milliampere from the second detector was obtained from Muehlacker's transmission. The condenser readings were then reduced a quarter of a division at a time, and the milliammeter readings plotted in Fig. 2 were taken. It was impossible to take a reading at 40 since the milliammeter was showing a full-scale deflection before this point was reached owing to the enormous field strength of the Brookmans Park station at a range of fifteen miles.

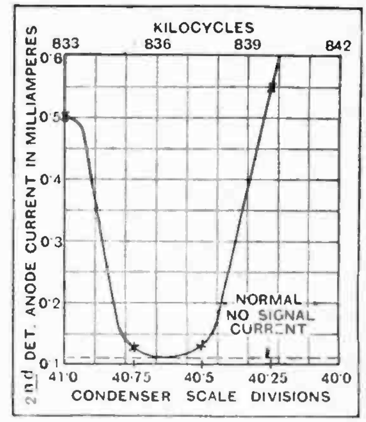


Fig. 2.

From the curve shown in Fig. 2 it will be seen that there is a clear and definite separation of these two powerful stations on neighbouring channels, and that no heterodyne beat occurs between them.

Curve Fig. 1 is also of interest as showing the exceedingly sharp resonance of the set. It would appear that the band of frequencies to which an even response occurs at resonance is less than 2 kcs. in width, for the finest movement made with the slow-motion condenser control is sufficient to bring the milliammeter reading down with a run. Yet the quality with a moving-coil loud speaker is superb, and my set is particularly good in its reproduction of brilliant treble passages.

Berkhamsted. R. W. HALLOWS.

RADIO SOCIETIES.

Sir,—I have been gratified to note the amount of interest that my recent letter on the use of radio societies by radio dealers has occasioned, and I hope that it may bear fruit.

A correspondent in your issue for March 18th seems to consider that the presence of dealers would present difficulties, and I am not able to agree to this except, of course, if the talk and demonstration is entirely of a sales nature and without real solid interesting matter in it.

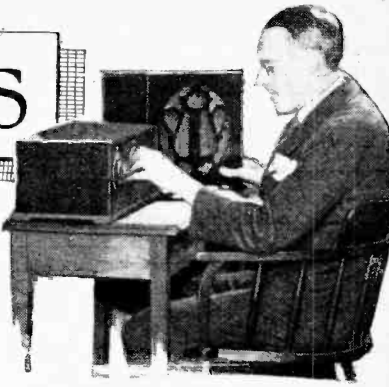
The type of lectures and demonstrations that I have had in mind in raising this subject were those which can be made equally instructive to the serious experimenter, the ordinary listener, and the trader, and it seems to me that there is no reason why such lectures cannot be carried out perfectly satisfactorily and very adequate information given without any question of giving away trade secrets or anything of that kind. Of course, the whole matter rests on the point of whether the apparatus being described or demonstrated is sufficiently good to tell the truth about; if it is not, it is obvious that the radio society is the last place where it should be demonstrated.

Since writing my previous letter I have had pleasure in giving talks before a radio society in Birmingham and one at Barnsley, and in both cases there was an attendance of over fifty members, notwithstanding very bad weather in one case, which is an indication that the enthusiasm was considerable, and in the case of the Birmingham Society a number of dealers were actually present, which shows that it is possible to run a society of which both the user and the trader are members.

I would suggest, in conclusion, that one of the most important requirements of a successful radio society is that it shall have a really live secretary, who is prepared continually to put in a considerable amount of work in connection with its organisation and in seeing that it obtains adequate local publicity.

Manchester. W. BAGGS.

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.

Mains Aerials.

My receiver has two H.F. stages, followed by a detector and pentode. Do you think that it would be possible to use the A.C. mains as an aerial, and, if so, will you describe the necessary connections?

One could never be very definite concerning the behaviour of a "mains aerial," but there is no harm in trying this scheme if it is inconvenient for you to erect a good outdoor or indoor aerial. A well-insulated mica condenser of 0.002 mfd. or more should be joined directly to one of the mains leads, and the other side of this condenser should be connected through a variable or semi-variable condenser of about 0.0005 mfd. maximum capacity, to the aerial terminal of the set.

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Pilot Lamps.

My A.C. mains receiver is fitted with a pilot lamp, which is connected across the 4-volt winding of the power transformer. The bulbs, which are rated at 4 volts, have a very short life, lasting only a few weeks. Do you think that this may be taken as an indication that the L.T. secondary of the transformer is delivering an excessively high voltage?

We do not think so. Flashlamp bulbs of the ordinary type do not last very long when operated continuously from an A.C. supply, and we suggest that you should use a 6-volt lamp. This will glow at less than normal brilliancy, but will doubtless provide ample illumination.

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Systematic Fault Finding.

I have just finished building the "All-D.C." receiver described in your issues of August 20th and 27th, 1930, but have so far been unable to hear any signals. Probably there is some minor fault that should be obvious enough, but so far I have not succeeded in tracing it. Can you suggest anything?

It is impossible for us to say where the fault is likely to be found; although this receiver is comparatively simple and quite straightforward in its circuit design, a mis-connection at any one of a number of points would entirely prevent its working. We suggest that you first concentrate your efforts on the detector-L.F. portion of the set. This can very easily be done by disconnecting the H.F. valve-anode lead and then joining it temporarily to the aerial through a condenser of about 0.0001 mfd. Altered in this way, the set should be operated as a simple det.-L.F. receiver.

We also advise you to check the filament voltage of each valve with a high-resistance meter, and also to measure the various anode currents with a milliammeter.

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Leaky Condensers.

Is the use of paper-dielectric by-pass condensers with poor insulation likely to have any prejudicial effect on the working of a mains-operated receiver? I have just been testing the condensers in my own set, and find that one of them shows an insulation resistance of less than 200,000 ohms; nevertheless, the receiver seems to be working well.

As a general rule, it can be stated that the effects of minor leakages in these condensers are not serious, though occasionally they are responsible for background noises. An exception exists in the case of coupling condensers, used in resistance-, choke-coupled and parallel-fed transformer amplifiers, but, except in the latter case, mica dielectric is always recommended.

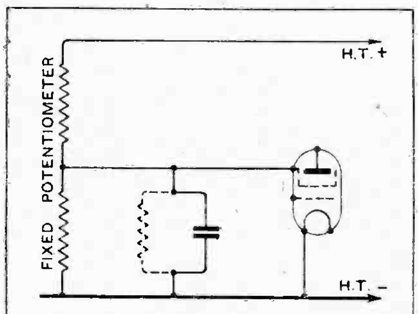

Fig. 1.—Showing how screening grid voltage may be reduced by leakage in a by-pass condenser, which is in parallel with one limb of the feed potentiometer.

A case recently came to our notice where lack of sensitivity was finally traced to a leakage (of considerably greater magnitude than that you mention) in a by-pass condenser connected in a screening grid circuit. As shown in Fig. 1, this was equivalent to the connection of a parallel resistance across one element of the fixed potentiometer, and consequently the actual voltage applied was very much less than that determined by calculation.

Improving Switch Contacts.

After working satisfactorily for some time, one of the wave-range switches of my receiver seems to have developed an intermittent contact. Sometimes it is necessary to rock the control knob to and fro several times before the set will work on the medium waveband. Long-wave signals are unaffected, but this is understandable, as the switch operates by short-circuiting long-wave loading coils.

The contacts have been cleaned, but with only a temporary and barely perceptible improvement. Can you suggest anything?

You do not mention the actual type of switch in use, but if it is of conventional design we advise you to bend the fixed contact springs in such a way that they come into close proximity with the moving blades or contacts. This bending must not be overdone, or a permanent short-circuit may be introduced; the object, of course, is to increase pressure between the contacts when they are closed.

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Filter Adjustments.

In order to obtain sharper tuning and consequently greater freedom from interference, I understand that a larger coupling condenser should be used in a capacity-coupled filter. When inductive coupling is used, does the same rule hold good, and, to obtain the same results, should turns be added to the coupling coil?

It is realised that sharper tuning than is provided by circuits as generally specified will involve some sacrifice of high notes.

In any type of filter of which the component circuits are coupled by common capacity or inductance, coupling becomes closer—and tuning becomes broader—as the reactance (or impedance) of the coupling device is increased.

At a given frequency the reactance of a condenser decreases as its capacity is increased; the position is reversed with regard to an inductance, of which the impedance will increase as turns are added. Consequently, to sharpen tuning when an inductively coupled filter is employed, it is necessary to remove turns from the coupling coil.

Effect of Over-Biasing.

Can any harm be done by inadvertently running a mains receiver for a few hours with an automatic bias resistance (for the output valve) of approximately double the correct value? I suppose this means that the valve would be over-biased by about 100 per cent.

It is most unlikely that the valves or receiver will have suffered any harm; high-tension voltage on the anodes of all valves will naturally rise, due to reduction of load brought about by over-biasing the output valve, but increases of anode current will be restricted, as far as the earlier amplifying stages are concerned, by the automatic grid bias arrangements which are doubtless included. The detector will be protected by its anode decoupling resistance.

There is a faint possibility that the rise in voltage will cause a breakdown in a by-pass condenser, but this is unlikely to happen if these components have a fair factor of safety with regard to their working pressures.

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Output Auto-Transformer.

It has been stated that an output choke with a number of tappings is sometimes useful as a help in matching a loud speaker to a pentode output valve. In carrying out experiments with a choke of this kind, is it correct to keep the loud speaker connection fixed (to the mid-point tapping) and to vary the position of the anode lead?

No: assuming the choke to have a suitable inductance value, it is best to join the valve anode to one end of the winding and to try the effect of connecting the lead which goes to the loud speaker

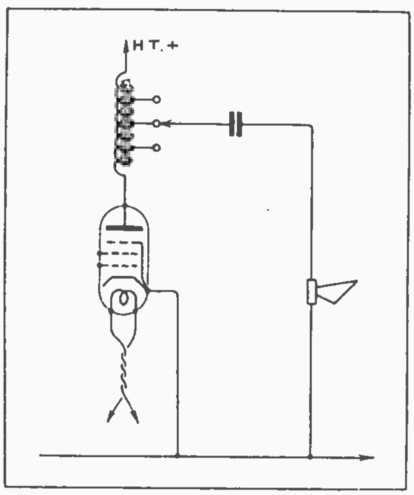

Fig. 2.—A tapped choke used as an output auto-transformer with variable step-down ratio.

(through a large condenser) to various tapping points. This is shown in Fig. 2.

If the loud speaker happens to be of low impedance, the correct point of connection will be near to the low-potential end of the choke—i.e., the end that is joined to H.T.+—and *vice versa*.

Weatherproof Lead-in Insulator.

I have a "Pyrex" glass bowl insulator, which was suggested in "The Wireless World" for June 4th last as being suitable for a yacht installation. The correct method of fitting this insulator is not clear to me; will you please give me a rough sketch showing how this should be done?

A suggested method of fitting this type of insulator is shown in Fig. 3. To avoid leakage, the surface on which the mounting is to be done should be quite true

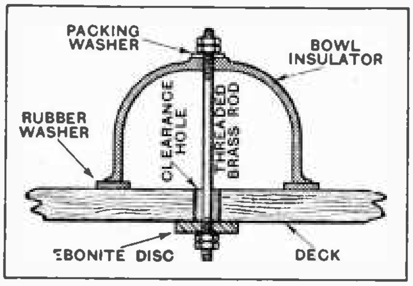

Fig. 3.—Aerial lead-in insulator for a yacht installation.

and smooth; it may be found advisable to interpose a block of hard wood between the insulator and rubber washer and the deck.

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Long-wave Filter.

My new receiver, with an input filter, one H.F. stage, and ganged tuning, behaves more than satisfactorily on the medium waveband, but, on changing over to the long waves, it is found that signals are weak unless the trimming condensers are re-adjusted. This is obviously inconvenient, as, on changing back to the medium band, it is necessary to "re-gang." Can you tell me what is likely to be the cause of this trouble?

It is probable that the inductance values of your long-wave tuning coils are unequal; unless they are properly matched, it is impossible that tuning capacity adjustments made on the medium band will hold good on changing over.

Alternatively, it may be that, when changing over to the long waveband, different proportions of the aerial or valve capacities are transferred to the tuned circuits.

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Distant Volume Control.

The input volume control of my H.F.-det.-L.F. receiver consists of a potentiometer which controls screening grid voltage of the H.F. valve. I now wish to instal the loud speaker in another room, and am wondering whether it would be permissible to remove the potentiometer, and to connect it to the receiver by extension leads of the same length as those for the loud speaker. Do you think that this procedure is likely to produce instability?

Provided that the screening grid circuit is properly decoupled—it will almost certainly be necessary to fit an extra resistance—it should be possible to use the S.G. potentiometer as a distant control of volume. The three extension leads for this component should preferably be taken to the distant point by a different path from that followed by the loud speaker wires: unless care is exercised in this matter, decoupling must be more than usually generous.

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The Vexed Question of Reaction.

It is noticed that several readers have recently been asking about the advisability of applying reaction in short-distance detector-L.F. sets with an input filter. My own problem is rather different from any of those that have been published. I live about seven miles from Slaithwaite, and propose to make a simple set of the type in question, to be used purely for local-station reception. Do you advise me to include reaction—not, of course, to increase sensitivity, which will obviously be unnecessary, but in order that the effects of detector damping may be largely removed, thus equalising loading of the second filter circuit?

Reaction should be quite superfluous in your case. By "tapping down" the detector grid connection on the second filter coil, it will be possible to ensure that the load imposed by the detector is sensibly equal to that due to the aerial.

The actual point of connection is best determined experimentally: it may be taken that operating conditions are correct when the two tuning peaks are symmetrical.

FOREIGN BROADCAST GUIDE.

GENOA

(Italy).

Geographical position: 44° 25′ 44″ N., 8° 59′ E.

Approximate air line from London: 640 miles.

Wavelength: 313.2 m. Frequency: 958 kc. Power: 1.5 kW.

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

Standard Daily Transmissions.

09.30 G.M.T., sacred service and music (Sun.); 11.15, light music (Sun.); 15.00, operetta (Sun.); 16.00, outside broadcast; 18.30, concert; 19.10, news, gramophone records; 20.00, operatic relay or concert; 22.00, dance music (Fri., Sat.); 22.55, news. Regularly relays Turin and Milan.

Woman announcer. Call: EIAR (phon.: *Ay-yah*) Radio Genova.

Interval signal: as Milan or Turin (Song of Nightingale).

When working S.B. with Turin and Milan the call is: *Radio Milano, Torino e Genova.*

Closes down with the words: *Buona notte a tutti*, followed by the Fascist hymn (*Giovinezza*) and the Italian National Anthem (*Marcia Reale*).

The Wireless World
AND RADIO REVIEW
(19th Year of Publication)

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

Apparent v. *Actual Sensitivity.*

IN these days of bewildering variety in types of valves it would seem to us that the time has come when the introduction of any further new types should take place only after most cautious investigation to ascertain whether such new valves can fully justify themselves. We do not, by such a statement, wish to suggest for one moment that improvements ought not to take place, or that there should not be a continual effort on the part of the valve manufacturers to meet whatever requirements may be demanded by new technique in receiver design. But valve manufacturers accept a great responsibility when they issue new types of valves, especially if these new valves have no outstandingly valuable qualities. Manufacturers of receivers, too, are themselves often to blame for creating a demand for a particular type of valve, because of some individual fad or fancy in the design of the receiver.

A particular case in point would seem to us to be presented by the proposed introduction of a two-grid or four-electrode valve of the type which has for years been so well known in France under the name of the "Bi-Grille." This valve was manufactured in France to meet the demand for use in a particular type of circuit employed in superheterodyne receivers.

In October of last year *The Wireless World* directed attention to the superheterodyne and pointed out in several articles the possibilities which the superheterodyne principle offered in providing an alternative means of obtaining a high degree of selectivity, and in the following month there appeared in *The Wireless World* the first constructional design for a superheterodyne published in this country for several years. Since that date our recommendations have been widely followed, and the superheterodyne is fast gaining in popularity in this country.

Clearly we did not recommend the reintroduction of the superheterodyne so that circuit arrangements might be employed which should long since have been relegated to the museum.

For valve manufacturers to consider that the growing interest in superheterodyne receivers justifies them in the production of a four-electrode valve for use in such circuits, appears to us to be an error of judgment based on incomplete knowledge of the tendencies in the design of the superheterodyne of to-day.

As we write we have before us a technical report prepared after many weeks of investigation into types of frequency changers for the superhet. After stating various other objections to the use of the two-grid valve circuit, the report says: "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." Obviously, such a circuit is likely to achieve notoriety, for in the hands of the inexperienced user the *apparent* number of stations may be many times the *actual* number receivable, thereby giving an entirely false impression of sensitivity.

In This Issue

Simple Test Apparatus

by H.B. DENT

An Inexpensive Bridge for Measuring Resistance and Capacity.

ASSUMING a perfection in production such that only one component in 100 is likely to be faulty, the chances of failure in the making up of a modern receiver are considerable. There may be some 50 components used in the construction of a four-valve set, and rather than risk disappointment some means of testing them becomes almost essential.

EVERY amateur who has given serious thought to experimental work, especially in connection with the development of his own conception of a receiver, will sooner or later begin to realise that if a precise knowledge of the values of some of the components had been available, many of the aggravating troubles that so often arise during the test stage could have been countered at the beginning. The need for some relatively simple method of accurately measuring resistances and small condensers is a very pressing one, and is met by a simple bridge, details for the construction of which are given in this article.

A high-grade milliammeter and a good multi-range voltmeter will assist materially in this respect, but these instruments are expensive, and as a rule the average experimenter has to content himself with something less ambitious, although the accuracy of the instruments available will, no doubt, meet the everyday needs of measuring anode current and H.T. voltages.

The purpose of this article is to describe and explain the operation of a simple bridge by means of which the actual values of resistances of from one ohm upwards, and of condensers ranging from 0.00005 mfd. to 0.05 mfd. can be obtained. Intelligent handling of such apparatus as that dealt with here is possible only when the operator has a working knowledge of the principle on which it is based.

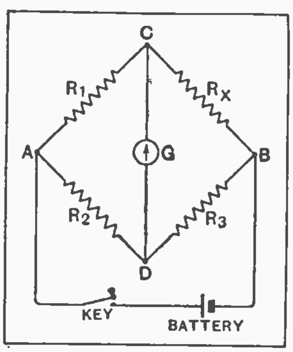


Fig. 1.—The basic principle of the Wheatstone bridge consisting of four resistances, three of which are of known value. R_2 and R_3 form the ratio arms.

All bridge circuits are based on the fundamental Wheatstone principle which, in its simplest form, consists of four resistances arranged as in Fig. 1. Across one diagonal, CD, is connected a galvanometer, and across the other, AB, there is a battery and a key to make and break the circuit. The three resistances, R_1, R_2, and R_3, are of known value, while R_x is the unknown resistance whose value it is desired to ascertain. The resistances R_1, R_2 and R_3 are adjusted until the current flowing through R_1 and R_x is the same as that in R_2 and R_3. Consequently, somewhere on the upper path there will be a point where the voltage is the same as at a point on the lower path, so that if a sensitive galvanometer were connected between them there would be no movement of the needle, since current cannot flow between two points which are at the same potential.

In the network illustrated to achieve a condition where no current will flow from C to D the

$$\frac{\text{Voltage drop in } R_2}{\text{Voltage drop in } R_3} = \frac{\text{voltage drop in } R_1}{\text{voltage drop in } R_x}$$

Simplifying this equation, we can say that

$$\frac{R_2}{R_3} = \frac{R_1}{R_x} \text{ ......Equation 1.}$$

and

therefore $$R_x = \frac{R_3 \times R_1}{R_2} \text{ ....Equation 2.}$$

It can be seen from Equation 1 that it is not necessary to know the actual values of R_2 and R_3; we only desire to know the ratio of one to the other, and that the requirements of the bridge can be met by having one known resistance, namely, R_1.

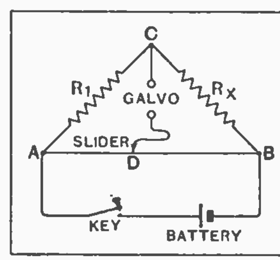


Fig. 2.—Modified version of Fig. 1, with ratio arms replaced by a straight wire resistance AB, with sliding contact D.

Thus it becomes possible to simplify the circuit and employ an arrangement such as that depicted in Fig. 2. Here the resistances R_2 and R_3 have been replaced by a single length of No. 36 S.W.G. resistance wire with a slider that can be moved from A to B. Now we can rewrite our equation in the following manner and say that

$$R_x = \frac{\text{distance in inches from B to D}}{\text{distance in inches from A to D}} \times R_1.$$

This is the fundamental circuit adopted for the bridge here described.

A sensitive galvanometer is an expensive instrument, and as our immediate concern is to keep expenditure down to the absolute minimum it was decided to use an audio-frequency for energising the bridge, as headphones could then be used in place of the galvo. Subsequent tests showed that a stage of L.F. amplification

Simple Test Apparatus.—
helped considerably in accurately determining the silent point, but this is not a serious drawback, as the simplest of arrangements will suffice. Most experimenters must have a spare L.F. transformer and a general-purpose valve available with which a simple amplifier can be built. Alternatively, the output from the bridge can be passed through a transformer, the secondary of which is connected across the gramophone pick-up terminals of the home broadcast set.

Simple Construction.

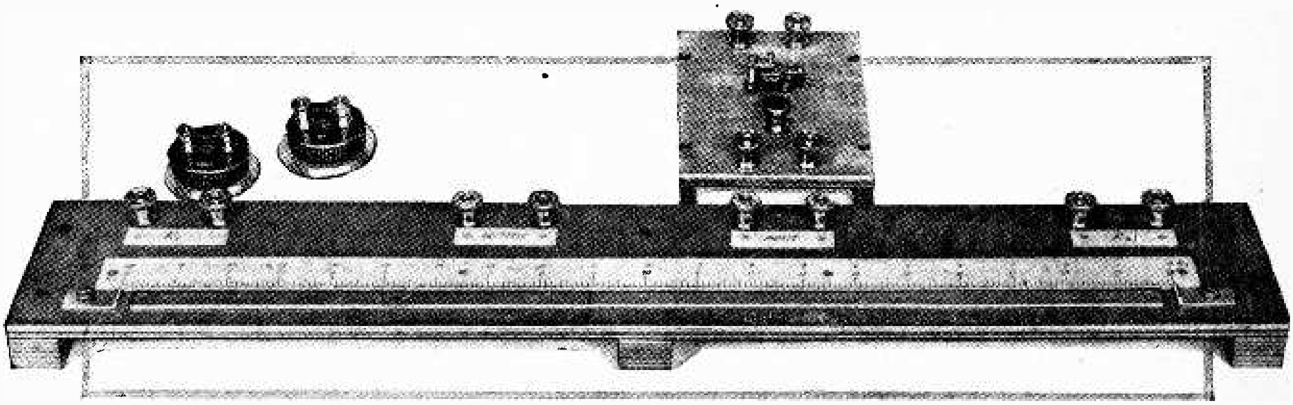
By using a buzzer, or any other source of audio-frequency, it is not possible to measure the ohmic resistance of components possessing inductance, such as L.F. transformers, L.F. chokes, and the like, since the bridge would show the impedance of the component and not its pure D.C. resistance. As a matter of interest, if a source of audio-frequency comparatively free from harmonics was employed in place of the buzzer, and its actual frequency known, the bridge could be used to measure the inductance of L.F. transformers, and chokes, with a fair order of accuracy. However, this is another story, and somewhat outside the scope of the present article.

Every effort has been made to simplify the constructional work, even to the point of dispensing with a slider, as this is rather difficult to arrange in a simple manner without a long, trailing, flexible wire. The method adopted here consists of a length of brass strip $\frac{1}{2}$in. wide, $\frac{1}{16}$in. thick, and $19\frac{3}{8}$in. long, screwed to the base immediately below the straight resistance wire. By pressing the resistance wire down on to the brass, using an ordinary needle pushed into the end of a wooden rod, contact is made with the wire, and the point of contact varied by sliding the device along the length of the scale until the silent point is located.

The straight resistance wire is stretched above the brass strip and spaced $\frac{3}{16}$in. from it. The tension keeps it away from the brass until pressed down by the slider, but in the course of time it will stretch and tend to sag. Thus, some means of tensioning the wire is required, and in the present case this is arranged by soldering the ends of the wire to the side of the head on cheese-head type 2 B.A. screws. By slacking off the nut holding one of the screws in position, and giving the screw a fraction of a turn and then tightening the nut, the slack can be taken up.

These screws also serve to position the small angle-shaped knife-edges over which the wire is stretched, and in assembling the parts it is essential to see that these line up accurately with the two end divisions on the 20-inch scale. The scale is marked on a strip of white cardboard obtainable from most stationers specialising in drawing-office equipment and officially known as Bristol board. The strip is 21in. long and 1in. wide, and the scale is 20in. long. It is marked out in inches with each inch division divided into 10 equal parts.

The inch divisions are then marked 0 to 20, reading from left to right, and 0 to 20 reading from right to left. The first set of markings are called the R_2 scale, while those reading from right to left become the R_3 scale. Referring back to Fig. 1, it will be seen that the straight wire replaces the resistances R_2 and R_3 in the arm of the bridge ADB.



Resistance and capacity bridge and buzzer unit described in the article.

The wiring between the terminals must be carried out with thick copper wire, as its resistance must be exceedingly small compared with that of the straight length of resistance wire. No. 16 S.W.G. copper wire is recommended, although No. 18 S.W.G. can be used satisfactorily. A finer gauge is not advised.

The High-note Buzzer.

This forms the bridge proper, and to complete the apparatus it is now necessary only to construct the audio-frequency energiser. A buzzer will meet this need, but those who desire something more ambitious can make up a valve oscillator, which has the advantages of mechanical silence, greater reliability, and provides a source of L.F. more closely approaching a sine wave than is possible with a buzzer.

Assuming the constructor decides to employ a buzzer, it is well to mention that only what is known as the high-note type is suitable, and this can be obtained from the Grafton Electric Co., 54, Grafton Street, Tottenham Court Road, London, W.1, and costs but 3s. 6d. This was found to have a resistance of 25 ohms, and required about 4 volts to operate it satisfactorily. Three large bell-type dry cells will give months of service if a 4-volt accumulator cannot be spared for this purpose.

Simple Test Apparatus.—

The resistance R_s across the coils of the buzzer, shown in Figs. 3 and 4, is not absolutely essential, and may be omitted without affecting the working of the buzzer. Its function is to absorb the back voltage generated when the contact points open and to reduce sparking, which will in time cause pitting of the contacts. It should be about ten times the resistance of the buzzer, and that used in the present case was 250 ohms, approximately, being obtained by winding 7ft. of No. 45 D.S.C. Eureka resistance wire non-inductively on a piece of ½in. ebonite rod.

Before the bridge can be put into use some guaranteed standard resistances will be required for use in the position R_1. A 10-ohm resistor will enable unknown values from 1 ohm up to 100 ohms to be measured with an accuracy that should suffice for all ordinary purposes. The standard should be accurate to one part in a thousand, but this does not imply an expensive component, as suitable resistances are obtainable from F. E. Becker and Co., 17, Hatton Wall, Hatton Garden, London, E.C.1, the 10-ohm resistor costing 6s. 6d. One of 500 ohms value will extend the range to 5,000 ohms, giving a comfortable overlap on the range covered by the smaller value. If desired, still higher values can be measured by acquiring a 15,000-ohm resistor, when the range can be extended to 150,000 ohms.

Having set up the bridge with the buzzer unit connected to the input terminals and the output either to a pair of telephones or to a transformer feeding an amplifier, connect the standard resistor to the terminals R_1 and the resistance to be measured to the terminals R_x. Move the sliding contact device along the wire and press it down to make contact with the brass strip until a point is found where the buzzer note ceases to be heard in the telephones, or is at the minimum of audibility. Now read off on the scale the values corresponding to R_2 and R_3. R_2 represents the distance in inches from the left-hand end to the point of contact of the slider, and R_3 the distance from the right-hand end.

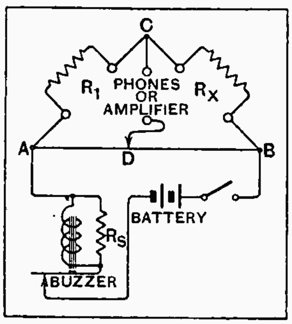


Fig. 3.—Theoretical arrangement of the resistance and capacity bridge here described, using a buzzer to energise the circuit.

Let us say that $R_2 = 3.3$in. and $R_3 = 16.7$in., then the value of the resistance is found by

$$R_x = \frac{R_3 \times R_1}{R_2} = \frac{16.7 \times 10}{3.3}$$
$$= 50.6 \text{ ohms.}$$

The operator should at first experiment with some resistances of which the approximate values are known as a guide in the early stages while he is becoming acquainted with the operation of the bridge. A good test is to connect a 15- or 20-ohm variable resistance to the terminals R_x and adjust it until the silent point is found when the slider rests on the 10in. mark on the scale. That portion of the resistance connected across the terminals R_x should then be 10 ohms. To check both the accuracy of the bridge and the skill of the operator, change over the two resistances R_1 and R_x, taking care not to disturb the setting of the latter, and note if the silent point still coincides with the 10in. division on the scale. If it is found to be within $\frac{1}{10}$th of one inch either side of this mark the difference between the two measurements will amount to one per cent. This may be due either to a small error in reading the scale or to inequalities in the resistance of the straight wire, or to the limitations imposed by the method.

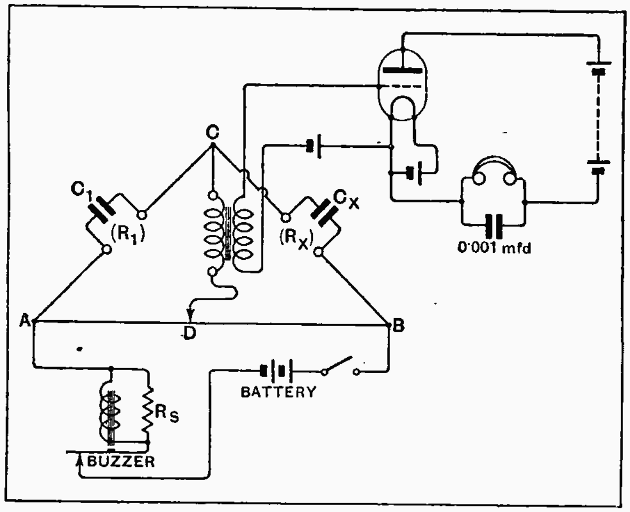


Fig. 4.—The addition of an L.F. amplifier is necessary when measuring small capacities. In this case the standard condenser is connected to the terminal R_1 and the condenser under test to R_x.

Now, as a matter of interest, let us examine its limitations and determine the degree of accuracy that is possible of attainment, assuming a theoretically perfect length of wire, and a standard resistance of an exceedingly high order of accuracy. With the exercise of the greatest care in marking out the scale, and fine judgment in reading the position of the silent point, it should be possible to place this definitely within ¼ of $\frac{1}{10}$th of an inch, i.e., an accuracy of one part in 400 at the centre of the scale. Converted into a percentage, this gives us an error of 0.25 per cent. It can be shown by simple arithmetic that the error is not a constant quantity throughout the scale, but increases as the point of balance moves away from the centre. At the 5 and 15 divisions the error becomes 0.5 per cent., and at the 1 and 19 divisions 2.5 per cent.

Small Percentage Error.

The graph shows at a glance the distribution of the theoretical error throughout the scale. If the initial marking out is not very carefully executed it may not be possible to assure a greater order of accuracy in reading than to the nearest 1/20th of an inch, in which case the theoretical error will be doubled at all positions of balance. The curve relating to this condition is drawn as a full line and marked A on the graph (Fig. 5), while the dotted-line curve relates to the higher order of accuracy. Incidentally, the error which is the governing factor is that error introduced by the smallest

Simple Test Apparatus.—

quantity, whether this be R_2 or R_3, as the case may be.

To show that the human error can be largely eliminated with practice, some measurements made with the actual bridge here described are given in the following table:—

TABLE I.

Distance from left to slider (R_2 scale).	Distance from right to slider (R_3 scale).	Measured value of $R_x = \frac{R_3 \; R_1}{R_2}$	Actual value of R_x correct to 0.1%.	Percentage error compared with R_1.
16.69	3.31	1.98	2	− 1%
13.35	6.65	4.98	5	−0.4%
10.0	10.0	10.0	10	—
8.02	11.98	14.9	15	−0.7%
4.97	15.03	30.25	30	+0.8%
3.30	16.70	50.6	50	+1.2%
2.30	17.70	77.0	75	+2.6%
1.75	18.25	102.8	100	+2.8%

The resistance of R_1 is guaranteed to one part in 1,000. For the next range a standard resistance of 500 ohms will be required. With this, resistances of from 50 ohms to 5,000 ohms can be measured, and for higher values a standard resistance of 15,000 ohms is recommended. This will carry the available range up to 150,000 ohms. Accurate values of resistances above this are rarely necessary, and the maker's figures can be accepted.

The discrepancies between the actual values and the measured values given in the above table are only slightly larger than the theoretical errors introduced by the limitations of the device used, and it can be seen that those accounted for by all other possible sources of inaccuracy do not amount to much.

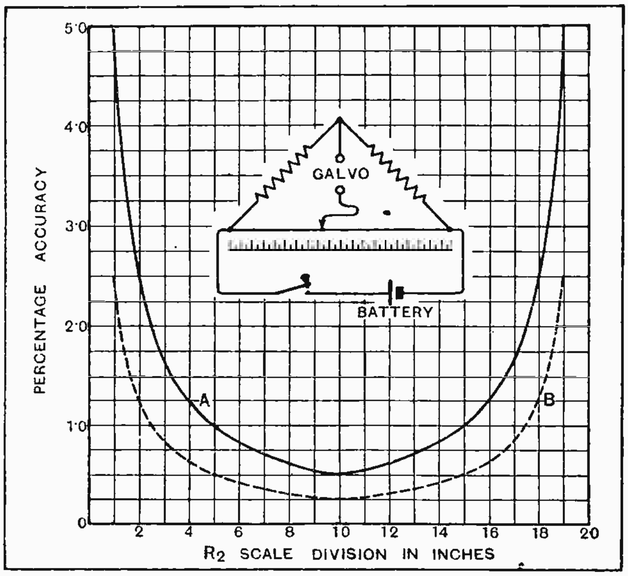


Fig. 5.—Curves showing the calculated order of accuracy that can be attained at various parts of the scale: A, when it is read to the nearest 1/20th of an inch, and B, when read to the nearest 1/40th of an inch.

Measurements of capacity are carried out in a similar manner, but with a standard condenser in place of the known resistance R_1, and the condenser to be measured is connected across the terminals marked R_x. What the bridge actually does in this case is to balance up the resistance, or reactance, of the unknown condenser, using the reactance of the standard condenser in place of R_1 to complete the resistance network of the bridge. As a consequence this method is applicable only when an alternating potential is fed into the bridge, and could not be used, of course, when a galvanometer replaces the headphones.

Measurement of Capacity.

Owing to the exceedingly high reactance of small condensers, such as 0.0005 mfd., for example, compared with the very low value of the straight wire resistance, the A.C. current flowing through the capacity arm of the bridge will be very small indeed compared with that in the resistance arm. As a consequence the buzzer note will be practically inaudible in the telephones for quite a considerable distance either side of the balance point, and an amplifier becomes an essential adjunct to the apparatus.

The circuit used for the capacity measurements discussed here is given in Fig. 4. As the amplifier proved so useful for resistance measurements also it was utilised on all occasions that the bridge was operated.

Now the reactance of a condenser is inversely proportional to its capacity, other factors being unchanged; that is to say, a large capacity has a low reactance and a small capacity a high reactance. It follows that we must modify our formula for calculating the value of the unknown condenser, and so our equation now becomes

$$C_x = \frac{R_2 \times C_1}{R_3} \quad \text{........Equation 3.}$$

The accuracy of the bridge is not materially modified by the changed conditions, and for all practical purposes the curves discussed in the earlier part of this article may be said to apply to the present case. However, it is extremely doubtful if the same high standard of accuracy can be maintained, as the silent point is not so well defined, owing to the matter of current distribution mentioned above.

The Likely Error.

As an indication of the nature of the accuracy that can be attained, a few of the capacities measured with the bridge are given in the following table, together with the actual capacity to ±2 micro-mfds., of the condenser used in the position R_x.

TABLE 2.

Distance from left to slider (R_2 scale).	Distance from right to slider (R_3 scale).	Measured value of $C_x = \frac{R_2 \times C_1}{R_3}$ mfd.	Actual value of C_x to ±2 micro-mfds.	Percentage error compared with C_1.
		mfd.	mfd.	
3.8	16.2	0.000117	0.000116	+0.9%
7.65	12.35	0.000306	0.000311	−1.6%
10.3	9.7	0.000532	0.000543	−2 %
11.85	8.15	0.000726	0.000738	−1.6%
13.55	6.45	0.00105	0.00108	−2.8%
18.10	1.90	0.00476	0.00437*	+ 9%

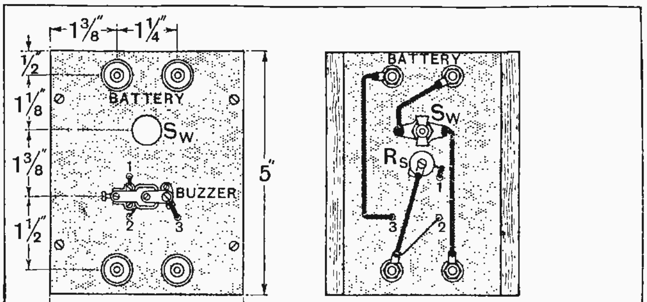
* The accuracy of this capacity is to ± 6 micro-mfds.

The condenser used as a standard in the position C_1 had a value of 0.0005 mfd. whose accuracy can be guaranteed to ±0.3 per cent. Although the variation of the percentage error does not agree so well with

Simple Test Apparatus.—

the theoretical error as shown by the curve, the general form of which the resistance measurements so closely followed, the values obtained are sufficiently near to the selected known capacities for most practical purposes.

With a standard condenser of 0.01 mfd. connected across the R_1 terminals, unknown values of capacities between 0.001 mfd. and 0.1 mfd. can be determined. The Dubilier Condenser Co. (1925), Ltd., Ducon Works, Victoria Road, N. Acton, London, W.3, will supply condensers and give the value to within ±5 per cent.



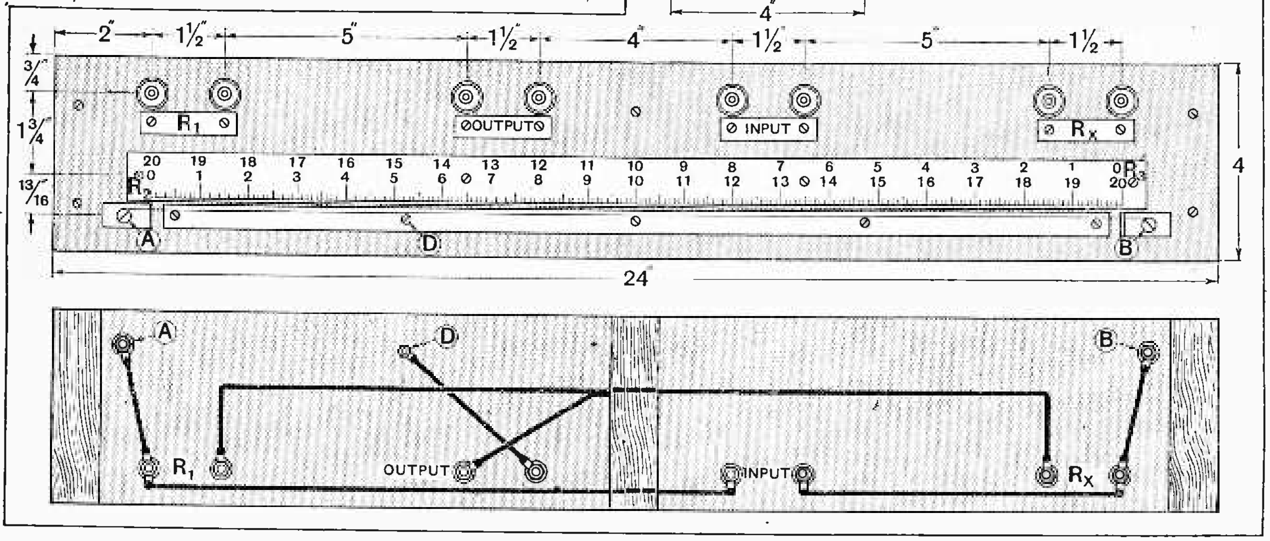


Fig. 6.—Dimensional layout and wiring of the bridge and buzzer unit.

at an additional charge of 15 per cent. over the list price. With this order of accuracy in the standard it should be possible to determine the capacities of condensers to within 10 per cent. of their actual value, which will be accurate enough for most purposes.

If this does not satisfy, then the standard must be guaranteed to within closer limits, and the reader is advised to purchase a Dubilier type 577 condenser. This type is available in all usual values up to 0.01 mfd., and the capacity is given to within ±1 per cent. of the marked value. They are more expensive and cost 7s. 6d. each.

CLUB NEWS.

Step-by-Step Fault Tracking.

A demonstration of tracking faults step by step was successfully carried out by Mr. R. Heaton at the last meeting of Slade Radio (Birmingham). A diagram of a simple three-stage circuit (H.F., detector and L.F.) was drawn on the blackboard, and the lecturer proceeded to describe his own method of going over a circuit in search of the elusive source of trouble.

Hon. Secretary, 110, Hillaries Road, Gravelly Hill, Birmingham.

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Historic Valve Display.

No fewer than 179 exhibits of radio valve ranging from a carbon lamp of 1880 to one of the latest valves, namely, the Ediswan PP5/400, were shown by Mr. Largen at a recent meeting of the Ilford and District Radio Society. Members learnt from the display that progress in valve efficiency was comparatively slow till 1927, when A.C. valves were introduced, but that since then striking improvements had been made and that mutual conductance had jumped from 0.2 to 3 and even, in one case, to 7.5 m/v.

The Hon. Secretary, Mr. C. E. Largen, 16, Clements Road, Ilford, would be pleased to show the collection by arrangement to fellow clubmen.

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A Good Year.

Despite the acquisition of additional apparatus during the past year, the treasurer's report at the annual general meeting of the North Middlesex Radio Society revealed a financial balance substantially the same as last year. In his very interesting summary of the Society's activities during the past year, Mr. E. H. Laister, the retiring Hon. Secretary, said that there had been twenty-five ordinary meetings. Six lectures had been given by manufacturers' representatives, and ten by members of the Society, while six of the meetings had been devoted to informal discussions. In addition, a series of visits had been paid to technical laboratories and other places of interest. Two field days were held, and much useful D.F. work was carried out. Mr. F. T. Chapple has been re-elected to the position of President, and the new Hon. Secretary of the Society is Mr. M. P. Young, 40, Park View, Wynchgate, Winchmore Hill, N.21.

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The Press.

An interesting innovation marked a recent weekly meeting of the Bristol and District Radio and Television Society at the University, when a competition evening was held. The Chairman, Mr. W. A. Andrews (5FS), introduced a competition which tested the observation of members of matter published in the wireless Press.

Hon. Secretary, Mr. S. T. Jordan, 1, Myrtle Road, Cotham, Bristol.

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For Slough Enthusiasts.

At a meeting of the Slough and District Radio Society held on April 15th members had the benefit of a demonstration given by Messrs. Philips Lamps, Ltd., on A.C. receivers.

A welcome to the meetings is given to all interested in wireless, and full particulars of the Society can be obtained from the Hon. Secretary, Mr. G. H. Anderson, 58, Gloucester Avenue, Farnham Royal, Bucks.

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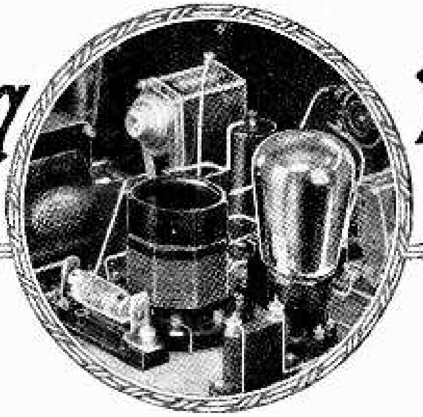
Old and New Compared.

The Stenode Radiostat was the subject under discussion at the recent monthly meeting of the Hounslow and District Wireless Society, when Mr. W. R. Emery, leading the discussion, compared the receiver, both with diagram and in practice, with a superheterodyne built by him some years ago. Certain similarities were strikingly apparent, and the Chairman complimented the lecturer on the results obtained with a receiver built so long ago.

The Society hopes to hold fortnightly meetings when the proposed experimental hut is erected.

Hon. Secretary, Miss W. Ross, 304, Hanworth Road, Hounslow.

Comparing Detector Valves



Their Efficiency Measured under Working Conditions.

By W. T. COCKING.

UP to the present the characteristics of very few valves have been measured working as power grid detectors, the chief exception being the Mazda AC/HL, of which very full details have already been published.[1] In this article, therefore, the results with some other valves are given; but before proceeding to discuss these it may be well to give some details of the method of measurement that has been used.

THE detector is such an important part of the modern receiver that it is unfortunate that the static valve characteristic curves, so useful for amplification purposes, are of little help in arriving at the best operating conditions. It is true that it is quite possible to calculate from the static curves the rectification efficiency, but the methods are so complicated that it is usually simpler to resort to measurement. Much useful information will be found in this article on designing a power grid detector stage and on the relative efficiency of battery and mains valves as rectifiers.

The circuit used is shown in Fig. 1, and the H.T. voltage was maintained constant at 200 volts throughout. The grid condenser had a value of 0.0001 mfd. with a grid leak of 0.15 meg., which was returned directly to the cathode with indirectly heated valves, and to the positive terminal of the valve filament with battery-type valves. In every case a 0.001 mfd. anode circuit by-pass condenser C was used so that the anode circuit load impedance would have a low value for H.F. currents. The H.F. input was provided by means of a local oscillator tuned to 760 kc. (395 metres) and the input was measured by a valve voltmeter connected as shown.

Various input voltages were applied to the valve under test, and the anode currents noted with and without signals from the local oscillator; the difference between these figures gives the change of anode current due to rectification, and this is plotted in the curves of Fig. 2. Now the product of the change of anode current in amperes and the anode resistance in ohms gives the D.C. voltage change across the resistance, and this is equal to the L.F. voltage output with a 100 per cent. modulated H.F. input. We have, therefore, a simple method of determining the detector output for a given input.

Turning now to the actual results, the curves of Fig. 2 show the change of anode current given by two different valves with various values of load resistance. Curves A and B are for the Mazda DC/HL valve with loads of 10,000 ohms and 20,000 ohms respectively, while curves C, D and E are for the Mazda L.210 with loads of 10,000 ohms, 20,000 ohms, and 40,000 ohms respectively. Now these curves as they stand are not directly useful for determining the efficiency, but they serve to indicate the optimum change of anode current to be used in practice.

D.C. Mains Valves.

The curves of Fig. 3 show the output voltage for 100 per cent. modulation for the DC/HL valve, and it will be seen that with either value of load resistance the curves are straight for input voltages up to 1.75 volts R.M.S. The 20,000 ohms coupling resistance, however, gives greater efficiency, and at the same time the standing anode current is lower, so it is obviously the better value to use. A small amount of distortion on 100 per cent. modulation is not very important, and so we can say that the whole curve up to an input of 2 volts is available. This limits the maximum unmodulated input to 1 volt R.M.S. with which the output obtainable on full modulation is 11 volts

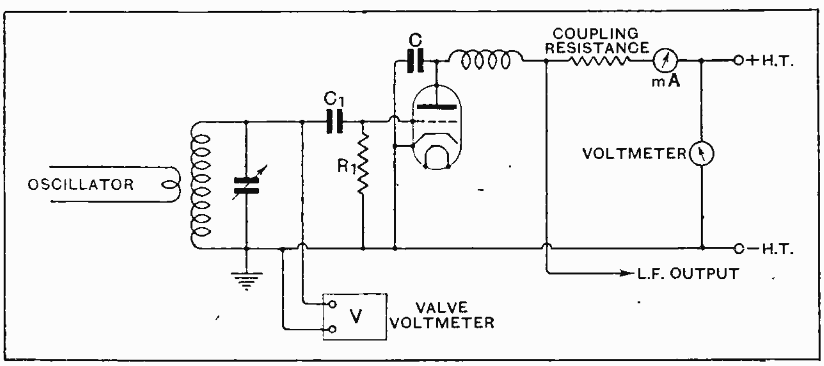


Fig. 1.—The circuit used in taking the measurements; the condenser C had a capacity of 0.001 mfd., while C_1 and R_1 were 0.0001 mfd. and 0.15 meg. respectively. The valve voltmeter was connected as shown at V.

[1] "Power Grid Detection," May 7th, 1930. "Detector Damping," July 30th, 1930.

Comparing Detector Valves.—

peak across a 20,000-ohm coupling resistance. This is sufficient fully to load many pentode output valves with resistance coupling, and it is amply sufficient to load quite a large triode when a 3-1 ratio L.F. transformer is used, since the voltage available would then be approximately 33 volts. This valve, therefore, should work very comfortably before a P.X.4 output valve, and the quality would be of a very high order indeed.

With this optimum input of 1 volt the curves of Fig. 2 show that the change of anode current is 0.55 mA., while the anode current with no applied signal is 5 mA. With the optimum input, therefore, the anode current is 4.45 mA. and the actual anode voltage is 200 – (0.00445 × 20,000) = 112 volts. Since the anode current is not large it may, if desired, be passed directly through the primary of the intervalve transformer, and the coupling resistance omitted, when the H.T. voltage need not be greater than about 125 volts to allow for the voltage drop in the winding.

In order to effect a comparison with the AC/HL type of valve some curves were taken under the same conditions as with the DC/HL. It was found, however, that they were almost identical, and so they are not reproduced here. Owing to this fortunate coincidence the data on the AC/HL published in earlier issues of this journal may be taken as applicable to the DC/HL, except, perhaps in the case of the damping of the input circuit. The D.C. mains user is now fortunate in possessing a valve which is quite as efficient as any A.C. type.

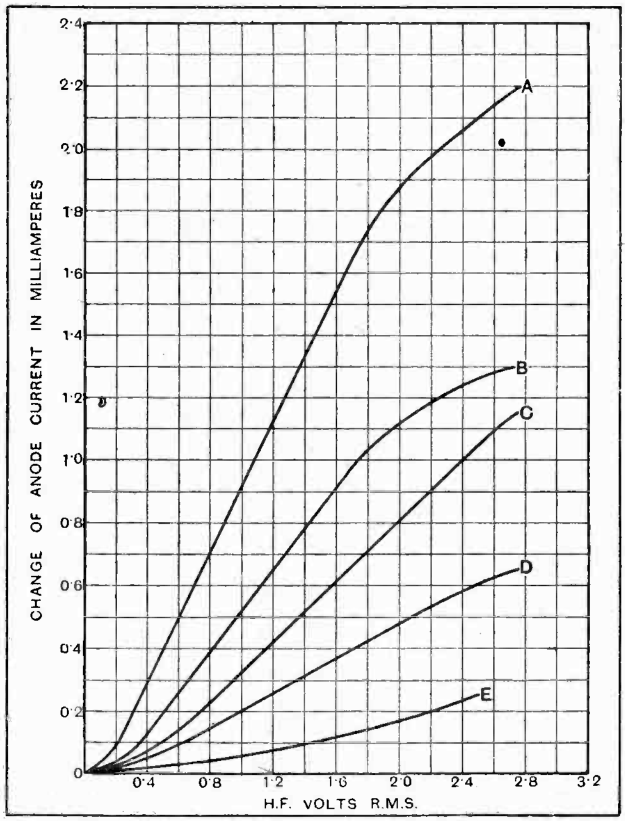


Fig. 2.—Curves A and B show the change of anode current with the DC/HL valve with anode resistances of 10,000 ohms and 20,000 ohms respectively, and curves C, D and E with the L.210 valve and anode resistances of 10,000 ohms, 20,000 ohms and 40,000 ohms respectively.

Battery Valves.

The characteristics of the Mazda L.210 battery-type valve were next investigated, and these are shown in Figs. 2 and 4 for three different values of load resistance. It will be seen that again the 20,000 ohms value is the best, and that both lower and higher values give reduced efficiency; in addition, a load of 40,000 ohms considerably increases the distortion. This valve can accept a somewhat larger input than the DC/HL and the distortion is not excessive until the input reaches 2.5 volts R.M.S., which means a maximum modulated input of 1.25 volts. From Fig. 2 it will be seen that this represents a maximum change of anode current of 0.27 mA.

With an input of 1.25 volts the output is 5.5 volts peak, which is barely sufficient to load even a small resistance-coupled pentode. With any ordinary transformer, however, it is sufficient to load any pentode output valve and many of the smaller triodes, but if it be desired to use an output valve such as the P.X.4 a transformer with a ratio of about 6-1 will be required.

It will be apparent that the output of this valve is considerably less than that of the DC/HL, while the input required is somewhat greater; the efficiency, therefore, is much less. The L.F. output volts for 100 per cent. modulation divided by the H.F. input volts gives some measure of the efficiency, and applying this to the valves under consideration, we find that the DC/HL has an efficiency of 7.78, while the figure for the L.210 is only 3.1. That is to say, the indirectly heated valve is 2.5 times as efficient as the battery type.

An examination of the static curves shows that the indirectly heated valve has a mutual conductance of nearly twice that of the battery valve, and this accounts for most of the difference. The remaining difference is probably accounted for by the grid characteristics governing the rectification. It must never be forgotten that the detector performs two actions at once: it rectifies and it amplifies. The efficiency of rectification depends upon the curvature of the grid volts-grid current curve; and it is notorious that indirectly heated valves have better grid characteristics than the battery type. The amplifying action is governed chiefly by the mutual conductance, and this also is better in the indirectly heated valves. It would be well if a range of indirectly heated valves could be made in which the current consumption were small enough for battery operation.

The Intervalve Coupling.

In all the curves which illustrate this article a resistance coupling has been used, which means that the normal anode potential is in the neighbourhood of 100 volts; with the optimum applied signal the actual working anode potential with the DC/HL is 112 volts, and with the L.210 it is 94 volts. Experience with the AC/HL valve has shown that this is a little on the low

Comparing Detector Valves.—side for the best results, and that 120-150 volts anode potential is more suitable. Higher voltages than 200 will not usually be available except where A.C. mains can

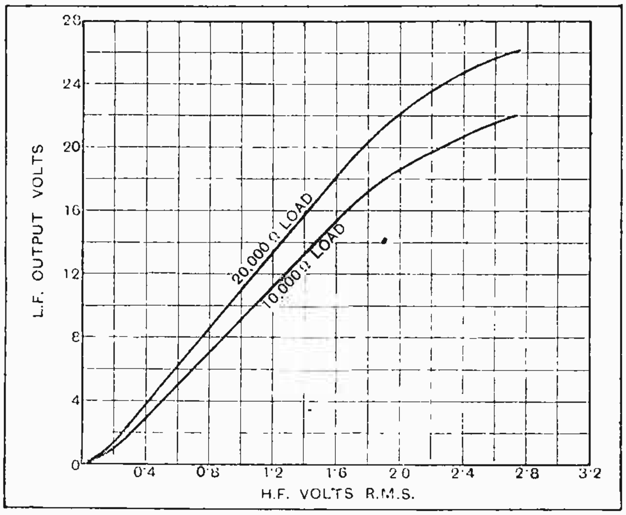


Fig. 3.—The curves show the efficiency and maximum output obtainable from the DC/HL valve with 200 volts H.T. and coupling resistances of the values marked on the curves.

be used, and advantage must be taken, therefore, of the low D.C. voltage drop across a choke, as pointed out in a recent article.[2] Unfortunately, with this method of coupling there is no simple way of deriving the dynamic characteristics of the detector. It is possible to gain some idea of the efficiency, however.

If the actual anode voltage with choke coupling is arranged to be equal to that with resistance coupling then the maximum undistorted output will be approximately the same, but the H.F. input voltage required to produce this voltage will be smaller. That is to say, the substitution of a choke or transformer coupling for the resistance has little effect on the output available, provided that the anode potential remains constant, but the efficiency of the detector is increased by a small amount.

This increase in efficiency is due to the higher L.F. amplification obtained with choke coupling, and follows exactly the same laws as in an ordinary amplifier. The L.F. amplification given by a DC/HL with a 20,000 ohms coupling resistance is 18.8 times, but with choke coupling it is 30 times. The use of choke coupling, therefore, increases the detector efficiency by 30/18.8 = 1.6 times. The same reasoning is applicable to the L.210 valve, or to any other valve, and it will be seen that in this manner it is readily possible to obtain some idea of the efficiency with choke or transformer intervalve coupling.

Practical Adjustment.

The best method of setting up a power grid detector when the dynamic characteristics are unknown is as follows: Insert a milliammeter in the valve anode circuit, and adjust the H.T. voltage until the anode current with no applied signal is equal to the maximum rated value for the choke, transformer, or resistance. Next, tune in a station which is modulating deeply, and watch the milliammeter needle carefully. As the input to the detector is increased the anode current becomes smaller, but there should be no flickering of the needle in sympathy with the modulation. It is quite probable that a small amount of flickering in a downward direction will take place, but this does not necessarily indicate distortion; any flickering in an upward direction, however, is a sure sign of distortion.

Now, if it be found that the output stage can be fully loaded with the detector milliammeter needle remaining perfectly steady, the detector can be taken as working satisfactorily, and it may even prove possible to reduce the H.T. voltage. If it be found impossible to load the output stage, however, without causing detector distortion then the H.T. voltage must be increased, and a choke or transformer with a higher current rating substituted, or a change must be made to resistance coupling and a much larger H.T. voltage. An alternative course is to substitute a transformer with a higher step-up ratio, or to add a stage of L.F. amplification between the detector and the output stage. In any normal circumstances, however, there should not be the least difficulty in fully loading any reasonable output stage from a power grid detector with 150 volts or so actually on the anode, and if a milliammeter be placed in the anode circuit one can keep a watchful eye upon the performance of the detector.

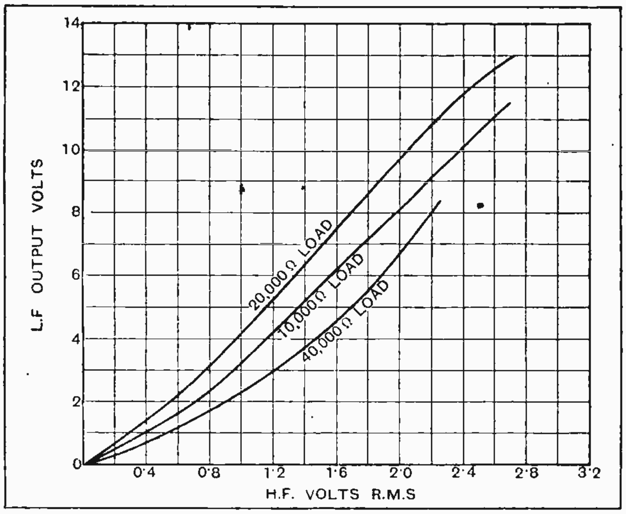


Fig. 4.—The effect of varying the anode resistance with the L.210 valve can be clearly seen, and the distortion introduced by the use of too high a value of resistance is very evident.

Although the best results are obtained when the detector is just fully loaded, it is usually found that the distortion introduced by quite a large amount of underloading is undetectable by ear, while overloading is very apparent. In designing a receiver, therefore, it is advisable to allow for a somewhat smaller output than the figures for 100 per cent. modulation which are given in this article, for any risk of overloading will then be eliminated.

[2] "Low Voltage Power Grid Detection," December 3rd, 1930.

Ormond A.C. Mains Transportable

A Compact Three-valve Transportable Weighing only 28lb.

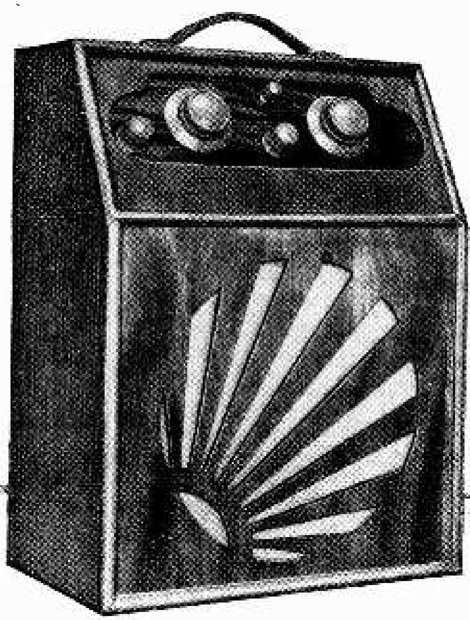
SINCE the earliest days of broadcasting Ormond products have maintained a reputation for simplicity and directness of design combined with skill in toolmaking and a high standard of quality in materials, and the new Mains Transportable, which made its début at Olympia last autumn, exhibits all the qualities which have gone to make up the reputation of Ormond components.

In general design the set resembles a popular type of battery portable, in which the loud speaker grille occupies the front panel of a vertical case, and is surmounted by a sloping control panel. But for the twin flex lead and adapter from the back of the cabinet, the set might easily be taken for a battery portable, for its dimensions are 18½in. × 14½in. × 8½in., and the weight is only 28 lb.

The appearance and general finish deserve a paragraph to themselves. The case is of highly polished walnut, and the control panel, which is actually part of the aluminium chassis, is faced with real walnut veneer wood, polished to match the case. Against this background the pale brown mottled control knobs stand out in handsome relief.

A sliding back panel gives access to the valves, the loud speaker adjustment and the variable primary tapping of the mains transformer. One side of the mains connection is completed through contact springs and a metal strip attached to the bottom edge of the sliding back panel, so that the mains current is automatically switched off as the panel is withdrawn.

The chassis unit is of compact and rigid construction, and may be withdrawn, if necessary, for servicing, by unscrewing two small cleats. The H.T. rectifier and smoothing unit is mounted on the base behind the loud speaker baffle, the H.T. connections to the receiver unit being made through suitably numbered plugs and coloured sockets attached to flexible leads. A terminal strip extending across the full width of the chassis carries, in addition to the safety contacts already mentioned, a mains "on-off" switch and sockets for an external aerial and earth. The flexible lead and plug adjacent to the aerial socket enable the aerial terminal to be connected through a small fixed condenser to one side of the mains as a means of supplementing the pick-up in the frame aerial. The latter is wound round the outside of the loud speaker baffle; the turns are spaced, and the winding as a whole is treated with varnish in order to keep the wire in place. The long-wave winding is centre-tapped, an arrangement which gives freedom from mush and instability, and improves selectivity on long waves.



SPECIFICATION.

CIRCUIT: Three stages (H.F., det., L.F.). Tuned grid H.F. coupling, grid detector, pentode output with choke-filter coupling to loud speaker. Provision for mains and outdoor aerials.

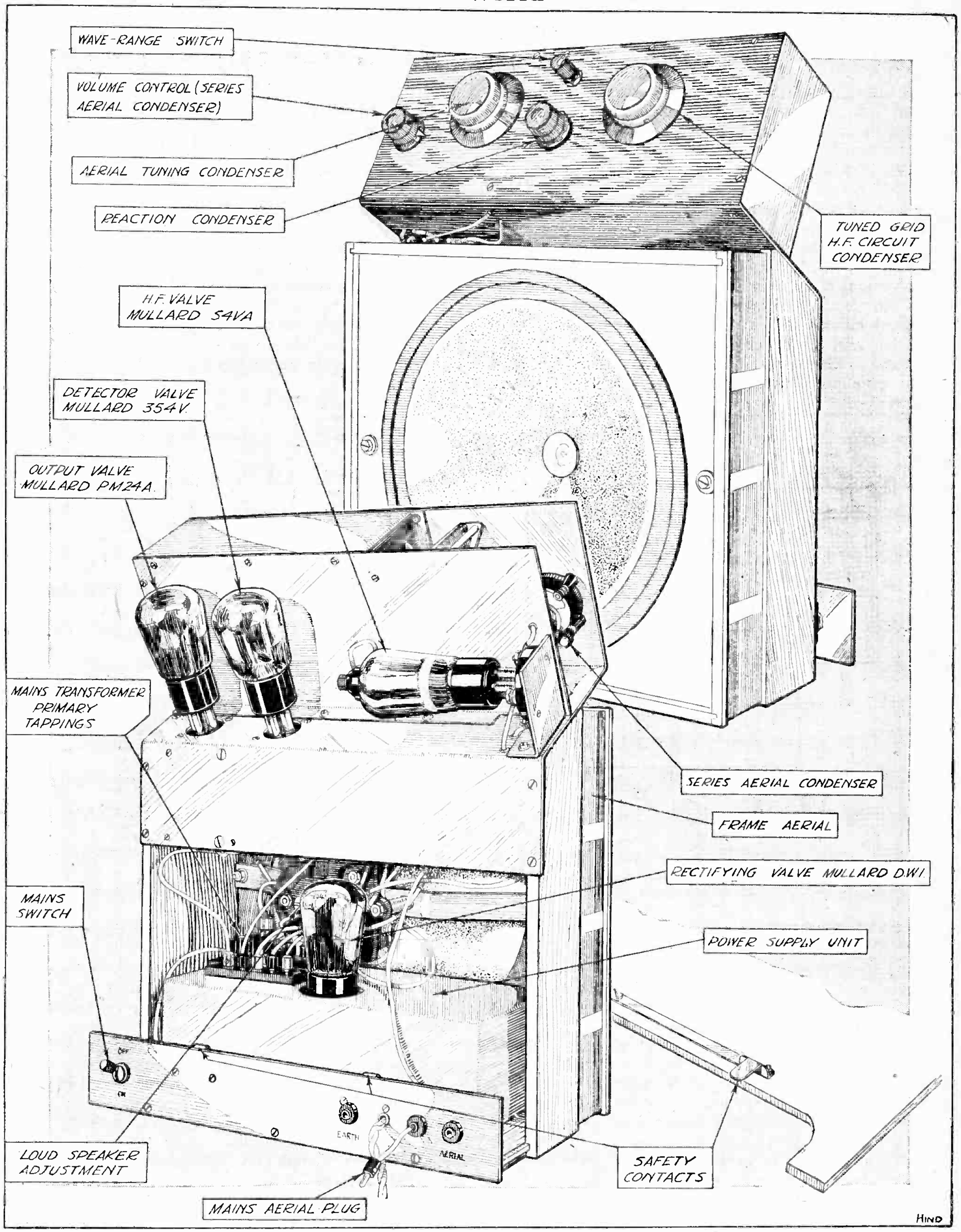
CONTROLS: Two tuning controls (aerial and H.F. circuits). Series aerial condenser (volume and selectivity). Reaction. Wave-range switch. Mains switch at back of set.

GENERAL: Dual mains plug adaptor. Safety contacts on removable back panel.

The three-valve circuit employs indirectly-heated valves in the H.F. and detector stages and a directly-heated pentode in the output stage. The detector functions as a grid rectifier with zero bias, and the negative bias for the H.F. and output valves is obtained by means of resistances in the cathode leads. It will be seen that the filament circuits of all three valves are connected to a single filament winding on the mains transformer. This is an interesting point, for the filament heaters of the first two valves are raised to a potential above earth equal to the grid bias of the last valve. This is a perfectly legitimate course for the designer to take, for in any case the bias of the indirectly-heated valves is independent of the potential of the heaters, and nowadays valves are designed to stand a much higher difference of potential between cathode and heater than is provided in this case for bias purposes in the last stage.

In other respects the circuit is straightforward, and should be easy to follow from the circuit diagram. Tuned grid coupling is used for the H.F. stage and transformer coupling for the L.F. stage, while a tapped output choke is used to feed the loud speaker. The latter is built up of a standard Ormond 4-pole unit and a shallow-angle cone which seems to give extraordinarily good results.

The power unit is in keeping with the straightforward design of the rest of the circuit, and makes use of a DW1 full-wave rectifier followed by a single stage smoothing circuit and a system of decoupling resistances for all H.T. feeds to the receiver unit with the exception



Constructional details of the Ormond Transportable chassis, showing safety contacts on the terminal strip and back panel.

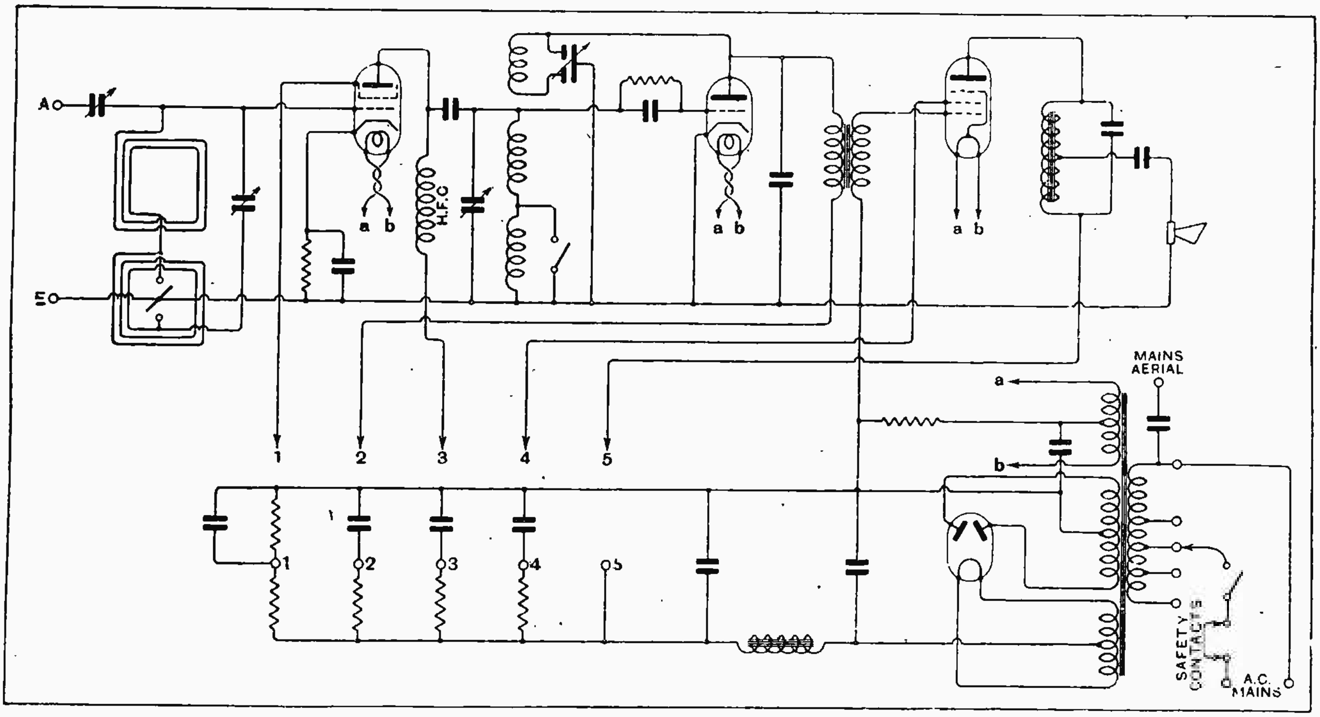
Ormond A.C. Mains Transportable.—
of the anode current supply to the pentode valve in the output stage.

It will be observed that the mains aerial connection is made through a small fixed condenser in series with the series condenser already provided for outdoor aerials. The mains aerial connection was tried, but on the particular mains used the contribution to the net result was so small that it was decided to test the set with only the frame aerials as sources of energy. Incidentally, the mains aerial connection when tried gave no additional trace of hum.

Throughout the period of the test one's attention was recurringly attracted to the brightness and clarity of reproduction. There is definitely none of the "tubbiness" frequently associated with boxed-in loud speakers. As might be expected in these circumstances speech is excellent, and the articulation of singers is in no way impaired. Pianoforte music is good, and an organ recital gave proof that the brightness of tone is not achieved at the expense of bass reproduction. Undoubtedly the clue to the excellent performance on the score of quality is the absence of any marked resonance in the lower middle register combined with a good response down to at least 100 cycles, and in the upper register to 4,000 cycles.

Following a preliminary test in London, when thirteen foreign stations were logged during the interval in the B.B.C. transmissions on Sunday evening, the set was taken to within five miles of Brookmans Park for more exacting tests as regards selectivity. Not the least difficulty was experienced at this close range in separating the twin transmitters; in fact, with the frame set at minimum and making full use of the reaction control, a sufficiently wide band was cleared between the local stations to enable two foreign stations to be enjoyed without any trace of background. In all, seven foreign stations were received on the short-wave band while the B.B.C. programmes were in progress. The majority of these were logged at the upper end of the scale, where, in contrast with the majority of sets, the sensitivity appears to be the highest.

On long waves the sensitivity is of the same order as on short, and eight foreign stations were received, Huizen, Radio Paris and Eiffel Tower being the most prominent. Reaction is a little fierce on this wave range, and the set may spontaneously burst into oscillation if the adjustment is too critical. For the majority of stations, however, close reaction is not required. It was gratifying to note that in spite of the proximity to Brookmans Park there was no tendency for either of these stations to break through at the lower end of the long-wave range.



Circuit diagram of the Ormond Mains Transportable. The power unit is connected to the receiver through five number sockets and flexible H.T. leads and a pair of leads for the filaments.

To summarise, the Ormond Mains Transportable has a bright clean performance in keeping with the interior workmanship and external appearance of the set. Two minor criticisms are possible; the one-hole fixing mains on-off switch might be further recessed in the terminal strip, as at present it tends to become loosened in transport; and a ventilating grille might with advantage be introduced in the back panel immediately behind the indirectly heated valves, which of necessity radiate considerable heat during an extended run. No inconvenience was experienced on this score during the period of the tests, but it is conceivable that after a time the back panel may become warped.

CURRENT TOPICS

Events of the Week in Brief Review.

BRITTANY NOW: BRITAIN NEXT?

The first lady announcer, or "annonciatrice," to be heard in France will shortly face the microphone of Radio-Rennes, Brittany.

OH, YEAH?

An American radio salesman inserted an advertisement: "Moving to country; will exchange electric radio for a battery set."

This brought him in the addresses of many prospective buyers of mains sets.

GET READY.

Threatening to be one of the biggest noises in the West European ether, Radio-Paris will inaugurate transmissions from the new Essarts-le-Roi plant within the next few days on a power between 85 and 120 kilowatts. Our Paris correspondent reports that the station authorities are only awaiting a Post Office permit to establish lines between the transmitter and the Paris studio.

The triangular aerial is supported by three masts, each 675 feet high.

FLORENTINE ENERGY.

Tuscany, with its many mountains, has been worrying the Italian broadcasting authorities, who have been forced to admit that the whole region has a poorer service than any other part of Italy. Not to be outdone, however, they announce that the new Florence transmitter, when it actually starts, will be second only to Rome in importance, and will be heard in every town in Europe. October 28th next will be the opening date.

THANKS IN ANTICIPATION.

The emergence of 5SW from the experimental stage is still being eagerly awaited in the Dominions. Says *The New Zealand Radio Record*:—

"A very hearty welcome will be accorded the big British short-wave broadcasting station that is contemplated, when it does come on the air. Plans are in prospect for this station to be made of outstanding character and quality. It will be quite in accordance with British tradition to be perhaps a little late in entering the field, but listeners can be assured that when the station does appear it will take first rank for service in the fields of power, quality and nature of transmission."

This anticipatory bouquet is the most encouraging item of the week.

SHORT WAVES FROM PARIS.

FYA is the call-sign of France's new Colonial short-wave station to start transmissions with the opening of the forthcoming International Exhibition in Paris. The wavelength will be 40.73 metres.

A SCIENTIFIC EXCURSION.

"A Journey into the Realms of Science," is the attractive title chosen by Mr. G. G. Blake, M.I.E.E., F.Inst.P., for the lecture and demonstration which he will give on Wednesday next, April 29th, before the Incorporated Radio Society of Great Britain.

The meeting will be held at the Institution of Electrical Engineers, Savoy Place, W.C.2, at 6.15 p.m. (tea at 5.30).

NEW YORK "RADIO CITY": DESIGN CRITICISED.

Building a radio city on "cathedral lines" is not a paying proposition, according to Hugh S. Robertson, of the engineering firm charged with the construction of New York's new broadcasting centre, a model of which was illustrated and described in *The Wireless World* of April 1st. Criticism of the design has been widespread, and, according to a correspondent, a new model is to be constructed which shall be more expressive of the spirit of radio.

Meanwhile, the demolishing of existing buildings in Fifth and Sixth Avenues has already started in preparation for the new structure. It is hoped that "Radio City," the landlord of which will be John D. Rockefeller, Jnr., will be ready by 1934.

U.S. SATED WITH RADIO LAWS.

Listeners in Britain, where the same law holds good from Land's End to John o' Groats, would smile if they were brought up against some of the hundred and one minor radio regulations obtaining in different parts of the United States. Our Washington correspondent cites, among others, the recent attempt in South Carolina to enforce a local radio tax, since held to be unconstitutional. New Jersey—another example—has a law forbidding changes in wavelengths, powers or stations unless authorised by the State Public Utilities Commission; the law is disputed by the Federal Radio Commission. The New York Legislature has a Bill providing penalties for equipping cars with short-wave sets, obviously to guard against criminals listening-in on the police wavelengths. Massachusetts imposes a sales tax on radio parts, and a stir has been created in California by a suggested receiver tax. In North Dakota a legislator proposes compelling stations to grant "time on the air" to political candidates at $10 per hour. Texas and Minnesota have Bills defining and providing punishment for slander and libel over the microphone.

RADIO *v.* GUNMEN. American police cars are now equipped with short-wave sets beneath the driver's seat. To prevent gangsters from eavesdropping a New York radio law prohibits short-wave receivers on private cars.

FACES IN THE AIR.

"Apparently skyscrapers have a habit of cutting off people's noses and ears," writes a New York correspondent, in explanation of the short-wave television tests which the National Broadcasting Company are now carrying out on top of their roof studio at the New Amsterdam Theatre. The experiments are aimed at exploring the effects of high buildings on the radiated wave, and the data are expected to be of great value when a workable television system is developed.

Above their building in Madison Avenue the Columbia Broadcasting Company, not to be outdone, are also broadcasting television. "So now," writes our correspondent, "everybody's happy, shooting funny faces all around the skyscrapers."

"WIRELESS FOR THE BLIND" FUND.

Members of all amateur radio societies are invited to the concert and dance to be given this evening (Wednesday) by the Lensbury Radio Society at 6.30 o'clock at 16, Finsbury Circus, London, E.C. Admission (including refreshments) is 1s., and the entire proceeds will be handed over to the British "Wireless for the Blind" Fund. All expenses are being borne by the Society.

ELIMINATING STATIC.

In reproducing the collection of black-and-white illustrations accompanying the article on "Eliminating Static" in our issue of March 11th last, we should have drawn attention to the fact that these vivid little pictures were taken from the interference-prevention film prepared for the German State broadcasting authorities by the "Commerzfilm" Company. We apologise for the omission.

New Output Valve

The Mazda PP5/400 Tested.

> *A NEW standard of performance has been set by the Mazda PP5/400 three-electrode power output valve. Hitherto a mutual conductance of the order of three has been considered remarkably high for a loud speaker valve. It is, therefore, of outstanding interest to find that the figure of 7 is attained in the valve under review. Not less than 5,000 milliwatts undistorted output are developed for a grid swing (peak) of only about 33 volts, which shows an efficiency even greater than that of the high-voltage pentodes.*

MUCH has been heard lately of the advances made in the design of screen-grid valves, detector valves, pentodes, and others, but the greatly improved characteristics shown by present-day super-power valves of the larger type are not so widely known. One reason for this may be that the average listener could not utilise, advantageously, the output from, say, a 25-watt valve if he possessed one; the need for the reproduction of broadcast matter and gramophone selections for public entertainment in large halls rarely comes his way. But those who are concerned with this particular aspect of wireless and sound reproduction will be interested to learn of the new developments made in this direction, the Mazda PP5/400 being one of the latest additions to the large super-power valve class. It has a maximum anode dissipation of 25 watts, and will deliver some 5 watts of undistorted A.C. power to the loud speaker, or loud speakers, as the case may be.

Its rated characteristics are:—

Maximum anode volts, 400.
Filament volts, 4.
Filament current, 2 amps.
* A.C. resistance, 1,500 ohms.
* Amplification factor, 9.
* Mutual conductance, 6 mA/volt.

* Measured at 100 volts H.T. and zero grid bias.

Although we are accustomed, and, furthermore, expect, to see better general characteristics in all new valves, the mutual conductance of this particular one is exceptionally good. It has been attained by careful design of the electrodes, and in particular by reducing their spacing to the smallest possible extent compatible with rigidity. This is all the more noteworthy when it is realised that to dissipate 25 watts the anode must have a considerable area to assist rapid radiation of heat.

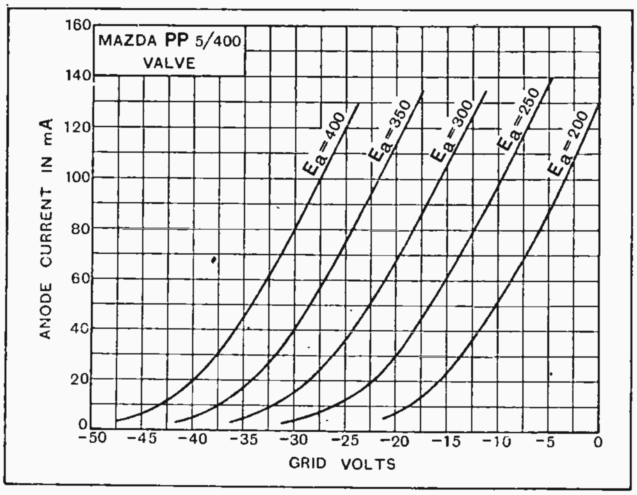
In the valve under discussion the anode takes the form of a rectangular box $2\frac{1}{8}$in. long, $1\frac{1}{4}$in. wide, and $\frac{7}{32}$in. thick. The grid and filament must be exceedingly rigid, and the whole assembly so interconnected that there is no possibility of the various electrodes changing, by the merest fraction of an inch, their relative positions. A well-devised system of supporting rods and wires definitely preclude this happening.

The filament takes the form of a double "M," with the two "M's" connected in parallel. It consumes 2 amps. at 4 volts, and may be heated with either D.C. or A.C. The value of filament potential enables the designer to build a complete set, using 4-volt valves only. Despite the generous size of the electrodes, it has been found possible to accommodate them in a

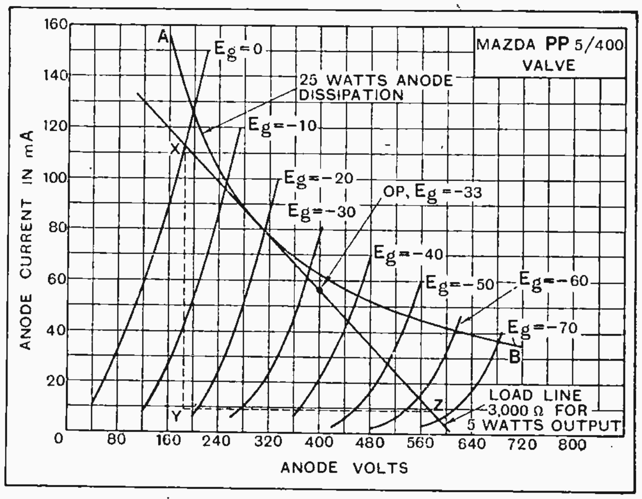
Type.	Filament.		At zero grid bias and 100 volts H.T.			A.	B.	C.	D.	G.	Price.
	Volts.	Amps.	A.C. Resistance (ohms).	Amplification Factor.	Mutual Conductance (mA/volt).	Max. Anode Volts.	Grid Bias (for A).	Average Anode Current (for A and B) (mA).	Max. Undistorted Output (for A, B and C) (milliwatts).	Optimum Load (for D) ohms.	
Mazda PP5/400	4	2	1,500	9	6	400	32 A.C. heating	60	5,000	3,000	30s.

This table is on the lines of *The Wireless World* Valve Data Sheet (November 26th, 1930), and gives the characteristics of the valve under the conditions now generally adopted by valve manufacturers for three-electrode valves; i.e., 100 volts H.T. and zero grid bias.

New Output Valve.—
bulb only slightly larger than that used for the average A.C. indirectly heated valve; the overall dimensions of the valve being 6in. high and 2½in. diameter. When dissipating its full wattage, the outside of the bulb becomes too hot for comfortable handling; consequently 3,000 ohms and an undistorted A.C. power output of 5 watts. The optimum grid bias to meet these conditions is −33 volts. If the filament is heated by D.C., the grid bias can be reduced to −30 volts, but it is doubtful if this condition will obtain in any but very rare cases, as the cost of current would be high.



Grid voltage-anode current curves from which the mutual conductance can be derived.

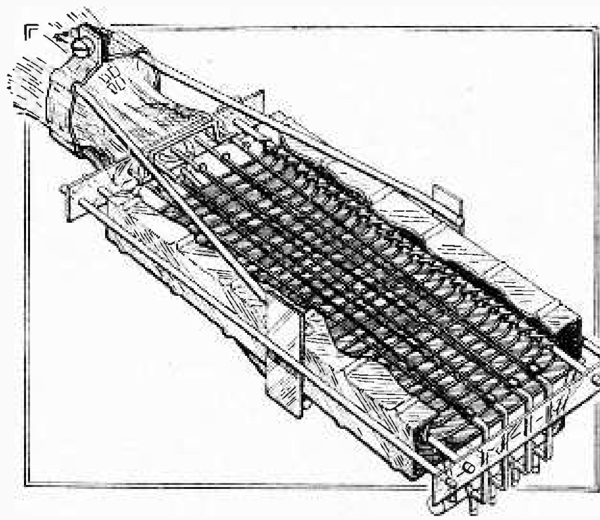


Anode current-anode voltage curves. The 25-watt characteristic is shown, above which the optimum load line must not fall. The power output is seen to be about 5 watts for a load of some 3,000 ohms.

it would be well to provide ample ventilation, should the valve be enclosed in a screened case; furthermore, it is important to mount the valve vertically.

The first set of curves prepared were the familiar anode current-grid volts variety for several selected values of anode voltage. These do not convey much useful information, apart from giving, at a glance, a general idea of the slope characteristic or mutual conductance of the valve. A far more informative set of curves is that connecting anode volts and anode current for equal increments of grid bias up to double the normal working value, and with anode voltages up to about one and a half times the maximum working potential.

Those reproduced here were taken with the filament heated by raw A.C., and with the grid circuit returned to a centre tap on the filament transformer. On the graph has been drawn the 25-watt anode dissipation line AB, beyond which it is, normally, not advisable to operate the valve, otherwise its life may be curtailed.



The electrode assembly of the PP5/400 showing the rigid mounting of the component parts.

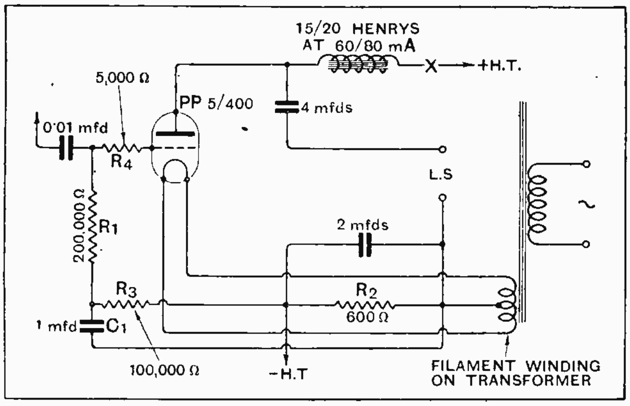
With this as a limiting factor, the best load line we could obtain, allowing 5 per cent. second harmonic, was that shown by XZ, giving a load resistance of about

Since the A.C. condition will be the more widely used, it follows that the grid bias will be derived from some point on the H.T. supply circuit, being what is commonly known as the "free" variety. It would be more accurate to describe it as "self grid bias" if it is obtained from the voltage drop in a resistance due to the passage of its own anode current; the conditions are shown in the small theoretical diagram. Here the resistance R_2 connected between the centre tap of the filament winding on the mains transformer and the H.T. negative busbar passes the anode current associated with the last valve only, and the voltage dropped across it is, therefore, entirely independent of any changes that may take place in the other stages of the set or amplifier. This is by far and away the best arrangement, and should be adopted to the exclusion of all other methods.

In the case of the PP5/400 a resistance of 600 ohms is about the right value for the average specimen; this gives −33 volts bias when 55 mA. flow in the anode circuit. With 400 volts H.T. the anode current must not be allowed to exceed 63 mA., which is the maximum for 25 watts anode dissipation. Although the valve has a big factor

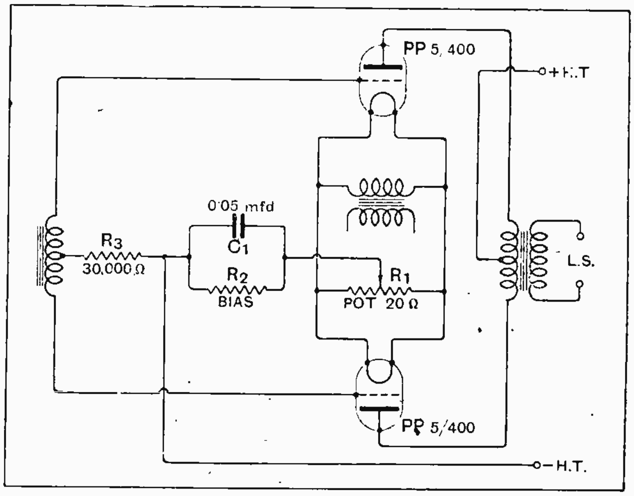
New Output Valve.—
of safety, its life is likely to be curtailed if it is overrun, so that it would be well to check the working conditions by inserting a milliammeter in the anode circuit, at the point marked X, and note the value of the anode current flowing. If much in excess of the safe maximum amount, check the value of the resistance R_2, and measure the filament A.C. volts on load, since these are most likely to be the responsible factors. The same advice applies if the current is much below the rated amount.

Resistance-capacity coupling is shown in the diagram as the coupling medium between the penultimate valve and output stage, as it is believed that a voltage step-up will not be necessary in view of the comparatively high amplification factor of the valve. Under the operating conditions cited above this was found, by measurement, to be 9, and the A.C. resistance 1,280 ohms; the mutual conductance attained the remarkable figure of 7 mA. per volt. It will be seen that a 2-mfd. condenser is shunted across the 600-ohm bias resistance



Showing a suitable circuit when resistance-capacity coupling is used before the PP5/400. Note the low value of the grid leak and the 5,000 ohm grid resistance to prevent parasitic H.F. oscillations.

and that the grid circuit is decoupled with a resistance of 100,000 ohms and a capacity of 1 mfd. It is advisable to keep the external grid-filament resistance low in value; R_1—the grid leak—has, therefore, been given



Two PP5/400 valves in push-pull. In this case the anti-oscillation resistance should be about 30,000 ohms and the grid bias resistance need not be shunted with a condenser greater in value than 0.05 mfd.

a value of 200,000 ohms. If two valves are used in push-pull, the circuit of the accompanying diagram should be employed. A large by-pass condenser across the bias resistance in this case is unnecessary, since the low-frequency currents of the valves neutralise each other, but it is desirable to include a small condenser of, say, 0.05 mfd. Decoupling, for the grid circuit is unnecessary with push-pull.

Owing to the extremely high mutual conductance of the valve, parasitic H.F. oscillations at 3 to 5 metres may be set up owing to standing waves being generated on short wires, especially where the wiring is symmetrical. Such oscillations, which will adversely affect quality, are combated in the case of a single valve by a grid resistance not exceeding 5,000 ohms, and in the case of push-pull by a resistance of about 30,000 ohms (see circuit diagrams).

The makers are to be congratulated on designing a valve with three electrodes, the efficiency of which is about 6 milliwatts undistorted output per volt squared grid swing—a figure which compares favourably with the high-voltage pentodes.

TRANSMITTERS' NOTES.

Two-way Working with Japan.

On Sunday, April 12th, Mr. F. R. Neill, GI5NJ, of Belfast, was in communication for nearly an hour with J.1EE, Mr. K. Nakagawa, Tokyo, on about 20 metres. Signals at both ends were reported as very satisfactory. Mr. Neill was using an input of 75 watts, and his final valve was an Osram DET 1SW, crystal controlled. This is believed to be the first two-way working between amateurs in Ireland and Japan, though Mr. H. L. O'Heffernan, G5BY, worked with J.1AW from his station near Croydon about two years ago.

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R.S.G.B. Competition.

The annual 3-watt contest for the "Blank Trophy" has been won by QRP, Group 8B, which covered 9,220 miles with approximately 3 watts input for each member, after a keen contest with Group 8A, which covered 7,600 miles with approximately 2.7 watts. The trophy consists of an Irish shillelagh, and is awarded to the low-power group of the Contact Bureau, which does the best long-distance work during the year. The maximum input allowed is 3 watts, and the six best claims of each group are totalled up. The winners comprise G2VV, G2OA, G5JF, G6SO, G5CM, and 2ANJ, and, in the contest, they made contact with Finland, Iraq, Canary Islands, and Roumania. Group A, comprising G5RV, G6MB, G2WP, G6LF, G5VB and 2ABS, worked with Russia, Finland, Hungary, Latvia, Poland, and French Morocco.

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South African Amateurs.

The South African Radio Relay League, which embraces the whole of the amateur transmitters in South Africa, including Kenya, Uganda and Tanganyika, held their annual conference in Cape Town on April 4th, which was attended by delegates from all parts of the southern continent.

His Excellency the Governor-General consented to accept the presidency of the S.A.R.R.L. for the ensuing year, and presided at the opening ceremony. The proceedings were broadcast through the short-wave station of Mr. H. Reider, ZS1P, on a wavelength of 42.5 metres.

Broadcast Brevities

Mr. Noel Ashbridge (standing), the Chief Engineer of the B.B.C. "snapped" at Moorside Edge while conversing with Mr. Edward Liveing, the Northern Regional Director.

Afternoon Tests from Moorside Edge.—Vanishing Relays.—Greenwich Time Signal Attacked.

Prime Minister to Broadcast.

The Prime Minister, Mr. Ramsay MacDonald, will give an Empire Day broadcast from the National transmitters on May 23rd.

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Attacking the Time Signal.

Even a wife-beater or murderer is not without a spark of decency if he can think of something nasty to say of the B.B.C.'s death tick interval signal, but I confess that I can find nothing admirable in the man who is urging the abolition of the Greenwich time signal.

In writing to the B.B.C., this correspondent describes the signal as "an irritating little noise" which, he suggests, could easily be dispensed with.

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Pleasing Everybody.

This is rank heresy. The time signal is the one item that unites highbrows and lowbrows. It is the one item that gives offence to none while meeting the needs of the largest multitude. Unlike the news bulletin, it lets bygones be bygones, and, unlike the weather forecast, it dashes no hopes.

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A Vanished Excuse.

The provision of exact time was one of the first services rendered by broadcasting, and the result has been a change for the better in the habits of the nation. It is now the exception rather than the rule to find public clocks at variance, and even household clocks now show a leaning to correctness. That no one can excuse himself for unpunctuality on the score that his watch is wrong is the only complaint that can be brought against the broadcasting of Greenwich time.

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Is the Piano Interlude Going?

Reverting to the question of the interval signal I notice a disturbing tendency to lengthen the "turns" of this ghoulish night-walker, with a corresponding drop in the number of piano interludes. There is no excuse for this, because a pianoforte accompanist is generally to be found at Savoy Hill at all reasonable times.

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The Accompanists Staff.

Actually there are three members of the accompanists staff—Miss Cecil Dixon, Ernest Lush and Berkeley Mason—all of whom have a large repertoire of "impromptu" pieces and a ready skill in extemporising at a moment's notice.

The Fifty Per Cent.

Whether or not the programme branch of the B.B.C. has mastered the art of pleasing the public, there can be no doubt that the technical people have gauged the popular temper very neatly. By their manner of introducing Northern Regional, they have gained many friends at the outset, as may be judged from the fact that of the thousands of letters received concerning the initial tests, more than 50 per cent. contain unqualified praise.

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Courteous Correspondents.

Grumblers, of course, have signified their disapproval in the usual manner, but it is noteworthy that the majority of persons who have objections to lodge seem more anxious to obtain advice than to vilify the B.B.C.

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Northern Regional: the Next Step.

I understand that the next phase in the experiments will begin in a week or two with afternoon transmissions, probably between 4 and 5.15 p.m., when Slaithwaite will "take over" from Manchester for the light music which usually precedes the "Children's Hour." The late dance music on three nights a week will also be undertaken by the new transmitter, which on other evenings will provide "sextet" music for an hour after the customary close down at 11 o'clock.

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Farewell to the Relays.

Despite warnings extending over at least two years, there seems to be some genuine surprise over the imminent closing down of the relay stations in the Northern region. The affected stations are those at Sheffield, Hull, Liverpool, and Stoke, which, I am officially told, will for ever hold their peace when Northern Regional begins regular functioning during normal programme hours.

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A Listener in Huddersfield.

"Give me a candid report on your reception of Moorside Edge," was a question I put to a friend living in Huddersfield, whose collection of receivers has struck envy in more than one Yorkshire heart. After many laborious nights he has complied.

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A Candid Report.

"The quality of reception from Moorside Edge has been a revelation," he writes. "There is an atmosphere of realism which is lacking when the programme comes from Manchester (usually interfered with by foreign stations) or Midland Regional (which fades)."

He expresses joy that a really powerful signal is sounding the death knell to several forms of local electrical interference, and adds that "the general impression is that the job of 'cutting out' Moorside Edge is not so bad as was expected."

A popular transportable with two S.G. stages deals very satisfactorily with Northern Regional, but, as in London, experience will no doubt show the need for a more extensive adoption of pre-H.F. band-pass tuning.

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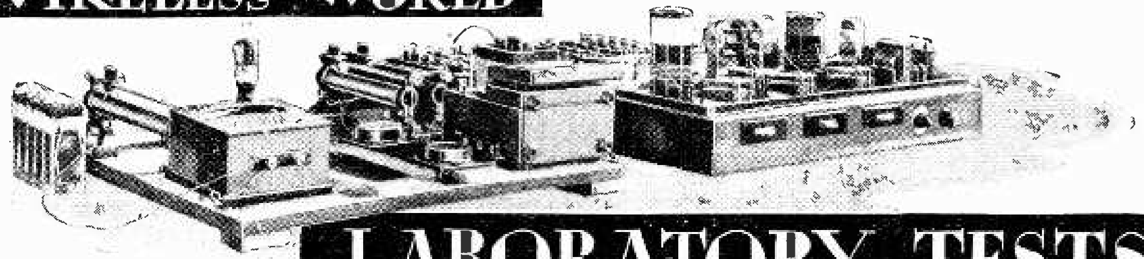
The Prince at the Microphone.

The Prince of Wales will lose little time in renewing his acquaintance with the British microphone on his return from his Argentine tour. His Royal Highness will speak as the guest of honour of the Clothworkers' Company at their dinner on May 27th in Clothworkers' Hall, Mincing Lane, and the speech will be broadcast.

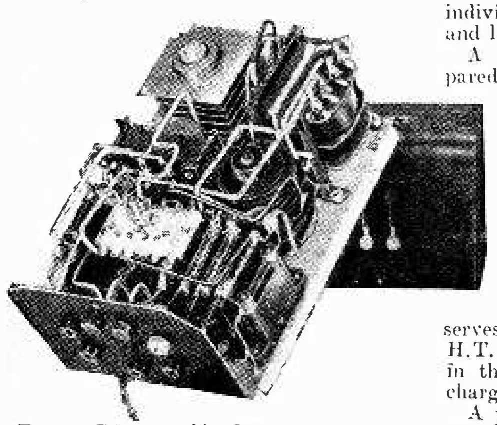
WIRELESS WORLD LABORATORY TESTS



A Review of Manufacturers' Recent Products.

TANNOY MODEL GB1 COMBINED POWER UNIT.

This is one of the most compact, comprehensive A.C. power units we have examined so far. Within the small space of 8¼in. × 5¼in. × 4½in. has been packed all the essential equipment to provide H.T. grid bias and an L.T. trickle charger. Despite this, efficiency has not been sacrificed, as the equipment is not skimped in any form. The smoothing is adequate for the purpose for which the unit is intended. Power is available for three- and four-valve sets whose total current demands do not exceed some 20 mA. in all.



Tannoy G.B.1 combined power unit with cover removed, showing the neat layout of the components.

Three H.T. tappings are provided, one for the power valve, one for the detector stage, and one to supply voltage to the screen grid in S.G. H.F. valves. Grid bias is available in three voltages, giving approximately 1.5 volts, 3 to 4 volts and 10 volts negative respectively. The grid bias voltages are entirely independent of the H.T. load, and are obtained in a very ingenious manner.

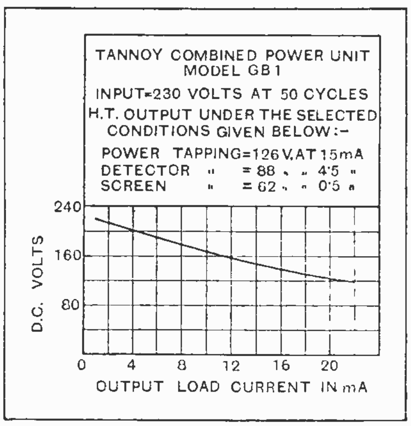
When not used to supply H.T. and G.B. to the receiver, the unit can be employed as a trickle charger, measurements showing that it will charge a six-volt battery at 0.14 amp.; a four-volt battery at 0.24 amp., and a two-volt cell at 0.35 amp.

A Westinghouse full-wave rectifier, in conjunction with a voltage doubling circuit, is adopted, and the intermediate voltages are derived from a potential divider, and, although each tapping has its own by-pass condenser, it would be well to include some decoupling resistances in the set as a precaution against L.F. instability. As a matter of interest this has been guarded against quite effectively by incorporating in the unit an anti-"motor-boating" device to offset any detrimental effects introduced by the common resistance of the potential divider. Furthermore, the grid bias tappings are individually decoupled by high resistances and large condensers.

A voltage regulation curve was prepared of the output from the "power" tapping but without current being taken from the intermediate tappings. This is shown on the graph.

Before connecting the unit to the supply mains, the small wander plug, located underneath the base, must be inserted into the appropriate socket having regard to the voltage of the mains. The switch on the top of the case serves a three-fold purpose; it switches on H.T. and G.B., switches off the unit, and, in the third position, brings the trickle charger into use.

A practical test, using a 1-v-1 receiver with a pentode output valve, proved the unit to be entirely satisfactory; there was no noticeable hum. If a separate grid bias battery was used the set was inclined to "motor-boat," but this can be remedied by inserting a 5,000 ohm. resistance in the auxiliary grid lead to the pentode with a 2 mfd. condenser connected from the valve terminal to earth. This trouble did not arise when a power triode was used in the output position. The unit is housed in a well-ventilated metal case and complies with the I.E.E. regulations. The makers are Tannoy Products, 1-7, Dalston Street, W. Norwood, London, S.E.27, and the price is £4 15s.



Voltage regulation curve taken at the power supply socket but without current being drawn from the intermediate tappings.

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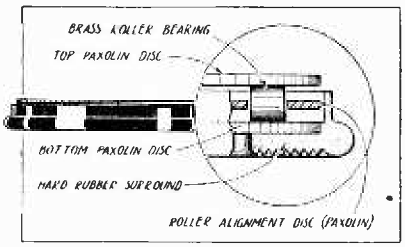
NON-METAL TURNTABLE.

It is felt in some quarters that a turntable for attachment to portable and transportable sets made of non-metallic material might possess certain advantages, the principle of these being the avoidance of damping of the frame aerial should the turntable be mounted in close juxtaposition to the wires.



British Radiophone paxolin and rubber roller-bearing turntable.

The British Radiophone, Ltd., Aldwych House, Aldwych, London, W.C.2, has recently placed on the market a roller-bearing turntable in which paxolin forms the predominating material, the only metal used being for the small rollers. To the lower disc is fixed a circumferential ring of hard rubber, which serves definitely to position the set and, in addition, protects any polished surface on which it is placed.

The price of the turntable is 3s.

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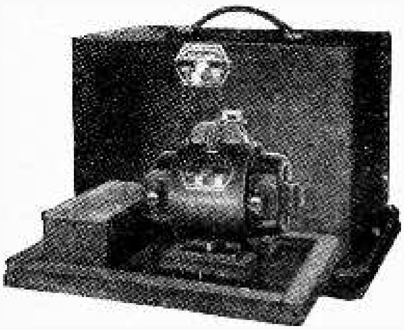
A.C. FROM D.C.

The problem of converting a direct current into an alternating current has occupied the attention of engineers for long past, and now the ever-increasing popularity of the All-A.C. receivers has led to a demand for small-power machines capable of making this conversion without introducing electrical interference.

The rotary transformers made by the Electro-Dynamic Construction Co., Ltd., Devonshire Grove, London, S.E.15, have been developed after much patient research into the nature of the interference brought about by this electrical conversion, and a recent test made by us confirms, in every way, the claims made by the manufacturers. Nothing would be more responsive to electrical interference than a receiver with very high H.F. amplification, and with some misgivings we first made a test using a nine-valve A.C. super-heterodyne receiver. The rotary converter—a 200-volt-amp. model in a screened portable sound-proof cabinet



E.D.C. Co.'s rotary converter removed from its sound-proof cabinet. Note the filter unit on the left.

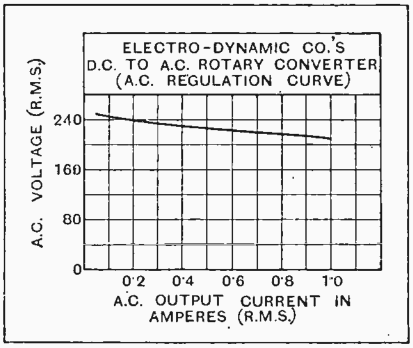
—proved entirely satisfactory, the background noises being no greater than when the set was connected to the A.C. supply mains.

No special precautions were taken to prevent interference; on the contrary, trouble was courted by placing the machine within a few feet of the set. It was not even necessary to earth the metal container. The mechanical noises were so slight that with the loud speaker in action they were absolutely inaudible. With the receiver detuned, only a faint hum could be heard which, if the machine was housed in a cupboard or a large wooden cabinet, could be eliminated entirely.

This absence of mechanical noise is achieved by mounting the converter on sponge rubber and bedding down the metal cover of the sound-proof case on to sponge rubber also. Vibration has been eliminated, so far as it is necessary, by mechanically balancing the armature. On full load the heat generated is not sufficient to raise noticeably the temperature of the air inside the cabinet.

The brush gear is very robust and will give long service without attention. The machine bearings are packed with wool yarn and should be lubricated every few weeks; but for this they require no attention.

The absence of electrical interference is due largely to the special filter units developed by the makers, and it is essential to obtain the correct unit for the machine that is to be used. They are not necessary where the converters are used to operate gramophone amplifiers only, and

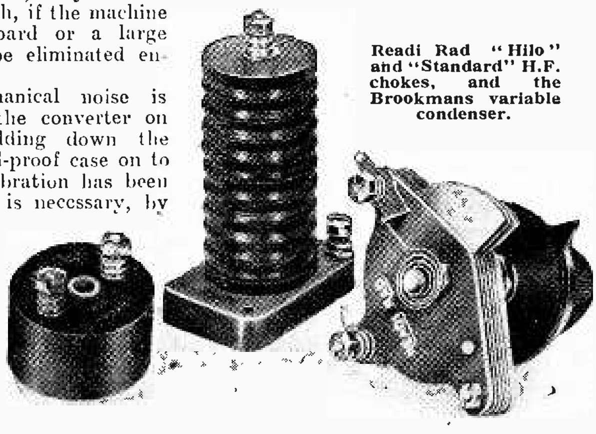


Regulation curve of the A.C. output from the Electro Dynamic Construction Co.'s 200-watt rotary converter.

for this reason are not built integral with the machines.

Some measurements were made of the A.C. voltage on load, and these are shown in the form of a regulation curve. The efficiency of the conversion depends on the loading of the machine, the greatest efficiency being obtained at full load. Under these conditions the A.C. voltage approaches nearest to the rated value. On full load the output watts were 60 per cent. of the input watts, in the case of the machine tested, while on half load, i.e., 100 watts, it fell to 50 per cent. At 50 watts output the efficiency was a shade over 30 per cent.

The price of the complete equipment as illustrated, which includes 200-watt converter, filter unit and portable sound-proof cabinet, finished in black crystalline enamel, is £21; the machine only costs £16 15s. There are in all nine sizes listed, ranging from 40-50 watts to 600 watts output, the prices of the machines only being £10 for the first-mentioned and £28 for the last-mentioned size.



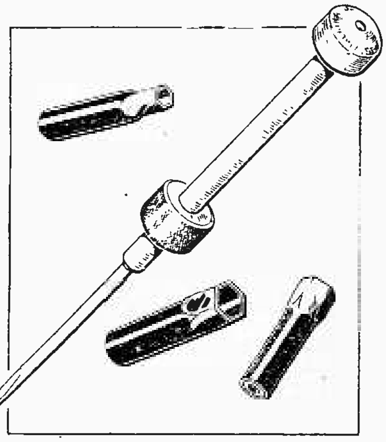
Readi Rad "Hilo" and "Standard" H.F. chokes, and the Brookmans variable condenser.

READI RAD COMPONENTS.

Of the many small components sent in for test by the Ready Radio, 159, Borough High Street, London Bridge, London, S.E.1, only a few can be dealt with in this review. A test was made on the "Hilo" H.F. choke, a sectional wound component claimed to have an effective range of from 10 to 2,000 metres and priced at 4s. 6d. When shunted with a capacity of 10 micro-mfds., representative of the valve capacity, its holder and wiring, the resonant wavelength of the choke was found to be 1,640 metres. Below this wavelength reaction control will be normal, but above the resonant wavelength a little difficulty may be experienced in achieving smooth control.

A cheaper model, officially known as the Standard pattern and selling at 2s., was found to resonate at 940 metres when tested under the same conditions as above. There is a range of small variable condensers, designated the Brookmans. These have paxolin dielectric and are made in four capacities—0.0001 mfd., priced at 2s. 6d.; 0.0003 mfd., 0.0005 mfd., and 0.00075 mfd., the price being 3s. 6d. in each case. A sample 0.0005 mfd. was tested, its minimum capacity being 12 micro-mfds., and its maximum 0.000333 mfd.

This firm has recently been appointed distributors of the Atalanta screw-driver,



Atalanta combination screwdriver and box spanner.

a combination tool which can be converted into a box spanner by fitting suitable attachments to the blade of the screw-driver. These are made to take 2, 4 and 6 BA nuts, and the price complete is 3s.

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CATALOGUES RECEIVED.

Next season's programme has already been announced by Graham Amplion, Ltd., of 26, Savile Row, London, W.1. New loud speakers produced by this firm include a permanent magnet moving coil instrument which is sold as a chassis unit, complete with step-down transformer, at 67s. 6d. The Amplion range of receivers is to include a self-contained A.C. mains transportable set.

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An artistic descriptive and illustrated brochure dealing with the new Ferranti radio-gramophone, which embodies a four-stage receiver with L.S.5A valves in the output position.

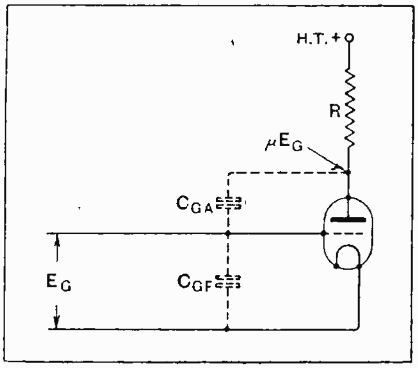
Modern Terms Defined

A Concise Summary of Recent Developments in Receiver Design.

(*Continued from page 411 of previous issue.*)

Input Impedance.—A general term covering all the complex electrical properties of the grid-to-filament path in a thermionic valve. The input impedance exhibits the properties both of a resistance and a capacity, and is capable of seriously modifying the preceding circuit to which the grid and filament of the valve are connected. In low-frequency amplifiers the capacity component is of greatest importance, while under high-frequency conditions both capacity and resistance must be taken into account. The resistance component has the effect of damping the tuned circuit of the valve, so reducing its effective selectivity, while the capacity component must be taken into account if ganged tuning is employed.

Working Capacity.—The effective grid-to-filament capacity of a valve under working conditions as an amplifier may be many times greater than electrostatic



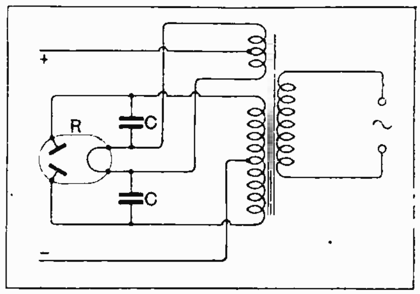
Explaining the increase of input capacity of a valve under working conditions.

capacity (C_{gf}) measured with the filament cold. This is due to the presence of the grid-to-anode capacity (C_{ga}) through which fluctuations of voltage at the anode of the valve are communicated to the grid of the valve. It follows, therefore, that the increase of input capacity can take place only when there is a load in the anode circuit, for with R omitted and the anode connected directly to the steady H.T. battery voltage, no change in the potential of the anode would result from variations in the input voltage (E_g). Under working conditions R would be large compared with the resistance of the valve, and the full amplification of the valve (μ) would be obtained. Thus an applied grid voltage of E_g would result in the development of an anode voltage of $\mu \times E_g$. It is important to realise that as the grid voltage is increased the anode voltage decreases. (Increasing the grid potential causes an increase in the anode current and a greater fall of potential across R. There is consequently a small fraction of the full H.T. voltage available at the anode.) The significance of this in relation to the input capacity is as follows: In addition to the charging current drawn from E_g by C_{gf} there is also that due to C_{ga} which is being rapidly depleted by the large fall in potential of the anode (μE_g). Thus the effective capacity of the input as measured by the difficulty of charging up the combined valve capacities C_{gf} and C_{ga} under working conditions is obviously much greater than C_{gf} alone. It can be shown that the working capacity is equal to $C_{gf}+(\mu+1)C_{ga}$, where μ is the *effective* amplification of the valve under working conditions.

Shot Effect.—The emission of electrons from the hot surface of a valve filament is a discontinuous process, and although the average emission may be constant, the emission at any instant may be regarded as consisting of a series of electrons or group of electrons which are shot across the intervening space between filament and anode. It is this shot effect which gives rise to the well-known breathing noise in multi-stage H.F. amplifiers, and sets a limit to the minimum signal voltage which can be usefully amplified.

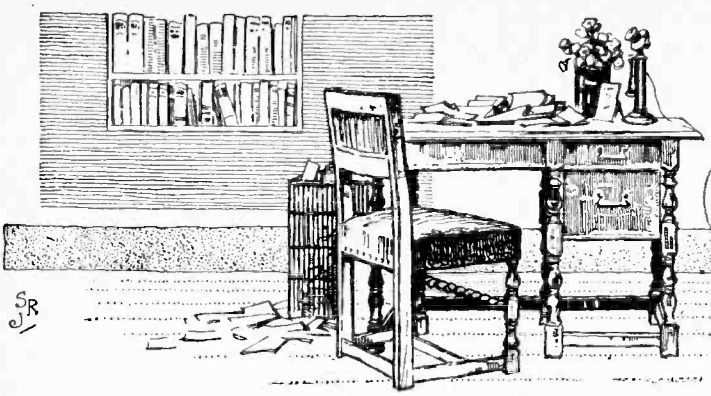
Parasitic Oscillation.—The performance of receivers and amplifiers is sometimes seriously affected by local self-oscillation of an obscure character which does not make itself apparent by the usual heterodyne whistle associated with oscillation in the tuned H.F. circuits of the receiver. In general, parasitic oscillation takes place at a frequency outside the limits of audibility, and its presence is first manifested by a mysterious reduction of overall amplification, distortion, or a reduction in the life of valves.

It has recently come to light that oscillations of very short wavelength can establish themselves in the output stage of a receiver, particularly when valves of large power-handling capacity are used. The effect is even more marked when a symmetrical push-pull circuit is employed, and unless steps are taken to suppress the parasitic oscillations there is a danger that the valves will be seriously overrun and their life reduced to a few weeks.



Parasitic oscillations may occur in valve H.T. rectifier units. A cure is effected by connecting condensers (C) between each anode of the valve (R) and the filament.

Another instance of parasitic oscillation is to be found in the power rectifier unit of an A.C. mains receiver. Where a valve rectifier is employed, it is not an uncommon experience to find that high-frequency currents are generated during the process of rectification. These currents find their way into the H.F. and detector stages of the set, and, being modulated at 50 or 100 cycles by the superimposed mains current, provide a troublesome source of hum which is not suppressed by the usual L.F. smoothing circuits. Condensers of low H.F. resistance having a capacity of, say, 0.01 mfd., effectively cure the trouble if connected as shown. (*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.

LONG WAVES.

Sir,—You have opened up again the question of twin long-wave stations. I think another long-wave station would be far more useful than the other medium-wave stations. The long-wave transmitter is the only station audible, I understand, in the *daytime* in Cornwall or distant parts of England on any type of commercial set, and is pleasant to listen to on any good portable receiver. The long-wave transmitter at Daventry definitely serves a bigger area than any of the other medium-wave stations which at a distance are inaudible until after dark, and an alternative programme would be appreciated by many.

CHAS. W. JENNINGS.
G6JG.

MODERNISE 5XX.

Sir,—I agree with the attitude of Mr. N. C. Baker in his letter in the issue of March 18th with regard to the modernising of 5XX.

I remember when my set was an unselective tuned anode with one resistance and one choke coupled stage. How often I gave my friends a surprise by demonstrating the great difference in quality between the then new Daventry 5XX and our much older local (even though we *were* proud of our pioneer relay station).

In these days of high-voltage output valves, push-pull improvements and almost perfect moving-coil performance, comparison is easy, and, in my humble opinion, 5XX could do with a good "dusting." "QUALITY FIRST."

Sheffield.

THE BELL TELEPHONE.

Sir,—The article by Mr. John Harmon on "Tone and Volume Control of Gramophone Pick-ups," in your last issue, commences with a reference to the early use of the original Graham Bell telephone.

It may interest some of your subscribers to read that I have in my possession the remains of a pair of telephones manufactured at about the period referred to in the said article, and which telephones were stated to be examples of the original Bell type.

Each of these unwieldy articles had to be capable of performing the dual offices of transmitter and receiver by the awkward process of being moved from mouth to ear and vice versa. This fact naturally necessitated pauses in a conversation between two persons, or to allow time for the movements named to be accomplished.

Each telephone is externally composed of varnished or polished wood, and has an overall length of $6\frac{1}{4}$in. The thin metal, and originally lacquered diaphragm, $2\frac{1}{2}$in. in diameter, is clamped by screw-pressure between two divisible halves of the mouthpiece, and the magnet consists of a single rod, $\frac{3}{8}$in. in diameter, within a bobbin wound with very fine wire. The last-named appears to be insulated by means of what looks like thin cotton.

I distinctly remember, as a boy, "listening in" with one of these identical telephones, and of being considerably astonished at hearing sounds with the same, which were otherwise quite inaudible. The distance over which these sound effects were carried could, as a matter of fact, be most easily measured in yards. A. GADD.

Manchester.

IDENTIFYING SIGNALS.

Sir,—There have been many suggestions published with regard to the *identification* of wireless transmitting stations, but, so far as I am aware, the following simple suggestion has never been put forward.

That a suitable simple standard identification signal should be chosen by the International Board. That a schedule should be drawn up and published of transmissions of this signal showing the station and time of transmission, and, if there is any unavoidable departure from the schedule, it should be published officially subsequently.

The standard identification signal would necessarily be different from any now in use.

The idea underlying this suggestion is simply this: That each night after closing down two or three different stations should transmit the signal for 15 minutes to enable interested listeners to tune it in and record the exact setting on their receivers. The stations chosen for each night would be stations closing down at different times, so that no confusion would arise.

If the suggestion were carried out arrangements could probably be made for every European station to transmit the signal four times a year, and, in the course of six months, not only could most transmitters be identified, but one could also learn whether the transmission is really within range of the receiver.

I would also suggest that the standard signal should be slightly stronger than the normal transmission. D. WHIT.

Birkenhead.

TALKIE TROUBLES.

Sir,—In your article, "Unbiased," in a recent issue of *The Wireless World*, you have stated that the unwanted noise in talkies was due to motor-boating in either the reproducing amplifier or the recording amplifier. It may interest you to know that it may not be either. In many pictures it is a fault of printing, or may be due to the sound-track on the film being too small and the picture too wide.

If you examine a sound-film you will see that the sound-track is a very small band down the side of the picture. Its very small width necessitates the maximum use of it, and consequently if the picture is wider than it should be it transgresses into the area set apart for sound-purposes. Suppose now that the picture contains a scene in which there is something white—a sky, a white glove or hand, a man's shirt-front, etc.—at the edge of the picture adjacent to the sound-track. This white something interposes itself between the exciter lamp and the photo-electric or selenium cell, causing an intermittent flow of light. The film is moving at a speed of 90ft. a minute, and there are sixteen pictures to the foot. **This means that there** is a flow and stop of light which result in a series of little bumps at a rate of 2,880 per minute, or forty-eight a second, which, as you can see, would sound very much like motor-boating. Again, the same effect might be caused similarly by the lines separating the pictures. This can be overcome by masking the cell to prevent the unwanted light affecting it.

It may be a point of interest to know that I have noticed that the narrow track is very marked on Radio pictures.

I hope that my dissertion has not bored you, but I think it only fair that the recording amplifiers should be cleared of the stigma that you have put upon them. After all, it is only fair to suppose that, since the currents used in the making and reproducing of sound-films are so very small, it is essential that the amplifiers should be of a very high standard and such a complaint as motor-boating nothing short of criminal.

I ought to say also that I have never even seen a recording amplifier, but I have a great deal to do with the presentation of talking pictures, and practical experience with a little deduction have led me to the above conclusions.

Maybe your friend the cinema manager may like to see my remarks on the subject.

If the effect is only noticeable on a short scene, it is not always practical to remedy it, as it may have a deleterious effect on other parts unless it is only done on that scene.

Gainsborough. J. R. THORNTON.

Sir,—I beg to draw your attention to page 344 of the issue of *The Wireless World* for April 1st, in which your contributor, "Free Grid," is apparently under a misapprehension as to the cause of a strange sound he heard during the projection of a sound film.

This sound was surely due to what is known as "sprocket-hole noise," and is caused by slight irregularities in the placing of the sprocket holes on the edge of the film. If these holes are too far towards the centre of the film, they will pass through the beam of light which is focused upon the sound track, and will produce a sound which should be at a frequency of 96 cycles for standard film.

It may be that "Free Grid" is already aware of this trouble and well able to recognise it; if so, I apologise for trying to correct him. But sprocket-hole noise is (compared with an unstable amplifier, either reproducing or recording) so common a trouble that I cannot help feeling that it was what he heard.

Dundee. E. M. ELDRED.

DATA CHARTS.

Sir,—As a keen reader of your valuable journal, I should like to express my appreciation of the usefulness of your series of "Abacs" which was published in book form some months ago.[1] I obtained a copy on its second day of publication, and have since found it to be most helpful.

In the course of constructing an accumulator-charging plant to work from 230 v. 50 cycle mains I found them to be an invaluable aid in the design of the mains transformers. Of these there were two. The first feeds a Philips type 367 F. full-wave rectifying valve, which demands 1.8 v. 8 A. for the filament and 45 v. 3 A. for each anode. The second transformer feeds a Philips type 1,701 F. valve at 1.8 v. 2.8 A. for the filament and 340 v. 0.15 A. to each anode.

On a test, under full-load working conditions, which was carried out for two hours continuously, the temperature rise of the transformers was barely perceptible by hand.

Considering that these instruments were entirely home-constructed from data collected from the "Abacs," I feel that ample proof is contained here that anyone can place their full confidence in these exceedingly useful charts. It would be interesting to learn of other readers' experiences with these charts.

Vange, Essex. W. E. THOMPSON.

WOBBLY ORGANS.

Sir,—I am in entire agreement with your contributor "Free Grid" concerning his recently published opinion of modern cinema organs. When a church organ is installed the tuner, or finisher, as he is called, goes over the instrument stop by stop, softening loud notes, and increasing the strength of others, until each individual stop sounds as a perfectly balanced musical instrument, or, as the radio fan would have it, it has a straight line response curve. Attention is paid to the steadiness of the wind supply, to ensure that a jump from *ppp* to *fff* will not set the wind reservoirs on the shake, producing an unsteady tone. The church organ has a tremolo stop, which allows the wind to escape in frequent intervals, producing a wavering tone. This stop is used with *discretion* by the average church organist; the cinema organist would seem to have it permanently in use. I can vouch for the fact that many cinema organs are very badly constructed from the tonal standpoint, owing to limitations of cost; the pipes are thrown in and tuned up without any attention being paid to the regulation of each individual stop. The result is that resonances occur throughout the range of the keyboard. There may be a resonance at, say, 300 cycles on one stop, and a resonance at 100 cycles on another. Little wonder that to "Free Grid" the net result is akin to a Scotsman playing the Haggis on the bagpipes.

ROBERT REID JONES.

INTERFERENCE.

Sir,—Your editorial, "Policing the Ether," appeals very strongly to me. Situated as I am—and there must be very many who are worse—interference from trams is so bad that reception is a farce.

Imagine transmissions conducted from an augmented fried fish shop with the sizzling and banging ranging from not too diminuendo, through staccato, to crescendo (*ad lib.*), and you have a very good idea of reception here.

To get just passable results I am tied down to a battery-driven set using triodes.

If static increases as it has done in recent years it is not improbable that the P.O. will see its wireless licence receipts diminish to vanishing point and the gramophone flourish exceedingly.

I would suggest to the P.O. that they tackle this trouble at its source—as high-power stations suffer as badly as the low-powered ones—before the B.B.C. has to shut down from lack of funds.

W. A. A. PAGE.

Norwich.

Sir,—I was considerably interested in your Editorial comment on interference caused to radio reception, and agree it is about time something definite was done.

From a business point of view it is very awkward indeed to have to demonstrate receivers, and in the middle of reception have a crashing, grinding noise inflicted on the prospect's ears, caused by trams, which seem to me the worst offenders. One realises that the trouble can be minimised by receivers using anode bend, and low-pitched speakers, etc., but the time has now arrived for the interference to be stopped by a law.

Torquay. S. FEWINGS.

VERTICAL OR HORIZONTAL DIALS.

Sir,—After reading "Free Grid's" recent contribution in *The Wireless World* (a page I always enjoy) regarding tuning dials and their attendant eye-strain, I must confess his article intrigues me somewhat.

Having spent a considerable time in the Far East, I remember once in my earlier days being foolish enough to question an educated Chinese friend upon some of the Oriental habits and customs which seem "left-handed," i.e., opposite to those of the Occident.

He asked me if nature, generally speaking, provided a good example for many of the workings of mankind, and upon my agreement, urbanely asked in which direction does the earth revolve upon its axis!! *Verb. sap.*

I then questioned him with reference to Chinese literature, which, as you know, is both written and read in vertical lines. My friend proceeded to explain that if we imagine the human eye to be pivoted through the centre of the iris, the fact of moving the eye horizontally must call for more work on the part of the controlling system than when it is moved vertically across a similar distance, due to the eye being oval in shape.

My friend maintained that far longer periods could be experienced by the human being using the Oriental method of scanning than by the Occidental way, and, in my humble opinion, it certainly seems the case, if one considers the Eastern system.

Devonport. E. T. E. H.

[1] Radio Data Charts. Price 4s. 6d. Published from the offices of *The Wireless World*.

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.

Composite Output Circuit.

I have a low-resistance moving-coil loud speaker with a built-in transformer, which is, according to the manufacturers, intended to match a triode output valve of 2,000 ohms A.C. resistance. It is now desired to connect this instrument to a receiver employing a pentode and with a centre-tapped output choke. Do you advise me to abandon the use of this device, and to endeavour to obtain a special output transformer, designed to suit both the pentode and the loud speaker?

From the information given, it is impossible to predict accurately what the working conditions will be, but we suggest that you should join the receiver output terminals direct to the primary of the built-in loud speaker transformer; in effect, this amounts to feeding the transformer through a choke and condenser. No harm can be done by adopting this form of connection, and it is certainly worth while trying it before going to the expense of obtaining a special transformer.

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Coil Screens.

I have some well-made tin containers, with lids, which are about 3¾in. in diameter and 4½in. long. Would these be suitable for use as screens for coils of 2½in. diameter and 3in. in overall length?

We assume that your containers are made of tinned steel plate; this material is not suitable for screening when the metal is in close proximity to the coil windings.

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Radio Interference.

In the design of radio-gramophones with H.F. amplification it seems generally to be considered unnecessary to take any precautions against interference from incoming radio signals when the set is being used for gramophone reproduction. Do you consider that it is worth while to take steps to prevent the application of H.F. voltages to the grid of the first amplifier, and if so, what measures would you suggest?

In the case of battery-operated sets with H.F. amplification, it is usual to make provision for interrupting the filament circuit of the H.F. valve (or valves), but in the case of a mains-operated set, this procedure may possibly upset the regulation of the eliminator, and also result in the application of excessive voltage to the heaters of the remaining valves. Interference can be avoided as a rule by detuning in conjunction, perhaps, with operation of the input volume control, if fitted. If desired, a switch for earthing the aerial may be included, but is hardly necessary.

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"Radio Reading Lamp."

Although the single-valve headphone set described in your issue of March 11th is intended for D.C. supply voltages of 200 or over, would it not be possible to modify it for operation on a 100-volt supply by replacing the smoothing resistance by a choke?

I am also in a quandary over the question of the voltage-absorbing lamp resistance: a 10-watt lamp, which would pass the necessary current, seems to be unobtainable here, but I can get 5-watt lamps. Would these be satisfactory if two were connected in parallel?

For operation on a 100-volt supply, it would be wise to abandon the use of resistance smoothing, and also of resistance feed to the telephones. For this purpose L.F. chokes should be used; they may be of inexpensive and comparatively inefficient design, and the windings of a cheap L.F. transformer would serve the purpose.

Two 5-watt lamps connected in parallel will, as you suggest, act as a suitable resistance. These alterations are shown in Fig. 1.

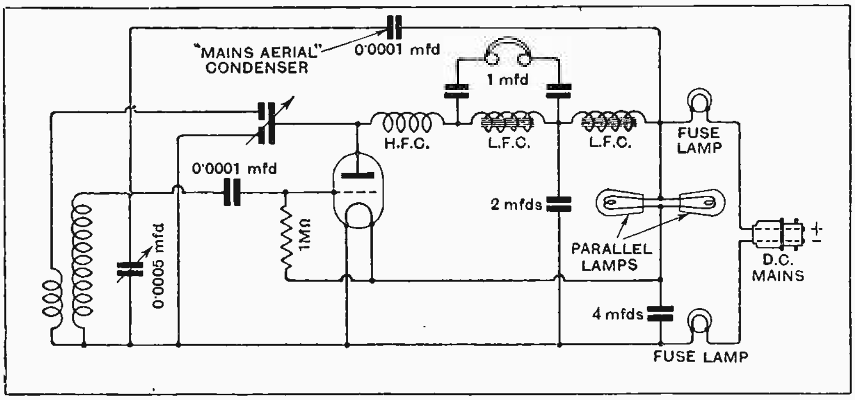

Fig. 1.—Single-valve set for headphone reception, modified for operation on low-voltage D.C. mains.

Effect of Screening.

Will you please examine my suggested specifications for a set of medium- and long-wave tuning coils, and say if you think that these windings would have correct inductance values, and also if they would be reasonably efficient for use in a "1-H.F." set with an input filter? Tuning condensers of 0.0005 mfd. are to be used, and the coils are to be mounted in individual screening "cans."

Provided that you intend to use screens of reasonably large dimensions, windings as specified should be quite satisfactory. We would emphasise the fact that the actual spacing between windings and screens has a considerable effect on the effective inductance values of the coils.

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Acoustic Reaction.

My two-valve receiver is inclined to develop a faint whistle, which sometimes increases in intensity to such an extent that it becomes necessary to switch off. Dimming the valve filaments effects a cure, but is not altogether satisfactory. Can you tell me what is the cause of the trouble?

This seems to be a clear case of acoustic reaction between detector valve and loud speaker, a trouble that was very prevalent at one time, but, with modern valves, is seldom encountered.

It will be easy to prove the correctness of our diagnosis by temporarily moving the loud speaker, on an extension lead, to another room.

The trouble can be overcome by mounting the detector valve holder on a shock-absorbing base, such as a block of sponge rubber; it may also be necessary to shield this valve.

Pre-selection A.C. Three.

I am about to build the "Pre-selection A.C. Three," but intend to embody apparatus at present used in an eliminator which gives a voltage output of over 250 volts; valve rectification is employed.

In these circumstances, would it be necessary to modify the detector anode circuit?

As your rectifier gives a considerably higher voltage output than that used in the original receiver, we suggest that the smoothing choke L.F.C.$_2$ might be omitted entirely. In its place a feed resistance of from 15,000 to 20,000 ohms should be inserted in series with the detector anode, as shown in Fig. 2. Condenser C14 will become the by-pass capacity for this decoupling resistance.

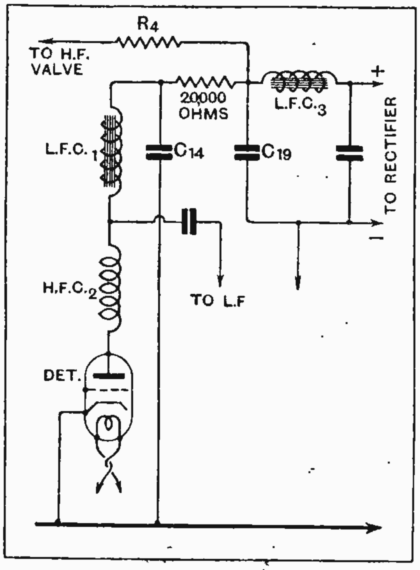

Fig. 2.—Anode feed circuit of a power grid detector followed by choke-coupled L.F. stage.

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Two-range Coil Assembly.

I have just wound a two-range tuning coil similar in design to several that have been described in "The Wireless World," although no particular design has been followed in its entirety. Unfortunately, reaction control is poor; on the medium waveband it is "fierce," and it is almost impossible to stop self-oscillation at the lower end of the scale, while on the long waveband, reaction effects are almost unobtainable on wavelengths above 1,200 metres. Do you think that the use of a larger reaction condenser, with an extra anode by-pass capacity for the detector valve, would put matters right?

From your description of the behaviour of the set, we take it that the position of the reaction coil, which is no doubt common to both medium- and long-wave sections of the tuning coil, is incorrect. The reaction coil should be rewound, and placed in such a position that it is more tightly coupled with the long-wave winding, but spaced to a greater extent than at present from the medium-wave tuning coil.

The best relative position for a reaction winding in a dual-range assembly such as you are using is always best determined by trial and error.

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Frequency Doubling.

The expression "frequency doubling" is sometimes applied to loud speakers. Will you please tell me what it means?

The use of this term (generally in connection with moving-iron loud speakers) implies that, when a note of a certain frequency is fed to the instrument, a note of twice the applied frequency will be heard.

This effect is mechanical and manifests itself on the lower notes.

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Measuring Bias Voltage.

By using a moving-coil voltmeter of high resistance, is it possible to make reasonably accurate measurements of the grid bias voltage applied to a valve through an "automatic" device by merely joining the meter between grid and cathode?

No: more or less serious errors will always occur, and in most cases the voltmeter reading will be hopelessly inaccurate.

Assuming the bias resistance to be accurately known, it is best to measure the current passing through it, and then, by multiplying resistance (in ohms) by current (in amps), to ascertain the bias voltage actually applied.

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Field Winding as Voltage-absorbing Resistance.

I am designing an "all-mains" D.C. receiver, and propose to rewind the field coil of my moving-coil loud speaker so that this winding may act as the main voltage-absorbing resistance for the filament circuit. A current of about 0.25 amp. is to be passed. Do you think that this plan is likely to be satisfactory?

This is an arrangement that has been included in sets described in this journal, and there is no reason why satisfactory results should not be obtained. Matters should be so arranged that the ampere-turns of the new winding are at least as great as, if not greater than, the original value.

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Reaction Between Grid Circuits.

The anode circuits of my mains-operated receiver are, I believe, sufficiently well decoupled, but, nevertheless, motor-boating sometimes occurs. Is it possible that interaction may take place in the grid circuits, for which bias is also derived from the mains?

It is certainly possible that interaction between the grid circuits may be responsible for the trouble, but in practice this seldom occurs. Due to the fact that no current is flowing in these circuits, it is possible to use decoupling resistances of very high value, which should confer complete immunity from interaction. Of course, the use of high resistances will not be effective unless the associated condensers are in order.

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Filters and Reaction.

It has been stated in your journal that the operation of a filter may be upset by the application of reaction. Due partly to the use of a short and rather badly screened aerial, I find that the sensitivity of my H.F.-det.-L.F. set is largely dependent on reaction, so far as long-distance reception is concerned, but local interference is serious enough to make me consider the use of an input filter. Do you think it would be worth while in my case?

We think you have overlooked the fact that the statement to which you refer applies only when reaction is applied to one of the filter circuits, as would be the case if it were used in a detector-L.F. set without H.F. amplification. When an input filter is used in conjunction with an H.F. stage, reaction is invariably applied to the intervalve coupling, and so the operation of the filter is in no way affected.

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A Correction.

In the "Readers' Problems" section of *The Wireless World* for April 1st, an error occurred in Fig. 1 (a). The low-potential end of the pick-up, instead of being joined to the cathode as shown, should be connected to the earthed base-line. Connected in this way, the voltage developed across the bias resistance will be applied to the grid of the valve.

FOREIGN BROADCAST GUIDE.

RADIO NATAN VITUS

(Paris-France)

Geographical position: 48° 51′ 30″ N., 2° 17′ 43″ E.

Approximate air line from London: 214 miles.

Wavelength: 312.8 m. Frequency: 959 kc. Power: 1 kW.

Time*: Greenwich Mean Time.

Standard Daily Transmissions.

09.00 and 11.00 G.M.T., gramophone records (Sun.); 16.30, sponsored concert (Sun.); 20.00, talk and concert (daily).

Man announcer.

Opening signal: Metronome.

Call: *Allo! Allo! Ici poste Radio Natan-Vitus, Paris.*

Interval signal: two notes (F sharp, D sharp).

Closes down with the playing of a French popular song: *Mont' la d'ssus* and usual French formula.

The broadcasts are simultaneously transmitted on 43.75 m.

(**France adopts British Summer Time.*)

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

America and Ourselves.

IT is very easy to be led astray by being too ready to compare receiver development in America with what is happening in this country, and if we try to prophesy the wireless future here, based on the experiences of America, we are likely to be wrong more often than we are right in our conjectures.

Standardisation in America has been pushed to such a point that manufacturers are at last feeling that they must break away from general practice in order to provide individual selling points for their sets. It has, in the past, been very difficult for American manufacturers to claim any outstanding points of design which justified a statement that one manufacturer's set was outstandingly different from another. It may be said, by comparison, that amongst British sets there is far more individuality in design and in final appearance of sets, and this is in no small measure due to the variety of specialised valves and components available over here. The contrast between our valves and those of America constitutes probably the outstanding distinction amongst the individual parts which go to make a wireless set. America has, in the past, gone all out for standardisation in valves, in order that there might be no difficulty in interchanging valves and obtaining replacements in any part of the States. Now that the need has arisen for breaking away from standardisation in order to create new selling features, America has turned to the valve as one of the most promising directions for introducing a change, and, in consequence, there is now appearing in America quite a crop of valves with new and unusual characteristics which will offer wide scope for new designs for the receivers of next season. But not everywhere in America are these innovations regarded as constituting progress. A contemporary American journal, we see, attacks the policy of introducing different types of valves to perform more or less the same functions. It will be very interesting to watch the outcome of this new trend, as it seems to be rather in contradiction to the feeling which is growing here that the time has come for a little more standardisation and a check on the production of special-purpose valves.

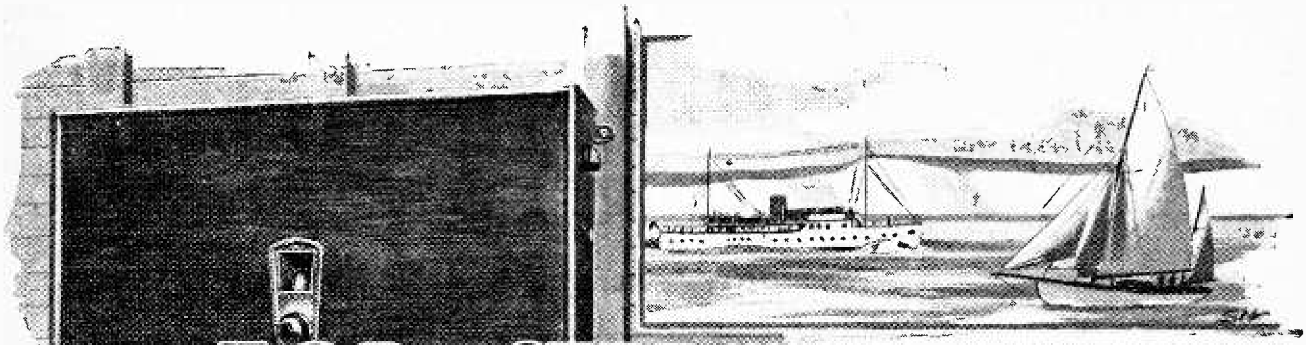
* * *

Wireless Exchanges.

IN a letter under "Correspondence" in this issue the Postmaster-General suggests that we were perhaps unaware that in the agreement between the Post Office and organisers of broadcast relay services it is stated that "The licensee shall not originate at the stations, or collect by wire, any programme or item, whether musical or otherwise, or information of any kind for distribution to subscribers."

We were aware of this clause, but confess we regard it as one of those unfortunate regulations which, in the nature of things, are often unenforceable. We recollect that in the early days of broadcasting listeners were forbidden by the Postmaster-General to use reaction!

In This Issue



FOR SERVICE AFLOAT

A Long-wave Receiver Designed for Small Yachts.

By H. F. SMITH.

THE "Yachtsman's Three" receiver, described in these pages nearly a year ago, was primarily intended for operation with an extremely short aerial, and, in consequence, it was considered unnecessary to use a two-circuit aerial tuner or input filter. But it is an undoubted fact that such a receiver, in spite of its tuned H.F. stage, is insufficiently selective for present-day conditions when used with an efficient aerial, even of the comparatively modest dimensions that can be installed on many yachts, and it is thought that a more up-to-date and efficient set, with ganged tuning control and highly selective circuits, may be of interest, not only to yachtsmen, but to many others who require a receiver designed purely to cover the long-wave broadcasting band. For reasons that have already been discussed, and which are all-too-well known to those living in certain coastal areas, medium-wave reception is almost impossible where "spark" interference is prevalent, and the provision of means for tuning to that band is little short of a waste of components; further, it entails the introduction of complications that are unnecessary.

With the addition of an input filter, the circuit of the new set (shown in Fig. 1) is basically similar to that of its forerunner, and embodies a single H.F. stage, followed by a regenerative grid detector and a transformer-coupled L.F. amplifier. Naturally, it is designed for battery-fed valves, and economy of current has therefore been taken into consideration.

As a coupling between individual circuits of the filter, a small variable condenser of some ten micro-micro-

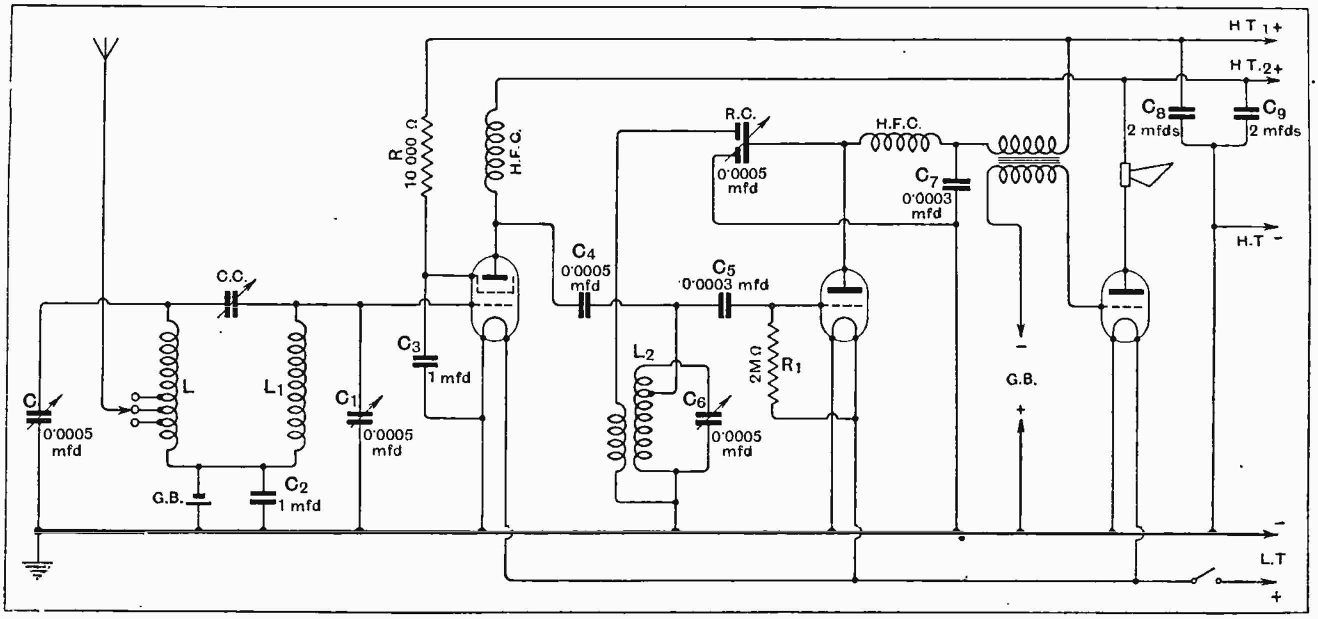


Fig. 1.—Complete circuit diagram. There is no wave-range switching, as the long waveband only is covered.

For Service Afloat.—

farads, driven by the main ganged condenser spindle, is used. This gives a reasonably constant tuning band width of some two or three kilocycles, which is narrow enough to confer all the selectivity that is likely to be necessary. Obviously, tuning is not broad enough entirely to obviate high-note loss due to "cutting" of sidebands, but it would be difficult, if not impossible, to combine this feature with the other qualities necessary in a receiver of this rather specialised kind. If broader tuning is needed, it can readily be obtained by increasing coupling capacity.

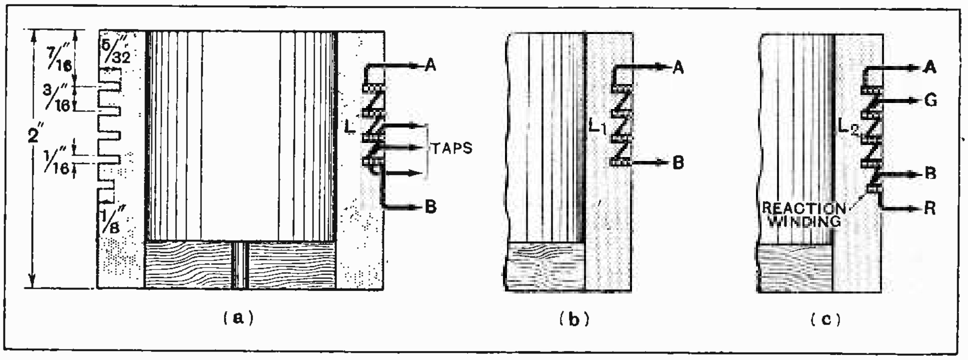
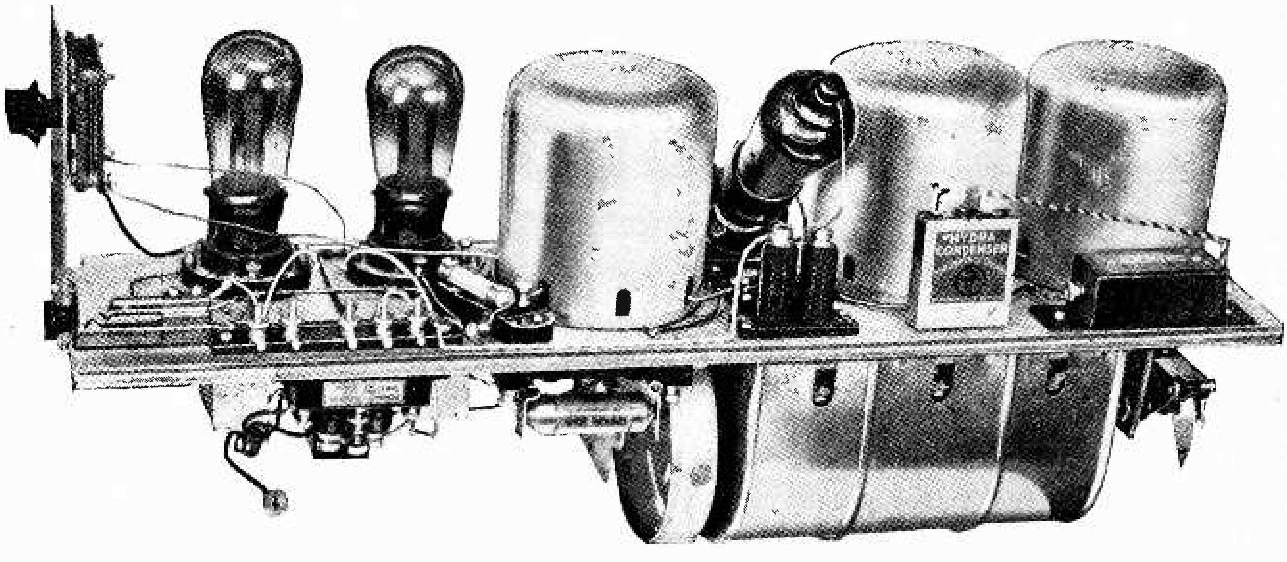


Fig. 2.—Preparation of coil formers and details of windings. Terminal points marked A are connected to the variable condenser moving vanes; B indicates low potential ends of the windings. Points G and R on L_2 are joined respectively to the detector grid condenser C_5 and to the reaction condenser.

No other features of the circuit call for special comment. It will be observed that "tuned grid" coupling has been chosen for the H.F. stage, and that reaction is controlled by a differential condenser: with regard to this detail, there is little reason why a plain condenser should not be used, but if this course is preferred, it is advisable to connect a fixed capacity of about 0.0003 mfd. between detector anode and earth. In the present case, matters have been simplified by the omission of a volume control, as the particular set described and illustrated is intended for operation at long ranges, usual. The amateur's constructional difficulties are apt to increase when he attempts to crowd his components into a limited space, but no trouble need be anticipated if the extremely simple layout of the present set be adopted. As shown in the accompanying illustrations, components are mounted on either side of a strip of plywood measuring 21¼in. by 4¾in.; this chassis can be mounted in any suitable kind of container.

Brackets of sheet aluminium or brass must be made to support the holder for the H.F. valve, which is mounted at an angle of about 45 degrees with the baseboard in order to save space, and also for the main condenser spindle. A similar support for the reaction condenser may be provided, but it may be preferred to



View showing the upper side of the chassis platform. Connection for the loud speaker is picked up through a jack, seen on the extreme left, which also closes the filament circuits. Flexible leads below it are for connection to the bias battery, which is mounted in the case.

where the reaction condenser will adequately perform this function. Some device for regulating signal input to the H.F. valve may be found desirable in certain cases.

Economy of space is all-important on board a yacht, and compactness is an essential feature of the receiving set, particularly with regard to its back-to-front dimension, if it is to be screwed to the cabin panelling, as is mount this component on the end of the cabinet and to fix its connecting leads after the chassis has been inserted. The coupling condenser is supported by a bracket of insulating material.

The construction of suitable coils for the receiver is illustrated in Fig. 2. The windings are carried in a series of slots, cut in 6-ribbed ebonite formers measuring 2in. in length by 2¼in. overall diameter. Four rows

For Service Afloat.—

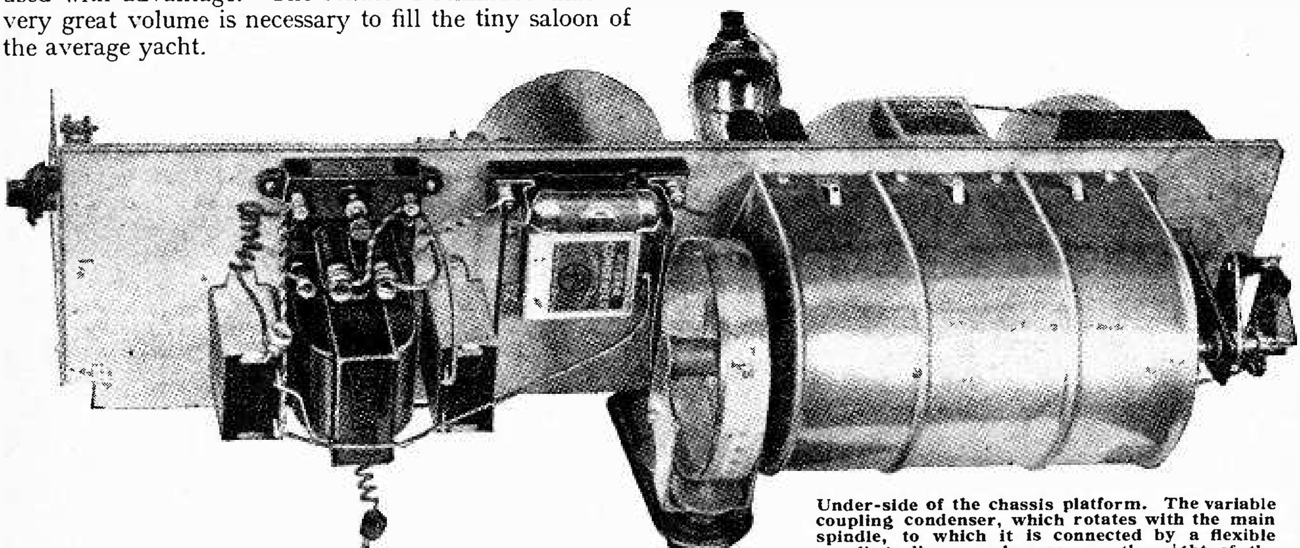
of slots, $\frac{5}{32}$in. deep by $\frac{1}{16}$in. wide, must be cut in the formers for coils L and L_1, and an extra row is provided for the reaction winding associated with the tuned grid coil L_2; a depth of $\frac{1}{8}$in. is sufficient for this.

Each of the three tuned windings are similar, and consist of four sections, each with 52 turns of No. 34 D.S.C. wire. Coil L is tapped at the 42nd, 52nd and 62nd turns from the low-potential end. The reaction coil has 25 turns of the same wire, and is merely a continuation of the tuned winding, being wound in the same direction. Coils are screened in individual containers, and, needless to say, should be accurately wound and symmetrically mounted so that their inductance values may be matched.

Choice of Components and Valves.

There is considerable latitude with components; although in making a choice dimensions must be taken into account. Among the parts that will be recognised in the photographs of the set are standard Colvern coil screens, Utility coupling condenser, Ferranti A.F.8 transformer, and a Burton reaction condenser.

Two-volt valves will generally be preferred for a yacht set; even if the boat is fitted with an accumulator battery of higher voltage, it is generally quite convenient to make connection to a single cell. Any efficient H.F. valve will serve, while, as a detector, a valve of about 20,000 ohms A.C. resistance is suggested as being economical of anode current. With regard to the output stage, this is clearly a case where one of the recently introduced high-efficiency valves, such as the Mullard P.M.2A. or Marconi or Osram L.P.2C. types might be used with advantage. The reader is reminded that no very great volume is necessary to fill the tiny saloon of the average yacht.



Under-side of the chassis platform. The variable coupling condenser, which rotates with the main spindle, to which it is connected by a flexible coupling disc, can be seen on the right of the ganged tuning condensers.

The container illustrated is a simple rectangular box of mahogany-faced plywood, and measures 22in. wide by 11in. high by 5in. deep. These dimensions, except the last, may be reduced slightly if necessary.

It is recommended that initial adjustments should be made before mounting the chassis in its case. As usual, trimming condensers should be carefully set with the coupling condenser (CC) set at minimum, and the aerial lead should be joined to the tapping point found by trial to give best results. If the aerial is extremely short, it will generally be best to join it to the tapping nearest to the high-potential end of coil L; in exceptional cases, an extra tapping may be made at the centre point of this winding.

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READERS' CORNER.

CERTAIN enquiries received from readers could, we believe, be most satisfactorily answered by other readers from their personal experiences through the pages of *The Wireless World*, and we therefore invite brief replies to the following enquiries extracted from recent letters:—

(1) W. R. Can any reader recommend where to go for the loan of historical lantern slides of wireless interest for lecture purposes?

(2) G. S. Can W.E.C.O. valves of the peanut type, as used in early B.S.A. sets, still be obtained, and, if so, where?

(3) H. H. S. Wanted: a short list of gramophone records suitable for demonstrating high- and low-frequency response.

(4) P. K. American broadcasting stations can now be readily received on the medium wave range with sets embodying good H.F. stages. Has any reader a list of the stations best heard with wavelengths and times of transmissions?

(5) W. S. L. What is the best D.C. to A.C. converter at a reasonable price, and free from electrical and mechanical noise? Readers' experiences wanted.

Any 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.

"My congratulations to *The Wireless World*, which celebrated its eighteenth birthday last week. I remember it at least for fourteen years, and must say that it has maintained and enhanced its reputation for the sane presentation of facts during that period. It is easily the least sensational, and probably the most reliable, of contemporary technical radio journals. Good luck to it!"—*Irish Radio News*, April 4th, 1931.

A commercial version of the Stenode made by R.I., Ltd.

The Performance of the Stenode

Overall Curves of Selectivity and Fidelity.

By E. L. GARDINER.

As there has undoubtedly been great interest shown in the Stenode Radiostat system of wireless reception, and particularly in the theoretical explanations of the remarkable results obtainable, a study of the accompanying set of performance curves of such a receiver is of exceptional interest.

In the course of Dr. Robinson's recent visit to the United States, during which he gave lectures and demonstrations of his invention before the leading American scientific institutions, it became increasingly evident that reliable performance curves taken by a recognised American laboratory would be of the greatest value in bearing out the results of demonstration, and in convincing engineers of the genuineness of this revolutionary system.

IN view of the discussions on the Stenode principle which have appeared recently in our correspondence columns, we have agreed to give publication to this contribution on the performance of the Stenode although it may be regarded as somewhat controversial. The article is written by one who accompanied Dr. Robinson on his recent visit to America.

Consequently, a Stenode receiver was placed in the hands of the Crosley Radio Corporation, whose laboratories are exceptionally well equipped for the carrying out of measurements of this kind, and the accompanying curves, which embody the results of those measurements, are published here for the first time in this country.

The Stenode receiver to which they relate employs the superheterodyne principle. A very high degree of selectivity is obtained by the use in the intermediate frequency amplifier of a quartz crystal, ground to resonate at the intermediate frequency of the superheterodyne, which acts as the equivalent of a resonant circuit of extremely low decrement, thus, imparting very high selectivity to this portion of the receiver. The distortion of the received modulation produced by this high selectivity is compensated for by the use of a special correcting low-frequency amplifier, in which the overall voltage amplification is designed to rise proportionately to frequency. This has the effect of completely correcting the fidelity of the receiver.

The Low-frequency Correcting Circuit.

The curve of the low-frequency amplifier of the Stenode is not given here, as it is very close to a straight line from about 20 cycles up to 3,000 cycles per second; this line rising, of course, with a slope of 45 degrees to the frequency axis. Above this frequency the amplification falls off somewhat. It must be borne in mind, however, that the receiver upon which these tests were made compares favourably with present-day American commercial practice, in which it is not considered necessary to reproduce to any great extent frequencies above 5,000 cycles, provided that the output is well maintained below that point. Hence an intentional cut-off is arranged in the audio amplifier a little above 5,000 cycles, the circuits being designed to give their maximum amplification at 5,000 cycles. There is, however, no reason why the response of such a receiver cannot be carried up to any desired frequency limit; all that is needed to effect this being a design of audio amplifier in which amplification is closely proportional to frequency up to the desired maximum frequency of response. If very high frequencies are required an extra audio stage may be

The Performance of the Stenode.—

needed, which was not thought desirable in the set to which these comprehensive measurements relate.

The high-frequency resonance curve shown in Fig. 1 was taken by feeding into the receiver continuous waves of variable frequency, and as resonance was progressively departed from, the amplitude of the input was increased to give a constant reading equal to that at resonance on a diode voltmeter connected between the grid and cathode of the second detector valve. This method of working eliminates any error which might exist in the calibration of this meter.

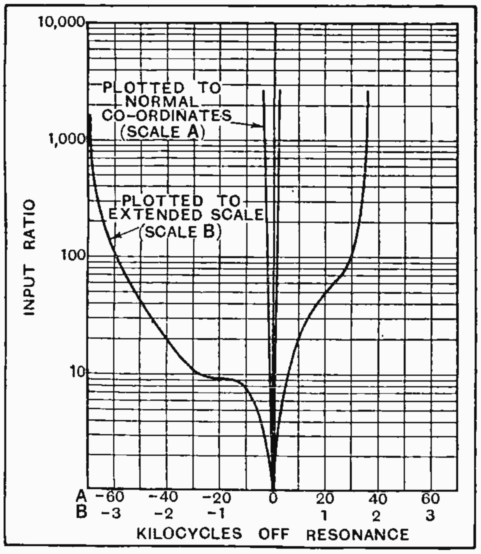


Fig. 1.—The resonance curve obtained by feeding the receiver with continuous waves of variable frequency, and increasing the input to give a constant reading as the frequency is shifted from resonance.

A number of curves were taken with different settings of the condenser which is employed to balance the shunting effect of the capacity of the quartz holder, this procedure being the simplest means for ensuring that the results are free from errors due to this cause. The curves shown are the composite result of four such tests, and the asymmetry shown by the curve is due to a slight misadjustment of the balancing condenser, which was not completely compensated for by the averaging process. It is not a fundamental feature of the selectivity curve of the Stenode. In order to obtain any reasonable curve it was necessary to open out the scale of frequencies, and curve B in Fig. 1 shows the results with the opened-out frequency scale, whereas curve A shows the results with the frequency scale normally employed in plotting the curves of conventional receivers.

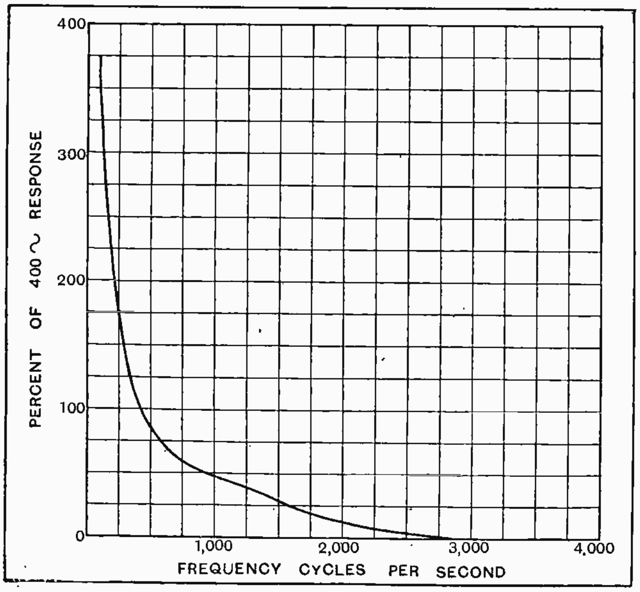


Fig. 2.—A more conventional resonance curve giving the mean of a number of readings.

In order to facilitate comparison with resonance curves of other types of receivers, the curve of Fig. 2 has been prepared. This curve is the mean of a number of measurements, and shows the actual intermediate frequency voltage across the grid circuit of the second detector valve plotted against the frequency difference from resonance. The peak of this curve is far off the top of the paper, and it may be regarded as an enlargement of the outer portion of one side of the resonance curve.

From 60 to 3,000 Cycles.

The very high selectivity of the Stenode is clearly shown by this curve, which is best considered in conjunction with Fig. 4, the overall fidelity curve. This curve shows the output voltage from the receiver measured across the speaker terminals for various frequencies of the received modulation. In taking it, a modulated carrier wave capable of modulation by frequencies from 50 cycles up to 6,000 cycles was employed, the receiver remaining tuned to this carrier frequency throughout the test.

It will be seen from this curve that the fidelity is good in comparison with present-day commercial practice. Low notes are well reproduced, there being a

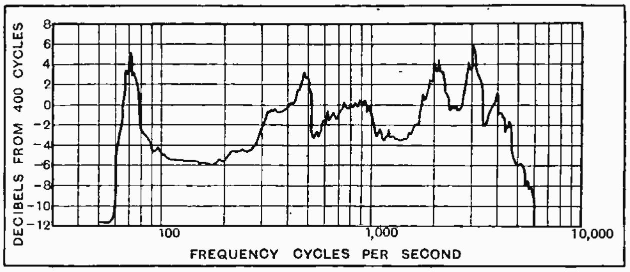


Fig. 3.—The fidelity curve of the speaker.

rising slope at 60 cycles, and the general level of reproduction is maintained with an upward trend to 2,000 cycles. At the higher frequencies up to 3,000 cycles the response is still good, the output at this frequency being equal to that at 100 cycles.

It is of particular interest to note that this high audio output at 3,000 cycles is obtained in spite of the fact that the resonance curve of the receiver has fallen to a value too low to measure at 3,000 cycles off resonance, and is, in fact, far less than 1 per cent. of the value at resonance. This fact would appear to prove conclusively that, as Dr. Robinson has pointed out, it is possible to obtain good reproduction of modulations of any desired frequency, no matter how selective the receiver may be, and these curves should be examined in conjunction with Dr. Robinson's pub-

The Performance of the Stenode.—

lished theoretical explanations of the receiver's performance.

It will be noticed that higher frequencies up to over 6,000 cycles are reproduced to quite a considerable extent, and it is not difficult to design Stenode receivers in which the falling off up to 5,000 cycles is very small. The receiver tested, however, was an early model in which the low-frequency amplifier was not so highly corrected as in receivers of more recent design, and hence some falling off in reproduction above 3,000 cycles is evident. The fidelity curve shown, however, compares favourably with other commercial superheterodynes of very much lower selectivity.

The curve of Fig. 3 is that of the speaker used in this particular Stenode receiver, and is interesting as showing how the speaker characteristic has been considered in combination with that of the set, so that additional correction is introduced by the speaker. The peaks of this curve at 3,000 and 4,000 cycles have a considerable effect in making up for the drop in the receiver output which begins at these frequencies, and results in the audible output being well maintained up to over 4,000 cycles.

Whereas these performance curves do not represent by any means the best which the Stenode principle can achieve, and although they are constantly being improved upon in the latest designs of receivers it is felt that since they are undeniably authentic they may be of assistance in throwing light on the true possibilities of this new system of radio design.

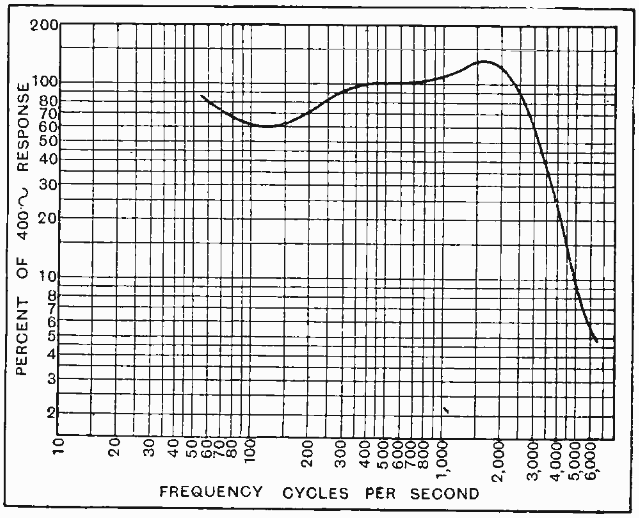
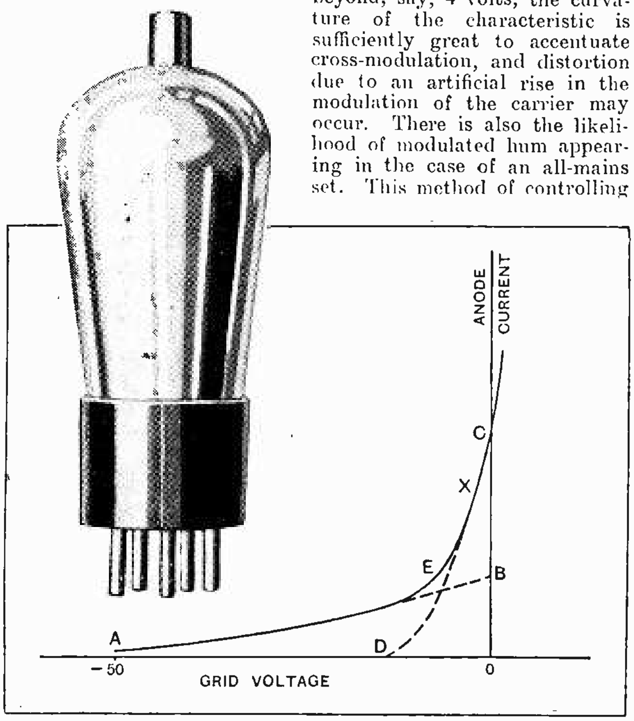


Fig. 4.—The overall fidelity curve of the receiver.

NEW AMERICAN SCREEN-GRID VALVES.

ATTEMPTS are often made to control the volume of a receiver by altering the control grid bias of the first screen-grid valve. With this type of valve as hitherto designed there is danger that as soon as the bias is increased negatively beyond, say, 4 volts, the curvature of the characteristic is sufficiently great to accentuate cross-modulation, and distortion due to an artificial rise in the modulation of the carrier may occur. There is also the likelihood of modulated hum appearing in the case of an all-mains set. This method of controlling volume is, therefore, strictly limited in its application, although in principle it is attractive in that it affords a means of altering amplification without unduly upsetting ganging, and for automatic volume control there would appear to be no substitute.



Characteristics of a typical variable-mu tetrode—the new American screen-grid valve with which it is claimed that cross-modulation is almost entirely eliminated.

A new S.G. valve has appeared on the American market which it is believed will find extensive use in next season's broadcast receivers. Essentially it contains the elements of two valves within one bulb, but there are only the usual number of contact pins in the base. The valve can, in fact, replace the ordinary screened valve without incurring any change in circuit other than the provision of means to increase considerably the normal negative bias so as to obtain a greater range of volume control. The anode, screen and heater voltages and currents are similar to those of the familiar S.G. valve.

Referring to the illustration showing a typical characteristic A E C of one of these new valves, it will be seen that there is a long and nearly straight portion E A in which the mutual conductance decreases towards A, and a short, steep portion E C of high mutual conductance. This unorthodox double characteristic is obtained by combining the electrodes of a high-mu valve C D with a low-mu type AB in the same bulb, giving the general characteristic A E C. The new valve is thus called a "Variable-Mu Tetrode."

When the bias has the normal value of $1\frac{1}{2}$ to 3 volts (working point X), distant signals of small voltage are given high amplification, but when a local station is tuned in and the bias volume control is adjusted to prevent overloading, the larger signal voltage is easily accommodated on the straight portion E A without rectification and cross-modulation from transmissions on nearby wavelengths. In the De Forest valve, for instance, there is room for a comparatively large signal at a negative bias of 20 volts where the mutual conductance has dropped to 0.08 mA./volt, whilst with the Arcturus 551 model the mutual conductance is 0.005 mA./volt at 40 volts negative grid.

In general it is claimed that cross modulation for a given input is reduced some 500 times when compared with the results of an ordinary screen-grid valve, so much so, in fact, that a single-tuned circuit can be used between aerial and first valve even where the ether is congested, as the selectivity is determined by the overall response of a number of circuits and not by that of the first circuit. W. I. G. P.

The VALVE at its BEST

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

No. 2.—The S.G. Valve.

WHEN the screen-grid valve first made its appearance it was hailed as the panacea of the radio ills which beset the ambitious set designer, with the regrettable result that a truly excellent invention has sometimes incurred criticism far beyond its deserts. In the short period during which the valve has been generally available a number of unsuspected phenomena have come to light demanding modifications of conventional circuits. Unless the peculiar properties of the screened valve are understood the surrounding circuits cannot be designed to give the highest efficiency. In this article, development from the earliest H.F. valves to the latest metal-sprayed mains valves will be briefly discussed and typical circuits suggested for a compromise between the conflicting requirements of selectivity, amplification and stability.

In the early days of broadcasting attempts were made to amplify at high frequency, using the three-electrode valve, with the result that uncontrollable self-oscillation occurred before there was a perceptible increase in signal strength. In the light of more recent mathematical treatment of H.F. amplification it can be shown that an anode-to-grid capacity of 10 micro-microfarads—the likely capacity of one of the earlier triodes—is sufficient to feed back energy enough within the valve to cause instability when the stage gain is about two. High-frequency amplification in these circumstances is impossible.

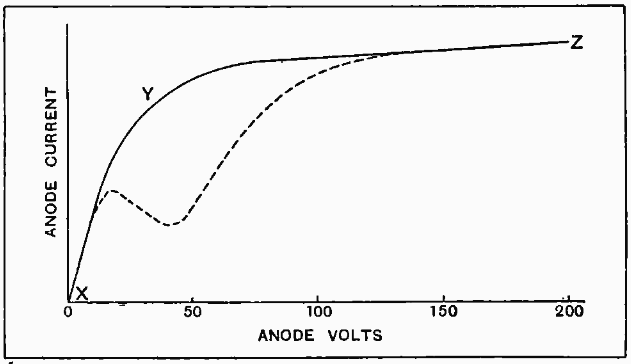


Fig. 1.—Characteristics showing the high impedance of a screen-grid valve.

Then came the neutralised triode circuit in which the valve capacity was approximately balanced out by a bridge. Receivers containing this arrangement were extremely popular until waveband switching became essential; then the complication involved was serious. A stage gain of about 40 on the medium waves was possible, but it must be conceded that complete stability across the tuning range was not always easy to obtain. The valve capacity is by no means a pure capacity and cannot theoretically be balanced out by a neutralising condenser except at one specific wavelength.

Just at the time when there appeared to be an *impasse* the "shielded-plate" valve appeared, in which a screen, earthed to high-frequency currents, was interposed between grid and anode. This had the effect of reducing the interelectrode capacity in the early samples to a value about 1/100th of that in the triode. To prevent the screen—which has to consist of a close-meshed structure—from restricting the flow of electrons, a positive potential is applied to it, so that there can be considered to exist, for the sake of argument, two anodes. The ideal curve connecting anode current and anode voltage for a four-electrode valve is shown as X Y Z in Fig. 1. Since the screen is of fine texture, the anode will only be able to take current from it and not be able to produce any extra current for itself.

High Impedance of the Screen-grid Valve.

If now we gradually increase the anode voltage from zero the anode current will rise rapidly from X to Y, and as soon as the anode has robbed the screen of practically all its current a further increase in H.T. potential cannot help the anode to collect any more electrons, hence the curve becomes practically horizontal between Y and Z. Now, as the impedance of a valve is measured by the change of anode voltage

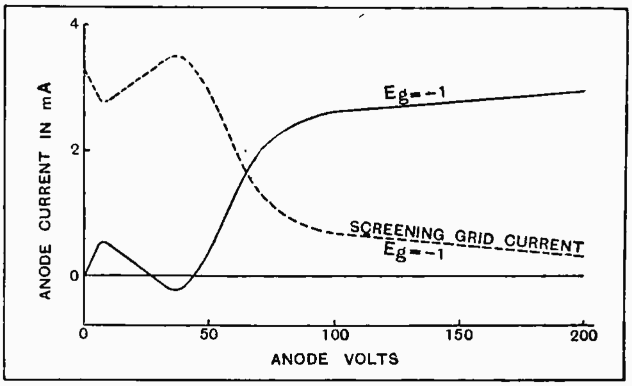


Fig. 2.—The sum of the currents of the screening grid and the anode at any point forms a constant. When the anode current decreases the screen current increases and vice versa.

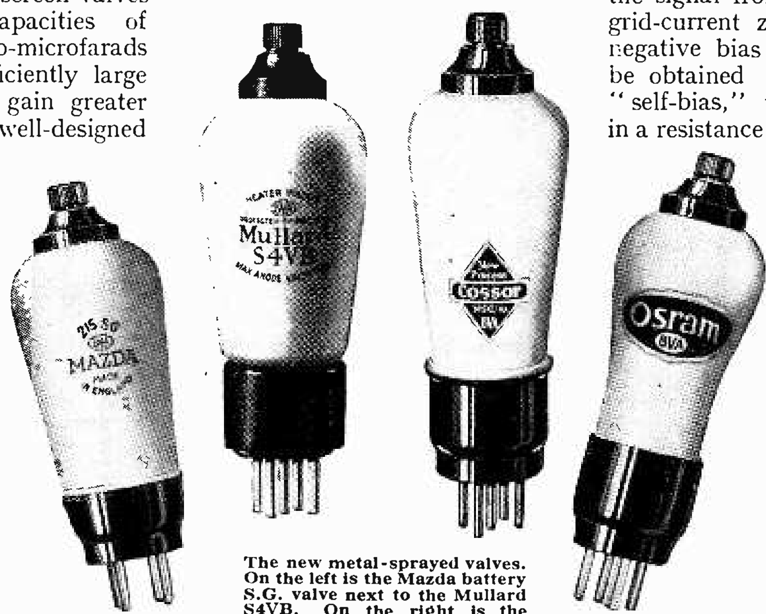
The Valve at its Best.—

AFTER summarising the fundamental facts on the working principles of H.F. valves, with particular reference to the modern S.G. type, the author directs attention to the important practical requirements necessary to avoid the condition of flatness of tuning so commonly met with in screen-grid H.F. amplifiers. In addition, the recently introduced metal-sprayed valves are described and their advantages explained.

divided by the change of anode current (and the current change is negligible along Y Z), it will at once be appreciated why the screen-grid valve is necessarily of high impedance and fundamentally different from the triode. In practice the working curve is not quite the same shape as X Y Z. Should the screen voltage rise above that of the anode, the screen will rob the anode of secondary electrons which are always to be found around an electrode which is being bombarded. For a short distance the curve will show a decrease in anode current for a rise of applied potential, and the working characteristic is given by the dotted line (Fig. 1).

This so-called negative resistance kink in the curve must be avoided in a screen-grid amplifier by keeping the anode voltage at least twice the screen voltage, otherwise there is a danger of self-oscillation taking place. That the anode and screen currents when added together form a constant can be seen from Fig. 2. Where the anode current rises the screen current drops, and *vice versa*. The two curves have the same shape, but one being reversed causes a symmetrical pattern.

The first commercial screen valves had interelectrode capacities of 0.05 to 0.1 micro-microfarads ($\mu\mu$f.), this being sufficiently large to prevent any stage gain greater than that of a well-designed neutralised triode. It was pointed out in *The Wireless World* in July, 1929, that a limit to stable amplification was to a large degree set by anode-grid capacity, and that if figures for this constant were published, calculations of H.F. amplification with various tuned circuits could be made. Subsequently a number of manufacturers measured the capacity, and by dint of research into the construction of screens we have to-day S.G. valves with two screens in cascade, cross-mesh and staggered screens, and other complicated constructions, giving residual capacities of the remarkably low figure of 0.003 and 0.002 $\mu\mu$f. It is important to realise that the better the mutual conductance the lower the residual capacity must be to maintain stable amplification.



The new metal-sprayed valves. On the left is the Mazda battery S.G. valve next to the Mullard S4VB. On the right is the Cossor MSG/HA valve for A.C. mains and the Osram MS4. On the outside of the bulb is a thick metal coating connected to earth which acts as a valve screen.

Simple calculation shows that with the latest type of valve it is possible to obtain a stage gain of over 200 with quite modest components, provided that the external screening of coils and components generally is carried out with meticulous care. As to whether it is expedient to use such high amplification with a single stage, especially if ganged circuits are employed, is another matter and involves many problems. In spite of certain limitations, most of which have come to light recently, the screen-grid valve has a great advantage over its predecessors. Considerably greater amplification is possible per stage, a number of stages in cascade (and ganged) are perfectly manageable, waveband switching is comparatively simple and reaction can be used without aerial re-radiation. This, indeed, is a formidable list of advantages.

Different Coils Require Different Screen Voltages.

Consideration will now be given to the potentials which should be applied to the various electrodes. The control grid with the battery-type of valve need not be biased negatively by more than 0.9 volt. A battery giving this voltage has been developed for *The Wireless World* by Messrs. Siemens Bros., and can be used with confidence. With mains valves, in order to prevent the signal from encroaching into the grid-current zone, at least 1.5 volts negative bias is required. This can be obtained most conveniently by "self-bias," using the voltage drop in a resistance in series with the anode-current return circuit. The anode voltage of a screened valve is not critical, but should be kept as near the makers' maximum figure as possible. Screen voltage, on the other hand, is rather critical and, incidentally, controls the anode current far more than the anode potential. As the screen current is likely to be a milliamp. or less it is unsafe to feed this electrode through a series resistance from a point of high potential, for small changes in current would be accompanied by comparatively large changes in applied pressure. Use should be made of a potentiometer shunted across the anode supply so arranged in value to pass about four times the screen current.

The impedance, amplification factor and, therefore, mutual conductance of a screen-grid valve are so profoundly modified by the screen voltage that it is impossible to quote these constants unless the exact

The Valve at its Best.—
conditions of measurement are specified. Since stage gain depends, in the case of tuned-grid and tuned-anode coupling, upon the relation between the internal and external impedance, also the working amplification factor, there will be only one screen voltage giving maximum amplification. It is quite possible for a good tuning coil to require only half the screen volts demanded by a bad coil. In Table 1 are given the optimum screen volts to obtain the highest possible stage gain with different coils. The figures are taken from *The Wireless World* laboratory test of the Cossor 215 S.G. valve. In the case of poor coils the valve has to supply more power to compensate for the losses in the tuned circuit.

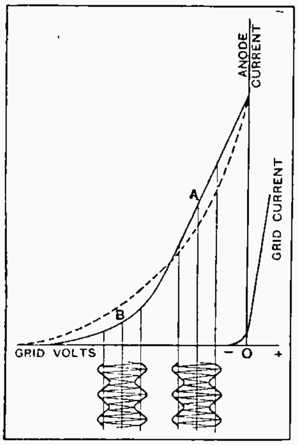


Fig. 3.—Showing how a curved characteristic can produce cross-modulation and modulation distortion.

As a generalisation it can be said that the higher the impedance of a valve the more curved are its characteristics. Screened valves, therefore, with impedances of a megohm and half a megohm must perforce suffer from non-linear properties, and it was not until the advent of certain powerful stations, both in this country and abroad, that a number of aggravating interference effects were really brought home to the amateur using these valves. It is possible, as a result of the curvature referred to, for the signal voltage of an unwanted station to be rectified and for the low-frequency impulses to modulate the carrier of the wanted station so that the two stations are heard together,

TABLE I.

Coil.	Stage Gain.	Optimum Screening Grid Volts.
4 in Litz R = 460,000 ohms.	420	50
3 in Litz R = 225,000 ohms.	240	55
1¾ in solid wire R = 100,000 ohms.	125	70
Good plug-in coil R = 50,000 ohms.	70	80

R is the dynamic resistance at resonance.

although the selectivity of the tuned circuits is ample to separate the two stations in the ordinary way. This is known as cross-modulation, and to preclude any but the desired station from being impressed upon the grid of the first valve it is almost essential, under modern conditions, to use a pre-selector or band-pass input circuit. Furthermore, to ensure that cross-modulation will not occur at one end of the waveband, it is desirable to use an input filter with constant peak separation.

Another aid is a pre-H.F. volume control, which may take the form of a potentiometer in the aerial circuit and may be ganged to a second volume control arranged to adjust the screen-grid or control grid voltage of the first H.F. valve so as to reduce the level of valve noise as the signal strength is decreased. On no account should the volume of a loud signal be reduced by altering screen or bias volts unless the signal input is decreased at the same time.

The greater the load in the anode circuit, that is, the better the coil, the worse is the cross-modulation likely to be. This suggests that the anode should be tapped into the coil, which also has the effect of throwing the anode-screen capacity on to a portion only of the tuned circuit. In Fig. 3 an ideal screen-grid valve characteristic A B is shown. When the signal is applied at B cross-modulation would be very evident, but absent when working at A. The average characteristic of a modern valve is more like the dotted curve in which cross-modulation could occur at any bias point.

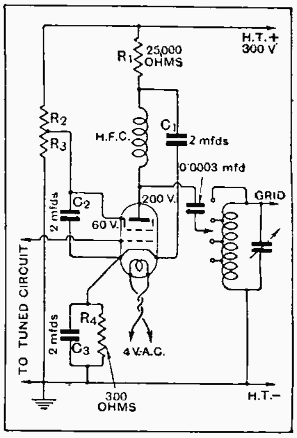


Fig. 4.—A typical screen-grid stage. Note that the anode is tapped into the grid coil to ensure stability, a minimum of cross-modulation and the transfer of only a fraction of the anode-screen capacity across the tuned circuit. The tuned input circuit should be of the band-pass type.

There is another effect due to partial rectification. The positive fringe of the modulated carrier may be amplified more than the negative fringe and the output of the valve will contain a greater average modulation than the original, resulting in distortion. A third effect, due to the same cause and especially evident when the valve is worked with a large bias, is the production of modulated hum in the case of mains valves. Happily these last two annoyances are reduced very considerably by applying the remedies for cross-modulation, and by maintaining optimum voltages on the electrodes of the valve.

A typical screen-grid circuit for a single stage of amplification using a mains valve is given in Fig. 4. Assuming that the valve requires a negative bias of $1\frac{1}{2}$ volts when the screen and anode have applied voltages respectively of 60 and 200, and that the screen and anode currents are 1 mA. and 4 mA.s, we can work out the values of the various voltage-dropping and decoupling resistances, also the self-bias resistance R_4. With power-grid detection and high-voltage pentode output, the anode potential for the H.F. stage is likely to be about 300 volts. The anode decoupling resistance R_1, therefore, must drop 100 volts at 4 mA. and must be made equal to $100/0.004 = 25{,}000$ ohms.

The value of R_4—the self-bias resistance—must be such that 5 mA.—the total anode and screen current—cause a voltage drop of $1\frac{1}{2}$. From Ohm's law we get $R_4 = \frac{1.5}{0.005} = 300$ ohms. With modern S.G. valves this form of bias has no detrimental effect, since a consider-

The Valve at its Best.—
able difference of potential between cathode and heater can now be tolerated. The only grid decoupling needed is the 2 mfd. condenser C_3 across R_4.

As it is difficult to prevent small leakage currents of about ½ to 1 microampere from flowing in the grid circuit of a mains valve it is not advisable to decouple this circuit with high resistances of the order of 1 megohm. One microamp. of leakage current through 1 megohm will cause a positive bias of 1 volt which will cancel the negative bias, and the resulting selectivity will be appalling.

The screen potentiometer R_2, R_3 must be of such a value that 60 volts are applied to the screening grid, and that about 4 mA. are wasted when the valve is cold. If R_2 is made 50,000 ohms, and R_3 15,000 ohms, these conditions will be satisfied. It is important that the screen-cathode condenser C_2 should be non-inductive and possess a small fraction of one ohm H.F. resistance at, say, 1,000 kc. If any appreciable impedance is connected at this point the valve will behave like a triode and lose its attractive H.F. properties.

Valve hiss is much accentuated by a high external resistance between grid and cathode; it is, therefore, not desirable to use two stages of tuned anode coupling unless the grid leak of the second valve has a very low value.

To eliminate valve rectification in H.F. stages, to which considerable attention has been drawn lately, it would appear that development may lie in the production of a low-impedance screened valve, such as a screened pentode, as suggested in *The Wireless World* in December 17th, 1930, issue, or the "variable-mu tetrode," described briefly elsewhere in this issue.

Readers will be interested in the new metal-sprayed valves, illustrated herewith, in which a thick coating of zinc covers the bulb and is connected internally to the cathode in A.C. valves and to one of the filament pins (suitably marked) in battery valves. The earthed shield so formed avoids the necessity of using a separate cylindrical valve screen, and assists in minimising hum and stray coupling. By virtue of continuing externally the internal screen between anode and grid the coating also has the effect of reducing the working interelectrode capacity. It must be remembered that should the metal covering touch any earthed screening boxes the bias resistance (if grid potential is derived as in Fig. 4) will be short-circuited, and in a battery valve if the wrong filament leg is earthed the L.T. battery might be damaged. It is understood that these valves will be sold at the same price as the ordinary valves. Metal-sprayed detector valves, with which screening is of particular importance, will also be available. Output valves will not be screened in this way.

CLUB NEWS.

Preparing for Summer.

At the beginning of the "open-air" season it was appropriate that at the last meeting of the winter session of the Bristol and District Radio and Television Society the subject should have been the design of a portable radio receiver. The Society was fortunate in securing as lecturer Mr. Frank Murphy, of Murphy Radio, Ltd., who dealt with the many problems in portable design, where lack of space so often necessitates a compromise. Making frequent use of the blackboard, the lecturer emphasised how it was possible theoretically to determine the efficiency of a set before it actually went into production.

A summer programme is being arranged, and enquiries will be welcomed by the Hon. Secretary, Mr. G. E. Benskin, 12, Maurice Road, St. Andrews Park, Bristol.

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From D.C. to A.C.

In view of the imminent change-over from D.C. to A.C. in the Southend district, the recent lecture by Mr. Russell Wood, of the Igranic Electric Co., Ltd., before the Southend and District Radio Society, was especially appropriate. Mr. Wood dealt with metal rectifiers, with particular reference to the Igranic-Elkon method.

Hon. Secretary: Mr. F. J. Waller, 49, Fermoy Road, Thorpe Bay, Essex.

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D.F. in Birmingham Area.

Moving iron, pleated diaphragm and double cone, reed type, balanced armature, four-pole balanced armature, true-balanced armature, dynamic inductor, moving coil, and "freaks"—these were the types of loud speaker dealt with in a comprehensive lecture on loud speaker designs of the last seven years delivered by Mr. A. F. Poynton at the last meeting of Slade Radio (Birmingham).

The proposed summer direction-finding tests are arousing keen interest, and many members have signified their intention of taking part. The Society invariably organises a vigorous open-air programme, and it is hoped that 1931 will yield as successful a season as those in the past. Particulars of forthcoming plans may be obtained from the Hon. Secretary, 110, Hillaries Road, Gravelly Hill, Birmingham

For Portsmouth Enthusiasts.

"Inside or outside aerial for reception?" was the "knotty" question discussed by members of the newly formed Portsmouth and District Wireless and Television Society at their recent fortnightly meeting in Pinks' Lecture Room, Surrey Street. The balance of opinion was in favour of the inside aerial.

The Society has now completed the groundwork of formation, but many vacancies still exist for members, and it is hoped that enthusiasts in the Portsmouth and Southsea area will write for particulars to the Hon. Secretary, Mr. H. E. Christie, 94, Suffolk Road, Southsea.

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New Society in Exeter.

The newly formed Exeter and District Wireless Society is rallying new members to its standard, but it is hoped that many more enthusiasts in the district will respond by getting in touch with the Hon. Secretary, Mr. Bartlett (5QA), 95, Tiverton Road, Exeter.

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Output Valves.

A lantern lecture on "Output Valves" was the attraction at the last meeting of the South Croydon and District Radio Society, the lecturer being Mr. Furner, of the Mullard Wireless Service Co., Ltd. The lecturer emphasised that to-day the power valve was called upon to deal with large outputs, signals being at much greater strength than formerly. After stressing the excellent characteristics of the pentode, the lecturer described the methods of determining power output, and the members were shown, by means of lantern slides, how, with the graphical method, curves at different grid voltages were plotted on a valve current against anode voltage graph.

The Society's winter season was concluded on Tuesday last with the annual dinner.

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

A Superhet. in Liverpool.

A modern superheterodyne receiver, using screen-grid valves in the two intermediate stages, was demonstrated at the April meeting of the Liverpool Wireless Society. In view of the present congested state of the ether it was a revelation to many members to find stations on the long and medium waves free of interference.

The next meeting will be held on May 14th, and full particulars can be obtained from the Hon. Secretary, Mr. G. Miller, 1, Rosedale Avenue, Great Crosby, Liverpool.

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Home-recording Demonstration.

A home-made record of the Prince of Wales's speech at the British Empire Exhibition in Buenos Aires was reproduced at a recent meeting of the City of London Phonograph and Radio Society. The lecturer was Mr. Arthur Kingston, inventor of the well-known "Kingston Home Recorder." Mr. Kingston first demonstrated his "Acoustic" model and then showed how the "Broadcast" model was used. The lecturer also demonstrated his new microphone, with which ordinary speech could be easily recorded at a distance of four yards.

The Society is anxious to develop the radio side of its activities, and will welcome new members. Meetings are held monthly at the Food Reform Restaurant, Furnival Street, Holborn. Full particulars can be obtained from Mr. R. H. Clarke, 5a, Tynemouth Terrace, Tottenham, N.15.

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Demonstrating the Stenode.

At the last meeting of the Croydon Wireless and Physical Society the members were entertained by an interesting explanation of the Stenode Radiostat, together with a demonstration by Mr. F. W. Smurthwaite.

The lecturer explained all the details of the circuit, and demonstrated an all-A.C.-operated receiver, the selectivity of which excited considerable comment.

Visitors are heartily welcomed at any of the meetings. The next meeting will take place on May 18th, 1931, at 8 p.m., at 5, Altyre Road, East Croydon.

Particulars regarding membership, etc., may be obtained from the Hon. Secretary, Mr. H. T. P. Gee, Staple House, 51 and 52, Chancery Lane London, W.C.2.

Unbiased....

By FREE GRID.

Why Not a Switch-boy?

BUSINESS cares have recently taken me to one or two of our larger provincial cities, and I notice that in several restaurants high-class radio receivers have been installed. Some of the music provided by the B.B.C. is very pleasant, but long announcements are very irritating. During talks and news bulletins, of course, the receiver is shut off, but the restaurant proprietors ought, I think, to keep a boy handy to switch off during long announcements which sometimes occur between musical items, since one can seldom hear what is said, and the net result is irritation, indigestion, dissatisfaction with the restaurant, and consequent loss of revenue to the proprietor. It is obvious from my highly logical argument that the wages of a boy specially trained to be snappy on the switch would be an actual economy. I remember that some years ago a West End restaurateur of my acquaintance who had lifted himself from poverty to riches by shaking the dust, or, rather, mud, of Manchester from his feet and acquiring an Italian name, a foreign accent and a garlicy "atmosphere," approached me with the suggestion that I design him a wonderful set which would automatically switch itself off when speech came along and switch itself on again when music reappeared.

Voice-controlled Set.

I was rather amused at his suggestion, but, nevertheless, introduced him to a young friend of mine who was by way of being an expert on tone filters. I was surprised to learn some weeks later that he had jolly nearly succeeded and would have done so completely if he could only have persuaded the human voice to confine itself to one end of the musical scale. As it was, the apparatus actually did function after a fashion and switched off when an announcer with a certain type of voice came on the air. Unfortunately it suffered from the defect that it did not respond to all voices.

New Wine in Old Bottles.

I had a very interesting discussion the other day with a well-known set designer, whose name is not unfamiliar to readers of *The Wireless World*, concerning the "life" of a radio set. We had been discussing our pet topic in a general way with particular reference to the depth of pocket which it is necessary to have in order to keep pace with the rapid progress of radio. He maintained that any set built to a design which had appeared more than six months previously was obsolete and ought to be ruthlessly scrapped, whilst at half that age—so he averred—a set could be considered to be "well hung." I reminded him, however, that if this were so there would soon be none but millionaires in the game, as the ordinary citizen simply could not afford to scrap everything twice a year. However, he stuck to

Snappy on the switch.

his guns—or rather his grid leaks, as I suppose I should say—and roused me to wrath by maintaining that in nearly all cases the parts of an obsolescent set were unsuitable for use in a new design.

Unfortunately for him, however, he immediately delivered himself into my hands by citing as a specific instance a receiver of his own design, details of which were given in this journal a few months ago. Now it so happened that I had only recently inspected a model of this particular perpetration of his which had been brought completely up to date by an enthusiastic amateur, the total expenditure for the renovation being less than the price of a wireless licence, and I maintained that the performance of the set was every bit as good as if a completely new receiver costing upwards of twenty pounds had been constructed.

Of course, a considerable amount of ingenuity and hard work had been put into it, which was, however, only to be expected of one who was an enthusiastic amateur in the literal sense of that much misused expression. It is my contention that no real enthusiast need ever plead expense as the reason for his set not being in keeping with the best modern practice. Unfortunately, however, it must be conceded that there are very many home constructors who have allowed themselves to descend to the level of mere blue print fiends and are, perhaps, more aptly described as "shamateurs" than as amateurs.

Using Old Parts.

There are many such people who have, according to their own confession, regularly "taken in" all the wireless periodicals for years and studied all designs, and yet apparently have learnt nothing either of theory or constructional work, and naturally enough when a new development comes along they are completely at a loss concerning the best method of incorporating it into their sets. I have even heard it said, although I must admit that this places a great strain on my credulity, that some amateurs (*sic*) of several years standing will still permit themselves to be seen nakedly and unashamedly studying a practical wiring plan.

At the same time, however, I think that in the interest of beginners and of those who are not fortunate enough to have ample leisure in which to make a real study of their hobby, set designers might with advantage give a few hints from time to time concerning the best method of remodelling obsolescent sets of their own design, using as many as possible of the original parts and of modifying the construction of the components where the latter course is within the limits of the skill and the workshop equipment of the ordinary man.

CURRENT TOPICS

TELEGRAMS FROM THE AIR. A passenger in a German "Luft Hausa" liner availing himself of the new "plane to ground" radio telegram service, by which messages at 2/- per word can be despatched over the ordinary postal systems to any locality in Europe.

BRITAIN AND GERMANY IN LICENCE RACE.

Germany seems likely to beat Great Britain in the race for the four millionth receiving licence, though the disparity will not be great, despite Germany's larger population. The latest German figure is 3,750,000, compared with 3,626,186—the British total for March.

oooo

THE OFFICE SET.

An "office radio" for business men, taking the form of a midget portable, is under production by the Radio Corporation of America. Meanwhile, the broadcasting authorities are arranging daily business transmissions consisting of morning news, market reports and other items of importance to office workers.

oooo

SOUTH AFRICA'S NEW SHORT-WAVE STATION.

Programmes from South Africa may soon be available to short-wave listeners in Britain. We hear that one of the schemes for distributing the Capetown, Johannesburg and Durban programmes over sparsely populated areas of the Union is the provision of a short-wave transmitter at Bloemfontein South Africa possesses approximately 25,000 listeners.

oooo

TONSIL REMOVAL BY RADIO.

To be operated on by a "radio knife" is a privilege in store for American hospital patients. At the Atlanta Surgical Congress Mr. H. C. Lowry, of Chicago, recently explained that the radio knife may be used in any type of surgery, with bloodlessness and quick healing as its chief advantages.. Technical details are not available, but Mr. Lowry, we read, stated that the patient "serves as the antenna of the set and the vacuum tube pulls the radio frequencies generated over the desired area. A tonsil operation is play."

oooo

VATICAN'S "STAND BY PLEASE."

The wireless receiver is sometimes a tyrannical instrument, and among the latest persons to be placed at its beck and call are the Cardinal Archbishops and diplomatic representatives of the Roman Catholic Church. In a new Vatican instruction it is required that these personages must in future hold themselves in readiness at certain times to receive possible communications from the Vatican wireless station. Sets are being forwarded from Rome to dignitaries all over the world.

oooo

BROADCAST PROPAGANDA PROBLEMS.

Diplomatic complications seem likely in connection with the new 100 kW. propaganda broadcasting station now under construction at Luxembourg, which will derive its income from the diffusion of advertisements. No broadcast advertisement being permitted in Germany, it is felt that many German firms will avail themselves of Luxembourg's special facilities, while it is equally probable that French firms will also jostle for space. Some interesting clashes seem likely.

oooo

KILL JOY.

A Paris landlord stipulates that prospective tenants must bring "neither cats, dogs, nor radio receivers."

Personally, we find landlords a greater nuisance.

oooo

A CASE FOR THE CURFEW.

The "curfew" law in many French towns, forbidding the use of loud speakers after 10 p.m., has recently been described as illegal, but the councillors of Bourg (Aisne) have parried with the interesting discovery of a curious local Order of 1885. This forbids citizens after seven in the evening to "practise on trumpets, horns, cornets, drums and similar instruments," and the councillors consider that wireless falls under the same ban, "inasmuch as it reproduces all the offending instruments"!

oooo

POLYTECHNIC LECTURES ON VALVES.

A course of six weekly lectures on Thermionic Valves will be opened on Wednesday, May 13th, at the Polytechnic, 307-311, Regent Street, London, W.1, the lecturer being Mr. W. H. Date, B.Sc., A.M.I.E.E. The lectures, which will last from 6.30 to 8.30 p.m., are intended for those engaged or interested in wireless, radio gramophone and talking film work, and cover the latest developments. The fee for the course is 7s. 6d., and full particulars can be obtained on application.

GRAMOPHONE BROADCASTS BANNED.

The banning of all gramophone broadcasts is the reported decision of the Danish broadcasting authorities. We learn that the measure is inspired by the prevalence of unemployment among professional musicians.

oooo

BINGLEY SAYS "NO."

The Bingley (Yorks) Urban Council has refused an application for permission to operate a radio relay service. "We do not feel," said a Councillor, "that it is desirable to have a network of wires from house to house in Bingley."

oooo

BALLOON SET TO TRACK AIR CURRENTS.

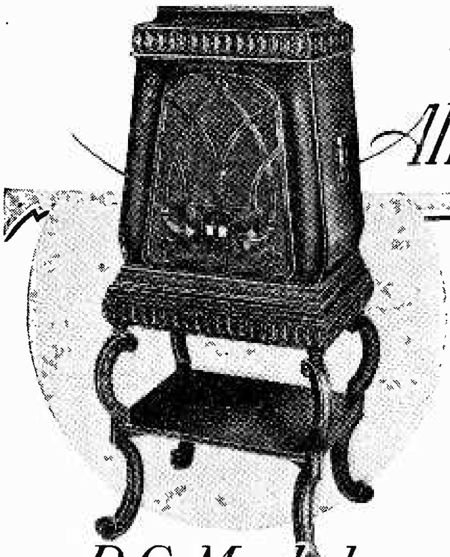
Our Washington correspondent reports that an automatic radio transmitter that is attached to free balloons and then tracked by radio direction-finding apparatus to trace air currents has been developed by Major William R. Blair, of the Army Signal Corps. Believed to be the smallest and lightest radio transmitting outfit ever built, the weight of the combined transmitter, antenna and battery is only 17¼ ounces. It is said to be capable of sending on a wavelength of 130.4 metres for distances up to 25 miles.

oooo

BARTHELMY'S TELEVISION DEMONSTRATED.

A French television system—that of M. Barthelmy—excited some interest when demonstrated a few days ago at the Electrical High School at Malakoff. According to our Paris correspondent, moving images from a studio at Montrouge, a mile and a quarter away, were picked up on an "Isodyne" receiver and gave a luminous picture 40 by 30 cms. in a well-lighted saloon. The image was described as "jerky and uncertain," but plainly discernible to those immediately in front.

"THE NAT"
All Electric Radio Gramophone



D.C. Model

A Two-valve Detector-L.F. Set Designed for Mounting Either on a Table or Pedestal Base.

SPECIFICATION.

GENERAL: For operation with external aerial on D.C. mains supply, 230—240 volts.

CIRCUIT: Regenerative grid detector, transformer-coupled to a pentode: both valves indirectly heated and wired in series. Transformer output to moving-coil loud speaker.

CONTROLS: Tuning condenser, reaction condenser, aerial series condenser, wave-range switch, radio-gramophone switch, pick-up potentiometer, on-off switch.

IT has more than once been suggested in this journal that the prospective purchaser of a broacast receiver would often be able to save himself unnecessary expense if he were able to form a concrete idea as to what he expects of it before making a final choice. Although long-distance reception possesses undoubted attractions, it is not everyone who cares to listen to foreign programmes, and for these it is clearly an extravagance to buy a comparatively elaborate and expensive long-range set if little or no real use is to be made of its sensitivity.

In spite of increasing difficulties with regard to interference, the two-valve detector-L.F. set is still capable of satisfying the needs of many listeners so far as its range is concerned; as to quality, there is not the slightest technical reason why its capabilities should be inferior to much more ambitious multi-stage receivers. The same holds good when we come to consider power output from the loud speaker; after all, the great majority of long-range sets differ from the simpler outfits only in that they embody an H.F. amplifier, which has no bearing whatever on the maximum volume that can be obtained before overloading sets in.

Valve-heating Elements in Series.

The "Nat" radio-gramophone, with which we are here concerned, includes a simple detector-L.F. circuit, and, naturally, has no pretentions towards exceptional sensitivity or selectivity. As an AC/PEN output valve is fitted and is run under nearly optimum conditions (as nearly as limitations of D.C. mains voltage will allow), volume is above the average.

From the accompanying circuit diagram, it will be seen that the heaters of detector and output valves are connected in series and are joined across the mains through a limiting resistance of 240 ohms. Anode current is, of course, obtained from the same source, but grid bias for both valves is derived from a dry battery. This procedure may be criticised on the grounds that the battery will require periodical examination, the need for which could be avoided by fitting an "automatic" bias system. But it must not be forgotten that, in dealing with a D.C. mains set, bias obtained in this way is at the expense of anode voltage, which will be reduced to a corresponding extent.

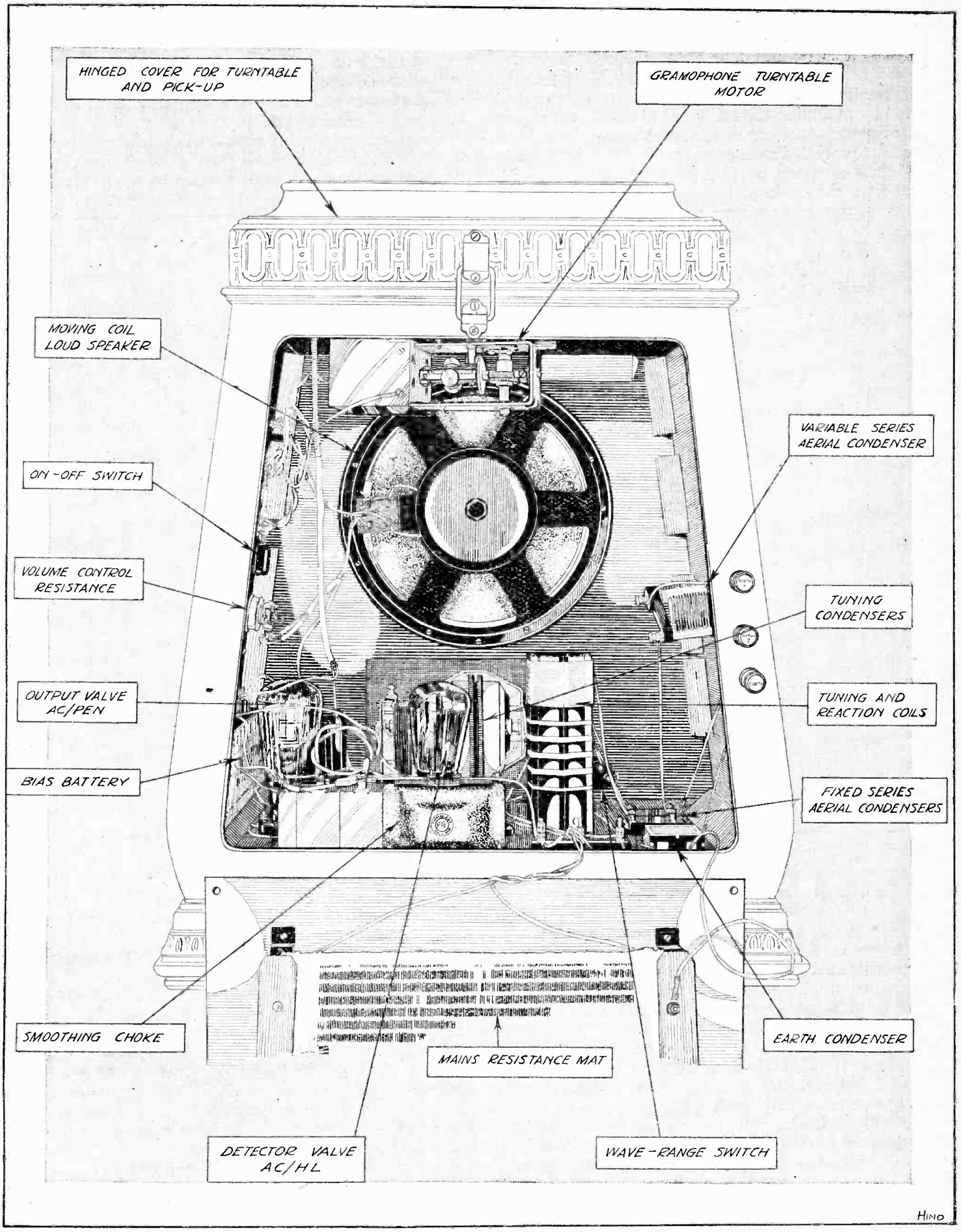
Alternative aerial terminals are fitted, so that connection may be made either through a fixed capacity of 0.0003 mfd. to the high-potential end of the grid coil, or, when greater selectivity is needed, through a variable condenser of 0.0005 mfd.—a capacity which, incidentally, seems to be rather unnecessarily large, as most of the useful control of aerial coupling takes place over the lower part of the scale. This second connection is made to the centre point of the medium-wave winding, and a large mica condenser is inserted in series as a safety measure.

The detector grid circuit is almost orthodox, both as regards values and connections, and works at a fairly low anode voltage, consuming about 3 milliamperes. It is noticed that the reaction coil is wound in two sections, connected in series and in inductive relationship with medium- and long-wave windings. The valve is operated with a small positive potential for radio reception, bias polarity being reversed, of course, when it is converted into an amplifier for gramophone reproduction.

A straightforward transformer coupling serves to link the detector and pentode, the former valve being fed with H.T. current through a "decoupling" circuit.

A Varley output transformer is fitted between the output valve and built-in moving-coil loud speaker, across the speech coil of which is connected a variable resistance which acts as a volume control. The loud speaker field winding is energised directly from the mains, and consumes some 60 milliamperes. The turntable motor is supplied in the same way, and its frame is earthed through a pair of small condensers.

Tuning and reaction condensers are controlled through side-by-side edgewise dials which project through the front panel, on which the wave-range and radio-gramophone change-over switches are also mounted. The remaining controls are fitted to the sides of the cabinet.



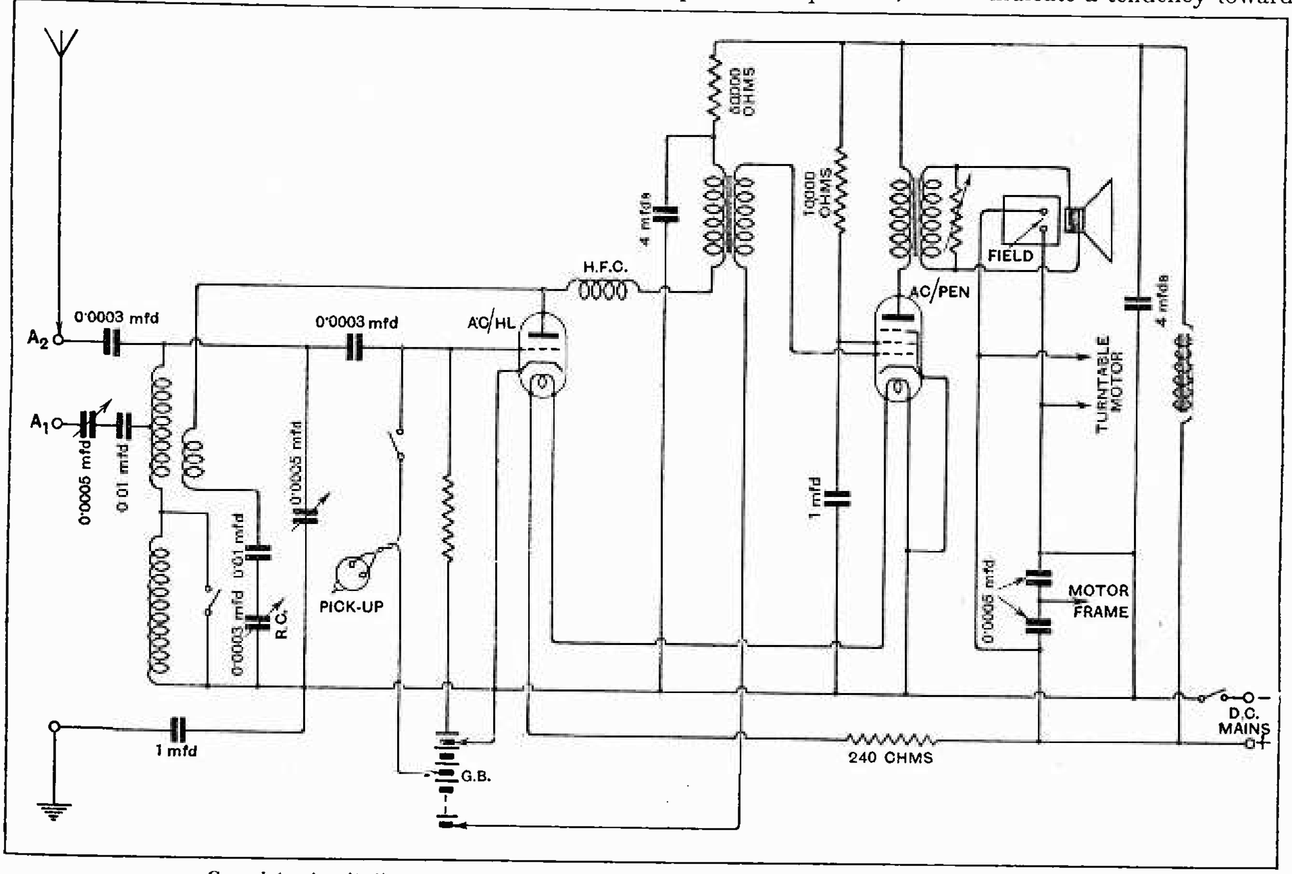
"The Nat" radio-gramophone as seen from the rear: the resistance mat, with its protective metal cover, has been displaced.

"The Nat" All-Electric Radio-Gramophone.—

As nearly a quarter-kilowatt is dissipated in the main resistance, it is natural that a considerable amount of heat should be generated. Any harmful effects that might result from an undue rise in temperature are avoided by mounting the resistance element, in the form of a woven wire-asbestos mat, at the back of the cabinet, where it is protected by a metal cover fitted with an internal cowl or scoop by means of which heated air is ejected from the cabinet.

it is possible to work with a loose aerial coupling, thus obtaining extra selectivity. Although it is generally agreed that a set of this type should not be advocated for long-distance reception, it is possible, in favourable circumstances and when receiving conditions are good, to hear a number of foreign stations.

Regarding quality of reproduction, there is plenty of bass and a more than usually well-marked upper register, but a slight "flutter," accompanied by the production of spurious frequencies, would indicate a tendency towards



Complete circuit diagram. A volume-control potentiometer is built into the pick-up carrier.

All components used are of well-known makes, and include a B.T.H. turntable motor, Harley pick-up, Mullard L.F. transformer and mica condensers, Hydra paper condensers, and Telsen H.F. choke.

As shown in the title illustration, the cabinet is of unusual design; it may be mounted on a special detachable base or simply stood on a table or other suitable support. Dark oak is the material chosen, and both construction and finish are excellent.

As stated above, consumption of current from the mains amounts to about a quarter-kilowatt, and so a single unit will operate the set for some four hours, thus the cost of running may readily be estimated.

Sensitivity and selectivity are well up to the standard to be expected from a simple detector-L.F. set; indeed, due to the use of highly efficient modern valves, and particularly of the pentode, overall amplification is considerable. Reaction control, if not especially constant, is reasonably free from backlash, and, in consequence, L.F. reaction. This applies to both radio and gramophone reproduction, but it was found that, in the case of the model actually tested, a considerable improvement could be effected by making a slight reduction in supply voltage. Smoothing seems to be entirely adequate, as hardly any hum could be detected when operating the set on D.C. mains which are by no means free of commutator ripple and other irregularities. The output volume control is satisfactory, provided that the resistance is not set at too low a value; this means, in practice, that it should be operated, when receiving wireless signals, in conjunction with the series aerial condenser and reaction dial; when gramophone records are being reproduced, the pick-up potentiometer provides sufficient regulation.

As a table model, the set costs £26 complete, £4 15s. extra being charged for the stand. The makers are A. H. Fellows & Son, 119, Soho Road, Handsworth, Birmingham.

New B.B.C. Dance Band?

Is the B.B.C. about to start a new campaign against "song plugging?" Some such inference may be drawn from the fact that the Corporation has been busy giving auditions to a number of dance bands at Savoy Hill. This practice has never been followed in regard to "outside" bands, and I gather that the intention is to pursue the suggestion recently referred to in these columns, viz., to engage an alternative "inside" band to Jack Payne's.

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Suppressing "Song Plugging."

By ringing the changes betweeen two "official" bands the B.B.C. would avoid the necessity of engaging outside combinations, and, therefore, let us presume, the reproach associated with the subsidising of dance band conductors by the music publishers.

But I am not sure that listeners would be anxious to forgo all hotel dance music even for the sake of such a sacred cause.

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A "Broadcasting House" Yarn.

That favourite "chanson triste"—the alleged poverty of the B.B.C.—is given a new variation in the tale now going the rounds that the Corporation is desperately borrowing from "the bank" in order to pay for "Broadcasting House."

Dismissing the question of security (though one wonders whether "the bank" would dismiss it), there is still a sufficiently cogent reason for unbelief.

oooo

Rent Day.

The truth is that the B.B.C. has never intended to buy "Broadcasting House," which will remain the property of a syndicate. The Corporation will begin its tenancy within the next month or two; in fact, rent will be due from the time that the last workman leaves the building, although the Corporation will not enter into occupation until the interior decorations and wiring are completed, probably early in August.

oooo

Wiring Innovations.

The wiring is regarded as one of the most important features in this, the first building in Britain specially constructed for broadcasting purposes. Certain of the floors and ceilings have been designed to open, so that rapid wiring tests can be carried out in the event of circuit breakdowns.

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Removal Doubts.

The actual process of removal from Savoy Hill to Portland Place is expected to occupy at least three or four weeks. The optimists are hoping that all will be "safely gathered in" before the harvest moon, but people who have examined the office accommodation at "Broadcasting House" are wondering whether everybody will be stowed in by Christmas.

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King Alfonso.

I am reliably informed that several determined efforts were made to bring King Alfonso to the B.B.C. microphone. Apparently His Majesty was in no mood to discuss recent events.

BROADCAST BREVITIES

By Our Special Correspondent.

Midland Regional Surprise.

The rather surprising increase in the signal strength of Midland Regional, following the drop in wave-length from 479.2 to 378.9 metres, is now explained. The engineers wisely made the wave change the occasion for adopting a new aerial system with masts 500ft. high in place of the original 300ft. antenna. This stroke of genius has compensated for the otherwise inevitable reduction in radiation due to the lower wavelength.

In N.W. London I find Midland Regional quite as powerful as the old 2LO in Oxford Street.

oooo

Mr. Burrows on High-power Stations.

It was comforting on Wednesday last to hear such an authority as Mr. Arthur Burrows refuting suggestions of an eventual power war in the ether. The talk of the Secretary-General of the Union Internationale de Radiodiffusion strengthened my belief in the influence and discretion of his organisation, which, as he showed, is using every legitimate means to keep a controlling finger on all European stations.

oooo

Optimism.

While trying to enter into Mr. Burrows' optimism, however, I cannot forget one of his closing remarks: "High-power stations are found by experience to be essential if rich and poor, townsfolk and those isolated in country places, are alike to benefit." Exactly, and every country has made the discovery, with results that are known to every listener. I am not sure that that power war is so remote.

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The Sheffield Relay Station.

Through a slip of the pen I made it appear last week that the Sheffield relay station was among those which will shortly close down. For Sheffield please substitute Bradford.

oooo

A Reprieve.

Rather rashly, perhaps, a B.B.C. official had given notice to terminate the tenancy of the Sheffield premises on June 24th next, but the published announcement was still wet from the press when the radio-minded people of Sheffield, represented by their Wireless Advisory Committee, secured a reprieve from Mr. Noel Ashbridge, who happened to be in the city at the time. A slick piece of work.

oooo

H.M.V. Concert from Paris.

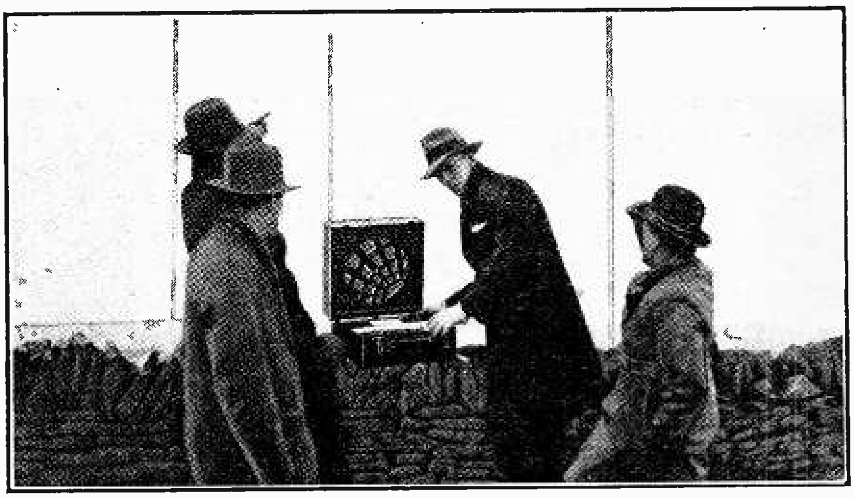
Rome is still far enough away for the majority of British listeners, who will be glad, therefore, that the "His Master's Voice" concert, originally planned for broadcasting from Rome on May 3rd, is to be transferred to Radio Paris (1,725 metres).

The concert, comprising records by famous artistes and bands, will be given between 10.30 and 11.30 next Sunday night, with a further concert at the same time on May 10th. The concerts will be conducted by Mr. Christopher Stone, and will be easily distinguished by a dog's bark preceding each item.

oooo

Murder, with Illustrations.

American broadcasting still has its bright moments. For instance, on Saturday last, according to schedule, Dean Gleason Archer, of Suffolk Law School, Boston, spoke over the N.B.C. networks on "Murder by Poisoning or Lying in Wait," offering "a variety of illustrations from actual cases that have been decided by the courts."



ON THE SPOT. Determined to scotch the notion that foreign reception is impossible in the neighbourhood of Northern Regional, Mr. C. G. Allen took a McMichael Super Range Portable to within a few hundred yards of the new transmitter. Several foreign programmes were received at full loud speaker strength and the "swamp area" of the B.B.C. station was only 25 metres on either side.

Notes on the EVERYMAN TWO

Modifications for All-Mains Operation and Gramophone Reproduction.

By N. P. VINCER-MINTER.

THE use of the "Everyman Two" receiver as a gramophone amplifier and the substitution of the batteries in it by suitable mains apparatus is quite a straightforward affair. From a considerable volume of correspondence which has been received concerning this set it is clear that those who have built it have had no difficulty whatever in using it with a commercial H.T. battery eliminator, since the substitution is quite a straightforward one, and there is ample space in the cabinet for any of the small eliminators—mainly intended to be used with portable sets—which have made their appearance during the past year. There are a large number of people, however, who wish to build their own eliminator, and in some cases to take all power from the mains, and since there is some doubt in their minds concerning the correct arrangement to use, the writer has thought fit to deal comprehensively with the whole problem in these notes.

The most common desire is to use the receiver in conjunction with a gramophone pick-up. It is quite a simple matter to do this and no complicated switching need be introduced into the set; the only extra components needed are two plugs and sockets of the type used for aerial and earth connection. These sockets should be mounted on the panel which already supports the aerial and earth connections. One socket should be wired direct to the grid of the valve, and the other socket should be connected by a piece of flexible wire to a wander plug, which should be inserted in a socket of the existing grid bias battery in order to apply a negative voltage of $1\frac{1}{2}$ to the grid of the first valve. The two plugs are simply connected to the pick-up (or to the pick-up volume control, as discussed later), and when it is desired to use the apparatus as a gramophone amplifier it is only necessary to insert these plugs into their sockets, at the same time withdrawing the aerial plug.

With regard to the question of controlling the output of the pick-up, it should be mentioned that this control must, as usual, be external to the set, a glance at Fig. 1 (which shows the set arranged for complete A.C. mains operation) will make clear how the pick-up volume control should be connected up; this control consists of a high-resistance potentiometer.

The Output Circuit.

It will be best if we now pass straight on to a consideration of Fig. 1, which shows the essential portions of the circuit with the addition of the A.C. mains apparatus necessary to dispense with all batteries. If this diagram is considered first, explanations for using an H.T. eliminator only—no matter whether it be for A.C. or D.C. mains—will be made simpler. Apart from the addition of the actual eliminator it will be seen that a choke filter output circuit has been provided, and, in addition, an H.F. stopping resistance has been put in series with the grid of the output valve. A choke filter output circuit is always advisable when mains are being used, even if the question of using an external loud speaker does not arise. The resistance R_4 is not absolutely essential, but is, nevertheless, advisable. It should have a maximum value of 100,000 ohms, and it should never be necessary to use a larger value in a simple set of this type. In position L_1 and L_2 it is possible to use any chokes made by reputable manufacturers which are definitely described by them as an output filter choke and a smoothing choke respectively.

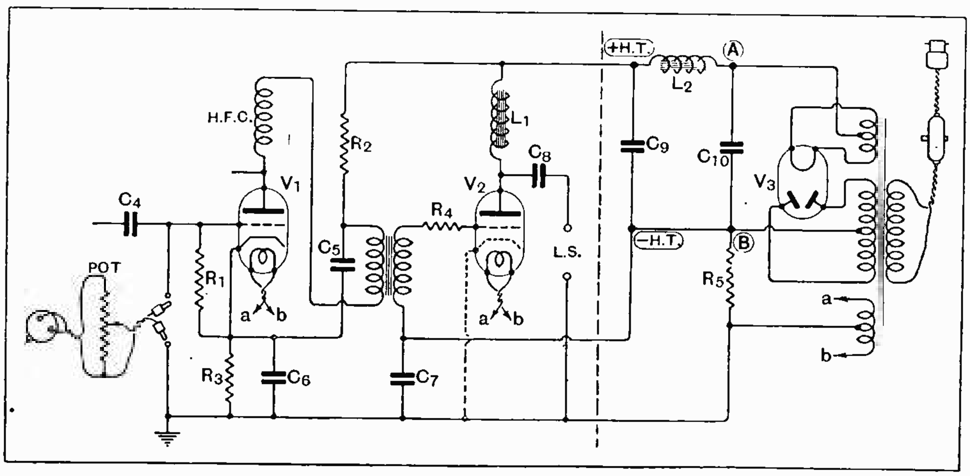
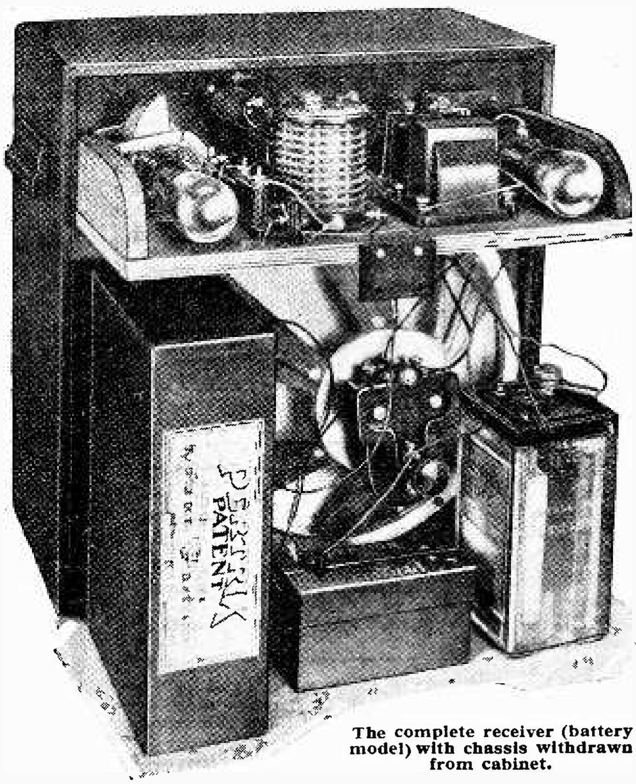


Fig. 1.—The modifications necessary when converting the Everyman Two Receiver for all-mains operation and for use with a gramophone pick-up.

The valve V_3 is an ordinary full-wave rectifying valve of the U.9 type, and the mains transformer should be one capable of supplying (in conjunction

Notes on The Everyman Two.

with the rectifying valve) an unsmoothed D.C. voltage of about 200. It must not be forgotten that the grid bias voltage which is obtained "automatically" has to be subtracted from the mains voltage, and if, therefore, the output valve chosen necessitated a plate voltage of 200, and the grid bias requirements were 30 volts, then the unsmoothed D.C. voltage would have to be not less than 230 volts. Those who prefer a metal rectifier will find Fig. 2, page 198, of the February 25th issue of this journal a useful guide to the method of connection. It is immaterial whether a directly or indirectly heated valve is used at V_2, and it is for this reason that in the diagram the cathode is shown as a dotted line. The value of R_5 should be calculated as usual by means of Ohm's law. The exact procedure is as follows:—



The complete receiver (battery model) with chassis withdrawn from cabinet.

First ascertain the plate current consumption of each valve, add these two figures together, divide by 1,000, and then divide the result into the figure representing the grid bias requirements of the output valve. The plate current and grid bias figures should be taken from the data supplied by the valve manufacturers or from *The Wireless World* "Valve Data Sheet." The procedure for calculating the value of R_3 is similar, except that the plate current of V_1 only should be taken into consideration and not the plate current of both valves.

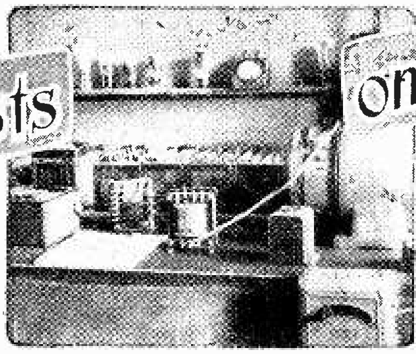
With regard to the actual eliminator, that is to say, all the components which in Fig. 1 lie on the right-hand side of the dotted line, it is recommended that this be mounted and wired up on a small piece of three-ply wood of such a size that it will comfortably fit into the bottom of the cabinet in the space normally occupied by the batteries. It will be found that there is plenty of room and the disposition of the actual components is unimportant. The possibility of converting the set to A.C. mains operation was considered when it was originally designed, and this was the reason why five-socket valve-holders were specified. It will be seen from Fig. 1 that a slight amendment to the filament circuit of the receiver is necessary. It is strongly advised that ordinary lighting "flex" be used for connecting up the valve heaters to the filament winding of the mains transformer. The grid leak, which in the original set was mounted on the actual valve holder, should be removed from this position and mounted in clips on the baseboard of the set. In the battery model of the receiver a combined wave change "on-and-off" switch was used, but as this is not of the "quick-break" type it is not advisable to attempt to put it in series with the mains. There is no need to disfigure the front of the set with another knob, however, and a "cord" switch, as shown in Fig. 1, is strongly recommended.

Owing to the fact that the overall dimensions of indirectly heated valves are somewhat large, it will be found necessary to alter the position of the valve-holders slightly, as otherwise the valves would project a little beyond the back of the set. In the case of the output valve it is only necessary to move the valve-holder back slightly; there is ample room for this to be done owing to the smallness of the reaction condenser. On the underside of the baseboard can be mounted the choke filter output components, L_1 and C_8; in fact, they can be mounted immediately underneath the output valve. It will be found that it is impossible to remove the valve-holder of V_1 farther back, owing to the tuning condenser being in the way. Since, however, the H.T. battery will be no longer in the cabinet, all that we have to do is to mount the detector valve underneath the baseboard in a position roughly corresponding to that which it previously occupied; this will mean that the general disposition of the wiring will be practically unaltered. R_3 and C_6 can be mounted in the space vacated by V_1. The sockets for the gramophone pick-up can, of course, be mounted next to the aerial and earth socket in the manner already referred to in this article.

The biasing of V_1 when a pick-up is used is quite automatic, and no switch or other complication is necessary. An indirectly heated valve having a plate current not exceeding three or four milliamperes should be used at V_1. In V_2 position any good output valve can be used, although the writer has a preference for one of the indirectly heated type. A pentode valve is, however, not advised in this particular set as it would necessitate a more ambitious smoothing scheme.

In the case of D.C. mains the rectifying valve and mains transformer will naturally not be required and the mains will connect direct to A and B, a two-volt accumulator being used for L.T. supply. It must not be forgotten that in this case the regulations demand that fixed condensers, having an adequate factor of safety, be connected in series with both aerial and earth leads.

Wireless World Laboratory Tests on New Apparatus



CLARKE'S ATLAS H.T. ELIMINATOR. Model A.C. 244.

This unit has been developed to meet the requirements of those possessing three- and four-valve battery-operated sets and who now desire to utilise the A.C. supply mains as a source of H.T. current. The maximum output current is

Clarke's "Atlas" 20 mA.-type H.T. eliminator, model A.C.244, for A.C. supply mains.

limited to about 20 mA.s, but, since a large number of factory-made sets, kit sets and portable sets do not, as a rule, demand more than some 12 mA. of H.T. current, the output is ample for the function the unit is intended to perform.

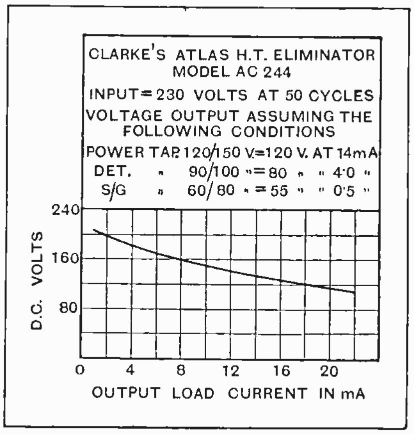
The overall size is 8in. × 5$\frac{3}{16}$in. × 3$\frac{1}{2}$in., dimensions which enable it to fit comfortably in the space reserved for the H.T. battery in portable and transportable sets.

Three output voltages are provided, nominally rated at 120-150 volts for the power valve, 90-100 volts for the detector stage, and 50-80 volts for screen potential for S.G. valves. These voltages are obtained in a manner that should ensure freedom from "motor-boating" troubles. The power valve supply is taken direct from the smoothing choke, but a series resistance is interposed between this point and the supply to the detector tapping. A fixed potentiometer is employed for the H.F. valve screen potential and each tapping has separate by-pass condensers.

Half-wave rectification is favoured, a Westinghouse unit being used, and the smoothing equipment is adequate.

Measurements were made of the output voltage at the "power" tapping at various current loads up to the maximum but without taking current from the intermediate voltage points. When current is taken from these tappings the curve shown on the graph will be moved bodily to the left; thus it is possible to compute the voltage at the power tapping if the current taken by each valve is known.

If the output valve requires 12 mA., the dector 4 mA., and the H.F. valve 3 mA., in all the total load amounting to 19 mA., then the maximum voltage available for the power valve is 118 volts. The unit was tested using a 1-v-1 receiver fitted with a pentode output valve, also with a similar set fitted with a power triode in the last stage. The unit is particularly suitable for two-, three-, or four-valve kit sets. There was no noticeable "hum," neither did we experience trouble from "motor-boating" or any other form of L.F. instability.



Voltage regulation curve taken at the "power" tapping of Clarke's "Atlas" model A.C. 244 H.T. battery eliminator.

The unit is housed in an attractive metal case, well ventilated and provided with an earthing terminal, thus complying with the I.E.E. regulations for mains-operated apparatus.

The makers are H. Clarke and Co. (Manchester), Ltd., Atlas Works, Eastnor Street, Old Trafford, Manchester, and the price is 59s. 6d.

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VOX VERITAS MOVING-COIL LOUD SPEAKER.

The model tested is a redesigned successor to the loud speaker reviewed in our issue of August 20th last. Little change has been made in the external appearance; the three-elements celluloid centring device is retained and the field magnet is finished in green enamel. It has been decided to standardise a 200-volt 100 mA. field winding for D.C. mains and to supply a separate rectifier unit, specially designed for this winding, for use on A.C. mains. Thus a purchaser who is at present on D.C. mains can buy the rectifier as an accessory if his supply is changed to A.C. at a later date. The price of the rectifier unit, including a Philips type 1560 valve, is the same as that of the loud speaker, viz., £3 15s.

In the new model a distinct advance has been made in the performance, particularly as regards sensitivity, which is now quite up to the standard which one expects from an instrument of this type. The frequency response is excellent over the range of frequencies tested, namely, 50 to 6,000 cycles. Apart from a bass resonance between 100 and 150 cycles and a slight increase of output from 4,000 to 5,000 cycles, the response is sensibly uniform over the whole range. Speech and music are reproduced naturally and without any unpleasant effects due to the bass resonance. The upper register is brilliant without showing any tendency to hiss or over-emphasise needle scratch.

In the particular model tested the field winding appeared to be loose inside the pot magnet, but it should be quite a simple matter to prevent this occurring in the future models.

The makers are the Morogoro Trading Corporation, Ltd., 12, Union Court, Old Broad Street, London, E.C.2.

Redesigned Vox Veritas moving-coil loud speaker.

oooo

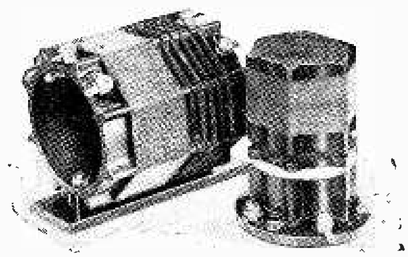
BURTON S.G. COILS.

These coils have been designed for use in single H.F. sets incorporating a screen-grid valve. The set consists of two coils, the one an aerial-grid coil and the other a tuned-grid-type H.F. coil with a reaction winding common to both medium- and long-wave portions. The aerial-grid coil is wound on an eight-ribbed ebonite former 2$\frac{5}{8}$in. maximum diameter and 3in. long. The medium-wave portion is wound in a single layer using stranded wire, and occupies just over 1in. in length. Spaced

$\frac{3}{8}$in. from it is the four-section long-wave coil, while disposed mid-way between them is the aerial coil provided with a tapping for use where a higher order of selectivity is demanded.

The H.F. coil is wound on a moulded bakelite former with six ribs, the maximum diameter of the winding being $1\frac{13}{16}$in. The medium-wave portion is a single layer solenoid occupying $\frac{7}{8}$in. in length, while the long-wave coil is wound in a single slot spaced $\frac{11}{16}$in. from it. The reaction coil is carried in a single slot suitably disposed between the two windings.

When tuned by a 0.0005 mfd. variable condenser and connected to an aerial of average size, using the most selective tapping, the wave-ranges covered by the aerial-grid coil were found by measurement to be from 206 to 579 metres and from 782 to 2,130 metres respectively.



Burton coils for single-stage H.F. receivers.

The H.F. coil was given a more searching test, especially on the medium waveband, since its qualities govern the stage amplification obtained from the H.F. valve. The inductance of the medium- and the long-wave portions were found to be 132 microhenrys and 2,870 microhenrys respectively.

When used in a tuned grid H.F. circuit fitted with a valve having a nominal A.C. resistance of some 270,000 ohms, and an amplification factor of 300, the measured stage amplification at 400 metres was 58 times. All measurements were made with the coil in a screening box of large dimensions.

The makers are C. F. and H. Burton, Progress Works, Bernard Street, Walsall, and the price is 10s. 6d. per pair.

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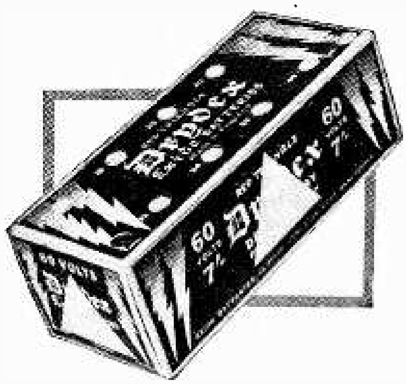
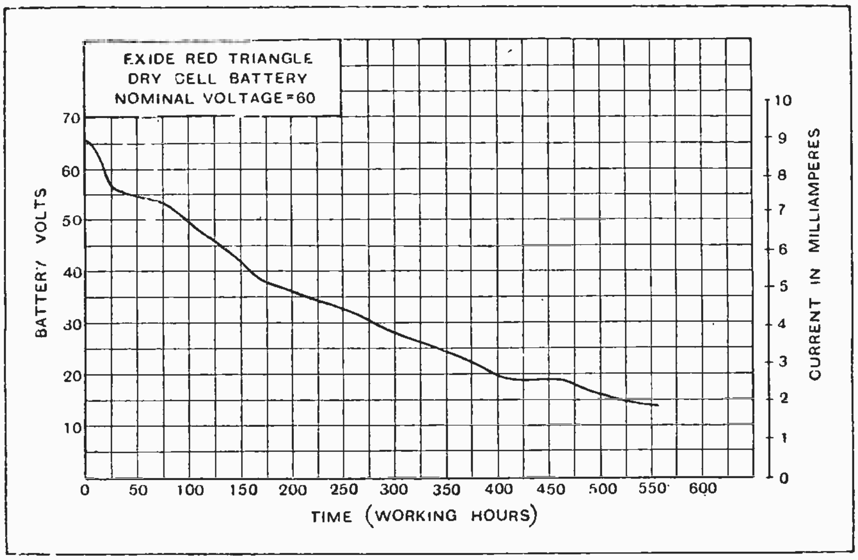


"Drydex" Red Triangle H.T. battery has a nominal voltage of 60 and is of the standard capacity type.

"DRYDEX" H.T. BATTERY.

When first we introduced to our readers the range of Exide "Drydex" H.T. batteries, a standard capacity size, officially known as the Red Triangle class, was undergoing a life test. This has now been completed, and we are able to give an account of its performance. In common with our usual practice, the battery was discharged intermittently, doing duty for four-hour spells interspersed with similar periods for recuperation. The rest periods are not shown on the graph, only the actual working hours being included.

The current was set initially at 9 mA.s, which is not unreasonable for a battery of this size, although possibly being very near its maximum economical discharge rate. This must be taken into consideration when judging the qualities of the battery.



Discharge curve of the 60-volt standard capacity "Drydex" H.T. battery.

After the initial rapid fall in the voltage, it maintained a steady rate of decline until the battery was exhausted.

If we maintain the battery in commission until the voltage per cell drops to 0.9 volt, it will give about 160 hours' work; this is equivalent to a capacity of 58 watt hours for the battery or 1.45 watt hours per cell. There are 40 cells in the battery. At this stage the battery showed 40 volts.

A further 17 watt hours can be obtained by keeping the battery in use until the voltage falls to 33, when each cell will show 0.75 volts. Thus the total capacity available to this point of discharge is 75 watt hours for the battery or 1.9 watt hours per cell with a useful life of some 250 hours in all. It is not yet moribund, but a boosting battery will be needed to raise the voltage to a useful working level.

Bearing the well-known Exide brand, "Drydex" batteries should make worthy companions to the large range of accumulators made by the Chloride Electrical Storage Co., Ltd., Clifton Junction, near Manchester.

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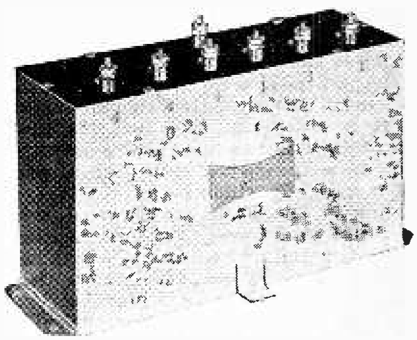
HEAYBERD BLOCK CONDENSERS.

In a modern all-mains receiver it is not uncommon to find some 20 mfds. of capacity divided up into separate units of 1, 2 and 4 mfds. each. The space occupied by these is considerable, so that where the exigencies of the design permit the use of block condensers will lead to quite a worth-while saving in space and a consequent reduction in the overall size of the receiver.



Heayberd 15 mfd. block condenser consisting of three 4mfd. sections and three 1 mfd. sections.

The block condensers made by F. C. Heayberd and Co., 10, Finsbury Street, London, E.C.2, will meet most requirements in this respect, being available in units of 15 mfds., in all divided into three sections of 4 mfds. each and three sections of 1 mfd. each.

Two types are made, the type "R," which is tested at 650 volts D.C. and costs 14s. 6d., and the type "J," tested at 800 volts D.C., the price of which is 17s. When used in A.C. circuits, such as for voltage doubling with metal oxide rectifiers, the maximum A.C. voltage must not exceed 180 volts in the case of the type "R" and 250 volts in the case of the type "J."

The overall size of the last-mentioned unit is $5\frac{5}{8}$in. $\times$ $2\frac{1}{8}$in. $\times$ 4in. high measured over the terminals.

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.

BROADCAST MONOPOLY AND WIRELESS EXCHANGES.

Sir,—The attention of the Postmaster-General has been called to the leading article in *The Wireless World* of April 15th concerning the service given by wireless exchanges.

It seems possible, from certain statements in this article, that the writer may not have been fully aware of the conditions under which the establishment of wireless exchanges is authorised. I am accordingly to inform you that any person authorised to establish a wireless exchange is required to enter into an agreement which provides that the exchange may not be used for the distribution of items other than wireless broadcast programmes sent for general reception. In particular the agreement specifies that "the licensee shall not himself originate at the stations or collect by wire any programme or item, whether musical or otherwise, or information of any kind for distribution to subscribers." In addition, the agreement provides that the Postmaster-General shall have certain general powers which would, it is considered, enable him to deal with any case in which the wireless exchange system was being improperly used.

F. W. PHILLIPS.

General Post Office,
London, E.C.1.
April 18th, 1931.

NUMBER OF VALVES AND THE PRICE.

Sir,—While it is quite true that the number of valves in a modern set does not indicate its performance, it does not follow that such information is valueless.

Take the following :—

(*a*) A four-valve set at £30 10s.

(*b*) A two-valve set at £10.

(*c*) A five-valve set at £4 19s. 6d. (1s. down and the balance by equal monthly instalments!).

It is obvious at once that the first is a real quality set, probably with two S.G., power detector, and output, and working from the mains, that quality, selectivity, and price have been carefully studied and the cost worked out to the odd shilling. The second, we can see, is simple and cheap to operate and just what Granny has been wanting. The last is a portable with two L.F. transformers, execrable quality, no range, and two H.F. valves doing little more than help to run down the 10 amp.-hour accumulator provided.

I quite agree that a better method of classification than by the number of valves would be an improvement, but there is nothing that would more readily convey to the man-in-the-street a set's capabilities. It has been found impossible for manufacturers to adopt a uniform and clear tabulation of valves. How then are they to be made to classify complete sets "intelligently"?

Any other method than that at present used is likely to be reminiscent of a Post Office form, with its letters and numbers, its strokes and hyphens and italics. And though this would be of great assistance to dealers, it would be of little use to the ordinary buyer who (worthy man!), in spite of his ignorance, prefers to choose what he likes for himself.

I heartily support your plea for more valves. Now that the pre-detector part of the set has been improved to such an extent, further improvement lies in the use of more valves with the results of easier and more complete ganging, more consistent performance, and better quality. Alas! This would also mean higher first cost and higher running costs. Even so, it should be possible to turn out, with modern production methods, a multi-valve set at a reasonable price and with performance better than those produced in America.

As long as the price of mains valves remains comparatively high, however, the restriction of the number of valves is a natural condition. The Quality Amplifier described in a recent issue would be ideal with H.F. equipment designed to suit the various ether-clearance schemes as they occur.

In conclusion I would like to comment on your statement that in America sets are not chosen by the number of valves but by their performance. This might be said of some sets sold in England. It is significant that in advertisements of American sets the number of valves is stated, often in a bold headline with a description of the set itself, thus :—

BOMBAST EIGHT-VALVE CONSOLE SUPER-HETERODYNE.

There we have it all in a nutshell. A glance at the highly coloured picture reveals one-dial control, and that is all the lucky yank wants to know. Whether he is in New York or Arizona, that set will bring in from the old Home Town the Peanut concert for which his soul yearns. And if business takes him to Nebraska for a few years, he doesn't have to call in the local expert directly he arrives because his Bombast has ideas of its own regarding D.C. mains.

But that by the way.

The point is that the American set is easily mass-produced and that the number of valves must in consequence be a criterion of performance, and there is nothing else beyond actual demonstration that will give a better.

HUGH A. RAMPTON.

Shortlands, Kent.

A NEW INDUSTRY.

Sir,—About every tenth person in this country above the age of thirty has defective vision, but when such a fate overtakes any one of us we do not despair; we set out to find an optician from whom to buy a pair of spectacles. Our search will not necessarily resolve itself to a visit to some large capital, for at practically every marketing centre a qualified optician will be found who is ready to sell us a pair of scientifically prescribed lenses mounted in what kind of frame our fancy dictates for about the sum of £1. However, let us suppose that monopoly of spectacles was in the hands of three or four London firms who at best had a few branches in the main provincial towns, and, moreover, that instead of the price being about £1 the price was about £10.

In these circumstances there is no doubt that very many fewer people would be wearing glasses, and even if the price were allowed to remain the same I firmly believe that a great number of people would be deterred from buying merely because of the inconvenience of having to go so far afield for what they were seeking.

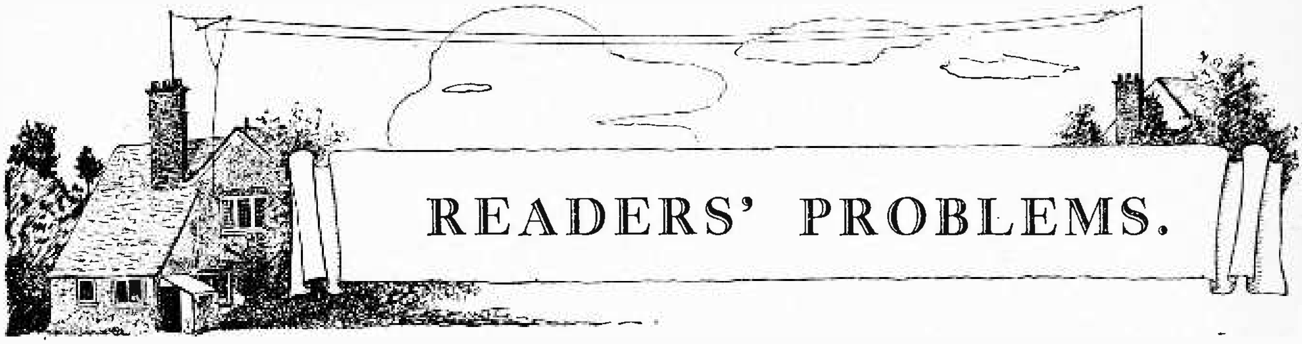
This, however, is how the state of affairs stands at the present moment in regard to electrical hearing appliances for the deaf. If one could realise the harm that would be done to the country if a million or so of its inhabitants were suddenly robbed of their spectacles, one could also gauge the benefit that would be derived in having an efficient service for the distribution of electrical appliances for the deaf throughout the country.

Who is it that is in the position to undertake this great work? Why, surely, the wireless trader. Ten years ago he was not. Five years ago he could not, but to-day his technique has developed to the necessary extent of being able to handle any article involving the reproduction of sound. If the trader has been established some years he will already have the confidence of a large number of his clients, many of whom may be in need of an acoustical instrument.

A great fillip would be given to our wireless manufacturers if they would turn their attention to this new field of industry. The price of a ten-guinea deaf aid would quickly tumble to £1 when manufactured on a mass-production basis, and would probably result in a better article being available. What person faced with the necessity of buying such an appliance would not prefer to buy a British-made article from his wireless retailer for the sum of, say, £1 than to be obliged to go to showrooms of some firm that is charging him £10 for probably a foreign and inferior article?

My opinion is that, as in the case of wireless, it needs but a spark to set this new industry ablaze.

CHARLES M. R. BALBI, A.C.G.I., A.M.I.E.E.,
Hon. Consulting Electrical Advisor to the National Institute for the Deaf.



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.

Switch Connections.

In connecting wave-range switches, which end of the circuit should be joined to the contact blades? Possibly this is not a matter of any real importance, but I suppose there is a right and wrong way of doing it.

We take it that your query relates to wave-range switches used for short-circuiting the long-wave windings: when an actual change-over of a connection is to be effected there is no option but to join the point to be changed to the moving blades or contacts. The usual rule is that the moving part of the switch should be joined to the earthed end of the circuit, although occasionally one can depart from this if it so happens that the fixed contacts are joined to a considerably larger mass of metal than the other.

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Two High-potential Connections.

When a variable condenser is inserted in series with the aerial circuit, should the aerial be joined to the fixed or moving vanes?

This is almost a matter of indifference, as both sides of the aerial condenser will be at high-oscillating potential with respect to earth. However, hand-capacity effect should not be particularly troublesome, especially if you fit a control knob of fairly large size, which will have the effect of keeping your hand at some distance from the "live" metal parts of the condenser.

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Universal Power Transformers.

In the "Readers' Problems" section of *The Wireless World* for April 8th the question of power transformers with primaries suitable for both low and normal A.C. mains voltages was dealt with. Although most of these components have tapped primaries designed for pressures between 200 and 250 volts only, the Igranic Electric Company point out that their own products have for some time been manufactured with windings for inputs between 100 and 250 volts.

This plan has obvious advantages at the present time, when many low-voltage electric supply systems are being changed to the standard pressure.

A Point of Criticism.

I am sending you a circuit diagram of a proposed H.F.-det.-L.F. set. Will you please criticise it, bearing in mind that, if possible, I do not wish to use any other components than those shown, and must restrict myself to the output of my existing eliminator, which provides about 140 volts at 23 milliamps, which, it is estimated, will be the actual current taken by the set.

The arrangement shown in your diagram should be satisfactory within the limitations imposed, and, without adding complications and extra components, we doubt if you could better it to any appreciable extent.

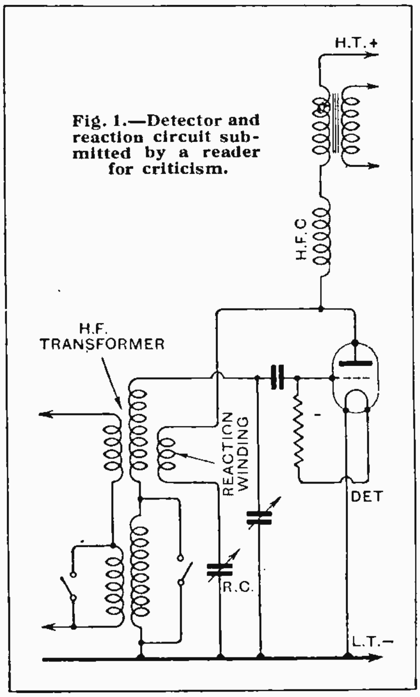

Fig. 1.—Detector and reaction circuit submitted by a reader for criticism.

There is, however, one point of criticism; we notice that the detector plate and grid circuits are to be connected as shown in Fig. 1, and that there is no anode by-pass capacity. This means that sensitivity will not be of a very high order when the reaction condenser is set at minimum, and consequently the range of the set will depend largely on adjustment of this control. To avoid this, we suggest that you join a small capacity, of about 0.0002 mfd., directly between anode and negative filament of the detector. Alternatively, you could use a differential reaction condenser connected in the conventional way, which will have a similar effect, as there will be a reasonably large anode by-pass capacity, even when reaction is not being used.

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Reducing Power-transformer Voltage.

I have a power transformer, one of the secondary windings of which supplies about 2 amps. at 7.5 volts. This output is really intended for heating the filament of a rectifier, but I wish to use it for a 6-volt output valve. Is it permissible to insert a series voltage-reducing resistance in exactly the same way as when one is dealing with a battery-fed valve?

Yes, surplus voltage may be absorbed by a series resistance, but, if a single resistance be used with a centre-tapped transformer secondary, the symmetry of the circuit will be upset, and hum may be produced. To prevent this the obvious course is to divide the necessary resistance into two equal parts, and to insert one of them in each filament lead.

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Oscillating L.F. Amplifier.

Since fitting parallel output valves to my receiver I have noticed that the set seems to become "choked" unless resistances of about 100,000 ohms are inserted directly in each grid lead. Can you tell me to what this effect is likely to be due? I am fairly certain that H.F. energy in the L.F. amplifier is not responsible, as there is an elaborate filter in the detector anode circuit.

This seems to be a clear case of self-oscillation, probably at a very short wavelength, in the output stage; similar effects are by no means uncommon, particularly when valves of very low impedance are used. The remedy you have applied should be effective.

Testing Waveband Switches.

As there is obviously an intermittent disconnection in my receiver, which becomes evident on the medium waves only, I have come to the conclusion that in all probability one of the wave-range switches is faulty. Can you suggest an easy way of proving this without dismantling the receiver?

We agree that your wave-changing switches are probably responsible. As the trouble manifests itself only on the medium waves, we assume that these switches operate by short-circuiting the long-wave loading coil: if this is so, a test may easily be made by making a temporary short-circuit across each of these coils with a length of wire Of course, if this cures the trouble, you will know that the switches are at fault, and further, will easily be able to localise the trouble.

Even if one or more of the switches operate by changing over a contact, as opposed to simple short-circuiting, you should still be able to make a test by putting in temporary connections to perform the function that should be carried out by the switch blade.

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Automatic Bias Conversion.

I am about to rebuild my H.F.-det.-L.F. receiver, and intend to fit an indirectly heated H.F. valve and detector, followed by a directly heated 4-volt triode. Will you please show me how to obtain "free" grid bias, bearing in mind that the heaters and filament of all three valves are to be supplied from the same 4-volt winding of the power transformer?

In cases such as you describe, it is usual to obtain free grid bias for the H.F. and output valves in the manner shown in Fig. 2; we assume that the detector will be operating on the grid principle, and consequently will not need any bias.

Referring to our diagram, R_1 is the bias resistance for the H.F. valve, while R_2, which is joined in the H.T. supply lead, provides negative grid voltage for the output valve. In determining the value of this latter resistance, it should be realised that the total anode current for all valves will flow through it. By-pass condensers and the decoupling resistance advisable for the output stage are indicated by C and R respectively.

Bias for Battery Sets.

If "free" grid bias is used in a battery-fed receiver, is there the same need for decoupling the circuits as when the same arrangement is applied to a mains-operated set?

In this case it is equally important that interaction between individual grid circuits should be avoided, and in consequence decoupling should be used. Perhaps we should point out, however, that in a mains-fed receiver the values of decoupling components are chosen partly with a view to providing extra smoothing for the grid circuits, and it should be possible for you to use rather lower values of capacity and resistance than is customary.

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Effect of Surge Currents.

After working well for some time, my detector-L.F. mains-operated receiver has developed a fault. Signals sometimes become weak, and are then accompanied by a "rushing" sound. A temporary cure is generally effected by switching off the mains for a moment. Careful tests have been made without result; particular attention has been paid to the L.F. transformer primary, which, I understand, is generally to be suspected when the symptoms described are observed. Can you suggest what is likely to be wrong? The set is quite conventional in design, and uses indirectly heated valves.

In spite of your having tested the L.F. transformer, we consider it likely that the primary winding of this component is defective. The fault may be due to the presence of a minute break in the winding; it is generally found that the effect of current surges, as produced by opening or closing the mains circuit, is temporarily to restore continuity.

You should make a prolonged test of the winding, preferably by passing through it a current comparable in value with that normally flowing. Alternatively, trouble may be saved by temporarily replacing the transformer by another that is known to be in good condition.

Of course, it is possible that the fault may be found in some other inductive iron-cored winding, such as an L.F. choke or the loud speaker bobbins.

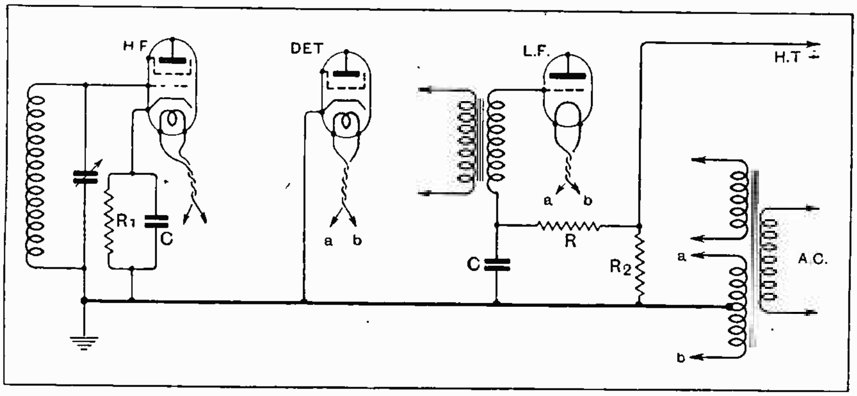

Fig. 2—Automatic grid bias for a 1-v-1 receiver.

FOREIGN BROADCAST GUIDE.

ZAGREB*

(Jugoslavia).

Geographical position: 45° 50′ N., 15° 58′ E.
Approximate air line from London: 830 miles.

Wavelength: 307 m. Frequency: 977 kc.
Power: 0.7 kW. (temporarily).

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

Standard Daily Transmissions.

10.30 G.M.T., concert (Sun.); 19.15, relay or concert; 21.00, relay of "talkie film" from Edison Palace Theatre; 21.25, concert (Sun.); 21.40, relay of foreign stations (Mon.).

Frequently relays concerts from Vienna, Prague, Warsaw, Berlin and Budapest and exchanges programmes with Belgrade and Ljubljana.

Woman announcer.

Opening signal: hooter. Call: *Radio Zagreb.*

Interval signal: Metronome (106 beats per minute, rather low in tone as of a hammer striking wood, similar to London signal).

Time signal: at each full hour, if between items, and indicated by musical note (Morse sign U ..–).

Closes down with the words: *Radio Zagreb zeli svima lakhu noc* (Radio Zagreb wishes everybody Good-night), followed by Croatian National Anthem (*Lijepa nasa*).

**Will be found in pre-war maps under name: Agram.*

Losing Anode Voltage.

It seems that the output of my eliminator is only just sufficient for supplying my proposed new receiver; there will be practically no surplus for "free" grid bias, which, I understand, generally involves a sacrifice of H.T. pressure. Is there any way of avoiding this loss?

Unfortunately, no. "Free" voltage for the grid circuit can only be obtained at the expense of an equal amount of anode voltage.

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The Car Battery.

Can any harm be done by using one cell of my 12-volt car battery for supplying L.T. to a small two-valve portable set? It is intended to make connection by means of a twin flexible lead and spring clips.

As far as we can see the car battery cannot be damaged, provided a short-circuit is not introduced. Of course, the wiring should be carefully done with good quality flex wire, having adequate insulation, and the spring clips should be of a type that are not likely to become loose.

Consumption of filament current will probably be so small that the question of unequal discharge of the various cells may be ignored. It will probably be best to use the earthed cell, i.e., that at the negative end of the battery.