Mainly about Construction

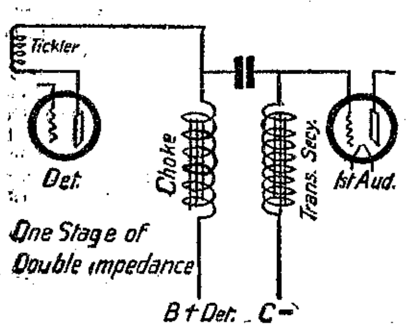
BY "MEGOHM"

The Audio Amplifier

A DOUBLE IMPEDANCE STAGE

WITH a view to improving the amplifier of the four valve-Browning-Drake as published in this column, and making it even better suited to the present conditions of reception in New Zealand, the writer has experimented with a form of dual-impedance amplication that has given very satisfactory results indeed, and proved a considerable improvement over transformer coupling for the first stage. At only two miles from 2YA there is no chance of distortion caused by distance, and almost unlimited volume is available. It then becomes a question of how much volume the receiver and loudspeaker will put out without distortion. Although previously the quality and volume were good, the change that is to be described has given the set a good step-up in quality for given volume.

This test at short range is mentioned because it demonstrates that continuous undistorted reception from 2YA is possible, and with the receiver in question



is an every-day routine, and of course the same remarks will apply to many other receivers. As the distance between the transmitter and receiver increases, as do the chances increase of distortion from two main outside sources —firstly unsynchronised reflection of the waves, and secondly distortion of signals by neighbouring radiating receivers, and the latter probably accounts for a deal more of the trouble than most listeners imagine. And a peculiar feature is that both these troubles are minimised during the daytime, the first because of the presence of the sun's rays and the second on account of the absence of most operators. Thus daytime reception affords the best means of judging to a great extent whether the distortion experienced at a distance is due to the receiver itself, or to outside influences that are evident mostly at night. If the receiver gives undistorted reproduction in the daytime it cannot be blamed for distortion which is evident at night on the same volume.

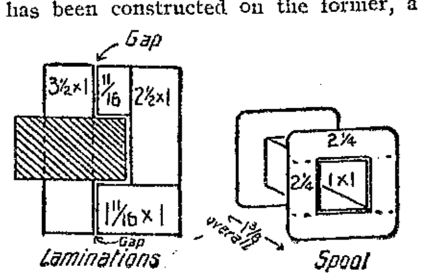
With a suitable speaker, of the cone type preferably, this method brings out without distortion the low notes of music so faithfully transmitted by 2YA. It might be mentioned here that 2YA appears to send out notes of much lower frequency than does 3YA, and on this account a receiver and speaker jointly incapable of handling low notes without distortion would be inclined to give better reception of 3YA than of 2YA, because the lower notes would not be there to distort. But, given a receiver and speaker capable of properly handling the "deep stuff" at good volume, one gets full pleasure out of the music from any station.

This article is for constructors who have made their own amplifier, and are, therefore, able to make any kind of alteration they fancy. All that is required to be made is a choke coil, the secondary winding of the transformer being still utilised as the second choke of the double impedance. Ordinary impedance coupling is usually considered as being in a general way a compromise between resistance and transformer coupling, and unless care is taken, distortion similar to that introduced by a badly-designed transformer may occur. With these points in mind it was decided to construct the impedance for the plate circuit in such a way as to have a fairly high inductance. This is accomplished by adopting a stalloy core of full square inch section, and a spool wound with half a pound of 40's s.w.g. enamelled wire.

The core and spool are identical in every way with those described on February 3 for an output choke. The only difference is in the winding, which is stated above. It will be no use constructors writing to ask if they could make the core of soft iron, as it would not be recommended, quality of the metal being of considerable account in this case. Full instructions for making a spool are given in the A battery charger article on March 2. The size for the present purpose is smaller, and the ends need not be of such strong material; in fact, heavy millboard would do quite well.

Referring to the diagrams, the method of building up the wooden former is shown, from four strips of wood of about the size marked, so that when put together with fine brads the outside measurement will be just a shade over an inch each way. This is to make sure that the stalloy strips will go in quite easily. No alteration in the size of the core should be made, as any reduction of cross-section reduces the inductance of the choke in proportional amount.

The former should actually be made about an inch longer ($2\frac{3}{4}$) than the finished size, and then if the brads are kept in from the ends, each end may be sawn off square, leaving the former exactly $1\frac{3}{4}$in. in length. When the spool has been constructed on the former, a



strip of strong millboard an inch wide is fastened by brads into the wood in the position shown by dots on the spool end. A hole in the centre of each takes the winding spindle.

One and a half dozen 3ft. strips of stalloy an inch wide will be required. A sufficient number of pieces $3\frac{1}{2}$in. long are cut to fill the one-inch square centre of the spool. Of the other lengths, $2\frac{1}{4}$, 1 11-16, and 11-16, a sufficient number of each must be cut to form a pile one inch high when compressed. The strips are cut with a sharp pair of ordinary snips, but this process puts a slight curve on the cut ends, which must be lightly tapped out with a hammer on an iron surface. If the ends are neatly flattened, the whole when assembled, will have a neat and thoroughly compact appearance.

It must be noted that the choke core is assembled in a different way to that for a transformer. The aperture through the spool is filled with strips, and this mass is separated from the remainder of the laminations by a piece of card about 1-32in. thick, so that there is no metalic contact. This card-filled space is called the "gap," and its purpose is to prevent magnetic saturation of the stalloy, a condition at which the effectiveness or inductance of the choke decreases. Nor must the card be too thick, as the increase of the gap causes a decrease in effectiveness. The larger portion of the core is built up brickwise, so that the joints in adjacent layers do not coincide, so that the 1 11-16 piece will be at one end in one layer and at the opposite end in the next. Shellac was not applied to the laminations, the ready-made insulation being sufficient.

THE SPOOL.

For the benefit of new readers, a brief description of making the spool is given. The wooden former is covered with one layer of thin card or heavy manilla paper, flush with the ends. Then a square aperture is cut in each spool end to be a tight fit over the ends of the card or manilla. The ends are then glued on with seccotine, and a fillet of seccotine is run round the inside angle to help in strengthening the joint. The inside edges of the spool ends should be bevelled off slightly by rubbing on glasspaper, so that in winding near the ends of the spool the wire will not tend to catch on the edge of the spool end.

WINDING.

The battery charger article shows how a rough winding jig can be arranged. In this case the wire is not put on in regular layers, but a system is adopted for rough winding whereby turns far apart with regard to the length of wire between them are not allowed to come into direct contact. A 26 or 24's wire should be soldered

QUERIES BY CORRESPONDENCE.

1. Every communication enclosing queries is to be addressed to "Megohm," ½ Box 1032, Wellington, and must be accompanied by a stamped addressed envelope for reply by post.

2. Questions must be written so that a space is left in which the reply may be added.

3. No charge is made for replies.

hole in the spool end. Now wind a group of wire ¼in. wide and say 1-16in. thick, then wind a similar group next to it, leaving all fairly level, then proceeding to the next group until a layer is filled, then put a layer of tissue paper on and return winding in the opposite direction in groups, place tissue between each layer until the full number of turns has been put on. Then solder or lead-out wire and cover the winding for protection.

The clamps are of wood, 4 in number, 4 inches long, 1 inch wide by ⅜in. thick, drilled $3\frac{1}{4}$in. centres to take the 3-16in. brass bolts which are 2in. long. A washer should be placed under each bolt-head and nut. A small strip of ebonite carries the two terminals.

THE DETECTOR VALVE.

The only proviso regarding the detector valve is that it shall be of the 240 type, that is, high impedance and high amplification factor, such as is used for resistance coupling. Suitable valves, then, are the UX240 (150,000), PM5B (74,000), Cossor 610RC (80,000), PM3A (63,000), Cossor 410RC (80,000), the impedances being shown in parentheses. The most suitable impedance for the purpose appears to be from 60,000 to 80,000 ohms.

CONNECTING UP.

The connections to the secondary of the first audio transformer remain as they were, but no connections are made to the primary winding, but these connections are made instead to the choke coil. A fixed condenser is placed across the grid and plate connections, the former on the transformer, the latter on the choke. This condenser is of fairly large capacity, and is used to regulate the balance between high and low notes and general tone. By trial of different valves, the reproduction can be made to suit one's own particular liking. In the writer's case the best value proved to be 24 plates using thin mica, the size as described in the "Record" of December 9. Those who have made a set of experimental condensers can pile them up for trial, add or take away one or two, find the best effect, then make a complete condenser with the total number of plates.

Nothing particularly new is claimed for this arrangement, but the writer has endeavoured to show the easiest way of effecting a considerable improvement in the first audio stage of the four-valve Browning-Drake receiver already described in these pages. It is assumed that the last stage will have a Ferranti AF3, or other good transformer and suitable power valve, and that an output filter or output transformer is provided, preferably the former.

The factory-made double-impedance units are made up on a figure 8 core, one coil on each of the outer legs. The winding in the grid circuit requires a great deal more wire than that in the plate circuit. Other differences are incorporated in a three-stage amplifier of this type.

The chief advantage of impedance coupling over transformer coupling is the much greater amplification of the lower notes, and less liability to distortion.

The High Tension Battery

AN ARGUMENT FOR "SUPER" SIZES

A BRITISH wireless journal gives the result of an interesting test carried out on B batteries of several makes, tending to show that the larger sizes of B battery pay better than the small or "standard" size.

"THE whole secret of success when dry-cell batteries are used lies simply and solely in the installation of units capable of standing up for a reasonable period to the load imposed upon them. This, unfortunately, is a point that is not realised by large numbers of wireless enthusiasts.

"Dry high-tension batteries fall as regards capacity into three main groups. There is, first of all, what may be called the "standard capacity" battery built up of cells measuring on the average ⅝in. in diameter by $2\frac{1}{4}$in. in height. Next comes the large capacity battery whose cells average $1\frac{1}{4}$in. in diameter by $2\frac{1}{4}$in. in height. Lastly there is the "super" capacity type whose cells have a diameter of $1\frac{1}{4}$in. and a height of about $3\frac{1}{4}$in.

Probably at least 75 per cent. of the batteries sold, no matter what the receiving set with which they are to be used, are of the standard capacity type. In other words, the purchaser is apt to think only of the volts and not to bother about the milliamperes. When a given number of new dry cells, whether large or small, are wired in series, the potential on open circuit will always be in the neighbourhood of 1.5 volt per cell.

RAPID VOLTAGE DROP.

"BUT whilst cells of large size can deliver a fair amount of current for a considerable time without much falling off in potential, those of small size show a rapid drop when under any but the lightest of loads. In the dry cell the fall in potential is of two kinds. There is, first of all, what may be called the temporary fall, which takes place while the battery is under load, and is due mainly to the effects of polarisation. A film of hydrogen gas collects round the carbon positive element and this causes a rising resistance to be present within the cell, since the depoliriser cannot get rid of it sufficiently quickly.

"When the cell is rested by being placed for a time on open circuit the accumulation of hydrogen is removed and the potential rises. It does not, however, quite reach its initial figure, and we thus have a second or permanent falling off in the voltage. From the wireless man's point of view both kinds of voltage drop are enormously important. We shall go more fully into the reasons in a moment.

"There can be no doubt that for the single-valve set or for the two-valve or even three-valve set employed only for telephone reception the use of the standard capacity battery is quite sound practice. Such batteries will stand up to an intermittent load of from 3 to 5 milliamperes for a very long time. But matters are rather different when the receiving set is required to work a loudspeaker.

HEAVIER LOADS.

"IF anything like quality is desired a small power valve must be used in the last holder, and for really beautiful reproduction a super-power valve is indicated. Both power valves and super-power valves impose heavy loads upon the battery, and the current required is likely to be from 8 to 20 milliamperes, according to the size of the receiving set. It is probably fair to take the current passed by the average loudspeaker set when the high-tension battery is in good condition at about 10 milliamperes. How will the standard capacity battery deal with this load? The question is an important one, and the best way of finding the answer seemed to be to undertake a series of tests under laboratory conditions. A load of 10 milliamperes when a battery is up to its full nominal E.M.F. is imposed when it is discharged through a resistance of 150 ohms per cell.

A STANDARD RESISTANCE.

"THIS, then, was made the standard resistance for the tests. Since batteries differ considerably in the number of their cells and in the tappings provided, the total terminal voltage was not by any means the same in all of those tested. Some, for example, were 36-volt units, whilst others had a nominal E.M.F. of 60 volts (really 63 volts), others of 66 volts, and others, again, of 100 volts.

"In every case, however, a resistance of 150 ohms per cell was used for the battery tested, so that all were subjected to exactly the same drain. To make comparisons easier, all results have been reduced to a percentage basis, an E.M.F. of 1.5 volt per cell being regarded as a hundred per cent. A battery was taken as done for when the E.M.F. had fallen to seventy per cent., or a little over 1 volt per cell.

THE TEST PERIODS.

"IT was decided to run the batteries for three hours a day from Monday to Saturday inclusive in each week, giving them twenty-one hours' rest in each twenty-four, and a rest of forty-five hours over the week-end. The total service hours were thus eighteen per week, which is very much what is asked of the average high-tension battery. Only batteries of well-known type were selected for test and two of each make were used.

"In every case the batteries were ordered specially so that there should be no possibility of their having deteriorated by having been in stock for a considerable time. The first process was to take the initial open-circuit voltage, and this disclosed some interesting variations.

BIG DIFFERENCES.

"BATTERIES of the same make gave, as a rule, similar readings, but there were big differences between

(Continued on Page 13.)