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FREE INSIDE! DATA SHEET No. 4. "MAINS TRANSFORMERS"

Practical Wireless

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THE SELECTONE THREE

by FRANK PRESTON.

READERS' QUERIES PROMPTLY and ACCURATELY ANSWERED !

Building The Selectone—A Super Set! See page 766

ROUND *the* WORLD *of* WIRELESS

British Empire Broadcasting from Daventry

G5SW, the short-wave transmitter at Chelmsford, closed down on December 17th. On December 19th, the British Empire Broadcasting Station at Daventry took over a regular service to the British Dominions and Colonies overseas. The transmissions are made daily (Sundays included) at the following times: GSD, 25.53 m. (11,750 kc/s), to the Australian Zone, from G.M.T. 9.30 to 11.30 a.m.; GSE, 25.3 m. (11,865 kc/s), to the Indian Zone, from 2.30 to 4.30 p.m.; GSA, 49.6m. (6,050 kc/s) to the African Zone from 6 to 8 p.m.; to West African Zone, from 8.30 to 10.30 p.m., and to Canada, from 1 to 3 a.m. Simultaneous broadcasts of each transmission are also made through GSC, on 31.3 m. (9,505 kc/s).

Site for the 100 kW. B.B.C. Station

THE new 100 kilowatter, which is to replace the present Daventry National and Midland Regional transmitters, will probably be erected at Wychbold, near Droitwich. The site is about forty miles west of Daventry. It is not expected to bring the station into operation before 1934.

Radio Safeguards for Colliery Workers

EXPERIMENTS with wireless installations are being carried out at several pits in the Yorkshire coalfields, with a view to establishing connection between the workers underground and the engineering staff at the top of the shaft. During the tests made it was found possible to transmit messages to various points of the mine and to broadcast warnings by loudspeakers. Attempts will now be made to establish a two-way communication.

Relays of the Austrian Programmes

THE Vienna broadcasts are relayed by an experimental station operating on 1,250 metres (240 kc/s) every Monday, Wednesday and Friday, from 6 p.m. G.M.T. onwards. On Tuesdays and Thursdays, between 1.30 and 9 p.m. G.M.T.; these programmes are also broadcast through the short-wave station UOR2, on 49.4 metres (6,070 kc/s).

New Station in Hungary

ONE of the three recently constructed relay stations to take the Budapest programmes is now on the air; it is that of Nyireghaza, which, with a power of 6 kilowatts, broadcasts daily on 267.6 metres (1,120.9 kc/s).

China Calling!

THE Nanking 75 kilowatt transmitter, erected by the Telefunken Company, was formally opened on November 12th. Records of a speech made by the Chinese Ambassador to Germany were made in Berlin and sent to Nanking for re-broadcast at the inaugurating ceremony. The station transmits on 440 metres, and reception of its signals has already been reported by listeners in the British Isles.

Radio Traps for Mosquitoes

THE United States Sanitary Authorities, according to a report, have invented a radio trap for the destruction of malarial mosquitoes. Experiments were carried out by the Engineers of the General Electric Company's transmitter at Lynn (Mass.). The insects were attracted by a high-pitched buzzer tone produced by an oscillatory circuit, the exact note of a mosquito in flight being produced by careful tuning. When swarms of insects had thus been collected they were destroyed by heat derived from an electric furnace. A description of this peculiar trap was given recently over the National Broadcasting Network.

Centenary of the Builder of the Eiffel Tower

RADIO-PARIS recently celebrated the centenary of the birth of Eiffel, the French engineer who erected the tower as a special attraction for the Paris International Exhibition in 1889. As the life of the structure was not guaranteed for more than twenty-five years it had been decided to dismantle it in 1914. The advent of the Great War, however, induced the Military Authorities to take it over as an official wireless station.

Wireless *versus* Pianos

FROM statistics established by the German musical industries, it is demonstrated that since the advent of broadcasting in that country, of two hundred makers of pianos only ten are in existence to-day. Where six thousand artisans found employment, only three hundred are now in regular work.

In Competition with the British Empire Broadcaster

THE French authorities are studying a proposal to transmit special concerts and news bulletins through the Radio-Colonial short-wave station, between midnight and 3 or 4 a.m. G.M.T. daily, for the benefit of French Canadians resident in the Montreal-Quebec districts.

Special Radio Theatre in Italy

ONE of the principal theatres at Turin has been taken over by the E.I.A.R. (Italian Broadcasting system), to be used as a studio for the broadcast of the majority of entertainments comprised in the Milan, Turin, Trieste, Genoa, and Florence programmes.

France to Build Another High-Power Station

ACCORDING to an official statement, a site has been found at Tramoyes, near Lyons, for the 100 kilowatt transmitter which the French P.T.T. propose to erect in replacement of the present Lyons (La Doua) broadcasting station.

Illustrating Bolshevist Industrialism

THE Leningrad and Moscow high-power stations have chosen, as an interval signal, the beat of a heavy hammer on an anvil, to symbolise the feverish activity of the Five Year Plan. The beats are timed to one per second, and at the end of each full minute the letter G (– – .) in morse is transmitted.

ROUND *the* WORLD *of* WIRELESS *(Continued)*

Securing Quality

I AM often asked how improvements can be made to a set which does not give good frequency response. The question is a difficult one because the fault—if one may justly call it by that name—might be traced to the speaker itself, the L.F. couplings, the use of incorrect H.T. and G.B. voltages or even to the tuning circuits. If the speaker is of a fairly old pattern, especially if of the horn type, one can assume fairly safely that it will not do justice to the lower notes. When the speaker is known to be good, one should tackle the intervalve low-frequency couplings. Where L.F. transformers are employed they should be fairly massive or otherwise they should be connected on the resistance-feed system. In regard to the high-tension voltage, this should be as high as convenient and the grid-bias voltage should carefully be adjusted to suit it. If a sharply-tuned single circuit (as opposed to band pass) tuner is employed a certain amount of high-note loss is inevitable and in that case it is necessary either to change the tuner or to apply some form of tone correction in the L.F. stages.

"Boomy" L.S. Reproduction

WHEN reproduction is "boomy" due to accentuation of the bass it is often possible to effect quite a noticeable improvement merely by reducing the capacity of one or more of the coupling condensers used in the L.F. stages. If choke-capacity feed is used for the loud-speaker the usual 2 or 4mfd. output condenser should be replaced by one of lower capacity, down to .25 mfd. or so.

Better "Attack"

THE lower capacity also improves the "attack" in many cases. I might be excused for explaining to non-musical listeners that this latter expression is used to denote the simultaneous reproduction of the same or corresponding note by every instrument in an orchestra. With many sets and speakers, the notes of the higher-pitched instruments, violins for instance, can be heard a fraction of a second before those of instruments of lower pitch such as the double bass. The result is that a certain amount of "blurring" occurs.

Another Cause of Poor Attack

POOR attack can frequently be traced to the use of a moving-coil speaker with an insufficiently powerful receiver. The coil and diaphragm in even the best speaker have a certain amount of inertia, and since they have to move through a greater distance for low notes there is a certain minimum input below which they cannot vibrate; even before that minimum is reached they do not readily respond to low notes. On the other hand, the diaphragm movement is quite small (though more rapid) when higher notes are being dealt with and consequently the notes are reproduced more easily even though the input to the speaker may be below the proper level. The above rather sketchy explanation shows why reproduction is "thin" and high pitched when a loud-speaker is being run from a small set which is lacking in "pep."

INTERESTING and TOPICAL PARAGRAPHS

POCKET RADIO FOR THE POLICE

Picture of the special transmitting station erected on the roof of the Brighton police headquarters, from whence messages will be sent out and picked up by the policemen whilst on their beats. The pocket apparatus is now in operation at Brighton, which is the first town in the country to be equipped with the pocket radio.

Ultra S.-W. Television

WE hear that the B.B.C. have already carried out a few television transmission tests from their 7.75 metre station situated on the roof of Broadcasting House. These tests, under the Baird television system, have been well received by the B.B.C. engineers on their experimental receivers at Nightingale Lane, and it is anticipated that regular television transmissions will soon take place during broadcasting hours.

Russian Stations

HAVE listeners noticed that Radio Stalino (Russian) is interfering with Toulouse, whilst Uraspol, another Russian station, has taken up a position about midway between London Regional and Mühlacker. As a matter of fact, a number of Russian stations appear to be butting in on all parts of the wavelength scale. A newcomer called Tartu has squeezed in between Vienna and Brussels, and Ivanor-Vosneszensk (what's in a name ?) has actually taken up a position right on the North Regional's wavelength.

Broadcasting House

I HAVE just scanned the new B.B.C. book entitled "A Technical Description of Broadcasting House." It is an excellent publication, written in interesting language, and beautifully illustrated. It gives fairly detailed descriptions of all the rooms and equipment in Broadcasting House, and no end of staggering statistics. A good five shillings' worth that would make a splendid present to a wireless enthusiast.

Frequency Response

DID you listen to the frequency tests which were given by the B.B.C. some time ago ? If you did you were probably struck by the poor response of your set and speaker. For the benefit of those who did not listen I would explain that a pure musical note which varied in pitch from 50 to 6,000 cycles per second was transmitted. All through the frequency range, the note was maintained at the same intensity at the transmitting station. When reproduced by the average loud-speaker the portions below about 150 and above 3,500 cycles were scarcely heard at all. At the time of the transmission in question, I happened to be listening with a new set of the Stenode type, fitted with tone control. By adjusting the resistance on the tone-control transformer, I was able to find a setting at which quite good response could be obtained over the whole range of transmitted frequencies. As a matter of fact, the only part of the range which was noticeably weak was that above 5,000 cycles. Even so, the note was quite audible at 6,000 cycles.

—JACE.

SOLVE THIS!

Problem No. 16

Ferguson had built a three-valve set which had worked for some weeks. One day it refused to give any signals, and he accordingly tested the anode circuits of each valve with a milliammeter. The normal reading was obtained in each valve circuit, but no signals could be tuned in. Grid Bias was normal; the loud-speaker was in order, and on test every connection was intact and correctly made. Tuning coils were changed and also tuning condensers, but still no signals could be heard. What was causing the trouble ? Three books will be awarded for the first three correct solutions opened. Mark envelopes Problem No. 16, and send to the Editor, PRACTICAL WIRELESS, Geo. Newnes, Ltd., 8–11, Southampton Street, London, W.C.2, to reach us not later than January 10th.

SOLUTION TO PROBLEM No. 15

Owing to the low resistance of the speech winding, Jones was virtually short-circuiting his output choke. He should have used a step-down transformer, and joined this to the two anodes through fixed condensers.

The following three readers received books in connection with Problem No. 14

F. Bird, Esq., Bury House, Town Green, Wymondham, Norfolk; H. Foster, 19, Regent Street, Dunstable, Beds.; J. F. Spore, 1, Pallas Terrace, Eltham, S.E.9.

Turn to pages 766 to 768 for details of Frank Preston's Selectone.

Fitting New Plates in an Accumulator

An Instructive Article on Dismantling and Renewing the Plates of a Low-tension Accumulator, Together with Several Points on Upkeep

By GILBERT E. TWINING

Fig. 3.—Using a small blow-lamp to finish off the pouring in of the composition.

THE life of a low-tension 2-volt accumulator is naturally governed by the manner in which it is treated, taking into consideration, of course, that its capacity was sufficiently large for the output necessary for the set when it was first installed. If a battery is overloaded its life will be considerably shortened and, if the discharge of a battery is too great, the paste will be driven out of the grids of the plates, and it will need to be recharged more frequently. Therefore, it must be emphasized, from the point of view of economy, to choose one of ample capacity whenever purchasing a new low-tension battery. The writer wishes to point out that if the accumulator case is made of celluloid, and in any way cracked or damaged, it will not be worth while fitting it with new plates, for it will not repay the time spent on it. Patching up with odd pieces of celluloid, and securing them with celluloid cement seldom makes a satisfactory job. This article deals principally with batteries having transparent glass containers. The obvious advantage of this type is that they do not discolour and it is always possible to see the condition of the plates and to keep the level of the electrolyte up to that marked on the outside of the case.

The plates may be obtained from authorized agents, and first-class garages, where they cater for the wireless trade. The name and index or type number of the accumulator should be quoted when ordering replacements. The following is a list of only one of the well-known manufacturer's prices, and these can be taken as representing the average prices in use to-day :—

Type.	*Plates.*	*Maximum list price.*
0.25	Positive Group	1s. 6d. each
,,	Negative ,,	1s. 6d. ,,
0.50	Positive ,,	2s. 6d. ,,
,,	Negative ,,	2s. 6d. ,,
0.75	Positive ,,	4s. 0d. ,,
,,	Negative ,,	4s. 0d. ,,

The prices of the glass jars are as follows, for if an accumulator jar is smashed the plates can quite well be placed in a new container :—

Type.	*Container Price.*
0.25	1s. 2d. each.
0.50	1s. 9d. ,,
0.75	2s. 9d. ,,

Removing the Plates

The two terminal knobs and the filler plug should be first removed from the top of the accumulator, and all the electrolyte emptied away. It will be assumed that the accumulator is at least two years old, in which case the top will be filled in with a composition which has first to be removed. Now if the reader has a gas fire handy the accumulator can be placed in front of it on its side upon a block of wood ; the wood is for raising it up level with the fire.

A tin tray—an old cigarette tin will do—is placed underneath the accumulator so that the heat from the fire will melt the composition and cause it to run into the container below it ; any small quantity which is left in the top may be scraped out with a screwdriver whilst still warm. Fig. 1 shows the accumulator on its side in position before the fire. If no fire is available, however, the composition must be chipped out, or the battery placed in a warm oven, and on removal the pitch dug out and scraped away ; chipping takes rather longer than the melting process.

When all the composition is removed from the accumulator the plates can be lifted clear of the glass container, together with the flat piece of composition board which holds the plates in position, and at the same time forms the bottom of the tray into which the composition was originally poured, thus preventing it from running into the interior of the battery. Fig. 2 is a section of the battery, and it clearly shows the board in position. The positive and negative blocks can now be withdrawn from the above-mentioned board, being replaced with the new plates, taking care to put these in the same holes from which the old ones were taken, so that they will correspond—when the battery is reassembled—with the positive and negative markings on the outside of the case. Any sediment at the bottom of the glass container must be washed away and the container rinsed out with clean water.

Inserting the New Plates

The new plates with the board can now be inserted into the case ; make sure to push the board right down on to the glass stops on the inside of the container, for this board prevents the plates from any upward movement and so stops rattling. The plug collar, which is threaded on the inside to take the screwed filler cap, is then placed in position over the hole in the board, and the composition heated in a tin over a gas ring. When this is in a molten state, it may be poured into the top of the accumulator.

(*Continued on page 758.*)

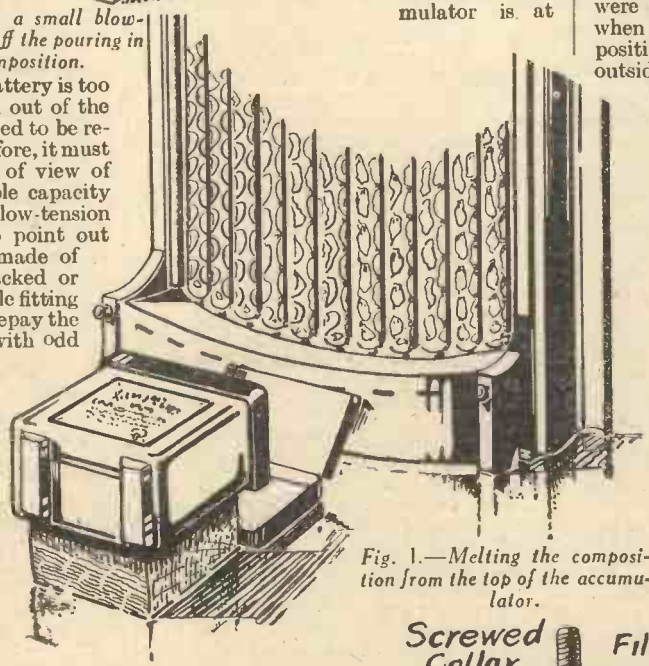


Fig. 1.—Melting the composition from the top of the accumulator.

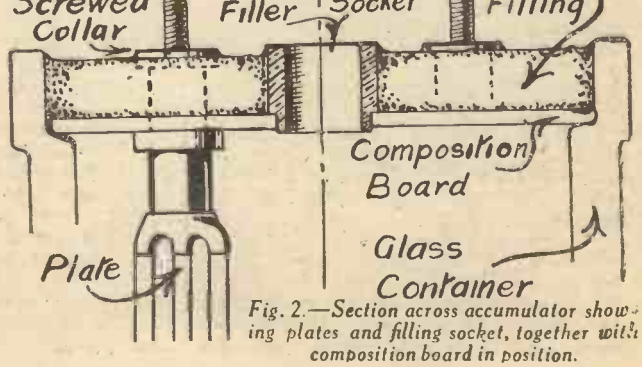


Fig. 2.—Section across accumulator showing plates and filling socket, together with composition board in position.

REJUVENATING

This Article by Frank Preston, F.R.A., Tells

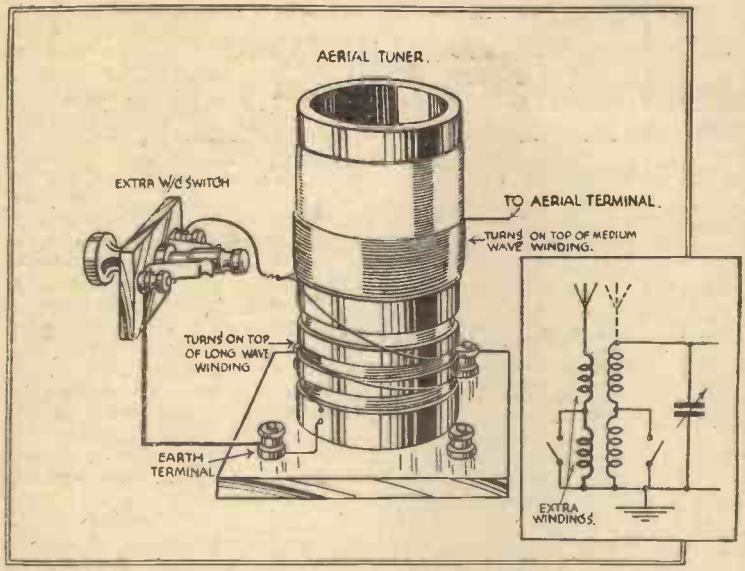


Fig. 1.—Improving selectivity by adding an aperiodic aerial winding.

A NUMBER of readers who are in possession of a set made some years ago have written to express their regret at being unable to build one of the many fine receivers described in PRACTICAL WIRELESS, due to the difficulty in producing the necessary cash. For financial reasons they are obliged to keep the old set, despite its many disadvantages. At the same time they would be quite prepared to spend a few shillings here and there in bringing the old set up to date if they knew just how to tackle the job, and what alterations should be made. The same difficulty must have occurred to hundreds of readers who have not yet written to us, for there is no doubt that times are distinctly hard, and money scarce. It is for the benefit of readers who are in the position of those just referred to that the following suggestions are principally intended, but it is hoped that they might also prove of assistance to others of an experimental turn of mind. None of the alterations I shall suggest will be of such a radical nature that the set will need to be entirely rebuilt, so it must be assumed that it is already in "working order," and simply out of date.

Although receiver design has undergone many changes during the past few years (principally due to improvements in broadcasting technique), I do not hesitate to say that any set made during the last three or four years, provided it was of modern design when made, can certainly be modified to make it satisfactory for present and future use. The first point to consider is what parts of the old set shall be retained, and which shall be scrapped. To enable you to decide on this point, we will trace through the stages of an average set and consider what improvements are desirable, and how they can best be made. I would say at the outset that I do not propose to pay so much attention to the super set as to the average types which I know to be in regular use. By the "average types" I mean the 3-valvers having either one screened-grid valve, followed by a detector and low-frequency amplifier, or a detector and two L.F. stages.

Selectivity

Whatever the type of set, selectivity is of paramount importance, especially when reception conditions are so good as they are this winter. If the set is unselective it is not unlikely that even the local station will be interfered with by a powerful foreigner. The methods of increasing selectivity which were popular a year ago, namely, inserting a small condenser in the aerial lead or reducing the length of the aerial, though still useful, are seldom sufficient. Probably the cheapest way to obtain real selectivity with an old set is to change to band-pass tuning. This can be done by buying a new tuner, of course, but a less expensive way is to fit a band-pass adaptor like that described on page 537 of PRACTICAL WIRELESS No. 11. If you object to a separate unit, and you will if the set is neatly housed in a large cabinet, the adaptor can be built into the set by mounting the necessary components at the "aerial" end of the baseboard. In that case, it is essential that the two coils should be screened. If the coils themselves are not fitted with screening cans a vertical sheet of aluminium should be erected between them, and connected to earth.

Band-pass tuning is open to the objection that it entails the use of two variable condensers. When two similar coils are employed a gang condenser would serve, but that would involve additional expense. If this is your objection, you can get any amount of selectivity by altering your aerial tuner, as shown in Fig. 1. A winding consisting of about twenty-five turns of 24's gauge d.c.c. wire is put on top of the medium-wave coil, and one of fifty turns (equally divided over the slots) on the long-wave coil. Both new windings are connected in series, and the turns must go in the *opposite* direction to those of the tuner. The aerial is taken from its usual terminal, and connected to the end of the new winding, whilst the other end of this winding is joined to the earth terminal of the tuner. A switch will be required to short-circuit the long-wave portion, and will be connected as shown. If desired, operation can be simplified by replacing the previous two-spring wavechange switch by one of the three-spring type; in that case, the junction of the new windings will be connected to the third terminal, the other two functioning in the same way as with the previous switch. The three-spring switch will operate simultaneously on both (old and new) sets of windings.

The latter method of improving selectivity is open to two objections; it will cause a reduction in volume and *might* reduce slightly the response of the set to the higher musical notes. The second objection will not apply if a pentode valve is employed or if it is proposed to fit a tone control transformer.

"Break-through"

A difficulty rather apart from the question of selectivity is that caused by "break-through" of the medium-wave local station at the bottom of the long-wave band. Occasionally an improvement in selectivity will reduce the interference, though this does not always follow. But break-through can be cured quite easily by inserting a suitable choke in series with the aerial lead. A choke specially designed for the purpose is made by Messrs. Lissen and connections for it are shown in Fig. 2. It will be noticed that a switch must be fitted to short-circuit the choke for medium-wave reception, but this can sometimes be combined with the normal wave-change switch by replacing the latter by one of the double-pole-double-throw type, such as the Bulgin type "S.29" or Wearite type "L.22."

Changing to Variable-Mu

Having settled the selectivity question, we can pass along to the S.G. valve (when used). If the set is so far away from the nearest transmitter that no overloading of the first valve occurs (generally distinguishable from the fact that signals become weaker when the set is tuned exactly to

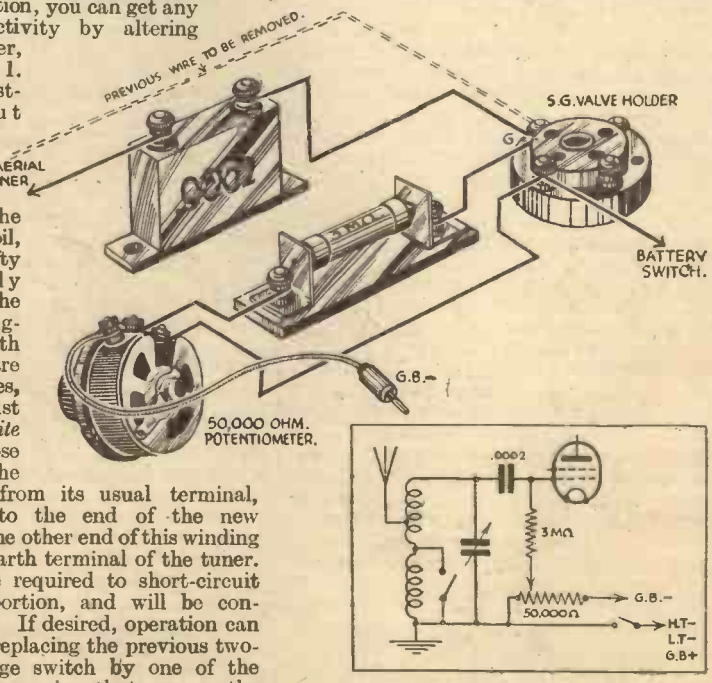


Fig. 3.—Adding a potentiometer for the employment of a variable-mu valve.

THE OLD SET

You How to Bring Your Old Set Up to Date

the station, and louder on each side of the proper tuning position), no alteration need be made, but if overloading does occur, it will be worth while to replace the present valve by one of the variable-mu type. The V.-M. valve will also provide an excellent and convenient volume control which can be used on any station.

A number of ways of fitting the necessary potentiometer for a V.-M. have been given in previous issues of PRACTICAL WIRELESS so I will mention only one here. This is shown in Fig. 3, from which it will be seen that a small fixed condenser (.0001 mfd. upwards) is inserted in the lead from the grid terminal to the tuning coil and a 3 megohm (approximately) grid leak is connected from the former point to the centre terminal of a 50,000 ohm. potentiometer. One of the outside terminals of the potentiometer is connected to G.B. negative by means of a flex and wander plug whilst the other is joined to that terminal of the valve holder which is connected to H.T.—, L.T.— and G.B.+ through the switch. By connecting the potentiometer in this way it is automatically disconnected from the G.B. battery when the set is switched off. In cases where the battery is housed inside the set care should be taken that its positive end is connected to the high tension negative terminal and not directly to the filament terminal of a valve holder. The method shown is not quite the best but is most convenient.

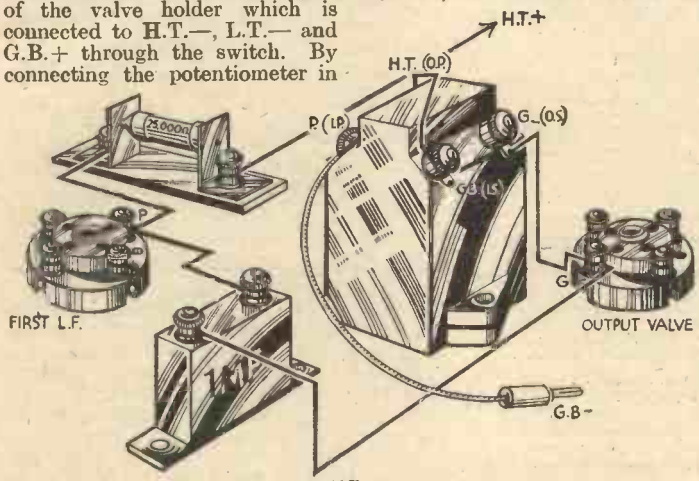


Fig. 3.—Reducing the amplification by altering the ratio of the transformer.

The Detector Valve

Now we pass on to the detector valve. No alteration will be required in its grid circuit but several improvements might be possible in the anode circuit. A number of H.F. chokes which were on the market a few years ago had so low an inductance that they were useless on the long waveband. This does not mean that the set would not work on long waves, but that reaction control would be unsteady or insufficient to produce oscillation. If your set suffers in this way, buy a good modern choke; get one of well-known make and pay about three and sixpence, it will be worth it. If reaction control is unsteady on both wavebands, it is unlikely that the H.F. choke is the cause of trouble. Try the effect of a .0002 mfd. or .0003 mfd. fixed condenser joined between the anode terminal of the detector valve-holder and H.T.—. (See Fig. 4.)

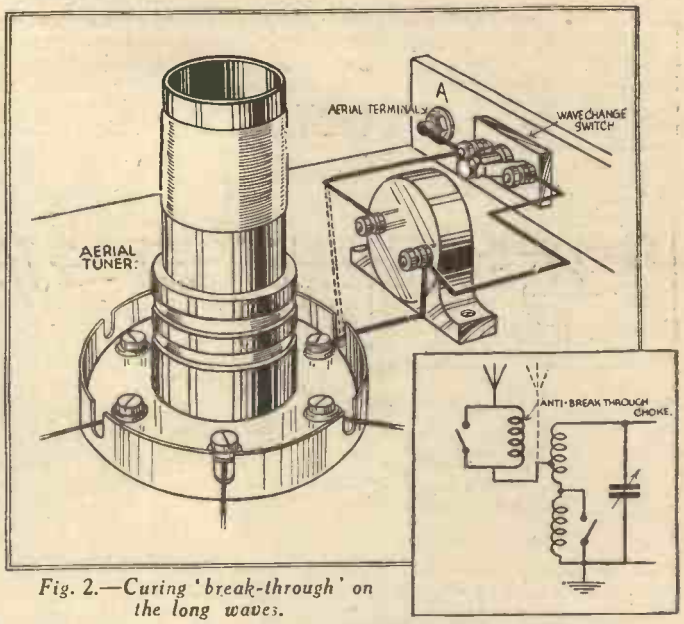
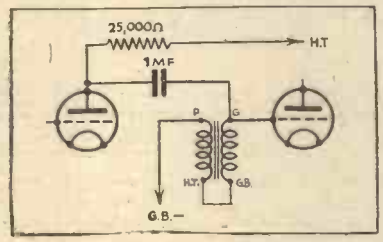


Fig. 2.—Curing 'break-through' on the long waves.



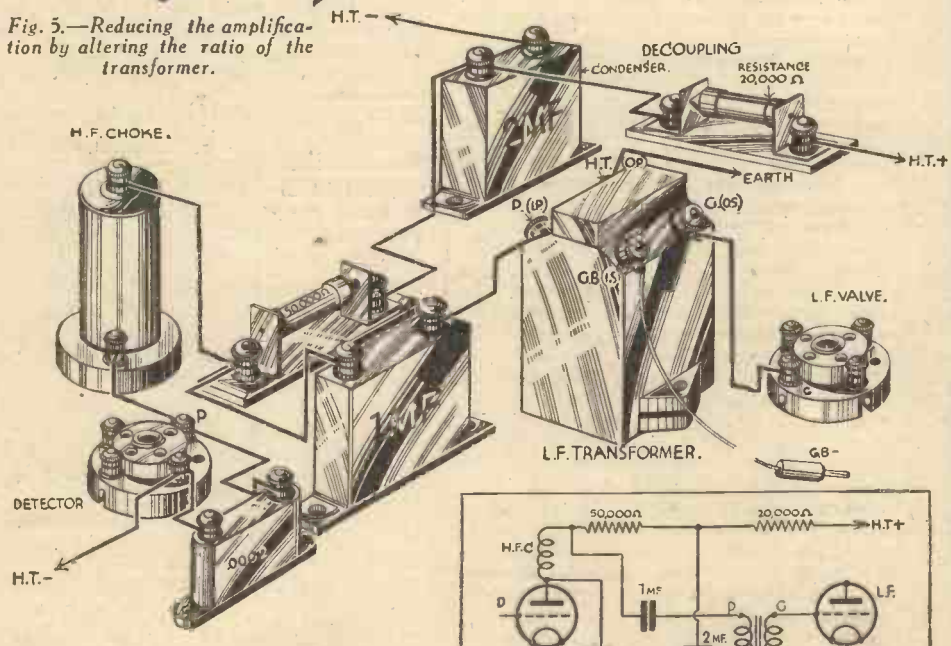


Fig. 4.—Improving the anode circuit of the detector stage.

Resistance Feed

The L.F. transformer will most likely be connected directly in the anode circuit of the detector valve. Unless it is of a large and fairly expensive type, it will probably cause a loss of low-note amplification so that reproduction will be lacking in bass. This can be overcome by connecting the transformer on the resistance-feed system as shown in Fig. 4. A fixed non-inductive resistance (metallised for instance) is connected in place of the transformer primary terminals and one of the latter is connected to the "anode" end of the resistance through a 1 mfd. condenser. The other primary terminal is joined to earth and the secondary connections remain as before. As the terminals of some of the older transformers are marked differently from those of the present-day ones, both kinds of lettering are given in Fig. 4. The resistance-feed method of connecting the transformer, besides improving bass response, will often cure distortion due to overloading.

Decoupling

The idea of decoupling the anode circuit of the detector valve has been advocated so often in these pages tha?

I feel I ought not to refer to it again. But it is so important that I cannot restrain myself. Decoupling prevents various kinds of instability besides prolonging the useful life of the H.T. battery, so you really must make provision for it if you have not already done so. The only components required are a fixed resistance of from 20,000 ohms. upwards and a condenser of 1 or 2 mfd., and they are connected between H.T. positive and the L.F. transformer or feed resistance as indicated in Fig. 4.

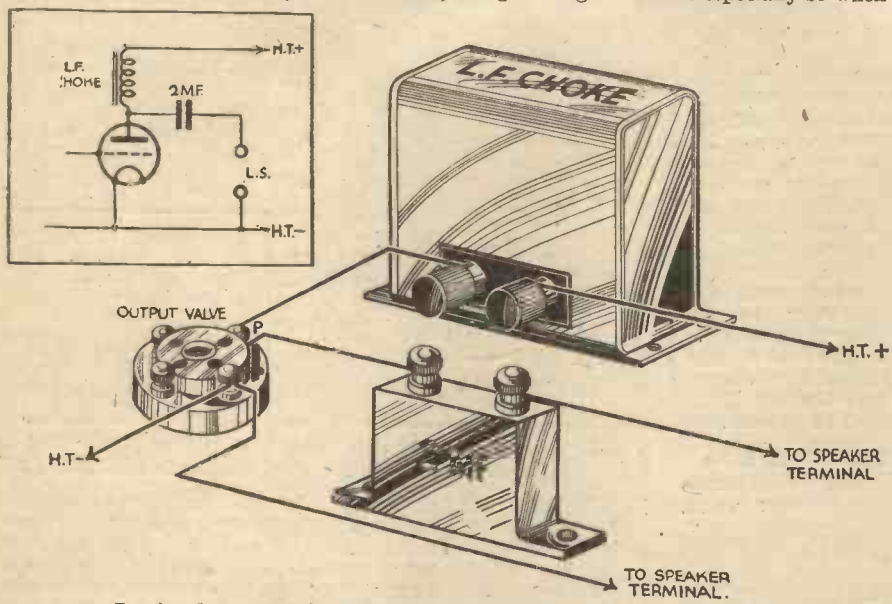


Fig. 6.—Improving the output arrangements by adding a filter circuit.

Preventing Overloading

When two transformer-coupled L.F. stages are employed it often happens that overloading occurs when using modern valves due to the overall amplification being too high. This is especially so when both transformers have ratios greater than about 3 : 1. The latter difficulty can easily be overcome by connecting the second transformer as shown in Fig. 5. When connected in this way the effective ratio is only 1 : 1 regardless of the transformer's rated step-up ratio. In any case the transformer should be resistance fed so you can try the connections of Fig. 4 as well as those of Fig. 5, and adopt the one which proves superior. The value of the feed resistance is given as 25,000 ohms. because this is a good average ; actually it should be equal to twice the impedance of the preceding (first L.F.) valve.

The Output Stage

We have now arrived at the last valve. When only a single L.F. stage is used this should be a small power valve of the high amplification type such as a Cossor 220 P.A., but if two L.F. stages are employed a "larger" valve of lower amplification such as the Cossor 220 P. or even the 230 X.P. will be far more satisfactory. If you have bought a moving-coil loud-speaker, it will be fitted with a suitable transformer and no other output device will be necessary. On the other hand, if you are still using a "cone" speaker it will be much better to employ a choke output filter when a P. or X.P. valve is used in the last stage. For this you will require an L.F. choke and 2 mfd. condenser ; they should be connected as shown in Fig. 6.

Use Ample H.T.

Remember that none of the alterations described above can produce the best results unless you give the set plenty of high-tension voltage, certainly not less than 100 volts, and carefully adjust G.B. tappings to their best positions. Besides, if the set is very old, an hour or so will be well spent in testing the components, as explained in the article "Test Your Components Before You Build," published on page 446 of PRACTICAL WIRELESS, No. 9.

Simple Tone Correction

By E. JOHNSON

SOME method of compensation for the restoration of the higher musical frequencies is becoming increasingly popular in modern receivers. It is a well-known fact that there is a decided tendency for high notes to be lost by reason of sharply-tuned circuits with their consequent side-band cutting. Moreover, unintentional stray capacities in the circuit have the same effect. In such cases the replacement of a triode output valve by a pentode will often put matters right. There are many little snags, however, which confound the tyro if he is tempted to banish his triode, and he may well be doomed to disappointment unless he be willing to experiment ; pentodes are very touchy to slight changes in the output impedance and require careful matching to assure good results.

Tone Compensation in Triode Circuits

Most methods now in vogue necessitate either a special tone-compensation transformer or an extra stage of amplification. This means additional expense. The scheme in use by the writer needs only a suitable L.F. choke. Fig. 1 shows the familiar resistance-capacity-fed transformer. The voltage amplification of the valve depends on the external impedance, which usually is a pure resistance ; other things being equal, therefore, the magnification remains sensibly constant over the musical scale. If, however, our external impedance is partially inductive, the impedance will rise with the frequency. Therefore increased amplification will result on the higher frequencies. In order to prevent excessive compensation we retain our usual coupling resistance ; the larger this is, or the smaller the choke, the less the degree of compensation.

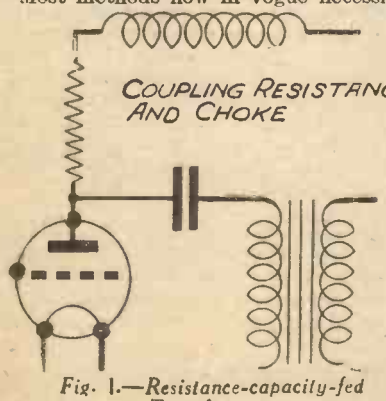


Fig. 1.—Resistance-capacity-fed Transformer.

One must not lose sight of the fact that the choke with its inherent self-capacity will resonate at some definite frequency which should be well removed from the musical scale, and in most cases will be above audibility. Fig. 2 will show this clearly, although it should be borne in mind that the ordinates are purely arbitrary. A bad choke of high self-capacity will cause a very nasty resonance in the audible spectrum, especially if we aim at a high degree of compensation by using a small resistance. In practice, a resistance equal to about half the impedance of the preceding valve will be suitable, in conjunction with a .5H. choke.

Voltage amplification =

$$\frac{I_E}{I_V + I_E}\mu$$

I_E = external impedance
I_V = valve impedance
μ = amplification factor

$$= \frac{R + 2\pi fL}{I_V + (R + 2\pi fL)}\mu$$

R = resistance in ohms,
f = frequency,
L = inductance in henries

The result in each case to be multiplied by the transformer ratio.

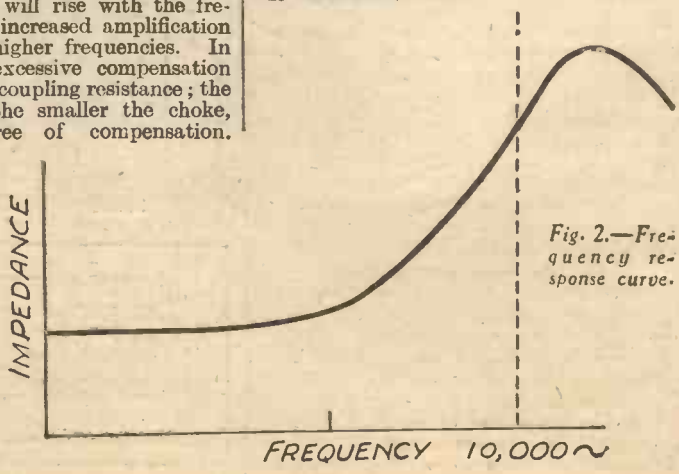


Fig. 2.—Frequency response curve.

WHAT *is* TELEVISION?—(5)

A Short Series Explaining the Fundamental Principles.

By H. J. BARTON CHAPPLE,
Wh.Sch., B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E.

I THINK the appetite of the reader should by now have been whetted sufficiently to make him desire to know how those one or two quite simple components described in last week's article can be assembled together so as to produce in the television receiver an image which is identical with the scene transmitted from the studio except for the greatly reduced size. Taking the items in turn, we must mount the motor on a bracket, which in turn is held generally on a baseboard having four feet, one at each corner. The height of the centre of the motor spindle from the table on which the apparatus rests will depend on the disc diameter, it being necessary to allow a clearance of, say, 1in. to permit easy running of the disc.

Fig. 1.—Showing the complete assembly of the various components used in a Baird disc model machine.

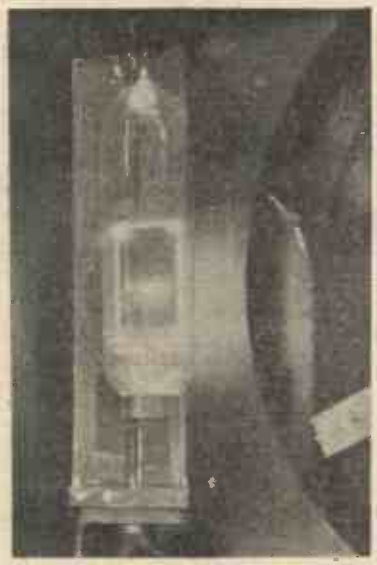


Fig. 2.—Showing how the flat plate neon lamp is scanned by holes near the outer edge of the disc, the magnifying lens being behind.

Now a slot must be cut in the baseboard to allow the disc to revolve, this being shown in the photograph, Fig. 1, which illustrates the assembled apparatus in the case of a Baird disc model machine, the disc projecting below the baseboard a matter of about 4in. With the disc held to the motor shaft by a screw passing through the boss and gripping the spindle, the neon lamp can now be positioned. To suit the type of television transmission now being sent out by the B.B.C., the disc must rotate in an anti-clockwise direction and when facing the front of the apparatus the single turn spiral of holes is in a clockwise direction. It is essential, therefore, to see that the disc is the right way round on the shaft, otherwise the resultant image seen will be reproduced so that all horizontal movement is reversed. The neon lamp is mounted in its bayonet holder so that it is on the extreme right of the disc immediately behind the spiral of holes.

Fig. 3.—A composite picture built up from elemental squares to give some idea of how the resultant television image is formed.

The centre of the glowing neon plate (assuming one of the flat plate variety is being employed) must be on the same horizontal line as the centre of the motor shaft. The illustration (Fig. 2) gives a fair idea of how the glowing neon lamp plate is scanned, this picture having been taken from the back so that the lamp is not obscured by the disc. Then in front of both our disc and lamp is placed the lens or lenses complete with their own particular type of mount. As a general rule it is wise to have interposed between the disc and the lenses a mask having a shaped area cut out to conform to the shape of the resultant light area revealed by the rotating disc. In this way any section of the light which is not required during the process of image reconstruction will be blacked out.

Still neglecting for the moment our synchronizing mechanism, as I intend to deal with that fully in next week's article, (the mechanism itself can be seen at the front of the motor in the illustration, Fig. 1), the only additional control we need mention is the variable resistance used for adjusting the speed of the motor. This, by the way, should have no "off" position, otherwise the individual working the apparatus is liable to move the contact arm to this position when the hand is on the control, but the eyes are on the image. The motor speed will at once start to drop and it becomes imperative to begin resolving the picture into an intelligible image all over again. This resistance is seen on the left of Fig. 1.

Fig. 4.—A cathode ray television receiver which has been demonstrated in Germany.

Working the Apparatus

Having now built up our imaginary television apparatus, three distinct forms (using a disc for scanning) of which are shown side by side on the stand of Fernseh A.G. at an exhibition held a year or two ago in Berlin, in Fig. 5, let us now see the method which must be employed to make it work. Tune in the wireless set to be used for the reception of the television signals so that it receives the London National station. If the television signal is heard on the loud-speaker, and this policy is always recommended to start with, the sound which will be listened to is of a rather peculiar rhythmic character, something like a high-pitched, steady note, with another high-pitched chirrup superimposed upon it.

Then disconnect the loud-speaker leads and join the neon lamp to the set's output terminals. Actually, the method of connection will vary according to the type of output used in the receiver, that is, whether direct, transformer or choke, but this item is really beside the point for the moment. Often a subsidiary source of high tension voltage is required in order to "strike" the neon lamp and make it glow, even when no incoming signals are passed through to it. When this is done, switch on the motor so that it drives round the perforated disc in front of the glowing neon lamp.

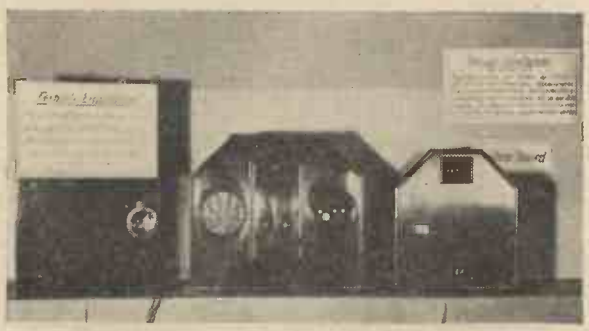


Fig. 5.—Television receivers at the Fernseh A.G. Exhibition stand in Berlin, 1929.

Now the mere fact that television signal pulses are being fed to the neon lamp will make the light intensity of its illumination change in accordance with the signal strength. Furthermore, the changes occur with the same rapidity as that which generated them at the transmitting end, this being due to the neon lamp's inherent properties which I referred to earlier in this series. It will therefore be possible to watch these fluctuating light changes through the small holes in the disc and an image will be built up for the following reasons:

First of all, to simplify the explanation, let it be imagined that the disc at the receiving end is running in perfect synchronism (see how that important point keeps cropping up) with the transmitting apparatus, that is to say, it is revolving at the same speed of 750 revolutions per minute and in the same phase relationship, or what is commonly called in step. When this happens, at any one instant, a hole in the disc of the receiving apparatus will reveal a tiny square area of the neon lamp glow. If, for example, we imagine the exposed area in the centre of the image, then it must be realized that at that identical instant there is a corresponding position in the centre of the scene or object at the transmitting end, which is being explored by the moving light spot.

Building Up the Television Image

The intensity of the tiny neon glow area shown must therefore be in direct proportion to the light reflected and picked up by the photo-electric cells at the transmitting end. This is because of the proportional changes it has passed through from end to end, the "links" in the chain of events being reflected light to photo electric current, amplification, passed to wireless aerial and broadcast, received on the home wireless set, again amplified and finally handed on to the neon lamp to modulate or regulate its glow intensity.

In effect, therefore, we are reproducing in terms of light the conditions prevailing at the transmitting end at that one instant, and this goes on spot by spot from the bottom to the top of the glowing lamp area, recreating a strip of incandescence which shows in miniature all the corresponding light and shade which has been transmitted electrically as a television signal. When one hole has finished its prescribed motion, then the next hole takes charge and performs an identical function by creating another light strip of varying intensity immediately next to its predecessor.

It is in this way that, strip by strip, lying side by side, the complete television image is built up, the various degrees of light and shade intermingling to bring about an intelligible and clearly recognizable image. A reference to the illustration shown as Fig. 3 will no doubt help still more to make this explanation better understood. Here a composite image of the head and shoulders of a young woman is built up from tiny elemental areas all correctly positioned one with the other. In actual practice the square pattern shown will of course not be noticed, as the image is built up from strip formation, but, what is more important, owing to the phenomenon known popularly as visual persistence, or persistence of vision, the eye lag makes the image appear as a whole. A certain amount of flicker is perceptible, but with the twelve and a half pictures per second now used with the transmissions from the B.B.C., the process is rapid enough to prevent the eye dwelling too intimately on the mechanics of the process.

In this way, therefore, it is possible to show in miniature a good proportion of the light, shade, contour and movement of the artist or subject performing before the photo electric cells in the television studio, or in other words, produce "vision at a distance" in the home. Of course, there are various ways of building up the apparatus in order to produce the image, and it is interesting, therefore, to see the illustration of Fig. 4, for there is shown a cathode ray television receiver which from the description underneath obviously emanates from Germany. Although a lot has been said concerning cathode ray apparatus, nothing has yet appeared beyond the laboratory stage, while the life of the tube is a very doubtful factor.

The next points that I want to deal with concern synchronism, the operation of the vision apparatus, and one or two peculiar effects which are often observed and also one or two items directly associated with the wireless set used for receiving the television signals. These, however, must be left over until next week's article.

The composition will probably require to be heated several times, and even then it will be impossible to get an even flow over the surface. If it is possible to obtain a small mouth blow-lamp, and just blow over the surface, it will smooth off the composition and make it settle down to a uniform surface, but take care not to apply too much heat to it, otherwise it will burn and char. The method of using a small blow-lamp is shown in Fig. 3.

Preparing the Accumulator for Charging

When the operation of running in of the composition is finished, the accumulator may be filled with electrolyte of the correct specific gravity stated by the makers on the outside of the case. The electrolyte can be obtained from a charging station or any first-class electrician. The battery is now ready to be charged, and it is advisable to work the battery only for about one half of its normal period after this first charge, the second charge will then place the accumulator in really good condition.

Points on Maintenance

To keep the accumulator up to standard,

FITTING NEW PLATES IN AN ACCUMULATOR

(Continued from page 753.)

it should be kept as fully charged as possible, and charged at regular intervals, a full charge being indicated by both plates gassing fairly freely, the voltage rising to approximately 2.5 volts. A battery should never be completely discharged or left for any length of time with a low voltage, for this tends to cause buckling and sulphation of the plates.

Sulphation

Sulphation appears on the plates in the form of a white deposit of lead sulphate. slight traces may be removed by a prolonged charge at a reduced rate, but if not checked immediately the battery will be ruined.

Level of the Electrolyte

Never let the electrolyte fall below the top of the plates; keep it up to the level marked on the outside of the case. The loss is caused by evaporation of the water only, sulphuric acid does not evaporate, therefore, it is only necessary to keep the level constant by the addition of distilled water.

Corrosion

When purchasing a new accumulator see that it is fitted with large non-corrosive and non-interchangeable terminals of the bright red and black top variety. Even if terminals which are said to be non-corrosive are left in a very dirty condition they will corrode, and the best cure is to clean all traces of acid away, and scrape the corroded parts bright with a pocket-knife, afterwards wiping over with ammonia, and then smearing freely with vaseline.

Testing the Battery

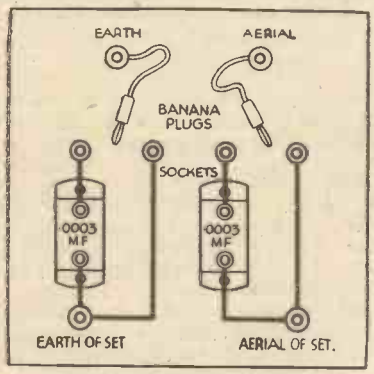
Testing the condition of a battery with a voltmeter should always be done under load, that is to say, when the set is working, otherwise a false reading will be given. A hydrometer should be used in conjunction with the voltmeter, for this will enable the specific gravity of the electrolyte to be kept up to the correct standard.

THE HALF-GUINEA PAGE

Radio Wrinkles FROM READERS

Simple Selectivity Gadget

I HAVE noticed that in order to obtain requisite selectivity a fixed condenser answers perfectly in the aerial circuit, while sometimes it is better in the earth

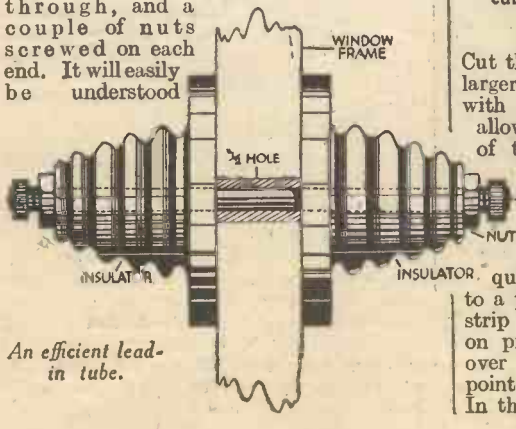


A simple selectivity device.

lead, while, when Continentals are extra strong, both are necessary. When both condensers are in circuit the selectivity is excellent. Therefore, I have made a very simple little gadget consisting of two .0003 mfd. fixed condensers, a piece of ebonite, four terminals, two "banana" plugs, and four sockets. These are arranged as shown in the accompanying sketch. Alternatively, the unit may be incorporated in the set with the plugs, and sockets at the back. Thus the "switching in" of the condensers is a simple matter of changing plugs. Another way is to use push-pull switches for "shorting out" the condenser or condensers not required. The "aerial" condenser may be variable.—R. S. MENZIES (Scarborough).

A Well-Insulated Lead-in Tube

EXPERIMENTERS who are not satisfied with the efficiency of the usual ebonite lead-in tube can make a very good one by using two porcelain stand-off insulators, as shown in the illustration. The bolts and nuts are removed from the insulators and after drilling a half-inch hole in the window-frame, one insulator is placed on each side. A piece of threaded 2BA brass rod is run through, and a couple of nuts screwed on each end. It will easily be understood



An efficient lead-in tube.

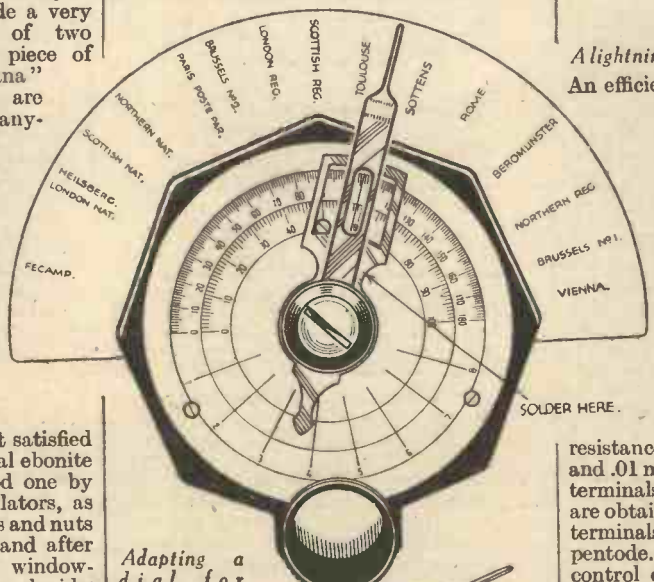
THAT DODGE OF YOURS!

Every reader of "PRACTICAL WIRELESS" must have originated some little dodge which would interest other readers. Why not pass it on to us? For every item published on this page we will pay half a guinea. The latest batch is published below. Turn that idea of yours to account by sending it in to us, addressed to the Editor, "PRACTICAL WIRELESS," George Newnes, Ltd., 8-11, Southampton Street, Strand, W.C.2. Put your name and address on every item. Please note that every notion sent in must be *original*. Mark envelopes "Radio Wrinkles."

that the insulation of this tube is very high. —V. H. BLARE (Edinburgh).

A Station-locating Dial

HERE is a simple method for enabling listeners to find stations again (after first identifying and marking them on the chart) in a second, and also giving slower motion. A piece of stiff white paper and strip of thin brass are the only additional parts necessary. Exact measurements are not given as all slow motion dials vary in size.

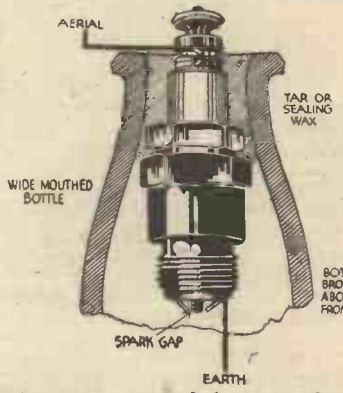


Adapting a dial for station indicating.

Cut the paper in a semicircle 1in. or 1½in. larger than the circumference of the dial with a piece cut out at the bottom for allowing the paper to slip past lock-nut of the condenser. Slip this behind the dial, making sure that it is perfectly straight. I find the pressure of the dial against the panel quite sufficient to hold it in place. The strip of brass can be quite thin. Cut the strip (¼in. wide) to a point at one end. The length of the strip must be just long enough to solder on present indicator and to bend round over the ebonite of the dial itself. The point should now rest lightly on the paper. In the centre of the brass strip a window is cut so that the degrees on the dial can be correctly registered. As the stations are identified the name of the station can be neatly printed on the paper disc, as depicted in the accompanying sketch.—F. SPINK (Peckham).

A Novel Lightning Arrester

WHEN lightning is about, one usually feels a trifle safer when the receiver is protected by some form of lightning arrester.

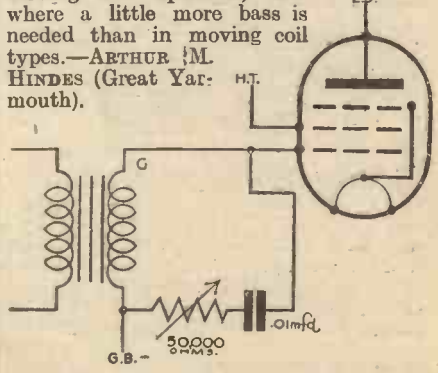


A lightning arrester made from a sparking plug.

An efficient arrester can be made as shown in the accompanying sketch. The parts required are a wide-necked bottle, an old sparking plug, and some sealing wax. The neck of the bottle is broken off, the sparking plug inserted in it, and the space filled in with sealing wax. The top of the plug is attached to the aerial, and the bottom to earth.—C. TAYLOR (Cardiff).

Tone Control

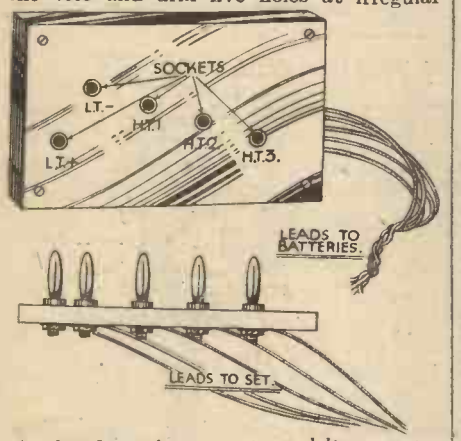
AFTER experimenting with several forms of tone control to be used with a pentode, I find that instead of fixing a resistance-condenser (50,000 ohms var. and .01 mfd.) control across the loud-speaker terminals as recommended, better results are obtained by fixing it across the secondary terminals of the transformer before the pentode. The resulting tone, and the control of tone itself is very much better than the former method and well worth trying, especially to constructors who use moving iron speakers, and where a little more bass is needed than in moving coil types.—ARTHUR M. HINDES (Great Yarmouth).



A simple method of tone control.

A "Safety-first" Gadget

WIRELESS experimenters are fully aware of the nuisance of having to disconnect all leads from the batteries before working on a set and then having to connect up again for testing. This trouble can be eliminated entirely if the gadget herewith described is made use of, as the leads can be connected or disconnected in half-a-second. The requirements are: Two pieces of ebonite about 3½in. by 2in., and five Clix coil pins and sockets. Put the two pieces of ebonite together in the vice and drill five holes at irregular

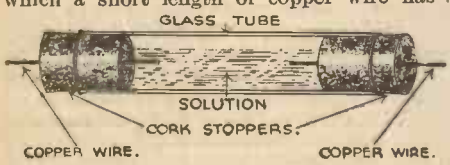


A safety device for connecting and disconnecting battery leads.

intervals right through. The drill used should be of a size to suit the coil pins (about 6 B.A. clearance). Fit the pins into position with one nut on each. The holes in the other piece of ebonite are now opened out to suit the sockets (about 2 B.A. clearance) and the latter secured with nuts. It will now be seen that the pins will fit snugly into their sockets. The leads from the H.T. and L.T. batteries are taken to the sockets and well secured. This unit is fastened to the wall or bench behind the set, and short pieces of coloured flex are then fastened to the pins, fitted with terminals at the other end for connecting to set. Only one negative lead need be taken to each pin and socket, as the two negatives (H.T. — and L.T. —) are usually connected in the set. To connect the set to the batteries it will be seen that all that is required is to "plug in," and to withdraw them when disconnecting. The diagram will make the scheme quite clear. —EDGAR WILLIAMS (Llanelly).

An Easily-made Pole Finder

HERE is a useful and inexpensive pole finder. A short piece of glass tubing about ¼in. in diameter is fitted with a cork (or rubber) stopper at each end through which a short length of copper wire has

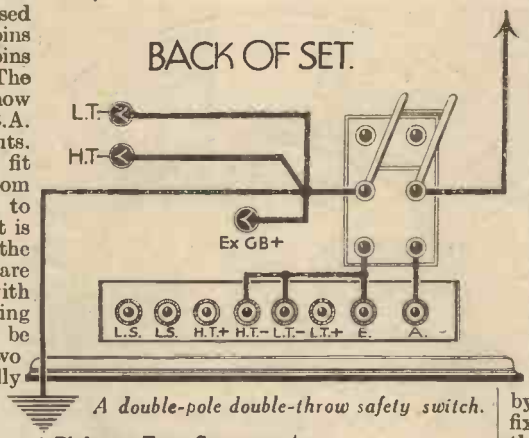


An easily-made pole finder.

been forced before fitting in the tube. The tube is half filled with a solution made up of phenolphthalein 10 grains (about a pennyworth), sulphate of soda (Glauber Salts) ½oz., and about 2oz. of water. Shake the solution before filling the glass tube as only a small proportion of the phenolphthalein dissolves in the water. A resistance should be placed in series when used on a source of H.T., but voltages up to six may be applied directly across the pole finder. The negative pole will turn the solution around that particular wire a red colour, which will disappear when the solution is shaken. —J. W. D. (Cork).

A Safety Switch

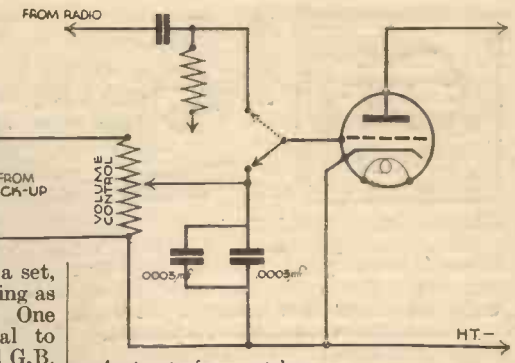
A DOUBLE-POLE double-throw switch, fastened to the back of a set, can be made to do some useful switching as shown in the accompanying sketch. One switching either connects the aerial to earth and cuts off the H.T., L.T., and G.B. batteries from the set, or disconnects aerial from earth and switches on the programme. No separate aerial-earth switch is needed, neither is any other switch required for switching the set off. Furthermore, when the set has been switched off there are no complete circuits to produce "shorts." Note that the two upper terminal points of the switch must be joined together with wire for the aerial to have a direct path to earth. The G.B. positive lead from the grid-bias battery plug is brought out through a small hole drilled in the cabinet and joined on to the same place as the H.T., L.T., and earth. Fit a terminal on each side of the switch, as shown in the sketch, so that connections can be made easily. These terminals, of course, must be wired to the switch.—E. ROBERTS (Croydon).



A double-pole double-throw safety switch.

Pick-up Tone Compensator

WHEN using a standard type pick-up on a home-constructed all-mains set, results are often disappointing, due to a hissing sound on high tones and loud passages, along with accentuated needle scratch. The cause of this would at first appear to be due to overloading of one of the valves, but, on reducing the input by means of the volume control, it will be found that this objectionable sound is still present. The condition is most prevalent in resistance-capacity coupled amplifiers, and is due to reasons other than overloading. The trouble is, however, satisfactorily overcome by the method illustrated. Connect a condenser of .0006 mfd. capacity between the grid leak on the volume control and the cathode or negative high tension. The required capacity will be best made up of two .0003 standard fixed condensers in parallel. This



A circuit for a pick-up tone compensator.

modification will result in reproduction of a rich and mellow quality, without serious loss of volume.—H. B. ROCHESTER (Manchester).

Making a H.F. Choke

A VERY useful H.F. choke for use on the short wavelengths from about 12 to 100 metres may easily be constructed from the oddments usually found in the possession of an amateur. The former on which the wire is wound is made from a piece of old ebonite, ¼in. or ⅛in. thick. This should first be cut into two pieces 2½in. long by 1in. wide, and the edges over which the wire is wound may with advantage be rounded with a file. Next make a mark on each piece 1¼in. from the end, which will give the centre position, and with a hack saw make two cuts from one end to the centre, the distance between the cuts being equal to the thickness of the ebonite. Next remove this centre portion by drilling several small holes; it may then be broken off and filed smooth. Providing the removing of the centre has been done carefully, the two pieces will now fit firmly together as shown in the sketch. Before fitting together, two holes should be drilled, as shown in Fig. 1, to take terminals. The wire for use on this choke should be of a gauge about 36 or 40; in the writer's case the wire from an old car coil was used. Connect one end of the wire to terminal B and then wind on 175 turns and connect the other end to terminal C. The choke may be mounted by a small brass or aluminium bracket, and fixed as shown in the sketch. Fig. 2 shows the completed choke, which has given splendid results on the wavelengths mentioned.—F. N. P. (Ruislip).

Next week's Data Sheet is entitled "Wire and Wire Gauges."

Fig. 2. Detail sketches showing of an H.F.

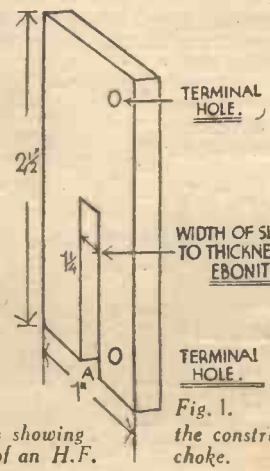


Fig. 1. the construction choke.

OUTDOOR AERIALS

Their Method of Construction and Erection, and How to Deal with Cases of Mishap.

By R. A. HARRIS

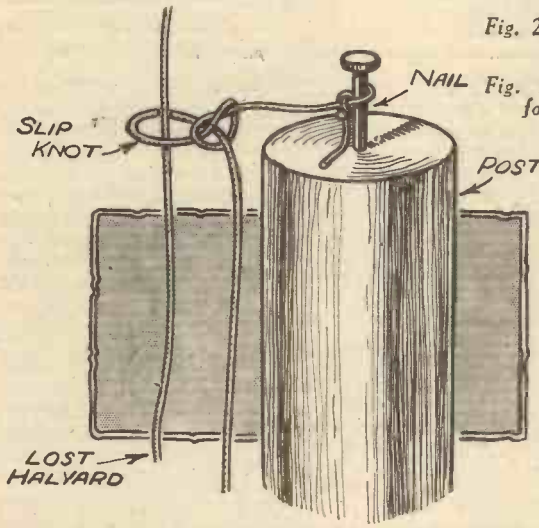
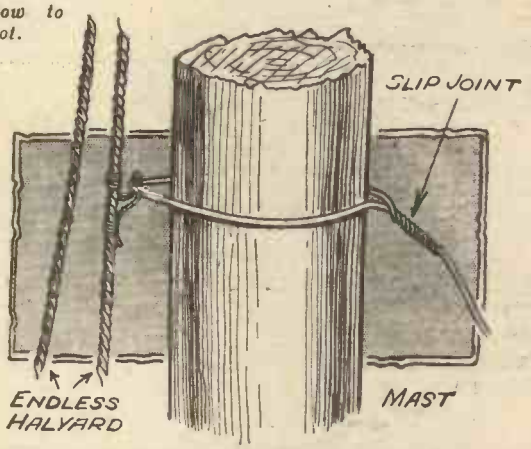


Fig. 2 (right). — Forming the slip joint.

Fig. 3 (left). — How to form the slip knot.



The Erection of a Mast

TO many, this means only the digging of a hole, inserting the mast and ramming the soil home. But, with a little forethought and extra labour at the initial erection, considerable time and labour can be saved when the need for renewals or repairs arises. A rusted pulley, broken aerial wire or dirty insulators all require either renewal or cleaning. Furthermore, a careful wireless enthusiast will wish to keep his mast in a good state of preservation, and this necessitates periodical repainting or re-creosoting.

To remove a mast from its foundation is no easy matter, and to obviate this trouble, the following mode of erection, which embodies the facilities necessary for the lowering of the mast will, no doubt, appeal to many readers. Assuming that the mast is from 20ft. to 35ft. in length and of average diameter, purchase from the wood merchant two lengths of wood 6ft. by 4in. by 3in., one length of 1ft. 6in. by 7in. by 3in., and one block 5in. by 4in. by 3in. From the ironmonger, obtain some long screws, and two bolts 12in. long with nuts to fit. For masts of greater length proportionally larger pieces of wood are required.

Firstly, take the 1ft. 6in. piece "A" (see Fig. 1), cut out a slot 4in. wide by 1in. deep, in and at the centre of each of the two 3in. faces. Place the vertical piece. "B.1." and "B.2." at right angles, so that the ends fit into the slots. With long screws (with nut and bolt, if preferred), fix firmly together. Now, take the spacing piece "C" (Fig. 1), fit this between the two verticals so that the top of the former is 3ft. from the top of the latter. Fasten firmly with screws. (A bolt can be used if preferred.) When this is done, take the mast and slide the bottom end between the verticals (if the mast is too wide, shave down to a width of 5in.) so that the base of the mast is 3in. above the top of the spacing piece. Bind temporarily but securely, with wire or cord.

Next, drill holes through the two verticals and the mast at point X (Fig. 1) 6in. from the top of the verticals and point Y 1ft. 9in. below point X. These holes are to receive the bolts, and it is advisable to insert the latter to ensure that the holes are correctly drilled. If everything is so far satisfactory, the mast can now be removed, and the now completed bearer should be creosoted or tarred. If desired, the bottom half can be charred for the purpose of preservation.

Fixing the Mast Bearer

The time is now opportune for the digging of the hole at the selected spot where the mast is to be erected. This hole should be 3ft. deep and sufficiently long to receive the bearer, but no more soil than is necessary should be excavated. The bearer can now be placed in the hole, but it must be ascertained that the base of the mast, when in position, will be above the ground level.

If the bearer is upright and facing the correct direction, the hole can be filled in with rubble, hardcore, and soil. Water well when ramming down to prevent subsequent subsiding. If time permits, it is advisable to leave the final fixing of the mast until the lapse of a few days, to allow things to settle down to normal. The next stage is the fitting of the pulley, aerial wire, and necessary stays. When this is done, it is only necessary to raise the mast and fix. This should be done as follows: Place the mast between the verticals, insert the top bolt, fit nut, and tighten up until the mast is just sufficiently loose to be rotatable. The mast can now be raised to the vertical position and the second bolt inserted. Now tighten up both bolts firmly. The completed job will give sufficient satisfaction to recompense the owner for the extra time and labour entailed.

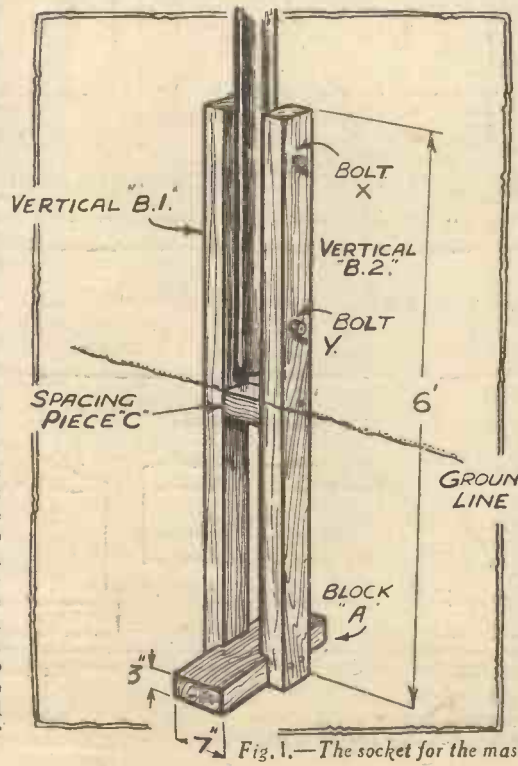


Fig. 1.—The socket for the mast.

Stay Wires

It is often found necessary to fit stays to an existing pole, and if the latter is embedded in the ground, considerable difficulties may be encountered before the operation is ultimately completed. In a case where a continuous halyard is in use, the following method of fixing is worthy of note:—

Take the mast end of the stay wire, loop round the base of the mast, and twist round to form a slip joint (Fig. 2). Bend a small piece of wire to form a hook, and fasten with string to the mast side of the halyard. Support the wire loop by the hook, and gently pull the halyard upwards at the same time relieving the weight of the wire by an upward pressure of the latter. When the required height is attained, a sudden downward and outward pull on the wire

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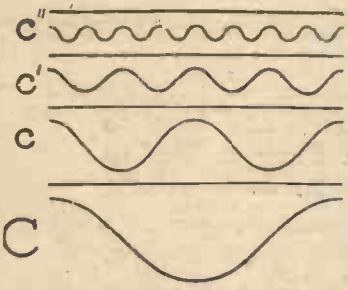

Fig. 1.—The curves of the musical note C and its octaves.

TONE CONTROL

An Important and Informative Article on a Subject Which Will Interest All Who Are Interested in Reproduction Problems

By F. W. LANCHESTER, LL.D., F.R.S.

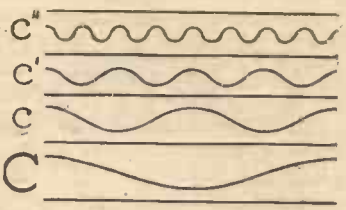

Fig. 2.—The curves of the gramophone record of C and its octaves.

THERE is nothing actually new about tone control, but recently it has come very much to the front. Tone control has been exercised by broadcasting stations for many years, but the tone control which is of interest to the owners of receiving sets means something different; it is the same principle applied to the set itself.

Broadly stated, tone control consists in a means of varying the "centre of gravity," and distribution of the acoustic spectrum, and it commonly involves the provision of a special circuit whose function is to give more amplification to the bass or treble, as called for. That is one way of expressing it, but it would be more true to say that it is a means of giving *less* amplification to the treble or bass, as the case may be, because the introduction of a tone control circuit can only act by *diminishing* the gain or amplification of the upper or lower frequencies. Consequently, tone-control cannot be made use of with any success, unless the set or amplifier has a great deal in hand which we can afford to throw away. Ordinarily, to justify the adoption of tone control in a set which gives *just* sufficient volume without, it is necessary to supply an additional L.F. stage.

For the Gramophone Amplifier

The subject is best approached by a simple example rather than by a generalisation. It is well understood that in the ordinary gramophone record, the bass, say, from about middle C downward (c′ = 256 frequency), is not recorded at full amplitude, and the lower the tone the more inadequate the amplitude; the result is that with the ordinary mechanical gramophone the reproduction is always deficient in bass; a characteristic imparting to music what is currently termed "gramophone quality." This may be regarded as a defect in recording, but it affects all kinds of recording, and it is a *necessary defect*: the reason being that in making a record the spiral spacing of the needle track cannot be varied to suit changes of pitch in the music; it is necessarily constant and is dependent upon the recording apparatus; it has to be such as will give the required length of run (about four minutes for a 12in. record). Thus, the pitch commonly adopted is approximately 1/100 of an inch; it varies a trifle with different records and different makes of record. If the track "band" (measured radially) on a record is 3½in., then the record will run for 350 turns, and dividing this by 80 (the speed of the turn-table) we find the run to be a little less than 4½ minutes. So we appreciate that the spiral pitch of the track must be strictly limited, and since fully half of this is taken up by the needle point, the maximum amplitude of movement permissible is certainly not more than .005 of an inch. Fig. 1 represents enlarged the amplitude for c′ (middle C)* and the two octaves c and C below, *as it should be for equal energy output*, and Fig. 2 the amplitude restricted by considerations of recording; c″ (an octave above middle c′) is given in both figures. Actually, for realism, the energy in the extreme bass should be many times that of the middle frequencies, as every organ-blower knows to his cost, but we are not considering that at present. So we have the problem of tone-control for the gramophone amplifier defined; it involves a relatively great amplification of the bass, or more accurately expressed (as has been pointed out), an *actual* attenuation of the higher acoustical frequencies. Referring in greater detail to Figs. 1 and 2, it is an established fact that for equal power (watts) the *amplitude* × *frequency* is constant; and c′ is shown with the full amplitude permissible, that is to say, occupying the whole of the available track width. Now comparing Fig. 2 to Fig. 1, the C one octave below has an amplitude only half what it should be, and for the C two octaves below (the C string of a 'cello 66—), the track width is only one-quarter of what it should be. In Fig. 1, the amplitudes shown for the 3 C's are those of equal energy.

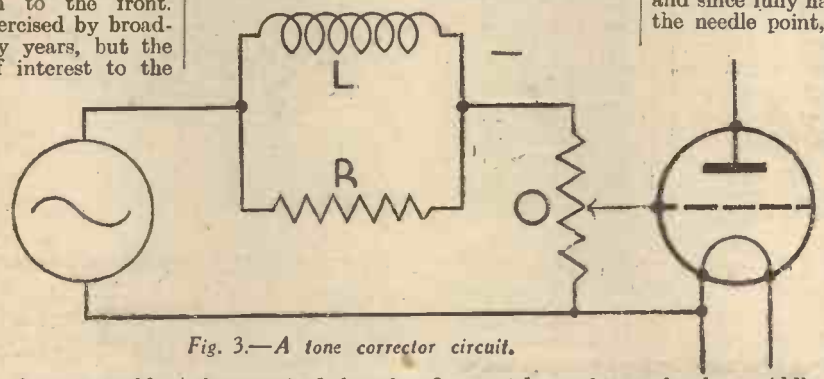

Fig. 3.—A tone corrector circuit.

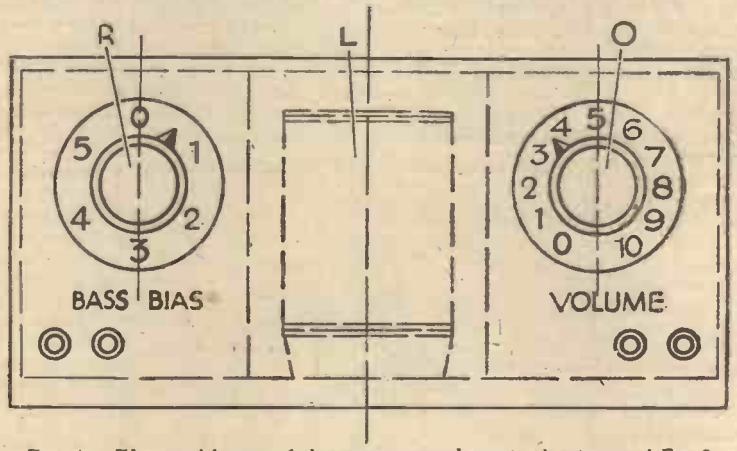

Fig. 4.—The panel layout of the components shown in the circuit of Fig. 3.

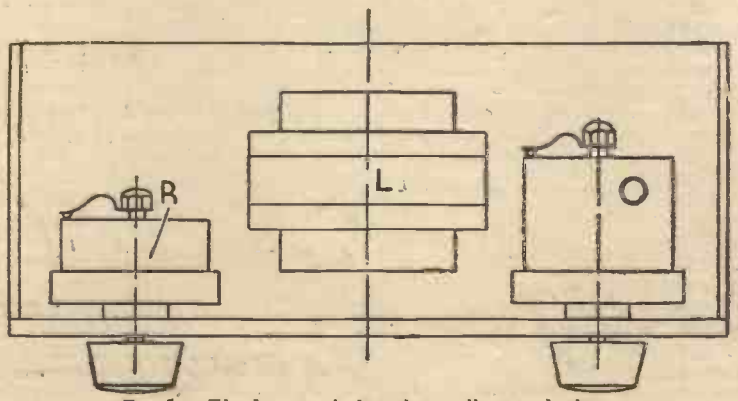

Fig. 5.—The layout of the scheme illustrated above.

Tone Control for High-Power Amplifier

In an amplifier used to illuminate a lecture given by the author of the present article, in the Town Hall, Birmingham, in January, 1929, gramophone records were used exclusively, there being too much interference from trams, etc., to make use of broadcast; a tone-control circuit was devised,

* The notation used is that of Helmholtz, C, c, c′ and c″; c′ is middle C.

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Tone Control

(Continued from page 762.)

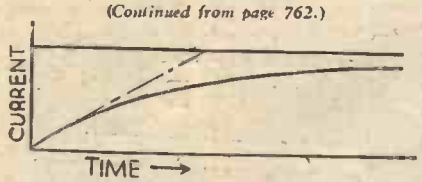
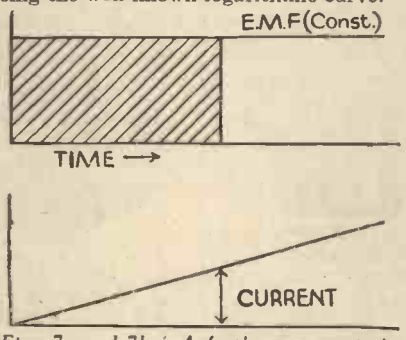


Fig. 6.—A diagram illustrating time and current.

following the pick-up, controlled by a rheostat which, by attenuating the upper frequencies gave various degrees of "bass-bias." In order to permit of the (relative) augmentation of the bass, which meant throwing away the upper frequencies wholesale, a four-stage amplifier was specially designed, having an over-all amplification of 100,000, or thereabouts. The H.T. E.M.F. was supplied by an Exide battery of 450 volts, and the power "galaxy" consisted of eight B.12 valves (B.T.H.), 4 and 4 in push-pull, with a maximum undistorted output (calculated), about 12 or 14 watts.

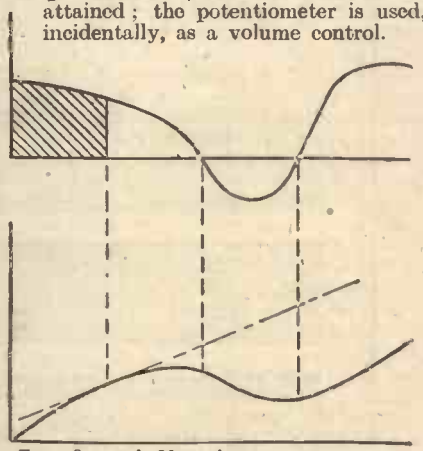
The extent of "bass-bias" required to restore organ music to its true majesty is far greater than that necessary for equality of energy, the bass needs many times the watts of the higher frequencies. We succeeded in reproducing the organ music with such power and realism that the bass shook the seats throughout the vast auditorium; many people, as they entered the hall and took their seats, were under the impression that the Town Hall organ was responsible. Fig. 3 is a diagram of the tone-control circuit employed. It comprised a choke or inductance *L* of about 50 henries (Ferranti, B.1), a potentiometer *O* of 2,500 ohms, and a variable resistance, *R* (rheostat) max. 500,000 ohms. Fig. 4 is a front elevation of the embodiment of the circuit, and Fig. 5 a plan view; the same reference letters are employed. The essentials of the circuit are the inductance and the potentiometer. The function of the rheostat is to by-pass the "bass-bias" circuit to diminish its influence; the rheostat knob is the means of tone control, and acts by varying the extent to which the higher frequencies are allowed to come through direct.

In considering the function of the circuit as a means of bass-bias, we assume the resistance *R* to be infinite, non-existent in fact. Then, when E.M.F. (in this case supplied by the pick-up) is applied to inductance *L*, the current rises in proportion to time; at first, strictly so, and later, at a less and less rate tending to a maximum (which is dependent upon the applied E.M.F. and the resistance in circuit), when the current becomes constant. The resistance in the present case is made up of the pick-up winding, the potentiometer resistance, and the ohmic resistance of the choke A. The rise of current with time, and its gradual approach to its maximum value, is shown in Fig. 6, the form of the graph being the well-known logarithmic curve.



Figs. 7a and 7b.—A further representation of Fig. 6.

The inductance of the choke *L* is sufficiently high in relation to the circuit resistance to ensure that the current never approaches its limiting value, and that the portion of the graph in Fig. 6 which is utilised can be regarded as the initial inclined line (without serious error), so that the current is proportional to the time of application of the constant E.M.F, and we have two graphs, namely, that of the applied E.M.F., which is constant (Fig. 7*a*), and the current which grows with time (Fig. 7*b*). It is now necessary to use terms which denote the relation of these graphs. In Fig. 7 graph *b* is said to be the *integration* of *a*, and conversely *a* is the *differentiation* of *b*, these are terms used in the calculus; the editor informs me that I may not presume that *all* his readers are mathematicians, so I will proceed to explain. In Fig. 7*b* the ordinate which represents current is the measure of the corresponding area in Fig. 7*a*, and the ordinate which represents E.M.F. in Fig. 7*a* is a measure of the slope in Fig. 7*b*, so that a constant value of E.M.F. Fig. 7*a*, when *integrated*, gives a constant slope or rate of increase in Fig. 7*b*. Conversely, a graph of constant slope in Fig. 7*b*, which represents a constant rate of increase, when *differentiated*, gives a constant value of E.M.F. The particular example is just a simple case illustrating the more general principle of graphic calculus. Thus, in Fig. 8 we have an arbitrary varying E.M.F. 8*a* applied to an inductance. The graph 8*b* representing current is derived from 8*a* by measuring areas such as that shown shaded (by means of a planimeter), and laying them off to a suitable scale to give the current at any instant as in Fig. 8*b*, and, conversely, if the graph of the current be given the corresponding E.M.F. value is derived by laying off ordinates (Fig. 8*a*) proportional to the slope (tan. angle) of the graph in Fig. 8*b*. So that we have learnt to regard the circuit of Fig. 3 as an *integrating* circuit, the *current* is an integration of the applied E.M.F. But we want a new *E.M.F.* which is the integration of the input E.M.F. By passing the current through a resistance (the potentiometer) the desired result is attained; the potentiometer is used, incidentally, as a volume control.



Figs. 8a and 8b.—A current variation plotted in accordance with this article.

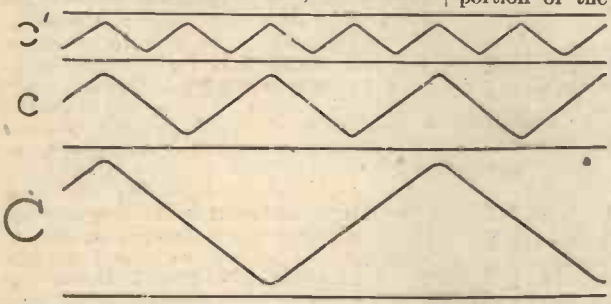


Fig. 9.—The record trace to give correct reproduction of C and its octaves.

TABLE I.

Frequency=f ..	64	310	1,600
$P=2\pi f$	400	2,000	10,000
R=infinite Imp.=	20,000	100,000	500,000
R=100,000 Imp.=	19,600	70,000	98,000
R=20,000 Imp.=	14,100	19,600	20,000

TABLE II.

Frequency=f ..	64	310	1,600
R=infinite	×6	×26	×126
R=100,000	×5.1	×18.5	×25
R=20,000	×4.5	×5.1	×6
R=0 *	×1	×1	×1

* Tone control cut-out.

The Action of an Integrating Circuit

Let us now see in what manner this integrating circuit acts in interpreting the gramophone record. Let Fig. 9 represent the trace required to give equal energy for middle c' and the c one and two octaves below respectively; we have seen that these cannot be properly recorded. For reasons that will be supplied later, in Fig. 9 a zig-zag has been substituted for the more conventional sine curve. Now, if we differentiate these zig-zags which (representing equal energy or power) are all of the same slope, we get a new set of three curves (Fig. 10) whose ordinates are all equal, for as explained, in differentiating, the ordinate is drawn proportional to the slope of the parent curve. We see at once that these differentiated curves fit into the recording scheme, *they represent equal energy for*

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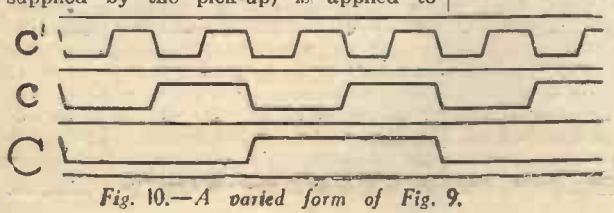


Fig. 10.—A varied form of Fig. 9.

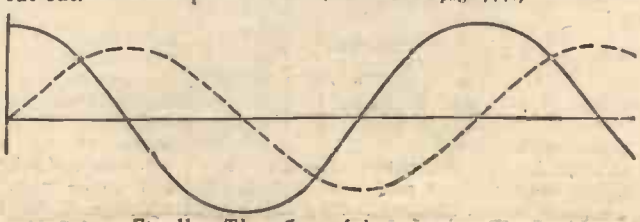


Fig. 11.—The effect of harmonics.

Receivers and their Records

We shall be pleased to advise readers regarding purchase of complete sets.

WHEN so many makers are devoting their activities to the production of mains operated receivers it is pleasant to know that there exist some reliable battery sets on the market which, offered at a reasonable figure, fulfil the requirements of the man whose house is not equipped with electric current. The "*Aerodyne*" *Screen Grid* "3", is one of the most popular models of the range of receivers made by Hustler Simpson and Webb, at their Walthamstow (London, E.17) works. It is, in effect, a highly sensitive instrument embodying a variable-mu screen-grid valve of the latest type, power grid detector and super-power output valve feeding a permanent magnet moving-coil loud-speaker. (Although the receiver is primarily designed for battery operation, it will function equally well if current is supplied by a high tension eliminator.) The receiver is housed in a cabinet of neat appearance; its design is strictly modern, and the general finish leaves nothing to be desired.

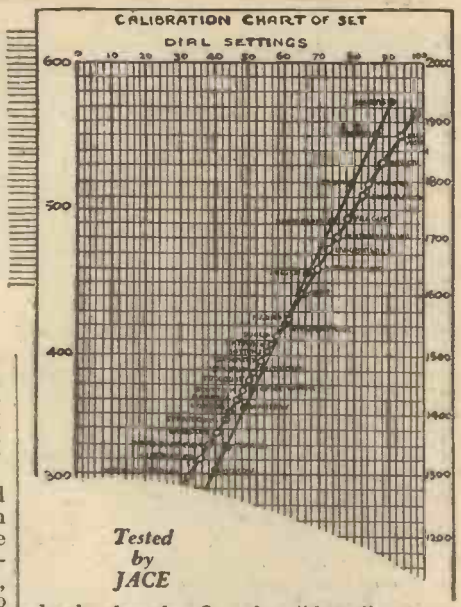
All the necessary controls—four in number—have been symmetrically grouped on the front of the cabinet below the loud-speaker grille. The main tuning knob which works the ganged condensers is also incorporated with a separate trimming device which acts as an auxiliary condenser and is of the utmost importance to fine tuning. By this means it is possible to increase the strength of weak signals in conjunction with the reaction and volume controls. The trimmer or compensator is on a spindle concentric with the main tuner knob. Underneath it will be found the combined "on" and "off" and wave-change switch giving three positions—namely, "shortwave" (250-500m.) to the left, "longwave" (1,000-2,000m.) to the right; and "off" when the point thus marked is uppermost. On the extreme left is the control which provides a variable volume. This is obtained by means of a 25,000 ohm potentiometer working on the bias to the screened-grid high-frequency valve. Finally, the right-hand knob represents "reaction"; it works smoothly and no difficulty was encountered in obtaining good sensitivity whilst keeping the valves just below oscillation point. There is a knack in tuning a receiver which the beginner must set himself to acquire at the outset, if satisfactory results are to be obtained. This principle applies to all receivers. A search for a transmission is facilitated if the volume control is first set at its maximum position. Tuning is then carried out by means of the main condenser knob or dial, in conjunction with the reaction control. When signals are heard they should be brought up to the required volume by means of this main tuner, and a finer reading on the scale secured by the concentric trimmer. Reaction must be kept as low as possible; if the mark is over-stepped the set will burst into oscillation and signals are blurred and distorted. If they are too loud, reaction may be further reduced by the appropriate control knob. When dealing with transmissions on neighbouring wavelengths, which require separation, it is better to reduce volume, to re-tune carefully, in particular with the trimmer or compensator, and to increase reaction within reasonable limits. Controls of all receivers, irrespective of their make and design, should be turned slowly if full advantage is to be taken of the selective properties of a circuit.

"AERODYNE" SCREEN GRID "3"

On test the "*Aerodyne*" *Screen Grid* "3" gave a very good performance and a number of British and foreign broadcasts were

The "Aerodyne" Screen Grid "3."

received at good loud-speaker strength. For the purpose, both outdoor and indoor aerials were used; in the latter case local transmissions provided good signals, but except under the best conditions, foreign stations were below useful strength. There are two aerial sockets at the back of the cabinet—namely, A1 and A2; the latter provided a higher degree of selectivity than the former, and proved its utility when dealing with severe interference. During daylight hours it was found possible, when coupled to an outdoor aerial, to hear Daventry, Radio-Paris, Eiffel Tower, London Regional and National programmes; during the evening, in addition to these transmitters, many others were successfully logged. The circuit showed a good degree of selectivity in permitting the separation of London National from Trieste, and again from Heilsberg; with better adjustment of the controls Turin was



Tested by JACE

clearly heard. On the "long" waves, such stations as Motala, Eiffel Tower, Daventry and Huizen could be tuned in easily, but Königs Wusterhausen was not clear of its neighbours. On the lower portion of the coil there appeared to be a break-through of the London transmission, but this occurred only over a small portion of the scale and did not interfere with the above-mentioned broadcasts.

The dial is very clearly marked in degrees, a principle which many makers might adopt, as, against readings in actual wavelengths, unless perfectly calibrated, such markings are liable to puzzle the beginner, because if any discrepancy occurs it makes identification of the transmitter a difficult matter.

The "*Aerodyne*" *Screen Grid* "3" may also be used for the electrical reproduction of gramophone records. The pick-up sockets are located at the back of the cabinet and it is only necessary to plug in the pick-up leads to obtain the desired result. To avoid, however, the superimposing of radio on gramophone signals, it is advisable to detune the instrument—namely, to make sure that the dial reading does not tally with the wavelength of a powerful local transmission. If volume of reproduction is too great, an external potentiometer control may be adopted. Generally speaking, the *Aerodyne* passed its tests very satisfactorily. It has been built with care and forethought and the construction shows a good standard of workmanship. The components have been carefully grouped on the metal chassis, and to ensure efficiency, all wiring is carried out under the base plate. The moving-coil loud-speaker gives an excellent quality of reproduction, with a very even response throughout the scale. Speech was crisp and clear, and tone remained natural so long as volume was not injudiciously forced.

The "*Aerodyne*" *Screen Grid* "3" (Battery) may be strongly recommended as an all-round efficient receiver which, although listed at the reduced price of £9 9s., is capable of giving the listener the choice of a number of British and foreign programmes. The makers, in order to assist beginners in wireless, have issued clear and concise instructions in the booklet supplied with the set, and to facilitate matters, have labelled every single lead in the cabinet which an unskilled person may be called upon to handle.

Introducing

THE SEL

AN ULTRA-EFFIC

Wonderful Receiver; Novel in Principle,

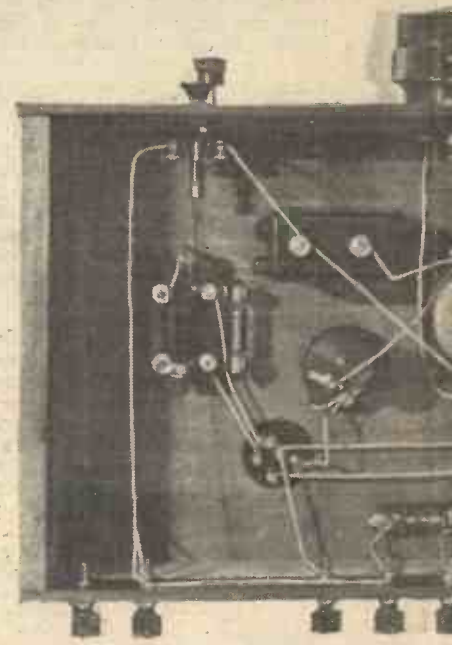
By FRANK

Mr. Preston, the designer of this interesting receiver

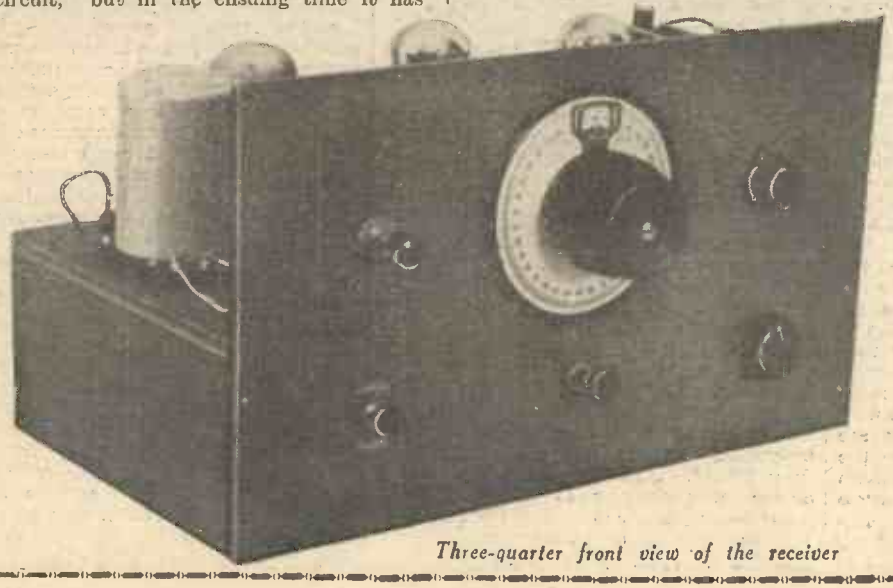
IN the first issue of PRACTICAL WIRELESS the Editor kindly invited me, along with my colleagues, to describe my favourite circuit. Since the time of publication numerous queries have been addressed to me (c/o the Editor) asking for further details and practical data in regard to the construction of a set employing the circuit I described. In each case I have been compelled by reason of our rules to ask those querists to wait for a little while, because (I did not tell them this) I was experimenting on a greatly improved version of my original idea. All readers of PRACTICAL WIRELESS are by now well aware of the fact that we absolutely refuse to supply constructional details of any set which has not been made and subjected to the strictest and most rigorous tests in our own laboratories. In no other way can we give an absolute guarantee of the set's performance. The Selectone, which I am going to describe, started its life on the test bench several months ago as a practical example of "My Favourite Circuit," but in the ensuing time it has grown to full maturity. It has passed through many experimental stages, and even six weeks ago it was a set of which I was proud. But that was not enough; I was determined that before I would present the design to readers of PRACTICAL WIRELESS the set must not only be good, but it must be as near perfection as possible. I should not have prepared this article now were I not confident that the Selectone is better than any other contemporary receiver in its class, and also that it represents a very definite step forward in design and technique.

Perfect Tone Control.

Before telling you just what the Selectone will do let me give an outline of its special features. In the first place the circuit is on the Stenode principle, which means that tuning is so dead sharp as actually to cut off a portion of the sidebands. For this reason the tuner is purposely designed to weaken the higher musical notes, *but* by using a variable tone control, which can be operated at will by the listener those notes can be restored to any desired extent. The full significance of this feature must be experienced to be fully appreciated, but it ensures that any desired tone from "shrill" to "boomy" bass can be obtained as desired. More than this, however, it makes possible in mild



The underside of the baseboa



Three-quarter front view of the receiver

LIST OF COMPONENTS

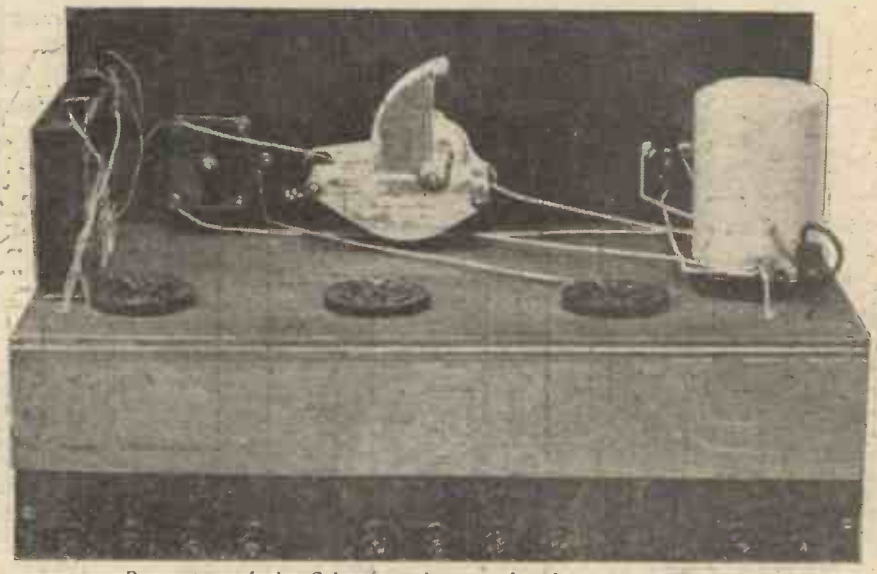
1 Vibranti plywood panel 14in. by 8in.
1 Utility Standard .0005 mfd. condenser.
1 Utility type W. 181 micro-dial.
1 Lissen .00015 mfd. differential condenser.
1 Colvern type "T.D." coil.
1 Lissen 3-point wavechange switch.
1 Telsen on-off battery switch.
1 Wearite type "G.C.O." radio-gram switch.
1 Lissen 5,000 ohm. potentiometer.
3 Eddystone chassis mounting valve-holders.
1 T.C.C. .0002 mfd. fixed condenser.
1 Dubilier 3 megohm grid leak.
1 Dubilier grid leak holder.
1 Telsen Standard H.F. choke.
1 Benjamin Transfeeda.
1 T.C.C. 2-mfd. condenser.
1 Varley Rectatone transformer.
1 Belling Lee baseboard fuseholder with 60 m.a. fuse.
10 Belling Lee "Junior" terminals; 1 each marked A, B, L.T.+, L.T.—, H.T.—,

ECTONE

ENT BATTERY SET

in Conception, in Design and in Performance

RESTON, F.R.A



Rear view of the Selectone, showing the clean appearance

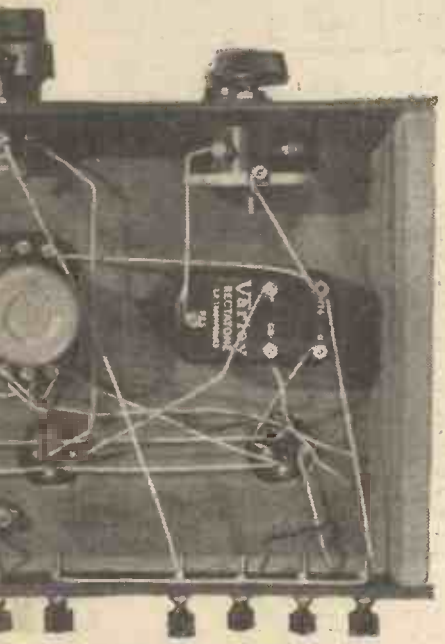
cases the complete elimination of heterodyne whistles created by stations working on adjacent wavelengths. This latter is impossible with any ordinary receiver unless fitted with a special whistle filter.

Variable Selectivity

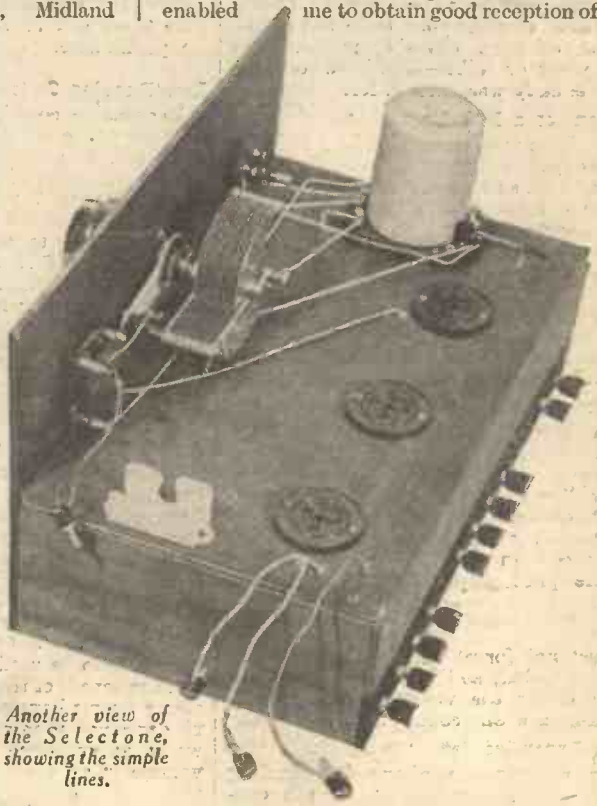
Tuning is perfectly sharp, so that no station (even if it is situated a few miles from your aerial) will occupy more than two or three degrees on the special micrometer tuning dial. The Selectone is not merely highly selective, however, but the degree of selectivity is under full control, and can be altered to suit any and every set of conditions. The extreme selectivity ensures a silent background and real enjoyment of the programme being received. On the long waves, Daventry, Zeesen and Radio Paris can all be received separately, even though the frequency separation of the two former stations is only 4 kilocycles, or insufficient to permit of their separation with a band pass tuner. Such stations as North Regional—Langenberg, Midland Regional — Bucharest and North National—Hilversum on the medium waves can be separated with ease, whilst even Mühlacker and London Regional can be received clear of each other by a slight sacrifice of the higher frequencies.

Sensitivity

Most highly selective receivers, except those using a large number of valves, are not particularly sensitive, but that cannot be said of the set under review. During the first test of the final model (at least four others were made during the experimental period) forty-two stations were well received at good speaker strength when using an outside aerial of 70ft. overall length. Reducing the length to 40ft. had very little effect, and even when the set was transferred to a poor indoor aerial running round the picture rail of a downstairs room, no fewer than twenty-five stations could be brought in at good programme strength. As the tuner covers a range of from under 200 to just over 500 metres in the medium-wave position, and from about 850 to 2,000 metres on the long waves, practically every worth-while European and American station is covered. It will be of interest to would-be constructors to learn that a few hours after completion the Selectone brought in two American medium-wave stations, KDKA on 306 metres and WGY on 379.5 metres, at fair speaker strength, even though the time (Greenwich) was only 1 a.m. Such popular Continentals as Fécamp, Bucharest, Hilversum, Rome, Mühlacker, Moscow and Radio Paris can always be relied upon to provide really good loud-speaker signals at any time of day or night. As a matter of fact a short test during the afternoon enabled me to obtain good reception of



ard showing the simple wiring



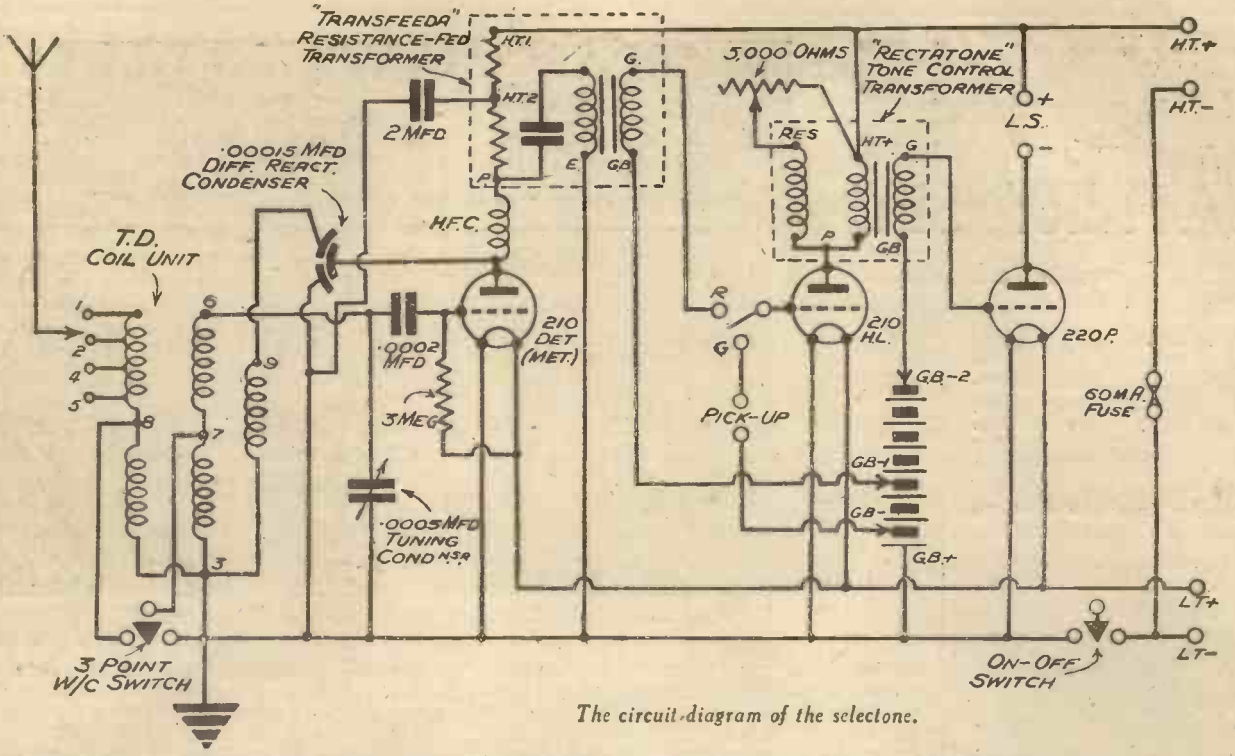
Another view of the Selectone, showing the simple lines.

FOR THE SELECTONE

H.T.+, L.S.—, L.S.+, and 2 marked Pick-Up.
6 Belling Lee wander plugs; marked G.B.+, G.B.—, G.B.—1, G.B.—2, H.T.+, H.T.—.
1 Strip Becol ebonite, 14in. by 1½in.
1 Bulgin G.B. battery.
1 Coil Glazite connecting wire.
1 short length flex.
1 5-ply baseboard, 14in. by 8in.
2 pieces hard wood, 14in. by 3½in. by ½in.
1 piece 3-ply, 14in. by 2in.
Approximate total cost — £4 10s. 0d.

Accessories.

1 Camco "Excelsior" or "Aston Senior" cabinet.
3 Cossor valves; 1 type 210 Det. (metallized), 1 210H.L. and 1 220P.
1 Ediswan 9v. G.B. battery.
1 Ediswan 105v. super capacity H.T. battery.
1 Ediswan 2v. 40 a.h. accumulator.
1 Celestion Soundex permanent magnet moving-coil loud-speaker.



The circuit diagram of the selectone.

a dozen foreigners. I will say no more at this juncture about the actual stations received, but will leave that matter for a later article in which I will give a more complete log and figures in relation to dial readings.

Loud Speaker Quality

The quality of reproduction will meet with the approval of the most fastidious of music lovers, whilst the fact that the actual tone can be varied will be keenly appreciated, whether your taste lies in the direction of jazz, chamber music, brass bands, plays or talks—high-brow or low-brow is equally well catered for.

Provision for a Pick-Up

Yes, I have made provision for a pick-up, and the quality of gramophone reproduction is just as good as that of radio programmes. The tone control is also operative on gramophone music and, in addition to its normal function, it can be employed as a scratch filter, so making it possible to eliminate needle scratch. The pick-up is brought into circuit by the action of a switch mounted on the front panel, so there is no need to probe about inside the set to effect the change-over.

Appearance

Both from inside and out the Selectone looks as good as it is. The clean layout and use of a box-form chassis make the interior "look good," whilst the Cameo cabinet, designed specially for this set, is of particularly handsome and attractive appearance; in fact, I can honestly say that the photographs do not do justice to it.

Safety

I must not forget to add that a safety fuse is provided, so that it is impossible to damage either the valves or components by making a wrong connection.

Not an Expensive Set

After reading the above introductory remarks you may have drawn the conclusion that the Selectone is going to cost rather a lot to build. I would not go so far as to say it is a "cheap" set, but it is definitely not expensive. Considering that it gives results equal to most super-heterodynes, and better than many of them, its cost is distinctly reasonable. You will see from the list of components that the price of the bare set is approximately £4 10s. 0d., in spite of the fact that really high-grade and modern components are specified. If you add to this the cost of the cabinet, valves, batteries and speaker you will find that there will be some change out of a ten-pound note.

Low Running Costs

Reasonable cost is not confined to the building of the set though, because running costs are, in proportion, even lower still. The consumption of high-tension current is no more than 7 milliamps when using a 108-volt H.T. battery, or 10 milliamps with 120 volts high tension. Filament current consumption is .4 amp., and so the 30 ampere-hour accumulator will give about 75 hours' running per charge. If you have a H.T. eliminator, even of the smallest type, it will be quite suitable for this set, because adequate decoupling is provided, and only a single H.T. positive tapping is required.

Ample Loud Speaker Output

When using the valves specified, in conjunction with a 108-volt high-tension battery, the Selectone has a maximum undistorted output of about 110 milliwatts, or with a 120-volt battery the output is 140 milliwatts. If desired the undistorted output can be brought up to 170 milliwatts by increasing the H.T. voltage to 150, but this will not be necessary unless the set is to be used in a very large room. For the benefit of those readers to whom the above figures have no significance it should be explained that an output of 100 milliwatts is sufficient to give really good volume in an average sized drawing-room when using a sensitive moving-coil speaker of the type specified.

For "Old Hands"

The Selectone will have a particularly strong appeal to "old hands" who are tired of reading descriptions of so many "new" sets which are obviously mere modifications of those they have been building for years. The new principles, up-to-date constructional methods, *de-luxe* features, really sensible and easily-calibrated tuning dial and businesslike appearance are just a few of the things that will at once be recognized. In addition they will be pleased to have a set with which the number of stations receivable varies in proportion to the skill of the operator. By skilful use of the reaction control the range of reception is truly unlimited.

—And Beginners

But the beginner will also find the set just to his liking. Its method of construction, combined with the complete wiring charts, sketches and photographs to be given next week, will be found so simple and straightforward that the veriest tyro need not hesitate to build the Selectone with full confidence of success. Although as pointed out in the last paragraph, the results vary in relation to the skill of the operator, I have proved that a person without any experience of receiver operation can bring in a goodly number of stations by the mere process of revolving the tuning knob. As a matter of fact, I recently asked an oldish lady to see what she could do with the Selectone, after I had connected the batteries. The test was made during the evening on an 80-foot aerial situated some twenty miles from the North Region transmitters. She did not attempt to use the reaction control at all, and yet was able to bring in eleven stations on the medium waves and four on the long. The tuning of each of the Northern stations spread over less than four degrees, and neither station could be heard *in the slightest degree* when the set was switched over to long waves. That, I think, is wonderful proof of the Selectone's capabilities!

CAN YOU READ A GRAPH?

FRANK PRESTON, F.R.A., here explains in straightforward language the advantages and use of graphs of the types frequently employed for wireless purposes.

AS you have observed, graphs are employed very frequently in wireless work and provide a simple means of supplying a large amount of data in what might be called tabloid form. Immediately you open a valve carton you find inside a graph showing the characteristics of the valve; when buying a transformer you are often supplied with a graph which shows its response to various frequencies; every week in PRACTICAL WIRELESS you will find on the page devoted to "Receivers and their Records" a graph showing the condenser settings for the various wavelengths; in a recent issue of PRACTICAL WIRELESS I gave some graphs from which one can find the ratio of an output transformer suitable for various combinations of loud-speakers and valves. But I need give no more examples—you know the kind of diagram I refer to.

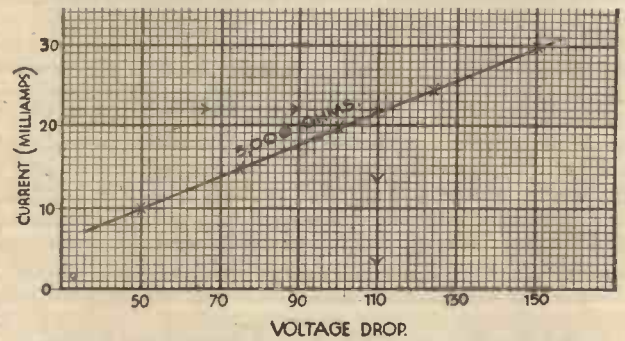


Fig. 1.—This graph shows the relationship between voltage drop and current for a 5,000 ohm resistance.

What do all these graphs mean to you; can you understand them and use them to the best advantage? I know perfectly well that many readers fight shy of graphical diagrams because they look uninteresting and perhaps rather "highbrow," if I may use that much overworked word. Believe me, they are neither, if you will spend about half an hour in considering them. A graph is a much easier thing to understand than is a bowling analysis or a bridge score card, once the basic principles have been grasped.

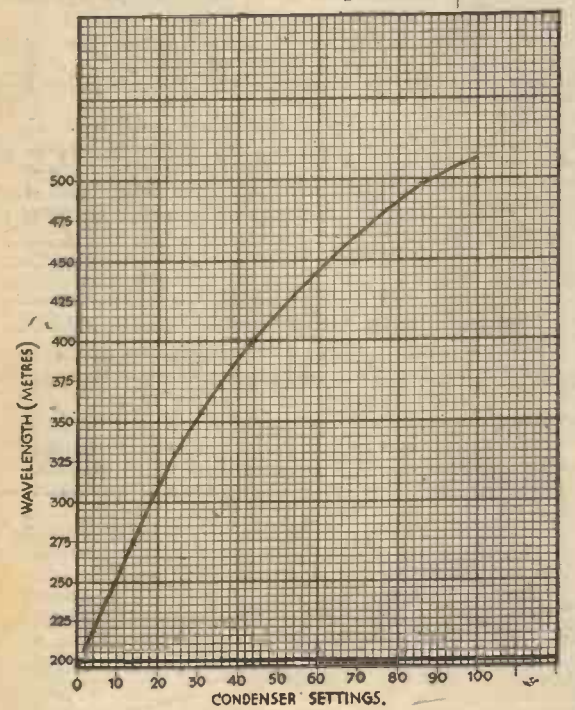


Fig. 2.—A typical tuning curve.

What a Graph Is

Stated briefly, a graph is a diagram used to show how one factor varies in relation to another. Thus we could, and often do, prepare a graph to show how the temperature changes from day to day or how the value of the pound fluctuates. A graph could also be used as a ready reckoner, so that corresponding values of two variable quantities can be read off at a glance. As an example of this I would ask you to compare the following table with the graph of Fig. 1.

Current. m.a.	Voltage Drop. volts.
5	25
10	50
15	75
20	100
25	125
30	150

Both the table and the graph show the voltage drop across a 5,000 ohm resistance when passing various values of current. But whereas the table only gives the voltage drop at a few specified current ratings, the graph is applicable to any current. For instance, we could not find from the table the voltage drop at, say, 22 milliamps, but by using our graph it is immediately apparent that the required figure is 110 volts. The result is obtained by finding 22 milliamps on the vertical scale and taking a horizontal line across to the graph; where it cuts the latter we take a vertical line down to the lower scale and read off the answer. By working in the reverse manner we could find the current necessary to produce any required voltage drop.

Curves

The graph of Fig. 1 is of the simplest kind, where the two variable factors, voltage and current, are in simple proportion. It is because of the latter fact that the graph is represented by a straight line. But it is more usual to find the relationship expressed by a curved line, such as that of Fig. 2, which is a typical tuning graph for a receiver.

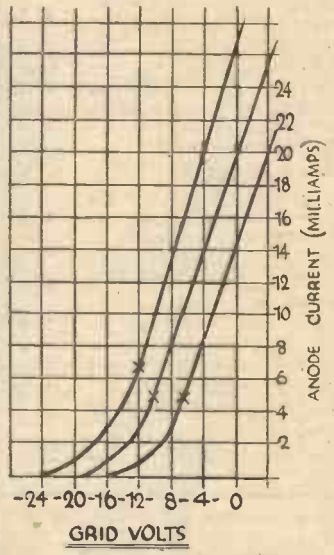


Fig. 3.—A "grid volts—anode current" curve of power valve.

Tuning Curve

The curve has been drawn by plotting various condenser settings against the corresponding wavelengths. Actually the curve was prepared by tuning in a few stations of known wavelength at different parts of the condenser dial and marking with a small cross the wavelength appropriate to each setting. Having obtained a few positions a smooth curve was drawn through them. When the curve is drawn it can be used to find the wavelength of the set at any position of the condenser or, conversely, to find the condenser setting required to tune the set to any desired wavelength.

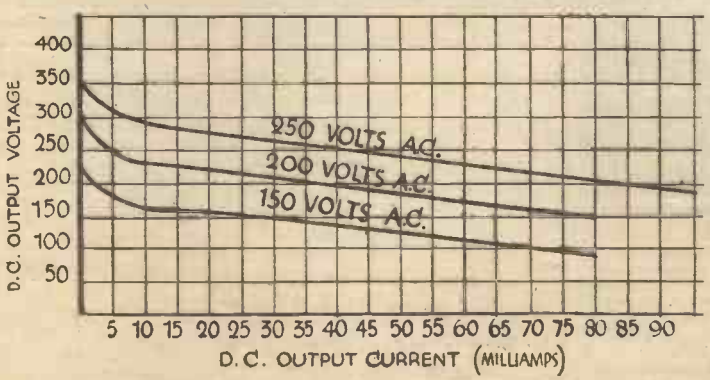
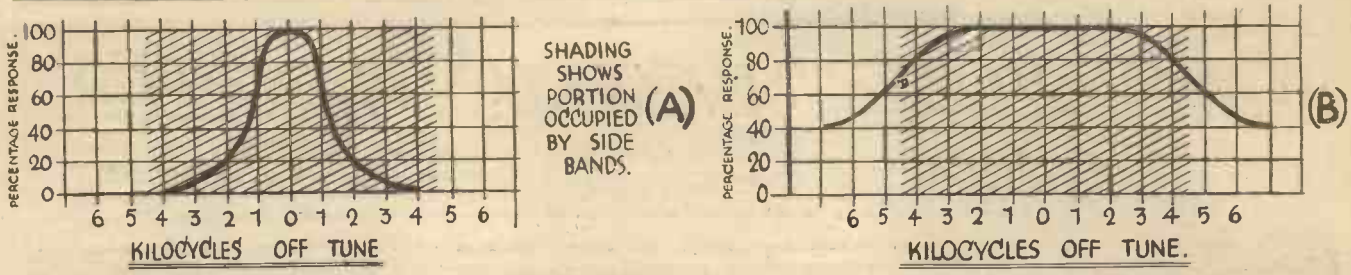


Fig. 4.—Load current for a half-wave rectifier.

"Anode Current—Grid Voltage" Curves

A similar kind of curve can be drawn to show how the anode current of a valve



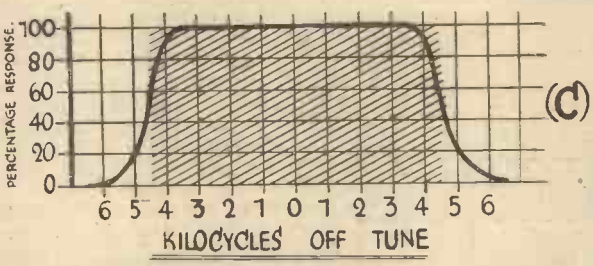


Fig. 5 A. B. and C.—Response curves for different kinds of tuned circuits.

varies with the grid bias voltage. The graph of Fig. 3 is that supplied by the makers in relation to a typical small power valve.] In this case three curves are drawn on the same graph to represent the conditions existing at three different anode voltages. Besides showing how much anode current the valve will consume, the graph can be employed to find the correct grid bias voltage for different anode voltages and also the power handling capacity of the valve. Space does not permit of my entering into the theory of valves here, but it can be explained that to produce distortionless amplification and to prevent overloading, the valve should always be worked on the part of the "curve" just above the lower bend. Thus when 100 volts H.T. is used the correct G.B. voltage is approximately 7.5 and at these voltages the anode current consumption will be about 4 milliamps. In the same way it will be seen that when 150 volts high tension is used, the correct grid bias voltage is about 12 and the anode current rather more than 6 milliamps.

Rectifier Output

Another use for a graph is to show the voltage output of a rectifier under varying conditions of current load. Fig. 4 shows the "load curves" for a half-wave rectifying valve when fed from three different transformer voltages. It will be seen that when 200 volts A.C. is applied to the rectifier the output voltage is 250 with a load of 10 milliamps, or 170 volts with a load of 75 milliamps (the maximum for this valve). The graph enables us to see at a glance what the output voltage would be at any particular current load. This information is invaluable when designing an eliminator or mains receiver because it enables us to calculate with certainty the correct values for the various H.T. fed resistances.

Curve Shape

Quite apart from obtaining accurate numerical data a good deal of information can often be gained merely by studying the *shape* of the curve. As an example of this I would ask you to examine the graph of Fig. 5 (*A*) which shows the response of a tuning circuit to different frequencies. The zero position on the horizontal scale represents the frequency of the carrier wave of a station and the figures on each side refer to the frequency of the side bands or musical notes impressed on the carrier wave. It will be seen that although full response is given to notes of low frequency, the response to high frequencies falls off very rapidly. The curve tells us that the circuit under review tunes very sharply and cuts off, or gives little response to, the higher musical frequencies. In consequence, it will provide excellent selectivity, but must be followed by some kind of tone-correction device if good reproduction is required. Now compare the graph of Fig. 5 (*A*) with that of 5 (*B*). The latter obviously represents a flatly-tuned circuit which would be unselective but would give practically an even response to all musical notes.

Fig. 5 (*C*) is the response curve of an ideal band-pass tuner; equal response is given to all musical frequencies up to 4½ kilocycles (the highest permissible under the present scheme of 9 kilocycle separation between stations), but higher frequencies are given a sharp cut-off. Thus the circuit represented will be very selective, even though giving full response to all musical frequencies. The curve will explain the reason for the term "square-peak" as applied to a certain band-pass tuner.

Voltage Amplification

Another kind of graph, of which the shape of the curve is most instructive, is that which is used to show the percentage amplification afforded by a low frequency transformer at various musical frequencies. Fig. 6 is a typical example of a percentage amplification-frequency curve, and shows us that the transformer represented gives practically uniform amplification to all frequencies from about 150 cycles per second to just over 2,000 cycles. Below 150 cycles the amplification falls off rapidly, whilst the same thing occurs above some 5,000 cycles. There is a "peak" at 4,000 cycles, and therefore notes round about this frequency will be emphasised to a certain extent. The curve is fairly representative of an average low-priced L.F. transformer.

It will be noticed that the scale of frequencies is graduated so that the lower frequencies are more "spread out" than the higher ones; this arrangement is generally employed in connection with musical notes since it gives a better representation of performance at the frequencies most commonly employed.

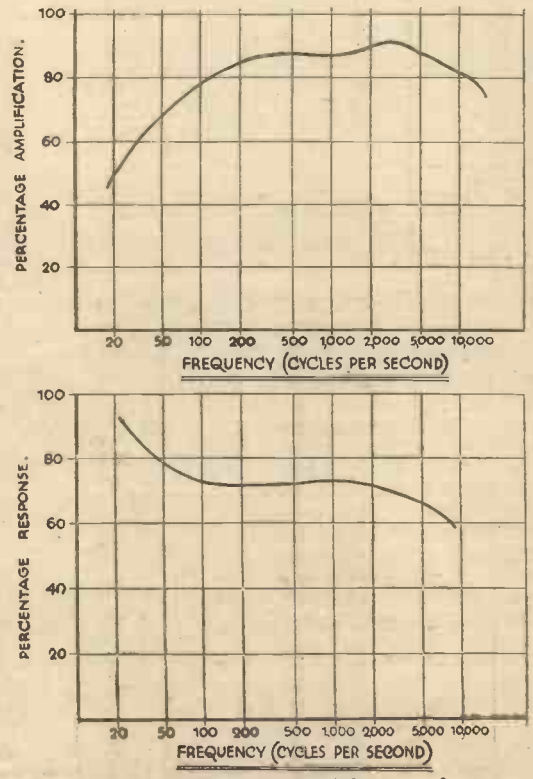


Fig. 6 (above).—Percentage amplification—frequency curve for an L.F. transformer.

Fig. 7 (below).—Response curve for an up-to-date pick-up.

Pick-Up Response

And now it will be interesting to compare Fig. 6 with Fig. 7. The latter is the response curve for a good up-to-date gramophone pick-up. The response to frequencies between about 100 and 2,000 cycles is more or less uniform, but the curve *rises* below 100 cycles and falls gradually above 2,000 cycles. A pick-up with characteristics such as these would make it possible to obtain an almost equal (loud-speaker) volume from all sound frequencies because the lower frequencies are of necessity attenuated (reduced in intensity) by the process of recording.

For the Practical Man

It would be impossible in a short article such as this to refer to every kind of graph, but it is hoped that sufficient has been said to enable every reader to give a correct interpretation to all those in common use. Remember that, although graphs are often prepared by the technician and theorist, they are intended for use by the *practical* man, and it is he who benefits most by them.

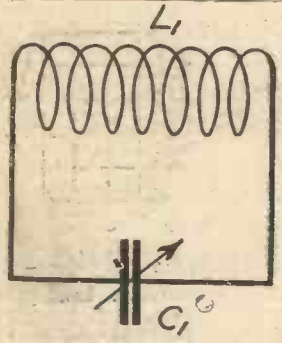


Fig. 1.—A closed circuit as used in the absorption wavemeter.

THE SIMPLEST WAVEMETER

A Practical Article on the Construction and Use of an Absorption Type Wavemeter. By K. E. BRIAN JAY

WAVEMETERS, or frequency meters as we ought to call them in these days, are of two kinds, heterodyne and absorption. The difference between them is this: the heterodyne type puts a signal of known wavelength into the receiver, while the absorption type takes power out of the receiver at a known wavelength. The first kind will obviously be elaborate, since it must contain the means of generating a signal; older types used a buzzer for this purpose, but were not very accurate; the modern instrument, the true heterodyne type, employs a valve which, acting as an oscillator, generates a signal that sets up a beat note in the receiver. Heterodyne wavemeters can be very accurate, but are unnecessarily complicated and expensive, for such purposes as the ordinary listener requires them.

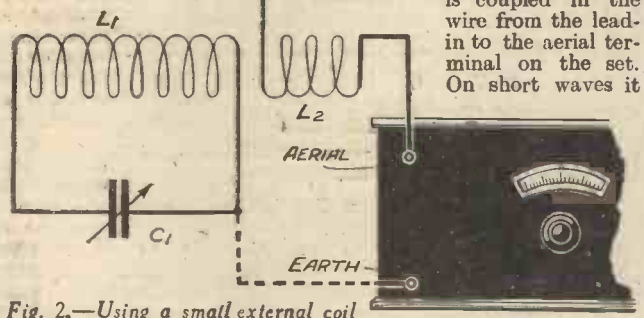


Fig. 2.—Using a small external coil for coupling the meter.

Absorption Type Wavemeter

The absorption type, on the other hand, combines reasonable accuracy with cheapness, and a simplicity that is unusual in radio apparatus. It consists merely of a coil and variable condenser loosely coupled to the receiver so that it absorbs a little power from the receiver when it is tuned to the same wavelength; this results in the signals heard decreasing in strength, or if the receiver is oscillating it will go out of oscillation. Fig. 1 shows the theoretical circuit of an absorption wavemeter, L_1 being the coil, and C_1 a variable condenser. The meter can be made up by mounting C_1 on a small panel fixed to a baseboard upon which the coil rests. If hand capacity effects are noticeable, connect the moving vanes of the condenser to earth; in cases where hand capacity is very bad, or should the constructor be ambitious for extreme accuracy, the meter can be mounted in a screened box. A good slow-motion dial with easily-read divisions and a fine indicating line must be fitted.

In use the meter is loosely coupled to the receiver, the simplest method being to place the coil in line with the receiver-coil and within an inch or so of it. On rotating the meter dial one point will be found where the signal strength of the station being received falls away considerably; the meter is then said to be in resonance with the incoming signal, *i.e.*, tuned to the same wavelength. In general, however, it is not possible to get the meter coil near enough to the receiver coil, especially if the latter is screened or the receiver is in a cabinet. To overcome this difficulty the meter coil is coupled in the wire from the lead-in to the aerial terminal on the set. On short waves it will be sufficient merely to loop this wire once round the meter coil, but on the broadcast band this is not enough. A few turns of wire should therefore be put on the former of the meter coil and connected as L_2 in Fig. 2.

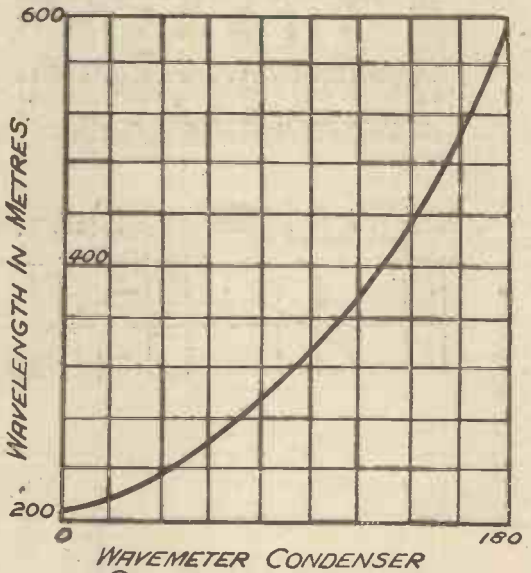


Fig. 3.—The tuning graph for calibration.

Constructional Details

With regard to constructional details, for C_1 any good variable condenser of .0005 or .0003 mfd. capacity will be satisfactory. The size of L_1 is not particularly critical: as a guide to making it at home, 65 turns of 28 D.S.C. S.W.G. wire wound on a cardboard tube of 2¾ins. diameter were found to tune from 239 metres at 49 degrees on a .0005 mfd. condenser, to 480 metres at 118 degrees. Corresponding readings of 72 degrees and 170 degrees were obtained with a .0003 mfd. condenser, which would therefore require a larger coil to cover fully the medium waveband; probably 70 to 75 turns would suffice for most purposes, any gauge of wire between 24 and 30 being suitable for either coil. A commercial unscreened dual-range coil would do quite well, and cover the long waves in addition. Whichever type of coil is used, however, it will be necessary to put on L_2 oneself. On the medium broadcast band about 8 turns wound close to one end of the coil should do, but on the long waveband more may be needed. This is a matter for individual experiment, the aim being to obtain as marked a reduction of signal strength as is possible, compatible with sharp tuning on the meter. To find out whether the coil L_1 is of the right size, if it is home-made, tune the receiver to a station as near the bottom of the waveband as possible, and adjust the wavemeter to resonance; the wavemeter dial reading should be near zero, say, 20 to 30 degrees for Fécamp on 223 metres. Do the same for a station, such as the North Regional, near the top of the band; in this case the meter reading must be around 160 degrees. As long as the whole waveband is within the wavemeter dial all is well. If the shorter wave station is at, say, 70 degrees, however, the coil will probably be too small; if no resonance point at all can be found for it, and the longer wave station is around 100 degrees, the coil is too big.

Calibrating the Instrument

We have now to calibrate our instrument, by no means a difficult operation despite its great importance. All that has to be done is to tune in as many reliable broadcasting stations of known wavelength as possible, tune the wavemeter accurately to resonance with each, and note its dial reading and the wavelength of the station. The

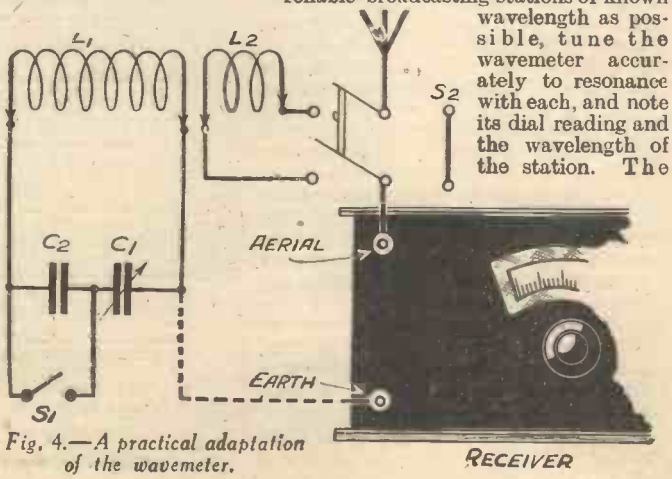


Fig. 4.—A practical adaptation of the wavemeter.

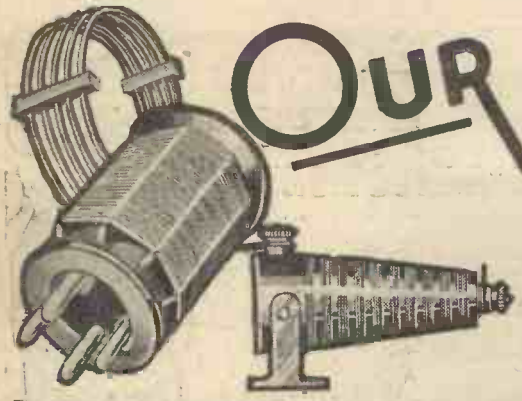
B.B.C. stations will give a useful nucleus of points, and there are several high-power foreigners who will be audible on most sets. A graph is then plotted on squared paper as in Fig. 3, wavemeter dial readings being marked along the bottom and wavelengths up the left-hand side.

The wavemeter can then be used to assist in identifying an unknown station. Suppose such a station is heard: the meter is coupled up to the receiver, and the knob turned until the signal strength is suddenly reduced. The condenser setting of the meter is then compared with the graph, and the wavelength read off. From one of the published lists of broadcasting stations the transmission nearest to this wavelength is found, and the station identified quite easily. If it is desired to search for a certain station the meter is set to the appropriate wavelength, and the receiver tuned until there is a sudden falling off in background noise: the meter is then de-tuned.

This type of wavemeter is particularly useful on short waves, but in this case a rather smaller variable condenser is desirable. For example, a .0003 mfd. condenser, together with a coil of 5 turns of 22 S.W.G. enamelled wire wound on a 2½in. former, will tune from 18 metres at 30 degrees to 50 metres at 180 degrees, and this is as wide a range as is comfortable. The same range is covered in less than 90 degrees with the same coil and a .0005 mfd. condenser, resulting in very cramped tuning; hence the smaller condenser is to be preferred. Coupling to the receiver is by a single turn of wire in the aerial lead. The most definite indication of resonance is obtained with the set just oscillating; at the resonant point it will stop oscillating with a click, and the coupling between meter and set should be such that the receiver stops and re-starts oscillating at practically the same point on the meter.

An "All-Wave" Meter

We have seen that a .0005 mfd. condenser, as used for tuning on the broadcast band, is too big for short waves, but in spite of this the wavemeter can be arranged to cover both long and short waves quite easily, by connecting a fixed condenser in series with the variable condenser, and so reducing its capacity to a value suitable for short waves. Fig. 4 shows such an "all-wave" meter. C_1 is the .0005 variable, and C_2 a .0005 mfd. fixed condenser: the total capacity of the combination is .00025 mfd., which will do for short waves. L_1 and L_2 are wound on the same former and arranged to plug in; ordinary six-pin formers could be used if they are available. Should it be felt that with .00025 mfd. tuning will still be unduly cramped on short waves, and there is no objection to using two or three coils, the effective capacity of C_1 can be reduced still further to about .00017 mfd. by making C_2 .0002 mfd. This will make the meter easier to tune, but several coils will be necessary. With the switch S1 closed C_2 is shorted out, and the whole .0005 mfd. becomes available for use on the broadcast band. Great care must be taken to keep the wiring of the meter, especially to S_1, quite rigid, or the calibration will not hold properly. On either waveband the meter may be left permanently in circuit. Deadspots can be avoided by de-tuning the meter or else cutting it out of circuit by a switch such as S_2, arranged as in Fig. 4.



OUR SHORT-WAVE SECTION

IT has nearly always been the writer's experience to hear the new-comer to short-wave reception express his disappointment at lack of results. Now, there is nothing fundamentally different in the construction of a short-wave set from one designed for normal broadcast use—in fact, from the detector onwards there is no need to make the slightest alteration in design. The tuning system is the heart of any set, and it is in this part of the receiver that the tyro so often errs. With this point in mind it will repay to investigate the matter at some length.

Nowadays it is customary for the tuning condenser in a normal broadcast receiver to have a capacity of .0005 mfd. In conjunction with a suitable coil the tuning range may often be from 200-600 metres; in terms of frequency this is 1,500-500 kc/s., or a band of 1,000 kc/s. width. Assuming we are using a 100 division tuning dial with a straight-line frequency condenser, each division will represent 10 kc/s. As probably most readers are aware, this is recognized as the width required by a simple broadcast transmission, although modern conditions have forced this separation down to 9 kc/s. It can be seen, therefore, that one station will occupy one division on our dial. Even tuning without a slow-motion dial presents no great difficulty. Let us now turn to our short-wave receiver and assume that we are using the same tuning condenser. With a suitable coil our tuning range very roughly may be 20-60 metres. Expressed in frequency this is 15,000-5,000 kc/s., or a width of no less than 10,000 kc/s., space enough for 1,000 stations spaced at 10 kc/s. intervals. Under these conditions there is room for ten stations to work comfortably in one division of the dial! Quite obviously a slow-motion dial is essential. Even then it is a tedious business searching. It is quite easy to see that the novice may very easily miss everything on tuning such a set, whilst in effect the dial may be alive with stations. An experienced amateur, thoroughly at home with a short-wave set, would not dream of tuning under such a handicap. Small wonder, therefore, that the tyro is beaten.

Small-capacity Tuning Condenser Necessary

The most obvious way of overcoming this difficulty is to use a tuning condenser of much smaller capacity. One often sees a .00025 mfd. specified. The writer, however, would never think of using anything larger than .0001 mfd. The great ease of tuning easily offsets the objection of limited tuning range, which in the case in point will be roughly from 20-27 metres. For those ultra-short-wave enthusiasts who like to delve into the mysteries of 5 and 10 metres, anything larger than .00005 mfd. (*four* 0's) is definitely taboo.

SHORT-WAVE TUNING

By E. JOHNSON

There is no basic reason why the normal broadcast receiver should not be used for short waves if provision is made for reducing tuning capacity. In passing it need hardly be said that careful attention must be paid to wiring and lay-out. Long straggling leads which pass muster on broadcast waves definitely will not do on short waves. Short and direct well-soldered connections are the way to success. Fortunately it is very simple to reduce our tuning capacity. All we need is a .0002 fixed condenser in series with our main tuning condenser. If the latter is the conventional .0005 mfd. our resultant tuning capacity is actually .00014 mfd., a value sufficiently near the one recommended above. Of course, a shorting switch must be fitted to cut out the fixed condenser when normal broadcast wave reception is desired. Fig. 1 will make this quite clear.

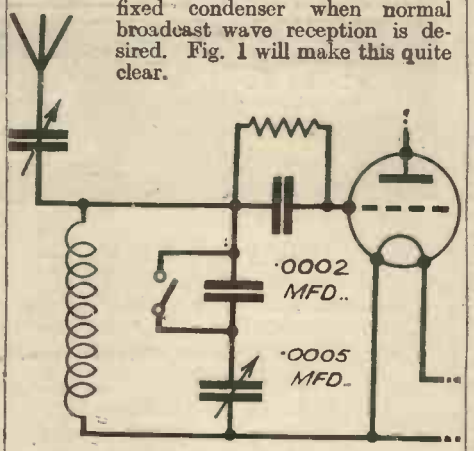


Fig. 1.—Method of switching to reduce value of tuning condenser.

The above method is very popular, but in the writer's opinion has rather a serious objection, viz., the switch. The ideal switch should have a negligible resistance in the closed position, a virtue seldom realized in practice. In any case switching in high-frequency circuits (especially *ultra*-high frequencies), is always a seat of loss. There is yet another drawback. Many short-wave sets are prone to body capacity effects, *i.e.*, the approach of the hand to the tuning dial entirely upsets tuning. Where the tuning capacity is small, especially at the lower dial readings, body-capacity troubles are usually noticeable because their extraneous capacity is a comparatively large proportion of the whole. A very simple way to overcome this, and one which has much to recommend it in another respect, seems at first sight contradictory to the first part of this article. In short, a .0005 mfd. tuning condenser is used with a .0001 mfd. in parallel. The large condenser is termed a band-setting condenser and is really not used for tuning-in at all. The procedure is as follows: Points are marked on the band-setting condenser corresponding to 20, 30, 40, 50, and 60 metres; the necessary stations must, of course, be tuned in for rough calibration. If we desire to search around 30 metres, therefore, all we have to do is to set our band-setting condenser to 30 metres and do the actual searching and tuning on the small condenser which will only have a tuning range of a few metres, thus making the handling of the set every bit as easy as on the broadcast waves. Another great advantage is that our body capacity is now a very small part of the main circuit capacity, and therefore has extremely little effect on the tuning.

Tuning coils need very little comment. Bare wire is the best, with as little dielectric as is compatible with mechanical strength. Regarding aerial coupling there is little doubt that a neutralizing condenser of low-minimum capacity in the lead to the receiver is the best solution, and simplifies matters by eliminating an extra coupling coil. Many new-comers worry because below 20 metres it is difficult to make the set oscillate without reducing aerial coupling to a very low value. Here and now it may be said that there is no need to be upset about this. On 10 metres the writer has known all the necessary aerial coupling to be obtained by merely dangling the aerial near the set. It seems that the lower one goes in wavelength the less necessary an aerial is, and, in fact, it seems quite likely that when these new micro waves are fully explored, aerials may be entirely dispensed with. After all, light is only a form of radio wave of extremely short length, and it would certainly seem ludicrous to find our street lamps complete with aerials to ensure proper illumination. This is certainly a case of *reductio ad absurdum*, but it illustrates the point.

MAKING IT OSCILLATE

By B. K. COOPER

OSCILLATION, the bane of the broadcast listener, is the short-wave enthusiast's necessity. Owing to the very small input of energy from the aerial to the grid of a short-wave detector, the valve must always work at maximum sensitivity, on the threshold of oscillation, in fact.

Probably the first effect noticed by the new-comer to the short waves on trying out his receiver is that the reaction control is

ineffective at certain settings of the tuning dial. Even with the condenser at maximum, no oscillation can be produced, and the set seems dead, except, perhaps, for faint murmurs from the very high-powered telegraphy stations. These "dead spots" are most likely to be encountered in sets of the simple detector and low-frequency type. Those employing a screen-grid high-frequency stage are usually free from them.

Aerial Damping

The dead spots arise from the "damping" effect of the aerial, and this is brought about in two ways. Firstly, there is the damping of a long aerial. This very often manifests itself by the set refusing to oscillate at all on the really short waves, say, from twenty metres downwards. It is often in evidence, too, at the top end of the condenser scale with certain coils, when higher reaction settings woud have to be used in any case.

To make an aerial effectively shorter, hence to reduce its damping, it is only necessary to couple it more loosely to the set. Most short-wave receivers include a very small variable condenser for this purpose in series with the aerial. Alternatively, the lead from the aerial terminal to the aerial coil is flexible, and provided with a tapping clip so that it can be connected to any portion of the coil found to give sufficiently loose coupling. Quite often both these schemes are employed, and it may be found that to make the set oscillate right down to fifteen metres or so, it is necessary to tap the aerial on to the coil at a point only half a turn away from the earthed end, and at the same time to reduce the setting of the series condenser slightly from its maximum.

It should be remembered that the more loosely the aerial is coupled to the set, the less volume will be given on all stations. You may find a very loose coupling that lets the set oscillate on every wavelength within its range, but do not leave it at that. Always work with as tight a coupling as you can, and do not grudge the little trouble you may have to take in finding the tightest practicable coupling you can employ on every station. Remember, tightest coupling and greatest volume, provided the set can be made to oscillate, are given with the aerial series condenser "all in," and the tapping clip at that end of the coil which is connected to the grid of the detector.

Eliminating "Dead Spots"

Even a short aerial will cause damping effects when its natural wavelength, or a harmonic thereof, coincides with the wavelength to which the set is tuned. "Dead spots" arising from this effect only extend over a few degrees on the dial, and conditions are normal on both sides of them. They can be shifted by making the aerial effectively longer, a proceeding that does not reduce volume. Try connecting a coil of thirty turns or so, wound on a former in series, with the aerial. Even a rather longer wire between the lead-in terminal and the set will sometimes be effective.

Damping may also be caused by long or carelessly-arranged leads in the wiring of the set. Every wire in the detector stage should be as short as possible. The coil holder, valve-holder, and grid-condenser should be spaced so that there is the smallest possible distance between those of their terminals that have to be connected to one another. Keep the leads to the variable condensers short as well, and see that they are well spaced.

TONE CONTROL!

(*Continued from page 764.*)

equal amplitude. And the fact that the recording instrument does actually reduce the amplitude below middle C to a constant, means that, in effect, the recording instrument does differentiate the "graph" for these low frequencies when engraving the wax. The differentiated record when interpreted by the ordinary gramophone sound-box as we know, does not sound right, *the differentiated record must be restored by integration*, this means that the graph of Fig. 10 is converted into Fig. 9 by the tone-control circuit, and the bass is *restored*, giving equality of energy.

Since the upper acoustic frequencies—above middle C—are recorded direct, and not differentiated, it would not be satisfactory to integrate everything that comes over; the object of the Resistance R (Figs. 2, 3, and 4) is to by-pass some of the E.M.F. from the pick-up, so that the signal received by the grid of the first valve, through the potentiometer, is in part integrated and in part direct.

A Question of Harmonics

There are several little points that require explanation. The reason the zig-zag has been chosen for illustration is in order that the parent and differentiated graphs should be different in appearance. If a sine curve be differentiated the result is another sine curve, out of phase with the first; the differentiation reduces sine curves of different frequency, but of the same energy value to the same amplitude, as with the zig-zag. This is shown in Fig. 11, but the contrast is not so striking. The zig-zag is justified by the fact that it is the type of trace made by a violin or other bowed instrument, such a graph including the *odd* harmonics only. But the bowed instrument does give forth *some* even harmonics of low intensity, and the zig-zag has rounded angles, as shown in Fig. 11. If it were not for this the differentiated curve would be absolutely square at its corners, and the needle could not follow the track.

To anyone not versed in acoustical theory the differentiated curve of Fig. 10 differs so strikingly from the parent zig-zag, Fig. 9, that it might be a matter for wonder how the record sounds as true as it does when used with the ordinary gramophone without integration. The answer is that it is not the shape of the graph that is important, except so far as the shape does define the harmonic composition of the note recorded; the same combination of harmonics (related pure tones) differently phased may, when recorded, make graphs of totally different appearance, but they all sound the same. Now the graphs in Figs. 9 and 10 both contain the same harmonics, but they are present in different proportions, and differently phased. The differentiation has, as we know, reduced the intensity of the bass relatively to the upper frequencies, and the shrill character of the ordinary gramophone rendering of the record is evidence of this fact, but the ear recognizes that the proper harmonics are there, and does not feel outraged, as it would were the harmonic combination changed.

It is of importance to examine the action of the integrating tone-control circuit quantitively. The inductance will be taken as 50 henries. The by-pass or tone-control resistance R will be taken at three different settings, namely: R = infinity, R = 100,000, and R = 20,000. We shall calculate the impedance of the circuit for these different settings at frequencies = 64, 310, and 1,600 cycles per second, the equation is:—

$$\text{Impedance} \quad \frac{1}{\sqrt{\frac{1}{P^2L^2} + \frac{1}{R^2}}}. \quad \text{Where } P = 2\pi f.$$

The results are given in Table I.

The potentiometer resistance (2,500 ohms) plus the resistance of the pick-up winding we shall denote by the symbol R_2; the value of this may be taken = 4,000 ohms. This is in series with, and therefore has to be added to, the impedances given in Table I. Since R_2 is the resistance or impedance which the pick-up has to overcome if the resistance R be made zero, there will be an attenuation = $\frac{R + R_2}{R_2}$ the additional magnification required to restore the signal to its full strength, that is, to make good the loss due to tone-control. Values for this are given in Table II.

We are able to see from these figures that the statement made at the outset, that tone-control, to be effective, requires an additional L.F. stage, is fully justified.

OUTDOOR AERIALS

(*Continued from page 761.*)

will tighten it to the mast. The mast side of the halyard can now be pulled down to release the hook when the stay wire can be permanently fixed to the stay block.

Doubtless, quite a number of our readers still make use of the single non-continuous halyard, although it is less convenient than the continuous type. During mending or cleaning operations, the reader may accidentally allow the first mentioned type to slip through the fingers, when it will usually fly up the mast, well out of reach. Should this happen, proceed as follows: Procure a length or lengths of pole (ordinary clothes props bound together will suffice) of sufficient length to reach the end of the wire or rope. Drive a nail into the end of the pole, obtain a length of cord, tie one end of the latter to the nail and make a slip-knot in the cord. (See Fig. 3.) The loop may be strengthened with the aid of a piece of small gauge wire.

With the loop standing out horizontally, raise the pole. On reaching the end of the halyard, guide the loop over the end and work up as far as possible. Now pull the cord, which will tighten the knot, to firmly grip the wire. The pole can now be lowered to regain possession of the wire.

A ladder is not always handy, when it is desired to fix a supporting wire to a chimney stack. Under such circumstances an alternative method, such as the following, might appeal to some readers.

Procure a ball of twine and holding one end, throw the ball over the roof near the stack, round which it is proposed to fasten the wire. Fix one end of the supporting wire to the near end of the twine, and from the other side of the house, pull over the wire, having first secured the other end of the wire. Wind up the string again, and return over the roof on the reverse side of the stack. From an upstair window (nearest to the stack) the next operation can be carried out. Either bind the two ends of the wire together and fasten on the insulator, or, fastening a small metal ring to one end of the wire, pass through the other end, and pull on the free end.

Interference from Electrical Apparatus

ONCE more I see the problem of interference of electrical apparatus with wireless sets has cropped up, and it appears that the number of complaints being received by the Post Office or the B.B.C. are increasing in volume daily. Over 10,000 cases per annum are dealt with by the Post Office and there is a growing opinion that the whole subject should be ventilated publicly. It is evident that with the increase in the purchasing of electrical apparatus more and more interference will be caused, and as machinery of an electrical nature is being bought by persons of a decidedly non-technical class in increasing numbers the difficulties will be considerable. Because of this it is felt that the onus should be thrown on the manufacturer of electrical plant and machinery, and that some sort of legislative powers be obtained to compel all apparatus likely to cause radio interference to be adequately protected. As the matter is at present, users of interfering apparatus usually fit smoothing devices as an act of good-will, and while the proportion of refusals is not high, some tramway companies have definitely refused to do anything to cure their interfering systems. I see the English Electric Co., Ltd., are marketing a pair of choke coils weighing some 34 lbs. for use on trolley buses which do much to stop interference from this type of vehicle. Most tramway systems with overhead collectors can be adequately filled with only one coil, as where lines are used the earth return is through these. In trolley buses, however, the return is made through a further overhead wire, so that for these vehicles the anti-interference device has to be duplicated.

Resistance-less Metal

JUST as the greater proportion of the power expended in moving any self-propelled vehicle is spent in overcoming wind-resistance, so is the larger part of electrical energy in any circuit used in overcoming resistance. Of course, in our radio sets we deliberately fit certain resistances for purposes peculiar to the circuits, but it is obvious that a resistance in series with any current supply is wasteful, and, strangely enough, the less resistance we insert in the flow of current the more will be available to overcome the resistance of the work to be done on the job, whether it be the heating up of a valve filament or in driving an electric motor. Some years ago—toward the end of the last century—a method was found of super-cooling certain gases to such extremely low temperatures as to cause them to liquefy. By using these liquefied gases various objects and metals were cooled far below zero, and among these was mercury, which, as you may know, becomes solid at low temperatures. A famous scientist—Dewar, I believe—tried the effect of passing a current through the mercury at varying low temperatures, and

JOTTINGS FROM MY NOTEBOOK.
By "DETECTOR"

found that the lower the temperature the less the resistance of the metal to the current passing. It was thus reasoned that if an absolute zero could be obtained a metal in this state would possess no resistance at all. Conflicting opinions arose and many great minds expressed the opinion that a resistance-less metal even at low temperatures was only a dream about on a par with perpetual motion. I see, however, in the pages of one of our scientific reviews that the subject has been worked upon by a noted British professor, who has been engaged upon a series of experiments dealing with the supra-conductivity of metals, as it is called. Metals have been cooled by means of liquid air, hydrogen, and helium, and the scientist has found that at temperatures around absolute zero —273° Cent.—mercury offers no measurable resistance to a current. A ring of metal was made, super-cooled by liquid gas, and a current was started in the ring. It was found that the current would flow indefinitely as long as the supply of liquid gas lasted, and a demonstration of this experiment was made before the Royal Institution during the past summer. This ring was immersed in liquid helium and was carried in an aeroplane several hundred miles. When the current in the ring was measured before the Institution some six hours later it was found that the original current of 200 amperes was still flowing undiminished. Power supply engineers and all engaged in the distribution of electrical energy in any form or other have watched the experiments with interest, as it can be imagined the possibility of carrying heavy currents over quite fine wires is attractive, to say the least of it. Further developments may be expected along these lines, as methods of making the system commercially possible are being explored as far as practicable.

Interference from a Neighbouring Set

A LITTLE while ago I came across a genuine case of interference between sets belonging to two neighbours. I had often read of such instances, but had never come across one myself, with the result that while I appreciated such a position might be possible, I do not think I realized just how serious such interference might be. In this case it certainly was serious, for at times one set seemed to blank out everything for the one next door, and only when both sets were tuned to the local station, or the long-wave Daventry, could reception be said to be worth listening to. Luckily the neighbours were quite good fellows, and were both open to reason, which was just as well, as for either of them anything approaching distance work was impossible when the other set was working. Anyway, we settled the problem by persuading the man with the most powerful set to use an indoor aerial until radical alterations could be effected to both of their outdoor aerials, which, incidentally, ran parallel to each other at about only seven feet apart. If you are troubled in this way it is a good plan to first of all try altering your earthing system. If the other fellow uses a water-pipe earth, try a natural or buried earth, or *vice versa*. If this does not make sufficient difference, pay attention to your aerial, and try and arrange yours or, preferably, his as well so that they are as far apart as possible, and not running both in the same direction. Again, it is a good plan to try an indoor aerial on your set. Selectivity is sure to improve, and volume does not always fall off to the extent that is often expected, especially as more often than not with a modern set much of the latter can be sacrificed without much loss. An indoor aerial can be placed around the picture-rail, it being assumed, of course, that good insulated wire be used; or you could stretch one of the spring type aerials sold for the purpose across the room from corner to corner. This might be considered unsightly, but during the festive season, at any rate, paper decorations could be hung from it without impairing reception to any great extent; in fact, for party purposes, or for operating radio sets in village halls and the like, this is an ideal way of disguising a makeshift aerial slung up. The ideal indoor aerial would be a vertical wire, and while this is not always a mechanical possibility, I have seen aerials taken up to an attic by means of the staircase well, the wire being neatly attached to the banisters; and once I saw such an aerial taken up a lift shaft. With the latter, however, the steel framing of the lift and the building shielded to a great extent the incoming signals.

Possibilities of the Quartz Crystal

IT is encouraging to remember that constantly a band of scientists are working to improve the lot of the radio amateur. I refer again to the work being done at the National Physical Laboratory in collaboration with the Radio Research Board, which, of late, has been on the lines of research into interference problems. The study of the behaviour of the quartz crystal used in a resonant circuit has been occupying the time of several of these workers, and it is believed that a new principle of "ultra-sharp" reception will be developed with the view of separating near-by transmissions. That there is a need for such a principle is self-evident, as you have only to touch the knobs of any valve receiver to find this out for yourself, and the problem of station interference is the greatest we have yet had to face.

Electrical Energy in Fruit

AN American chemist has found out that fruit possesses a small amount of electrical energy. He found that by inserting the two prongs of a very sensitive milliammeter into an apple that a small current was registered, this result denoting the acidity of the fruit. Different fruits gave different readings, and, as consequence, he assumed he had fallen across a new way of measuring the acidity of different fruits. Those of you who experimented with a potato as a detector in your crystal days may now scratch your heads, but please note I am aware that a potato is not a fruit—or is it ?

Public Address System

MANY of the large stores in London and other cities are now appreciating the possibilities of a public address system, and the Marconiphone Co. are busy fitting up several such department stores with an amplifier installation. S O S calls can be put through, and advice relating to the control of traffic through the stores given out without choking the telephone system with internal calls to the detriment of outside callers. Attention can be called to special bargains, and applications too numerous to mention can be thought of. Marconi-Reisz microphones are used, and a special amplifier has been designed by the Marconiphone Special Products Branch.

Useful Experiments at the N.P.L.

I MENTIONED, some time ago, the effect of different types of soil formation on wireless earths, and the N.P.L. have been recently carrying out a series of experiments for measuring the efficiency of different soils as earths in wireless reception and transmission. The importance of accurate knowledge of the electrical properties at radio frequency of the material of the earth's surface has been intensified by the development of ultra-short wavelengths of but a few centimetres, and the subject is being examined by laboratory methods. Samples of soil have been contained in a condenser, and from the measurements of the effective capacity and resistance of the condenser the specific conductivity and dielectric constant of different soils can be determined. It is proposed to measure soils falling into well defined classes from different localities, and the results will be tabulated and placed upon a definite quantitative basis. In this way a standard set of measurements will be available, and each kind of soil will have a certain number of units of efficiency. This is good work, and will enable us to form some idea as to the best locality for transmission and reception. Also the results will enable you to roughly judge the efficiency of the earth in the district where you live, and should, at the same time, indicate the best type of "earth" for your locality.

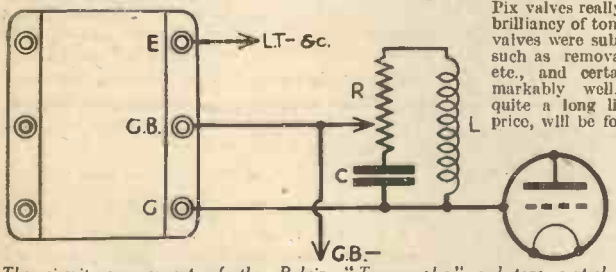
Faraday's Diary

VOLUMES I and II of Faraday's Diary have just been made available to the public, and it is doubtful if more absorbing reading can be obtained. The diary was bequeathed to the Royal Institution, and the work of editing and tabulating it has been going on for some time. In a foreword to Volume I, Sir W. H. Bragg refers to the section of Faraday's entries, where he tells of his experiments in which he induced a current in a wire by moving it in the neighbourhood of a magnet. By this Faraday detected the possibilities of electro-magnetic induction, and laid the foundation of all subsequent electrical experiments, experiments which led to the development of practically every kind of electrical apparatus we use to-day, and without which radio communication would be impossible. The whole of the work will be published at intervals, and when complete will consist of seven volumes, the total cost of which will be twelve guineas.

What we Found..

BULGIN "TRANSCOUPLER" AND TONE CONTROL

THE Bulgin "Transcoupler" gives even amplification under average working conditions, from below 50 cycles to well over 8,000 cycles, the top cut-off figure being largely determined by the capacity existing between the grid and cathode of the valve which succeeds it. In practice it is often found that for various reasons, certain frequencies are predominant, and although the "Transcoupler" will faithfully amplify all that is given to it, it will not in itself make any form of correction for unbalanced amplification due to other causes in the set or amplifier. If these causes are unremediable, *e.g.*, if the loud-speaker is incapable of balanced response, and has predominant resonances (so many of them have I) or if sidebands have to be cut in the interests of selectivity, some form of tone control must be used. The circuit arrangement above, shown additional to the "Transcoupler," enables everyone using it to tune matters to their liking. Turning the knob of the 250,000 ohm. volume-control-type resistance so that the amount of resistance towards the condenser is reduced, the treble will be reduced. Turn the other way, and the bass is progressively cut.



The circuit arrangement of the Bulgin "Transcoupler" and tone control. R=Potentiometer, 250,000Ω. L=250,000 μH. C=.001 to .01.

It will be seen that intermediate between the two extreme positions of the rotor-arm just the balance of reproduction the reader desires can be obtained.

The value of the condenser C governs the ultimate proportion of treble cut at the one extreme position of the resistance, R, and the value of the choke L governs the proportion of bass cut at the other extreme of rotation. Increase the value of the condenser if it is desired to cut more treble, and decrease the value of the choke, if it is desired to cut more bass.

The values given are, however, suited to most people's requirements.

The central position of the rotor-arm of the resistance will give substantially normal results such as the "Transcoupler" gives without the tone control circuit connected at all.

MAKING SHORT-WAVE CHOKES

WITH reference to the article on "Making Efficient Short-wave Chokes," on page 661 of our issue dated December 17th, 1932, Messrs. A. F. Bulgin and Co., Ltd., point out that this is similar to their choke, Type H.F. 3, appearing on page 30 of their catalogue.

PIX VALVES

THE British Pix Company are marketing a very extensive range of valves which are fitted with a special triple-coated neodymium filament. It is claimed that this gives a much greater emission than normal filaments, and that the tone is much improved by its use. On test, these claims would certainly seem to be substantiated.

An ordinary three-valve broadcast receiver was employed, and different makes of valve plugged into the valve-holders. With certain combinations of the Pix valves really fine results were obtained, with a brilliancy of tone which was quite marked. The valves were subjected to some rough treatment, such as removal of grid bias, severe shocks, etc., and certainly stood up to these tests remarkably well. They would appear to have quite a long life, and in view of the very low price, will be found very useful to the constructor who wishes to make up a cheap receiver employing a number of valves. The normal 2-volt series costs 4s. 6d.; the 2-volt power valves costing 6s. 6d. or 8s. 6d., according to class. The S.G. valve is 11s. 6d. For mains use, a range of indirectly-heated valves is obtainable for 11s. 6d., the mains screen-grid being 4s. extra. In addition to the types mentioned, full-wave rectifiers may be obtained for 8s. 6d. or 12s. 6d.

JACKSON "D" TYPE CONDENSER

THERE is a feeling of satisfaction when operating a condenser which rotates with a smooth, velvety movement. The condenser illustrated below is certainly a luxury instrument from more than one point of view. The finish and workmanship is of a very high order, the framework being highly nickel-plated, and the vanes of brass. Connection to the rotor plates is made by a plaited pig-tail connection which is firmly clamped at each end and provides a perfectly silent connection. Substantial terminals are provided for external connection. The slow-motion drive is effected by an elaborate epicyclic gear which is enclosed in a small box at the base of the spindle. The latter is drilled through and a small spindle runs through this and projects at the upper end. This may be clearly seen in the photograph. The operating knob is divided into two sections, the larger one clamping on to the spindle proper, and the smaller section fitting on the inner spindle. It is thus simple to obtain a direct or reduced drive by simply operating the appropriate dial. The reduction gear is of the order of 35 to 1, so that tuning of weak stations is rendered very simple, and the condenser is a high-class article which can be thoroughly recommended. The price of the .0005 capacity condenser is 14s.

The Utility bakelite condenser and disc drive. The hair-line escutcheon window may clearly be seen.

The "D" type slow-motion condenser, showing the double spindle employed for operating the direct and slow-motion drive.

WEARITE HETERODYNE FILTER

IT has already been stated in our pages that the trouble of heterodyne whistles, due to two stations working on very nearly the same wavelength, can only be overcome by employing some form of filter to remove frequencies of a high order. This naturally results in a top-note cut off and tends to spoil musical reproduction unless the cut-off apparatus is scientifically designed. The Wearite heterodyne filter is a piece of apparatus which may be usefully employed for the purpose in question, and it is made in two types, one cutting off at 3,500 and the other at 5,000 cycles. The cost of the instrument is 10s. 6d., but this will be found a very good investment, and in some localities will be essential if good reception is desired.

UTILITY BAKELITE CONDENSERS

FOR portable or other compact receivers it is often necessary to fit tuning condensers of the solid dielectric type in order to reduce the overall weight and size. This type of condenser normally has rather large absorption losses and is not advisable where the very best results are required. Messrs. Wilkins & Wright have, however, developed the condenser shown in the illustration, and this is quite suitable for tuning where really strong signals are obtained and losses do not matter very much. The condenser is very compact, and only the best bakelite is employed in the construction. The overall dimensions are roughly 2in. square by ¼in. thick for a capacity of .0005 mfds. The condenser costs 2s., and where it is desired to employ it for tuning, it may be obtained complete with the slow-motion dial and mounting bracket as shown. This dial is of standard size and pattern, and the escutcheon window enables the dial to be illuminated if so desired. The complete assembly costs 4s. 6d., in either .0003 or .0005 mfd.

NEW ETA VALVE

ONE of the new valves produced by the Electrical Trading Association, Ltd., has been received for test. This is the DW 4011, and is of the 4-volt indirectly-heated type. This valve has an impedance of 11,000 ohms with an amplification of 40. The slope is 3.6 ma/V. This is an ideal valve to employ for power grid rectification in mains receivers, and also makes a very good valve to insert in the first stage of a gramophone amplifier. The output from this is sufficient to warrant the inclusion of two super-power valves in push-pull immediately following it, with a transformer of only 3.5 to 1. The results are certainly admirable, and this valve costs 11s.

IMPORTANT NOTE

ON page 673 of the issue dated December 24th, in the advertisement of Jackson Bros., Ltd., the Figure 1 unfortunately became obliterated during printing. The price of the .0005 mfd. condenser should, of course, have read 18s. 6d., and not 8s. 6d.

Practical Letters from Readers.

The Editor does not necessarily agree with opinions expressed by his correspondents

Reports Wanted of Reception from Athlone Station

SIR,—I would be very glad to receive reports from any of your readers who may have heard the transmissions from the new Irish Free State High-Power Station at Athlone. The station works on a wavelength of 413 metres and will ultimately use a power of some 80 kilowatts. It would be interesting to hear of the reception experiences of listeners living in various parts of the country. The test transmissions usually take place after the ordinary programme at 10.30 p.m. each night.—JAMES KITCHEN (179, Pearse Street, Dublin).

Don't Use Milk Bottles

SIR,—Upon page 547 of the current issue of your journal, PRACTICAL WIRELESS, I observe that you publish an illustration of an accumulator Topping Apparatus as furnished by one of your readers, which involves the utilizing of an ordinary milk bottle. May I be permitted to respectfully point out that it is dangerous and illegal to put any harmful liquid into milk bottles, and the usage of such bottles for the purpose your reader suggests is most strongly deprecated by the Dairy Trade.—For and on Behalf of Milk Vessels Recovery, Ltd.—J. GILLARD STAPLETON (Secretary).

A "Practical Wireless" Club?

SIR,—As a wireless amateur since broadcasting began, and a radio-service mechanic by profession, I wish to congratulate you on publishing such a fine radio journal as PRACTICAL WIRELESS. Let us have plenty of "How to Make" articles, like some of the excellent articles that have appeared on making dual coils, etc.

I agree with Francis S. Coley, in his letter published in a recent issue, that PRACTICAL WIRELESS is written and illustrated so admirably that it is quite a pleasure to read it.

I would like to suggest that you give the short-wave side of radio more prominence, as this is definitely the thing of the future. Also, how about a "P.W." Radio Club, after the style of the Practical Wireless League. This, I think, would serve to make a greater success of PRACTICAL WIRELESS, and I, for one, would be pleased to try and form a local club. Perhaps you will put this suggestion before your readers. I would also suggest a Sale and Exchange page, where readers could advertise their unwanted components and sets at a cheap rate.

Wishing you every success.—ROBERT W. STEWART (West Hartlepool).

Station Chart Wanted

SIR,—In my opinion, what is needed is a chart giving the Continental stations, wavelength and call characteristics. Thus, Mühlacker would be 366.9 m., 60 kW; Call, three notes on tubular bells. These Continental announcers rattle off their call-signal at such speed and at such long intervals apart, it is very hard to find out what they are, especially the Swedish and Norwegian stations.—THOS. H. WEBSTER (Sydenham).

A Portable for 'Phones Only

SIR,—Every week I read letters published in PRACTICAL WIRELESS loading you with praise for the excellent value of your paper, and as a regular reader I would like to add my mite of satisfaction. I have "fooled about" with wireless for a few years now, but I think I have really learnt something during the past two months. After reading the issue of December 3rd I want to endorse the plea of Edward Logue (Glasgow), but I vote for a two or three-valve set with a frame aerial—in other words—an efficient battery Portable for 'phones only. If one must not wake the baby—or if others don't want the loud-speaker on—well, let us have a set which will give the National, all the Regionals and the main foreign stations at good 'phone strength. The frame aerial should be selective and directional and the S.G. H.F. valve could be cut out for the locals. Let PRACTICAL WIRELESS give us a set so that we may enjoy our programmes in solitary silence. Wishing the paper every success.—THOS. J. HITCHCOCK (Harrow).

CUT THIS OUT EACH WEEK

DO YOU KNOW?

—That the natural wavelength of an aerial is roughly four times its length.

—That a 75 or 100 plug-in coil makes a very good H.F. choke for short-wave work.

—That the response characteristics of a moving coil or other cone loud-speaker may be modified by scraping the paper thin at different points.

—That a remote control device costs practically nothing to operate, consuming only minute fractions of an amp. from a dry battery.

—That the highest wavelength used for broadcasting is 1935 metres, used by the Lithuanian station Kaunas.

—That a delay switch in the eliminator is a valuable safeguard when employing indirectly heated rectifying valves.

—That Eureka resistance wire has a resistance nearly thirty times as great as ordinary copper wire.

—That Tungsten has the highest, and Potassium the lowest melting point of the elements.

NOTICE

The Editor will be pleased to consider articles of a practical nature suitable for publication in PRACTICAL WIRELESS. *Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts, every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed:* The Editor, PRACTICAL WIRELESS, *Geo. Newnes, Ltd., 8–11, Southampton Street, Strand, W.C.2.*

Owing to the rapid progress in the design of wireless apparatus and to our efforts to keep our readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

Circuits Wanted for Plug-in Coils

SIR,—I am an enthusiastic constructor, and have purchased your paper since its inception, and have studied all your circuits. These are, however, all based on modern components, coils, etc., and to build these it means the purchase of expensive items. There must be a large number of your readers, like myself, who possess a large junk box of good and serviceable components, and would like to experiment with these instead of leaving them idle. For instance, I have a complete set of plug-in coils of well-known make, including short-wave coils; also enough fixed and variable condensers, transformers, etc., to make up several sets. Could you not give us wiring diagrams for building two, three, and four-valve sets using plug-in coils, both for ordinary wavelengths (200–2,000) and for short-waves (10–100). I am confident this would be much appreciated by a large number of your readers.—W. COLLINS (Birmingham).

Entertainment Literature Not Wanted

SIR,—The first part of PRACTICAL WIRELESS that I turn to each week is the portion devoted to readers' letters, and after reading the issue for December 17th, I feel compelled to write in reply to the letter published from "WILL EVANS" (Paddington). This gentleman seems to be under the impression that when one reads PRACTICAL WIRELESS one must of necessity "fiddle with the set," to use his own words. Is this necessary? Cannot one read his favourite wireless paper without starting altering the radio set? I consider that the paper should keep to its name, and be practical. No true radio fan wants his practical literature interspaced with notes on gramophone records, broadcast artists, etc. Other papers can be bought that deal particularly with these subjects. Wishing success to the future of PRACTICAL WIRELESS.—J. SUTCLIFFE (Huddersfield).

Practical Letters from Readers

(Continued from page 781.)

A Satisfied Scottish Reader

SIR,—I have never before "written to the papers about it," but I feel that I would be lacking in gratitude if I did not add my great appreciation of PRACTICAL WIRELESS to that of your very many highly satisfied readers. After reading the first few numbers, I was highly delighted to realize that, at last, I was able to get a wireless paper that really got down to "brass tacks" with regard to broadcast receiver construction, operation and maintenance. However, although I was very well pleased with your paper and, indeed, recommended it to my fellow amateurs, I had a feeling that it was incomplete. There were few articles on the design of broadcast receivers nor were there any on television and television receivers. Since then you have started a series of articles on television which will, I hope, continue through to the construction, operation and maintenance of television receivers, and I am hoping that you will soon commence a series of articles on the design of receivers. Your gifts of data sheets which you recently started are the "very thing." Truly, PRACTICAL WIRELESS is a masterpiece in wireless publications and every day in every way it gets better and better. Please do not spoil it by inserting articles of ordinary wireless news relating to broadcast programmes, radio stars, studios, etc., as suggested by some of your correspondents. That would, indeed, be a retrograde step. I do not think it is necessary for me to wish you every success because you have already succeeded, in my opinion. I do, however, most heartily tender my best wishes for the good work which you are carrying out so efficiently and, without misgiving, promise you my unstinted support for, I hope, many years to come.—ENTHUSIASTIC AMATEUR (Aberdeen).

A Reader's Thanks : and a Suggestion

SIR,—I enjoy your paper very much, as it is the only paper I have had that is really constructional. When I buy a paper I don't want to know what colour the B.B.C.'s pianos are! I hope you will keep this high standard up, because I am sure you will be blessed by many thousands of readers! I suggest that you publish an article on smoothing chokes, mains and L.F., on the same lines as the article on "Designing Your Own Mains Transformer." Wishing you success with your really fine *constructional* paper.—R. J. CANAWAY (Havant).

Set Wanted with Old Type Plug-in Coils

SIR,—With reference to a reader's letter—(A. Bedding, Clapham)—in the issue for December 10, and your remarks at the foot thereof, may I be permitted to back this reader up in his very practical suggestion. I should also like to add an idea of my own; may the proposed set be *an all-wave model*, with a screen-grid valve and thoroughly decoupled for work with an electric mains unit. I have to thank you for the many happy hours your most excellent paper has given me. It is the best of its kind.—W. ROBINSON (Welling).

Making a Mains Transformer : a Correction

One or two readers have pointed out a printers' error that occurred in respect to the article entitled "Making a Mains Transformer," which was published in our December 3rd issue. All those dimensions given in Table No. 1, under the heading "C" should be as follows: For size 5 stampings, ¾in., for sizes 4, 4A, 30 and 30A, 1¼in.; for size 28, 1½in., and for size 29, 1⅞in. We hope that this correction will put the matter right.

A Canadian Reader's Appreciation

SIR,—Your magazine, up to the present, is much better than I ever thought it could be. Your various articles are very thorough in their explanation, and the editor and contributors deserve to be congratulated on their efficient service. I would very much like to see the "Short Wave Section" expand, and also receive the combined efforts of the research staff in order to advance the efficiency of such sets. I would also like to see articles on A.C. short-wave sets operating on 110v. 60 cycle—CHAS. F. COVELL (Toronto, Canada).

A Bouquet from Aberdeen

SIR,—I have perused reader's opinions from No. 1 onwards, and as an Aberdonian I always like value for my money (so they say), and by purchasing your valuable paper I am certainly getting real value for money. There are many ideas on how to run your paper, some are good, others bad, and some indifferent. I think you are about 100 per cent in keeping with the heading of your paper. I hope you will stick to it. If you go into all details of what your readers want you will perhaps land with a publication thicker than the family Bible. I myself am more than pleased, and cannot suggest any further improvement you could make at the price; everything you give is simple arithmetic. I am particularly interested in the articles by Frank Preston, F.R.A., which are highly interesting. He explains everything so clearly that one cannot fail to understand. At the same time I do not belittle other contributors. They are all that can be desired. Carry on with the good work and give us plenty of practical hints of what can be efficiently made at home at a reasonable price. Good luck for 1933 and onwards.—ALFRED RAMIE (Aberdeen.)

A Complaint : and a Practical Hint

SIR,—I have read each number of your excellent paper from end to end, including the advertisements, and allow me to congratulate you on its superb contents. I have read a number of the letters published, and they are evidently from young men. I joined the Institution of Electrical Engineers in 1892, in which year I dabbled in wireless under Professor Sylvanus Thompson, and I am still dabbling. A complaint I have against electrical apparatus is in the modern "block" type accumulator. I have two different makes in use, also one of the old multi-plate ones in. When freshly charged, my total output in milliamps reads 9 with the latter and 6 with the former. This I attribute to internal resistance of the block type accumulator. I have found, from past experience, they are costly because they soon lose the paste, not due to heavy discharge, but to the accumulator manufacturer's friend, the local wireless man who charges or, should I say, ruins them. Now for a little practical hint on another matter. It may interest your readers to wind a "cage" aerial with three separate windings and tune them with a three-gang condenser, bringing one common wire from all three condensers to the aerial terminal of their set, and then tune the set. They will not need outside aerials, or complain of selectivity or volume.—V. DELEBECQUE (Hornsey).

LET OUR TECHNICAL STAFF SOLVE YOUR PROBLEMS

REPLIES TO QUERIES and ENQUIRIES by Our Technical Staff

The coupon on this page must be attached to every query.

If a postal reply is desired, a stamped addressed envelope must be enclosed. Every query and drawing which is sent must bear the name and address of the sender. Send your queries to The Editor, PRACTICAL WIRELESS, Geo. Newnes, Ltd., 8-11, Southampton St., Strand, London, W.C.2.

SPECIAL NOTE.

We wish to draw the reader's attention to the fact that the Queries Service is intended only for the solution of problems or difficulties arising from the construction of receivers described in our pages, from articles appearing in our pages, or on general wireless matters. We regret that we cannot, for obvious reasons—

(1) supply circuit diagrams of complete multi-valve receivers.
(2) Suggest alterations or modifications of receivers described in our contemporaries.
(3) Suggest alterations or modifications to commercial receivers.
(4) Answer queries over the telephone.

REMOVING REACTION

"I have a fairly good detector and two L.F. receiver, and am getting a really high-class quality from the receiver. It appears to me to be quite as good as I can expect from such a set, but after reading that reaction spoils quality, I should like to remove this part of the circuit from my receiver. I employ the normal condenser-fed arrangement, and should like to know whether I will spoil things if I simply short-circuit the reaction coil—to avoid dead-end losses—and disconnect the reaction condenser. If there is anything wrong with this perhaps you will suggest the best way to remove the part of the circuit referred to."—(R. Y., Broxbourne.)

The idea is quite practicable, but there is one point you must watch. Usually a small by-pass condenser is required from the anode to earth in the detector circuit, and this may already be provided in your receiver by part of a differential reaction condenser. By disconnecting the condenser entirely you may remove this by-pass condenser and by so doing affect the rectification properties of the detector. Beyond this, there is nothing wrong with your idea.

NEW VALVES

"I recently bought a completely new set of valves for my receiver, as I had read that modern valves were much more efficient than the old ones. Frankly, I am disappointed. The set is unstable, oscillates at the least provocation, and quality is terrible. What can I do? It was because I read in your book that the new valves were better that I wasted my money. I should be glad if you could tell me what to do, as I am extremely disappointed."—(Y. B., Hammersmith.)

The statements which you make in your letter prove that our remarks were correct. The modern valves are more efficient, and it is because of this fact that your old receiver is now unstable. Apparently you had taken liberties with the wiring of the old set, and there were faults in wiring, etc., which were not apparent owing to the comparative inefficiency of the old valves. If now you go over the wiring, and see that this is carried out efficiently (and possibly you will have to slightly modify the layout), you will find that the new valves will more than repay you for the money you have spent on them. The distortion is no doubt due to overloading of the output valve, due to the large signal being now passed on from the earlier stages. You must increase the H.T. applied to this output stage, and also see to the grid bias. Keep to the valve-makers' recommendations with regard to the applied voltages.

A TELEVISION POINT

"I have built up the Televisor described in your hand-book, and purchased a disc instead of making it. On trying it out I got a horrible series of patterns which were nothing like a picture. I read the article again and found I had got to get the speed right. The motor was not equipped with any form of control and I am not sure whether there is any method of getting the speed constant without fitting the special synchronising apparatus. Have you any little wrinkle which would suffice to enable me to see an image so that I may obtain sufficient interest to warrant the expenditure on a motor fitted with synchronising gear?"—(F. N. T., Blackpool.)

There is a perfectly simple way of getting the speed right, and that is by pressing the finger tips on the centre of the disc. By careful adjustment the disc may be kept at the right speed for the whole of the transmission. A more satisfactory way is to fit a small lever attachment with a screw adjustment so that the pressure may be adjusted and then left. Of course, any method such as this will not be so satisfactory as the synchronising gear wheel, but it will serve as a makeshift, for temporary reception.

MICROPHONIC VALVE

"I am puzzled by the behaviour of my receiver and should be glad if you could enlighten me on the peculiarity. When I tune in to a station there is a peculiar ringing sound, and as soon as the station is dead on tune the music is accompanied by a peculiar high-pitched singing sound. This seems to be some fault of the receiver and I should like to know how to cure it."—(T. G. B., Manchester.)

The trouble is due to what is known as a microphonic valve, that is one in which the electrodes are not very securely supported, or are perched at the end of long, thin supports. The result of this is that they take up all vibration and transmit it to the speaker. When you tune in to a station the sound waves impinge on the glass bulb and so add to the trouble. The remedy is to encase the valve in a sound-proof case, such as a cardboard box packed with cotton-wool, or to otherwise protect the valve from vibration. Sometimes an anti-microphonic valveholder will cure the trouble, although in some extreme cases it only aggravates it. You can try the effect of sticking lumps of plasticine or similar substance on the glass for the same purpose.

DATA SHEET No. 16

Cut this out each week and paste it in a notebook.

GERMAN SILVER RESISTANCE WIRE

S.W.G.	Resistance per yard	Yards per lb.	Current capacity
18	.117	51	3.5
20	.315	90	2.5
22	.520	147	1.5
24	.844	238	1.0
26	1.26	349	.5
28	1.85	527	.25
30	2.65	750	.2
32	3.50	984	.15
34	4.82	1360	.1
36	7.06	2000	.05

DEFECTIVE CONDENSER

"I have altered one of the low frequency stages in my set to employ the resistance-capacity principle. The values of the parts are as recommended in many books, but I get nothing but horrible distortion. The grid bias is correct for the valve; the preceding valve is getting its correct H.T., which has been compensated to allow for the voltage drop through the anode resistance, and in fact everything I can think of has been done. Where can this distortion be coming from? Your help would relieve me of a great worry, as I am now at a loss."—(D. S. C., Ayr.)

There is a simple solution to your trouble, and that is the coupling condenser in the R.C. stage. This is no doubt defective and is permitting the H.T. positive potential of the preceding anode circuit to be applied to the grid. This is neutralising the applied negative bias and is producing the distortion. If you replace the condenser we think you will find that the trouble will be definitely removed.

THE CHEAPEST SET

"I want to build up a cheap set to give as a present early in the new year. I want it to work a speaker, and the recipient is living quite close to a B.B.C. station. What circuit arrangement would you recommend? I do not want a poor set, but something which will be worth giving to a friend. Your advice on this problem would be greatly appreciated."—(F. H. J., Barnsley.)

We would suggest a two-valver employing a Pentode output stage. This would give sufficiently loud signals for good loud-speaker reproduction, and in conjunction with a good selective dual-range aerial coil will make up quite a good, and at the same time cheap, set. Use a 5 to 1 L.F. transformer for coupling purposes.

TRANSFORMER RATIOS

"Upon looking through a catalogue in order to choose a transformer for my three-valve set, I see that there are several different ratios obtainable. The catalogue does not state what the different types are for, and I should like some information to enable me to decide which ratio to get for the set. The circuit is the usual detector valve with two subsequent stages of transformer coupled valves."—(C. V. G., Dublin.)

As you are situated near to a main broadcasting station you will have to be careful that your output valve does not overload. Therefore the stage gain must be kept fairly low and we would suggest that the first transformer has a ratio of 3 to 1, and the second a ratio of 4 or 5 to 1. If, of course, you want to listen more to distant stations the ratio may be greater, but then you would have to arrange to cut out the first L.F. valve so as to avoid overloading.

DIAL LIGHT

"Having rebuilt my set, I should like the refinement of a light on the panel to see more clearly the tuning dial scale. I should like this light to be coupled up to the set in some manner so that when the set is switched on the light will also come on, and so provide an indication that the set is alive. Can this be easily carried out without complicated switching?"—(A. H. G., Belsize Park.)

The arrangement is quite simple, and consists only of joining the leads from the indicating light to the two filament terminals of one of the valve-holders. In this way, switching on the filaments also switches on the lamp. Do not be tempted to use an ordinary flashlamp bulb, as this has a rather high consumption. Special low consumption bulbs are obtainable at good wireless shops, and these only consume a very small current, and will make no difference to your accumulator charges.

EBONITE PANEL

"Some time ago it was the rule, rather than the exception, to employ ebonite for panels. In these later days one does not see so much employed, and I am keen to know whether the idea that it was a good insulator has now been exploded or whether there is some other explanation for its absence on many modern commercial receivers."—(F. B., Oxford.)

There is really no need to use ebonite for panels on many modern receivers, simply because the components which are now mounted on the panel are all at earth potential. Ebonite still holds its place as an insulator, but in these days the layout of a receiver has been modified so that the controls are connected to earth, and therefore there is no need to provide an insulated path between them. In certain cases, however, it is still necessary to see that there is no risk of coupling between certain parts, and therefore you should adhere to instructions given in periodicals which describe the construction of a receiver.

FREE ADVICE BUREAU

COUPON

This coupon is available until Jan. 14th, 1933, and must be attached to all letters containing queries.

PRACTICAL WIRELESS, 7/1/33.

CATALOGUES RECEIVED

To save readers trouble, we undertake to send on catalogues of any of our advertisers. Merely state, on a postcard, the names of the firms from whom you require catalogues, and address it to "Catalogue," PRACTICAL WIRELESS, Geo. Newnes, Ltd., 8/11, Southampton St., Strand, London, W.C.2. Where advertisers make a charge, or require postage, this should be enclosed.

BULGIN COMPONENTS

A USEFUL range of high-class components, covering everything the constructor is likely to require, is given in the latest catalogue issued by A. F. Bulgin and Co., Ltd. Included in the list are the new Bulgin Transcoupler "Quickwyre" for facilitating rapid and neat wiring, and a fine assortment of mains and battery switches. As usual, in the back part of the catalogue, there is a useful illustrated technical manual giving instructive information and showing how various Bulgin components are connected in different circuits.

ORMOND CONDENSERS

AMONG the new components shown in the latest Ormond list is a precision condenser, with friction control and slow-motion movement with a ratio of 55 to 1. Another new component listed is a logging drum dial with illuminated surface and a bakelite escutcheon plate and control knob. A slow-motion device is incorporated and condensers can be attached on either side.

HEAYBERD MAINS APPARATUS

THE home constructor will find a mine of information in the 1933 catalogue issued by Messrs. Heayberd, of 10, Finsbury Street, London, E.C.2. Instead of being simply a list of the products with prices, this book gives technical tips, and complete circuit diagrams for making up various types of eliminator. With the diagrams is a list of all the components for these eliminators, with prices, enabling any constructor to make up a mains unit to suit both pocket and technical requirements. A pocket attached to the inside of the back cover is intended to hold such leaflets as may be issued by Messrs. Heayberd. This is one of the most informative catalogues we have yet seen, and no constructor should be without one.

UTILITY COMPONENTS

A FINE range of "Utility" steel ganged condensers is shown in the new season's catalogue issued by Wilkins and Wright, Ltd. The chassis is built of heavy gauge steel; and the spindles run in ball bearings of ample size which ensure smooth action. All ganged condensers are matched to less than one-half per cent. For super-het. sets a model is supplied which incorporates a specially-designed section for tuning the oscillator circuit. These condensers are obtainable in the two, three or four-gang type. Other high-class components shown in the list include a new straight-line dial, anti-capacity switches, drum dials, and the "Utility" Micro-Dial with a ratio of 100 to 1. This dial, with its fine vernier adjustment and smooth action is specially suitable for short-wave tuning.

Broadcast Query Corner.

UNDER the above title, with the assistance of a recognized authority on foreign broadcasting matters and a regular contributor to wireless publications both at home and abroad, we are inaugurating a special Identification Service, which should prove of great assistance to our readers. When tuning in well-known stations it happens frequently that listeners pick up wireless transmissions of which they fail to recognize the origin. It is to solve these little problems that the *Broadcast Query Service* has been organized.

All inquiries should be addressed to *The Editor*, PRACTICAL WIRELESS, 8-11, *Southampton Street, Strand, London, W.C.2*, and the envelope marked *Broadcast Query Service*, in top left-hand corner. Stamped addressed envelope should *not* be enclosed, as replies cannot be sent by post, but will be published in due course, in each issue of PRACTICAL WIRELESS.

Replies to Broadcast Queries

SKY PILOT (Somerset): Beromuenster (Switzerland) relaying Stuttgart programme. PERPLEXED (Darwen): WJZ, Boundbrook (N.J.), National Broadcasting Company on 394.5 m. SEARCHER (Leeds): Dublin; new 80 kW. transmitter (at Moydrum), testing on 413 m. NAT (Bideford): According to your details and difference in time, the broadcast would appear to emanate from China, and possibly from the new 75 kW. Nanking station, but we cannot confirm, as this transmitter was advertised to work on 440 m.; the wavelength may have been changed. SHORTWAVE (Torquay): On December 11th, LSX, Hurlingham, Buenos Aires, 28.98 m., relayed a running commentary on the visit of the President of Uruguay to the capital of the Argentine Republic; possibly also re-broadcast by EAQ, Aranjuez-Madrid, on 30.43 m., but it was not advertised in published programmes for the latter station. SUPERHET (Bala): This was Leningrad on 835.4 m. TIRED (Ramsgate): (1) WBZ, Boston (Mass.), on 302.8 m. or KDKA, East Pittsburgh (Pa.), on 305.9 m.; (2) WABC, New York, on 348.6 m.

ADVERTISEMENT INDEX

P.W. Gift Stamp No. 15

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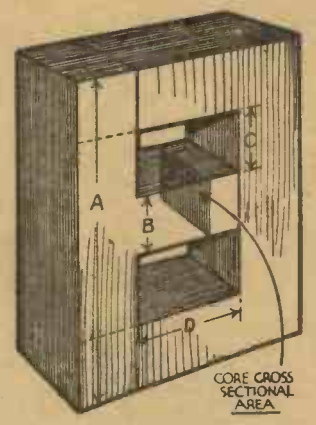
"PRACTICAL WIRELESS" DATA SHEET No. 4

Mains Transformers



The assembled core of a Mains Transformer.

FINDING THE NUMBER OF TURNS.

The formula for ascertaining the number of turns of wire for Mains Transformers is :—

$$\frac{V}{T} = \frac{A\,B\,n}{3.49 \times 10^8}$$

where $\frac{V}{T}$ = Volts per turn in both the Primary and Secondary.

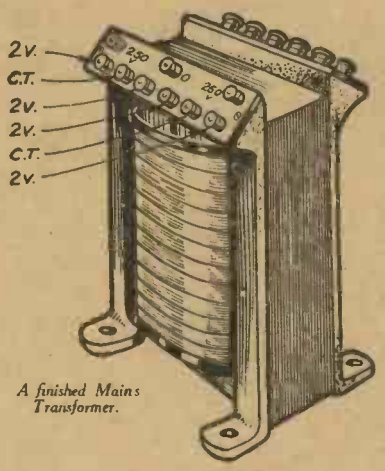
A = Cross sectional area of the core in sq. ins.

B = Flux in the core in lines per sq. cm.

n = Frequency of the supply in cycles per second.

The usual flux density varies between 6,000 and 8,000 lines.

The method of building up the laminations for the core of a mains transformer. The principal dimensions are referred to in the tables. The central bar is the most important part of the assembly, as it is principally upon the cross-sectional area of this that the number of turns of wire depends. The size of the winding area also enters into the calculations, but by purchasing standard sizes of stampings the calculations are greatly facilitated.



A finished Mains Transformer.

How to assemble the completed transformer, with a strip of ebonite to carry the various terminals. It is safest to take all the secondary windings to one strip situated on one side of the transformer, and the primary (or mains input) terminals to a strip on the opposite side. This prevents accidentally touching or shorting the mains. The feet and supports, as well as clamping bolts, should be of brass and not steel. If found more convenient aluminium may be used.

FINDING THE RATING.

The total rating of a mains transformer is obtained by adding together the wattage of each separate winding and then adding 20 per cent. to the resultant figure. The cost of operating a mains receiver can therefore be easily worked out.

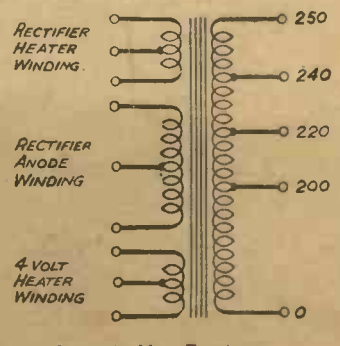
CORE PROPORTIONS.

Size of Stalloy Stampings.	Dimensions (ins.) A.	B.	C.	D.	Number of Stampings	Watts (approx.)	Turns per volt.
5	3¼	⅝	1⅜	1⅜	6 doz.	25	15
4	3⅛	1¼	1⅛	2⅛	6 doz.	50	8
4 A	3⅛	1¼	1⅛	1⅛	6 doz.	40	8
30	3⅛	1¼	1⅛	1⅛	6 doz.	40	8
30 A	3⅛	1¼	1⅛	1¼	6 doz.	35	8
28	5	1½	2½	3	6 doz.	100	6
29	6¼	2	2½	3¾	6 doz.	250	4

TESTING.

Before connecting a home-made mains transformer in circuit all windings should be tested for breaks, short-circuits and insulation. A high voltage dry battery may be used, in conjunction with a meter, and there should be no readings between different windings, nor from windings to core.

Theoretical circuit of a small mains transformer, showing how the primary winding is tapped to suit mains inputs of different values, and the manner in which all heater windings are centre-tapped. The Rectifier valve heater winding forms the positive lead of the H.T. supply, and the centre tap of the Anode winding is the negative lead. Where it is preferred the remaining heater windings may be provided with an adjustable centre tap by means of an external potentiometer instead of the wired point.



Circuit of a Mains Transformer.

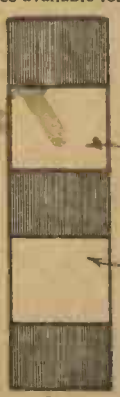
WIRE FOR TRANSFORMERS.

In the table below the number of turns per sq. in. makes no allowance for the end cheeks of the winding bobbins. This must therefore be taken into consideration. The Safe Current should also be regarded as the absolute maximum value, and if possible the next largest size of wire should be employed, especially for heater windings where large currents are to be handled. When using enamelled wire care must be exercised that the covering does not crack during winding. This wire takes up less room but greater care must be taken in the winding.

WIRE DATA.

Standard Wire Gauge.	Safe Current (amps.)	Turns per sq. inch. Enamelled.	Turns per sq. inch. D.C.C.	Yards per Pound. Enamelled.	Yards per Pound. D.C.C.
18	3.7	392	297	46.9	45.4
20	4.0	685	472	83.3	79.4
24	1.5	1,770	977	221	203
28	0.7	3,760	1,630	488	422
30	0.5	5,370	1,990	694	587
32	0.4	6,890	2,550	915	755
34	0.25	9,610	3,020	1,202	1,024
36	0.18	13,500	4,100	1,840	1,477
38	0.1	20,400	5,100	2,810	2,287
40	0.07	32,500	—	4,576	—
42	0.05	44,300	—	6,576	—

Section through the core showing the winding area in which all the windings have to be disposed. It is most efficient to arrange the windings on bobbins placed side by side as indicated, with heater windings disposed between the input and H.T. windings. This forms a screen and helps to prevent induced hum. This illustration should be studied in conjunction with the diagram in the upper left-hand corner of this sheet. The actual space available for winding has also to accommodate the formers of the windings, and this should be remembered when measuring the space available.



Section through core.