

ing which reduces self-capacity between the primary and secondary windings. In this way the amplification is kept even through the part of the musical scale in general use, and with only a very slight diminution at the extremes. Such transformers contain more material than the inefficient types and cost a little more, but the difference in cost is trifling when compared with the tremendous gain in performance.

Harmonic distortion is the insertion of harmonics that were not present in the original sounds. These harmonics may be only weak, but they may easily affect quality. They may be produced in the valves, but more probably by the iron in the transformers. The better transformers have cores of very special material in order to prevent this type of distortion.

But the transformer is not always to blame. Such distortion may also be caused by a too selective receiver, too much regeneration or regeneration in too many places, poor detection, and poor amplification, or a combination of these.

Introducing Distortion.

DISTORTION may also be introduced by improper battery connections, or voltages, or too low a filament voltage. Amplifier filaments should be fixed at the correct constant voltage by employing "amperites."

The lower the ratio of the transformer, the less the overall amplification for a given number of stages, but the better the quality if the transformer is properly designed. A 6 to 1 ratio does not give twice the overall amplification given by a 3 to 1 ratio; and as the ratio is reduced, the relative amplitude of the lower notes increases, with the result that the apparent decrease in amplification is less than it would be if the amplification were reduced in the same proportion over the entire scale of frequencies.

The primary of the first audio transformer carries the detector plate current, which is very small, but the second transformer carries the plate current of the first audio valve. This is also small as a rule, but when it exceeds 6 miles, as would only be the case in a large amplifier, its case becomes similar to that of the speaker windings at the output, and the current may cause distortion by over-magnetising the core. A choke-condenser filter can be used in this position, and has actually been employed in some instances, allowing only the a.c. component to traverse the primary winding.

The capacity of the condenser across the primary of the first audio transformer is usually stated as .001, but a much smaller one may be found better on trial, say .0002 to .0005 mfd. This condenser has to allow r.f. current necessary for reaction to flow through the detector plate circuit, but must block the highest audio speech frequencies so that they have to pass through the transformer windings. A condenser is not required across the second primary unless the low notes are lost and the resulting quality is "tinny," in which case a suitable capacity may be used to subdue the excess of high notes. Only for this same reason is a condenser put across a secondary, though it is seldom recommended.

Audio Oscillation or "Motor-boating."

THE output quality of many amplifiers is not as good as should be expected from the components employed, simply because distortion is

introduced owing to feed-back through a "B" battery used for all stages of the receiver, or a "B" eliminator with continuous resistor. In both cases there is high-resistance coupling, and in the case of the dry battery the resistance is gradually increasing as the battery ages, thus making conditions worse.

With a wire-wound resistance of 20,000 ohms in each plate lead except the last, and a 2 mfd. condenser across the plate side of the resistance and the earthed filament, a Ferranti engineer claims that motor-boating is impossible. In actual practice it might only be necessary to make this addition to one or two stages in the case of battery supply. When a "B" eliminator is used, in order to take advantage of this plate feed system, it is necessary to tap each voltage from a higher point than that required, reducing the voltage for each plate by a separate resist-

tion. A stage of resistance-coupling, followed by transformer coupling, is very liable to audio oscillation.

Output transformers do not tend to prevent audio oscillation because they allow the speech impulses to traverse the "B" supply.

Perhaps this form of oscillation is most troublesome when it is incipient; a condition in which it is sufficient to mar quality without being audible as oscillation.

Another form of distortion may be introduced by radio-frequency finding its way into the amplifier. By-pass condensers at suitable points as may be found necessary will subdue this trouble. The usual values are .001 from detector plate to filament, .25 mfd. from bias end of transformer secondaries to filament, B+ end of second transformer primary to filament, 1 mfd. A non-inductive high resistance (grid-leak type) to suit the amplification factor of the valve may be placed in the grid lead of the first audio valve. For an amplification factor of 5, 250,000 ohms; 10, 120,000 ohms; 15, 80,000 ohms, and 30, 40,000 ohms.

A New Amplifier.

FROM America comes a description of a resistance-coupled audio amplifier which "Radio News" states gives practically uniform amplification from 0 cycles per second to 20,000, with no feed-back troubles of any kind. Four stages are used, and a special plate supply is required, owing to the unusual voltages and bias. The amplifier will give a power output of 4½ watts over a band of 30 to 10,000 cycles per second.

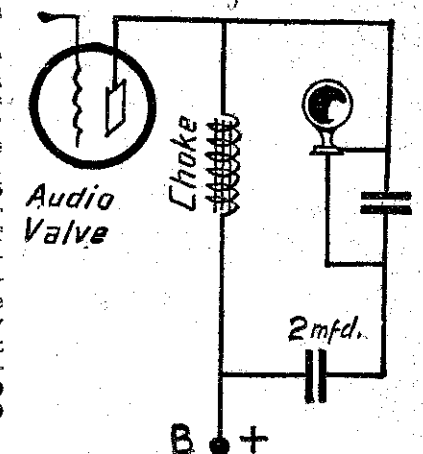
The voltages used vary from 560 positive to 240 negative. The valves employed are 240, 201A, 112A, and 250. The circuit is a "straight" resistance of special type, without coupling condensers.

The Loudspeaker.

THERE is no more important unit in the outfit than the loudspeaker. It truly has the "last word" all the time, and can preserve or mar the good product of the rest of the circuit. But the speaker is not altogether in an enviable position, for it frequently has to bear the blame for evil wrought by components earlier in the chain of reproduction. For the present we are leaving dynamic speakers out of the discussion, as this article is dealing with home construction of a simpler kind.

The cone speaker in one form or another has come to be the popular reproducer in place of the horn type. At

first a cone was actuated by the same kind of unit or glorified head-phone magnet that did duty in the horn speaker of the period, but as time has elapsed, great improvements have been made in magnetic units to operate cones. The introduction of the balanced-armature was a big step forward, and this type of unit driving home-built cones is now giving pleasure to

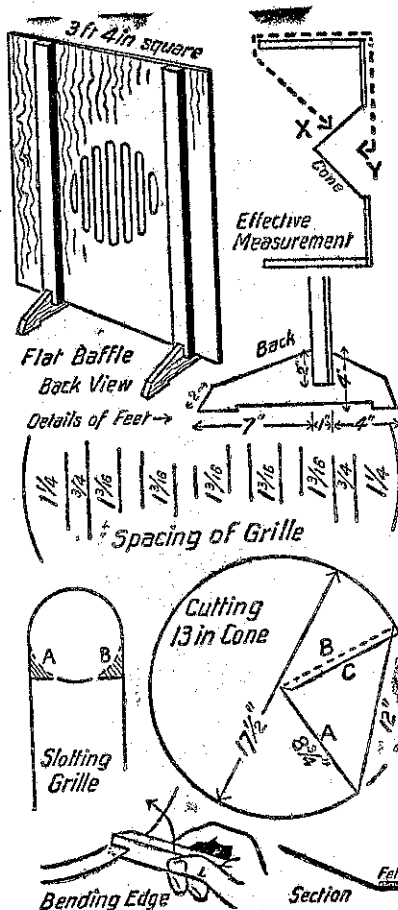


An output filter improves tone and saves the speaker windings.

many thousands of listeners in this country.

Condensers Across Speakers.

ENQUIRIES have sometimes been made with regard to placing fixed condensers across loudspeaker leads. With a good amplifier these are usually unnecessary, because when amplification is fairly even, both high and low notes are produced in more or less correct relation with regard to strength, and there is nothing superfluous. If the amplifier has a peak on the high audio frequencies, it will favour gramophone scratch, and unduly emphasise some high notes, and in such a case reproduction may be rendered more agreeable by subduing the higher portion of the musical scale by placing a fixed condenser across the speaker. The necessary value must be found by trial by suit each particular case. The value should be kept as small as possible to give the desired effect—large capacity reduces volume, and may give "woolliness" to speech. From .01 to .05 should be tried. If the capacity is too large, all the higher portion of the musical scale will be either considerably weakened or entirely lost, and the tone will seem to be lower on that account, but all bril-



ance in its particular lead, also adding the condenser on the plate side. Sometimes an audio choke is used in place of the resistance, but there is no guarantee of its effectiveness. A push-pull output stage prevents feed-back from the output valves, but only if the impedances are properly matched for both valves and transformers. Speech current does not then traverse the source of "B" current. Shunting a "B" battery with a 2 mfd. condenser is of little assistance in curing oscillation.

Sometimes it is recommended that the connections to primary or secondary winding of the audio transformer be reversed. This procedure may stop the tendency to howl at low frequency, but reduce signal strength and create distortion at a higher frequency, probably reducing amplifica-

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