Mainly About Construction

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SEEKING PURE REPRODUCTION

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which consists of separate direct-current and alternating-current components. These two combined will be too heavy for the fine winding of the speaker, so the correct practice is to by-pass the direct current, so that it goes through the plate circuit only, and not through the speaker, which only receives the alternating current which conveys the impulses that actuate the diaphragm. This by-passing of the direct current is the function of the choke-filter that has frequently been referred to. There are several methods of connecting up the choke, and these will shortly be dealt with and their respective merits discussed. It will be seen that although the choke, by reason of its great number of turns over an iron core, offers great resistance to the alternating current, it is important that its resistance to direct current must be kept as low as is practicable in order not to unduly reduce the plate voltage.

So far, everything being properly arranged, a fairly good reproduction of the broadcast may be assured, but there is the loudspeaker to deal with, and this is quite frequently the worst offender in the circuit. If a horn type is in use, then the middle and higher frequencies may be quite pleasingly reproduced, but below a certain frequency, depending upon the particular dimensions of the speaker, the trouble begins. Below this point, which may be 200 cycles, the speaker cannot reproduce faithfully any musical tones, and if it left them alone, matters would be fairly tolerable. But the speaker endeavours to reproduce the sounds that are below its compass or range, and can only present them in distorted form, either as "blasting" or as discordant blur. Some of the lower sounds it is able to reproduce, an octave higher as harmonics, and this sometimes gives an impression that the lower notes are being reproduced. It is possible to govern the range of a speaker within certain limits. A fixed condenser of suitable value across the leads will make the tone more inclined to mellowness than without it, but the value must not be overdone, otherwise "woolly" tone is produced. A fixed condenser may be placed in series in one of the leads in order to determine to some extent what depth of frequencies shall be reproduced at the lower end of the scale. This condenser, which in any case should not be less than say .005 or .01 mfd., according to the speaker, if increased, will allow more of the low frequencies to be reproduced, and by careful experiment can be regulated to cut off where the frequencies begin to distort. This arrangement is most suitable when a horn speaker is used in conjunction with a cone. The horn is then left to take care of the high frequencies only, and the cone the lower. Once the correct value of the condenser has been determined, it can be permanently fixed inside the base of the horn, not across the two leads, but in series with one of them. In most cases quite an amount of detrimental "mush" will thus be cut out.

A good cone speaker will reproduce most of the deep organ notes in ordinary use, and reproduce them without distortion if volume is not overdone, and provided the amplifiers are "delivering the goods," there will be little trouble at the lower end of the scale. Few cones will give much strength of tone above the middle frequencies, although odd makes stand out in this respect, but on very high notes they are all weak. This is where the high-pitched horn mentioned above steps in and preserves the balance in a pleasing and satisfying manner, when a speaker of each type is used.

RESISTANCE COUPLING.

It is necessary in amplifiers to have an amplification characteristic that is within certain limits independent of frequency, and the ordinary valve complies with this condition. But in the case of the methods employed in coupling the valves, a compromise is arrived at between the possible and the ideal. Pure resistance coupling, if it could be carried out upon the ideal lines that introduce too many practical difficulties, would be near to perfection, but in actual practice it is not convenient to use resistance alone, so the varying but not the direct potential of the plate resistance is conveyed to the grid of the next valve through a condenser of sufficient capacity. This type of amplifier depends solely upon the amplification of each valve, and to overcome this disadvantage valves with a specially high amplification factor are now made for resistance-capacity coupling. A great advantage of this method of coupling is that on the lowest organ notes, there is not the great falling-off in amplification that is present in high-ratio transformer coupling, and the amplification at twenty cycles may not fall as low as half that in the middle of the audible range. The use of high value grid leaks or larger coupling condensers is necessary to effect this, but in practice the amplification of such very low notes would cause trouble, and distortion would take place through overloading of the valves, besides trouble caused by the slow reduction of excessive charges by dissipation through the high value grid-leaks. With frequencies up to about 3000 the degree of amplification can be regarded as independent of frequency, or at an even rate through that range, above which it falls off.

Whilst a high voltage is necessary on the plate for best operation of resistance coupling, the drop across the high resistance keeps the actual voltage on the valve at a much lower figure than is given across the battery terminals, and consequently the best working voltage is frequently not supplied. Consequently, whilst even amplification is secured over a wide range of frequencies, there is a tendency for valves to be overloaded, with the result that distortion is present in what is generally claimed to be a distortionless amplifier.

IMPEDANCE AMPLIFIERS.

With a view to improving the resistance-coupling system, a low-frequency choke coil was substituted for the high resistance in the plate circuit. By this means a much higher inductance is obtained than is possible on the primary winding of a good transformer, and the great drop in high-tension voltage of resistance coupling is avoided. But this system, still retaining the grid leak, is liable to the choking effect caused by a heavy signal charge being unable to get away rapidly. In order to get rid of this effect, the dual-impedance circuit has been devised, in which a low-frequency choke of very high impedance (200 to 250 henries) takes the place of the leak between grid and filament. This is the principle of the "Truphonic" amplifier. Commercially, the two impedances are wound upon the two outside legs of a shell type of core, the plate impedance being of considerably lower value than that connected to the grid. Three stages of dual-impedance amplification may be used with success, but a good transformer is frequently used instead for the last stage, and increased volume is thereby obtained. For great volume the type of tube for the three stages would be 201A, 112, and 171. An output filter or output transformer should also be employed, and valves must be given full rated filament voltages, ample plate voltage, and correct grid bias.

A good method of adapting this method of amplification in the Browning-Drake receiver is to incorporate one stage in place of the first audio transformer, retaining the A.F.3 in the second stage of the audio amplifier. Experimenters can test the idea by connecting up the primary of a spare audio transformer as the plate impedance and the secondary of another as the grid impedance.

This amplifier allows of a greater degree of amplification of the lower frequencies than does any other system, and, moreover, by varying the values of the coupling condensers, the amount of such amplification can be adjusted to suit the loudspeaker and the taste of the listener.

SELECTIVE TUNING.

As a receiver is made more selective either by improvement of coils or tuning gear, or by the addition of a wave-trap, it becomes more necessary to pay careful attention to the tuning. On a near-by station many listeners make a practice of reducing volume by de-tuning the aerial circuit, and such a method has been advocated at times by British technical journals. Whilst with an unselective receiver little harm may be done by adopting this method, when selectivity is secured, both or all dials should be very carefully tuned to the exact maximum position, otherwise distortion is liable to be introduced. Volume must then be cut down by other means, the best being firstly the cutting-down of reaction to nil, and then the lowering of R.F. filament voltage. Detector voltage may also be reduced, but dimming the audio filaments should never be resorted to, as that will cause tone to suffer. A variable high resistance across the speaker is not a good volume control for most conditions, as if there is overloading of valves, operating the resistance only reduces volume without removing the overloading, which is simply made more bearable by its lessened intensity.

Want of fine tuning on the local station may easily give an impression of distorted transmission, especially when one tunes in to a distant station that must be tuned finely to be brought in clearly, and finds reception from that station free from distortion at equal volume to the local.

The Wellington station, 2YA, is a sharply-tuned station, and this assists listeners to obtain high selectivity the more readily, and at the same time careful tuning is necessary in order to do full justice to both station and receiver. But there should be no attempt to extort from the receiver more volume than it is designed to give, and a ten-guinea outfit should not be expected to equal one costing several times that amount. Dealers are not very keen on the idea of listeners tinkering with factory-made sets, and they are not to be blamed for this attitude. If you wish to experiment, buy a set of components or make any you feel capable of constructing, hook them up on a board, make alterations to your heart's content, and with care and patience you will soon improve the initial hook-up into a set that will give results superior to the average cut-price factory-made article, and at same time you will learn a great deal about the why and wherefore of radio.

ANSWERS TO CORRESPONDENTS

(Continued from Page 12.)

DANIEL CELLS.

One or two readers appear to have placed too much sulphuric acid in their gravity type cells, so that action has been rather violent. The original directions say "not more than one of acid to four of water," and the amount of acid may be considerably less than this, as violent action is to be avoided. The acid is only to commence the production of zinc sulphate solution, which rises to the top of the liquid, and forms a distinct layer, in which the zinc must be. It is this double layer of solutions that enables the porous pot to be dispensed with. The cells will probably give full voltage when settled down.

112-VOLT B BATTERY.

"Radio" (Auckland).—You appear to have made your plates before getting the tubes, but no harm is done, provided there is sufficient space for a strip of celluloid between the pair of plates. By sorting the plates you will probably be able to put most of the wide ones into the wide tubes. If a few are too wide to go in, bend them slightly down the centre to suit the curve of the tube. Tubes 1 1-8in. diameter are not usually obtainable in New Zealand. You will find most working dimensions stated exactly where necessary. The article you mention is to appear shortly. A chemical rectifier is not recommended for charging this battery. A valve rectifier is far more reliable, and is recommended. If a chemical charger goes wrong it may ruin the battery, but a valve charger can do no harm. Ordinary insulated wire can be used in the battery, but enamelled is best, as the acid spray during charging soon rots cotton or similar covering.

Valuable Tips and Jottings

(BY MEGOHM.)

VOLUME CONTROL.

Dimming the R.F. filament is one of the best means of volume control, as by this means the overloading of the detector and consequent distortion are avoided. Of course, reaction must first be reduced if the set is not a neutrodye. A variable high resistance across the speaker leads answers as a volume control within a certain range, but if it is used to give a big reduction of volume, tone is inclined to be scratchy.

SHORT-WAVE SUPERHETS.

Superhets for short-wave reception are finding favour in America. For the very low wave-lengths a good type autodynes the incoming signals to 30,000 cycles instead of the usual 1000 cycles. A two-stage amplifier, oscillating slightly, amplifies the 30,000 cycle signal component and a second detector makes the signal audible. The intermediate frequency amplifier oscillates weakly, say on 31,000 cycles, so that these two components combine in the second detector to give a 1000 cycle note. This method effects a great reduction in power and motor ignition interference.

DOUBLE-GRID TUBES.

American factories have started making the double-grid tubes. Mr. H. Gernsback, in a "Radio News" editorial, points out that the importance of this tube has been brought under the manufacturers' notice for two years, and no notice was taken of the matter, although during that time such tubes have been freely sold in Britain and Holland and, says Mr. Gernsback, "The chances are that the European tubes are every bit as good as the new American one."

THE SHIELDED GRID VALVE.

The new Marconi shielded grid valve is finding favour in Britain. Similar valves will shortly be produced in America. The valve is used for R.F. amplification and makes external neutralisation unnecessary. This is effected by interposing a fine mesh secondary grid or shield between the usual grid and plate, the inter-electrode capacity being thereby overcome within the valve. There are five connecting prongs, three at one end, two at the other. The valve is mounted horizontally, the centre resting in a correctly sized hole in a copper screen in the plane of the screening grid. This leaves the grid and plate circuits separated by the screen. Normal filament current 0.25 amp. at 6 volt, plate volts 120, 80 volts on screening grid, 9 volts on control grid, amplification factor 110, plate impedance 175,000 ohms.

AUDIO FREQUENCIES.

The normal human ear detects frequencies between 16 and 20,000 per second, but between the extreme ranges of the transmitter and receiver, audio frequencies are in practice usually limited within 100 to 5000 cycles. The lowest note of the piano is about 27 cycles. A 32-foot organ pipe gives 32 cycles, and a 64-foot 16-cycle tone The highest note of the piano is about 4100 cycles. The highest speech frequencies make th, f, s and z, about 6400 cycles per second. A 5000-cycle limit distorts these sounds.

LOUDSPEAKER COUPLING.

The condenser in a loudspeaker filter coupling should not be of too small capacity, owing to the fact that the reactance of this fixed condenser varies according to the cycle frequency. At 30 cycles the reactance of 2 mfds. is 2650 ohms, and at 5000 cycles only 31 ohms. It will thus be seen that at low frequencies high resistance is introduced into the circuit, so there should be not less than a 2 mfd. condenser employed. High capacity will reduce the a.c. resistance.

OUTPUT TRANSFORMERS.

A push-pull amplifier stage is at the same time an output transformer, so that a choke filter is not necessary. If an output transformer secondary winding has an impedance to match the loudspeaker winding at the lowest frequency used, maximum power will be delivered to the speaker at that audio frequency. As the transformer impedance rises more rapidly than the loudspeaker impedance. The output transformer compensates for some of the defects of the loudspeaker. In cases where an output transformer does not seem to be satisfactory, it is probably owing to the secondary not matching approximately the speaker winding in impedance.

RECTIFYING TUBES.

The Raytheon BH double-wave rectifying tube for B eliminators delivers 85 milliamps at 200 volts, with a suitable transformer. This tube rectifies without a filament, is guaranteed by the manufacturers for at least 1000 hours' service, which is, roughly speaking, twelve months' use. Larger sizes of the tube will pass 125 and 350 milliamps respectively.

FIXED RESISTANCES.

Fixed resistances may vary as much as 10 per cent. above or below their stated value, so where accurate results are required, two or three should be tried in turn and the best one determined for the particular position.

WAVE-TRAP.

Constructors of the selective crystal circuit as a wave-trap only, should try connecting the aerial to the end of coil opposite to earth, as under some conditions this may be found to be the best position.

HIGH CAPACITY FIXED CONDENSER.

The ordinary type of high-capacity paper dielectric fixed condenser stands up very well to high voltages for eliminator smoothing. The case of a new one of Dubilier make breaking down has been investigated and showed that the cause was an accidental tear in the dielectric paper, which was turned back, leaving only one thickness of paper where there should be two. This shows that the system as carried out is good, apart from accidents of a mechanical nature. This type of condenser is made from two long strips of thin tinfoil, between which are two strips of very thin waxed paper. Outside each is another strip of waxed paper, so that when the whole is rolled up, two thicknesses of paper everywhere separate two adjacent tinfoils.

"MOTOR-BOATING."

"Motor-boating" in resistance-coupled amplifiers occurs between zero and a value just above 30 cycles, usually because the filter systems of eliminators are resonant within that band. To eliminate this without external apparatus, the amplification over-all must not exceed approximately twenty.

PLATE CURRENT.

The average general purpose valve requires from 1 to 3 milliamps plate current, depending upon whether used as a detector or amplifier. A small power-valve takes from 3 to 10 milliamps, and a super-power anything up to 20 milliamps. The higher the plate voltage the greater the milliamps passed. Resistance-coupled audio amplifiers consume considerably less H.T. current than transformer-coupled.

A 16-FOOT LOUDSPEAKER.

An American experimenter in the search for sweet and mellow music, has constructed a 16-foot wooden loudspeaker horn. It is made from two 16-foot boards 16 inches wide, each sawed diagonally from corner to corner. In order to accommodate the horn in an ordinary house, the wide portion rests upon the rafters of the ceiling, and the narrow end comes down between the walls. The sound is conducted through an ornamental grating in the centre of the ceiling. It is said to give really good reproduction.

SECRET TRANSMISSION.

The latest idea for secret transmission of radio messages is to arrange two beam stations some distance apart, arrange for the message to be broken up into fragments to be alternately transmitted by the two stations. The beams are arranged to intersect at a given point, and in that zone both portions of the message are received as though sent out in the ordinary way. The area of the receiving zone would depend upon the sharpness of definition of the beams.

(End of Construction.)

A Hawera correspondent ("Buzz") writes asking whether power-line interference can be stopped if its source is located. The trouble is due to the generation of radio frequency currents at spots where there should be no radio frequency currents and the broadcasting of these volunteer energies with the power lines acting as an aerial. As one writer puts it, "What more natural, then, than to seize upon these emanations at their source and block them from the lines? There are various ways of doing it. In some instances they are allowed to wander into a condenser which acts as a sort of sump tank and loses them until their ambition is all gone. In others they are actually choked out of the line. Occasionally they are grounded."