The

FERRANTI

INTERVALVE

TRANSFORMER

TYPE

AF 3

The Ferranti Transformer, Type A.F.3, has been designed to improve loud speaker results and the curves shown below indicate the success obtained.

These curves are drawn on the musical scale which is the true basis for comparison, and it should be remembered that curves drawn on the frequency scale are misleading.

FIG. W. 8
RATIO, $3\frac{1}{2}$ TO 1.
DIMENSIONS, $2\frac{1}{4}'' \times 3'' \times 3\frac{3}{4}''$.
WEIGHT, 1 lb. 14 ozs.

25/- NETT.

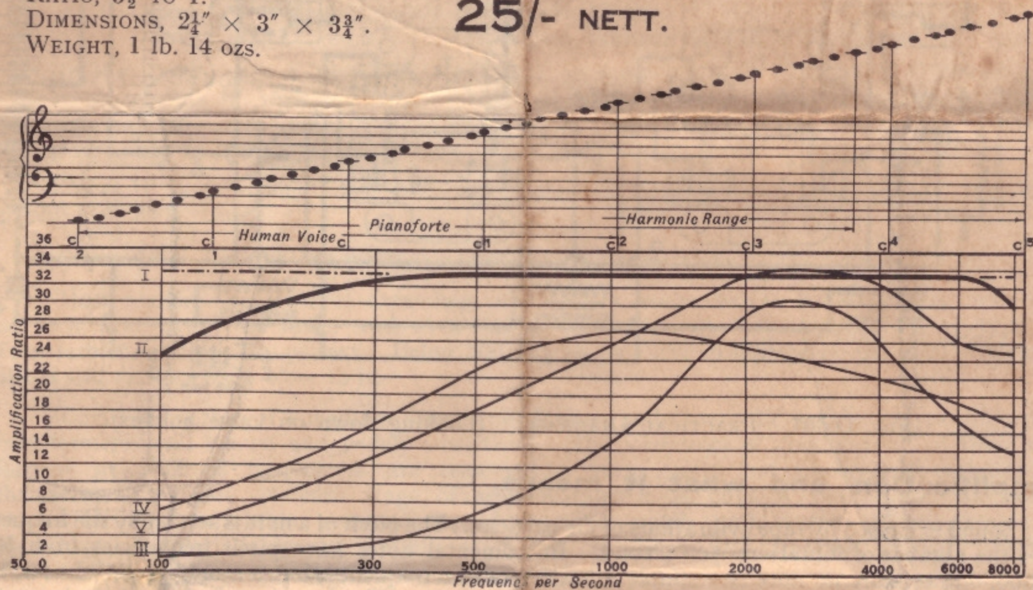

FIG. D.695. AMPLIFICATION CURVES. BASED ON A MUSICAL SCALE.

CURVE I. Perfection.
CURVE II. The Ferranti AF3 Transformer.
CURVES III, IV, and V. Well known Transformers of other makes.

It will be seen that the Ferranti Transformer is very nearly perfect.

NO BETTER TRANSFORMER IS AVAILABLE AT ANY PRICE.

September, 1925.
Wb401

Having produced a Transformer of superlative excellence the makers desire to ensure that it is properly used. The following notes have been written to enable the user to get the utmost value from his set.

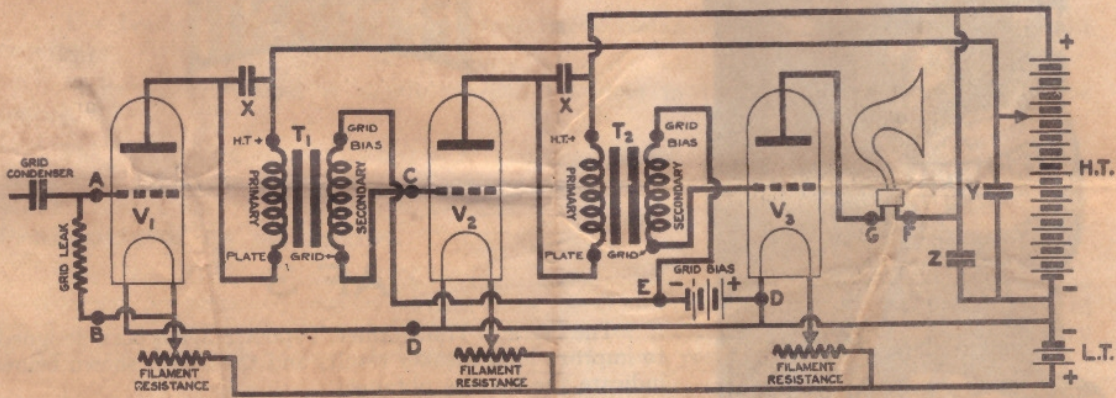

FIG. D.696. CONVENTIONAL DIAGRAM.

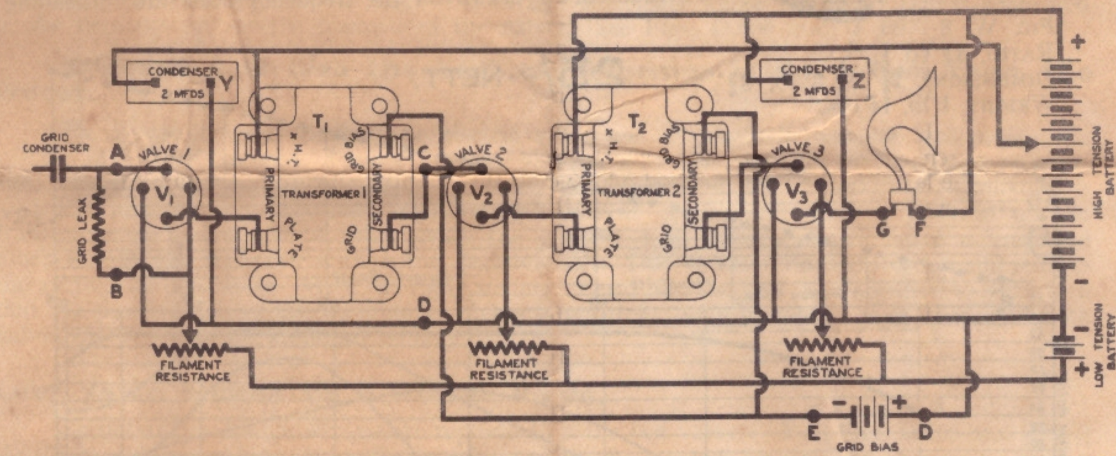

FIG. D.697. PRACTICAL DIAGRAM. (Looking down on valve holders).

Amplification and what it means.

Sound is caused by rapid vibrations of air particles. The pitch of a note is settled by the frequency, i.e. the number of vibrations per second. Instrumental notes have pitch frequencies from 50 to 3,500, but actually no note is a simple vibration of one frequency, but a combination of vibrations at frequencies which have a simple relation to each other. The lowest, called the " fundamental," give the pitch, while the others called " harmonics " give tone or quality, and cause the sound of one instrument to differ from that of another though producing a note of the same pitch. The frequency of the harmonics may be as high as 10,000 per second, and thus musical vibrations have a frequency range from 50 to 10,000. The sound vibrations are converted into electric vibrations in the Broadcasting Studio and are received as such in an aerial. They are reconverted into sound by the loud speaker, but first they must be amplified, i.e. magnified. The perfect Transformer and valve would amplify all frequencies equally.

Diagrams, Figs. D.696 and 697, show a detector valve and two stages of low frequency with two intervalve transformers, Type A.F.3. These diagrams are identical in principle, the first being according to convention, and the second in a more practical form.

An electrical vibration applied across "AB," the grid circuit of valve "V_1" is passed on much magnified by this valve and the transformer "T_1" to "CD," the grid circuit of valve "V_2" and the ratio of the magnification is called the **Amplification Ratio.**

Measurement of Amplification Ratio.

By means of apparatus specially designed the amplification ratios of type AF3 Transformer and of some other well-known transformers have been accurately measured and the Curves, Figs. D.695, page 1, and D.698, below, show the results obtained using the same valve and with the same conditions.

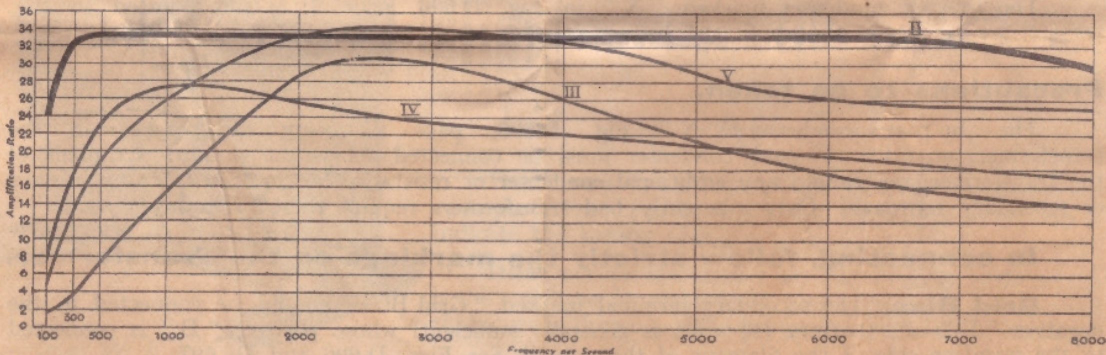

FIG. D.698 AMPLIFICATION CURVES BASED ON FREQUENCY SCALE
CURVE II The Ferranti AF3 Transformer.
CURVES III, IV, and V. Well-known Transformers of other makes.

In Fig. D.695, page 1, the curves are drawn on a musical scale base. Fig. D.698 shows the same measurements drawn on a base of which equal lengths represent equal differences of frequency. Although the latter is the usual method adopted in this country, obviously the musical scale gives the correct way of comparing the merits of the transformers.

Curve I is a straight line and represents the amplification of a perfect transformer amplifying 33·3 times.

Curve II is that of the Ferranti Transformer, type AF3.

Most makers show curves extending only over a range 300 to 3,000 periods, and it will be seen that over this range and even up to 6,000 periods the amplification of type AF3 Transformer is practically perfect. Below 300 periods its curve droops below the ideal straight line but is still exceptionally close to it.

Curve III is that of a medium priced transformer, and Curves IV and V, of two high priced transformers, well known and widely advertised. The variations of amplification of these transformers at different frequencies are seen to be very great, and since these variations are themselves magnified at each stage of amplification, it is obvious that these transformers cannot be used to obtain accurate reproduction of speech and music. Thus, two stages of III at 100 periods would amplify $(1\frac{1}{2})^2$, i.e. $2\frac{1}{4}$ times, and at 2,000 periods $(29)^2$, i.e. 840 times, or 370 times as much as at 100 periods.

Reasons for the good performance of Type AF3 Transformers.

(A) Ample core section with practically no air-gap.

(B) High inductance of primary (80 Henries at voltages usual in wireless sets).

(C) The ratio, $3\frac{1}{2}$ to 1, is as high as possible consistent with low losses at high frequencies.

(D) Great sub-division of the windings and special design to reduce the self capacity current and eddy current loss.

Features (A), (B), and (C) ensure good amplification at low frequencies, and (D) ensures good amplification at high frequencies.

Construction.

Only the best materials are employed, and these, and the transformer itself, are tested at all stages of manufacture to ensure reliability and compliance with standard performance.

The Transformer is shrouded in a pressed steel casing of pleasing appearance, its overall dimensions being $2\frac{1}{4}'' \times 3'' \times 3\frac{3}{4}''$.

Above each terminal is clearly marked the item in the circuit to which it must be connected.

The by-pass condenser marked "X" in Fig. D.696, page 2, is incorporated in the transformer to ensure that only the correct capacity shall be used.

Precautions to be taken.

The by-pass condenser "X" Fig. D.696, page 2, being incorporated in the transformer, no other by-pass condenser must be connected across the primary terminals of the transformer, nor should any additional condenser or resistance be connected across primary or secondary terminals. Only inherently bad transformers require these additions.

In connecting, follow strictly the markings on the Transformer.

Grid Bias. The secondary terminal marked "Grid Bias" should be connected to the negative "E" of a battery ($4\frac{1}{2}$ volts is generally sufficient) whose positive "D" is connected to the negative side of the filament of the valves. See Figs. D.696 and D. 697.

Without grid bias the best transformer is no better than the worst.

The reason for this is that the electric vibrations alternatively increase and reduce the voltage of "CD" the grid of valve "V_2." With no grid bias the grid first becomes positive, and, owing to the nature of valves, grid current flows and the transformer secondary is loaded. Then the grid becomes negative, grid current ceases, and there is no load on the transformer secondary. As a consequence the positive half of each electric wave is amplified much less by the transformer than the negative half. This causes serious distortion and reduces the average amplification. With the right amount of grid bias the grid is so negative to start with that the positive half of the wave never makes it positive; no grid current ever flows, and both halves of the wave are amplified equally.

Last Valve should be a Power Valve.

To obtain the best loud speaker reproduction the last valve, ("V_3", Figs. D.696 and D.697) should be a power valve. An ordinary valve cannot give enough current and voltage to work a loud speaker without distortion.

Back Coupling may cause trouble when using even the best transformer. One cause is that each valve is fed from the same high tension battery which has some slight resistance. The strong electric vibrations of the last valve do not pass quite freely to the negative of the valve; some small portion of their energy passing along the coupling wires to an earlier valve, is magnified, and appears as a whistle or howl. **This can be stopped** by connecting condensers "Y" and "Z" preferably of 2 microfarads capacity between positive and negative high tension wires as shown in Figs. D.696 and D.697. Back coupling is also often caused by not following the general principle of wiring illustrated in the diagrams, viz.: that the electric vibrations received at one side (left) should pass progressively as magnified to the output terminals "GF" on the other side (right).

Output terminals should never be fitted in the centre of the set for the sake of symmetry of appearance or the output wires brought over valves or other connections.

Failure of H.T. Batteries.

As the running down of the high tension battery ("H.T." Figs. D.696 and D.697) is the most common cause of trouble, see that it is always in good order.