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F. E. FIELD
INDUCTION COIL
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Fig. 1

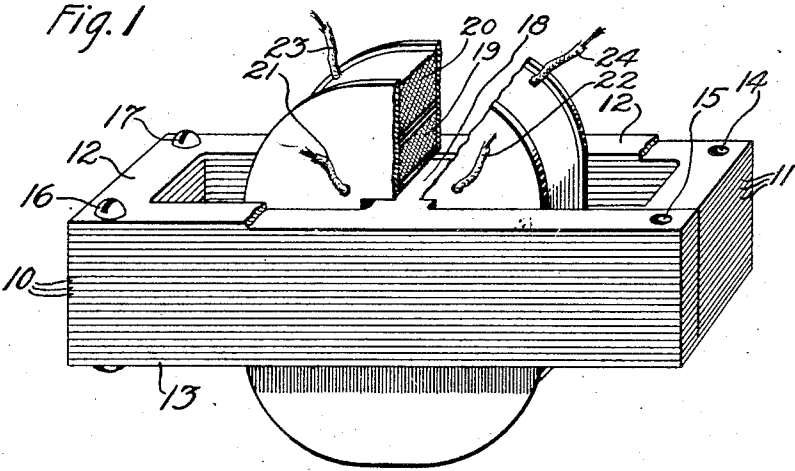


Fig. 2

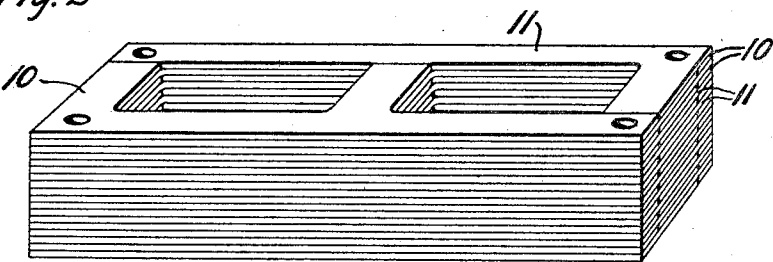


Fig. 3

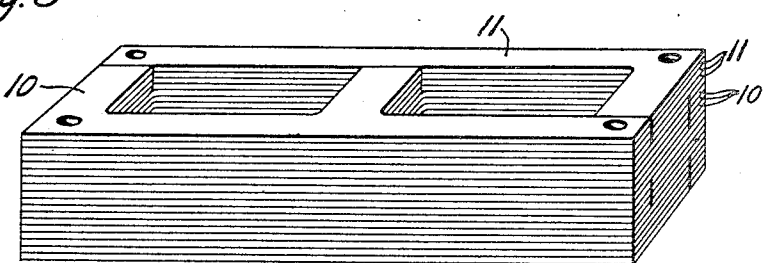
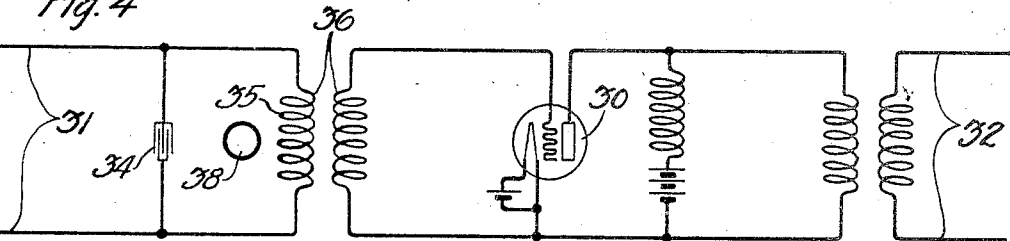


Fig. 4



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UNITED STATES PATENT OFFICE.

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INDUCTION COIL.

Application filed April 8, 1922. Serial No. 550,806.

This invention relates to induction coils and its object is to provide a convenient and simple method of adjusting the inductance of an induction coil.

Commercial transformer windings with equal number of turns and mounted on the same size core do not always have the same value of inductance. This variation, which may be as much as 30 per cent or more, is sometimes of no special concern, but it may be a disadvantage in cases where it is desired that a winding should have a definite predetermined value of inductance, for example, when it is desired to sharply resonate one of the transformer windings with a fixed capacity at one particular frequency.

The invention is hereinafter described in connection with a transformer having a substantially closed magnetic circuit core composed of a plurality of laminations. Each lamination consists of a plurality of separate pieces of core material, the points where the pieces of each layer come in contact with each other forming small air gaps for the purpose of reducing the variation with frequency of the permeability of the core. The pieces forming each layer may, for example, be F-shaped and L-shaped, which, when placed together, form a two-mesh magnetic core.

In accordance with this invention, it has been found that the transformer winding will have the maximum inductance when the F and L-shaped pieces are staggered one at a time, and that the inductance will be of minimum value when all the L-shaped pieces are on one side of the core and all the F-shaped pieces are on the other side, while staggering them 2, 3, 4 or more at a time, will give a value intermediate the maximum and minimum values. The method of this invention, therefore, comprises placing the winding on the core with the laminations or pieces of the core arranged in a suitable manner, measuring the inductance of the winding and then staggering a plurality of the strips in such a manner as to produce the necessary change in the inductance to give the desired result.

For a better understanding of the invention, reference is made to the accompanying drawings in which Fig. 1 represents a transformer with the pieces of magnetic material forming the core arranged in such a manner as to cause one of the transformer windings to

have a low inductance; Fig. 2 illustrates the same number of pieces of magnetic material arranged in such a manner as to give the transformer winding a high inductance; Fig. 3 represents the pieces of the core arranged in a manner to give the transformer winding an inductance intermediate the values resulting from the arrangements of Figs. 1 and 2; and Fig. 4 represents a signaling circuit employing a transformer constructed in accordance with this invention.

Referring in detail to the drawings, Fig. 1 discloses a transformer having a core of magnetic material composed of a plurality of F-shaped pieces 10 and a plurality of L-shaped pieces 11 held in position by two clamping plates 12 and 13 and by a plurality of bolts 14, 15, 16, and 17. Mounted on the portion 18 of the F-shaped pieces, is a spool comprising a primary winding 19 and a secondary winding 20. Leads 21 and 22 may represent the terminals of the primary winding while leads 23 and 24, the terminals of the secondary winding.

It has been found that when the F and L-shaped pieces are arranged as in Fig. 1 with all the L-shaped pieces on one side and all the F-shaped pieces on the other side, that the inductance of the primary winding 19 is relatively low. However, if the F and L-shaped pieces are staggered one at a time, as shown in Fig. 2, each side of the core comprising an equal number of L-shaped pieces, then the inductance of the primary winding 19 will be considerably higher than obtained with the core arrangement of Fig. 1, and may be as much as 30 or 40 per cent higher, or more, depending upon the number of laminations employed. It has also been found that staggering the F and L-shaped pieces 2, 3, 4, or more at a time, that the inductance of the primary winding, when measured under the same conditions as employed in the measurement with the arrangements of Figs. 1 and 2, has a value intermediate the maximum and minimum values obtained by these arrangements. Fig. 3 for example, shows the F and L-shaped pieces staggered several at a time.

When the laminations are arranged as shown in Fig. 1, a complete air-gap is formed in the magnetic circuit and the reluctance of the magnetic path is relatively high, giving the primary winding a rela-

tively low inductance. On the other hand, when the gaps are staggered as shown in Fig. 2, a substantially closed magnetic path is formed since at the gaps the magnetic flux can pass to the adjoining lamination which has no gap, the reluctance of the air-gap between the faces of the adjoining laminations being negligible. The reluctance of such a circuit is therefore low, resulting in a high inductance of the primary windings. In the arrangement of the gaps shown in Fig. 3, in order to form a complete iron circuit, the flux must pass through several air-gaps between the faces of the adjoining laminations. While the reluctance of a single gap between the faces of the laminations is negligible, the reluctance of a series of such gaps must be considered. The reluctance of the magnetic path is therefore somewhere between that of Figs. 1 and 2 and results in an intermediate inductance of the primary winding. Therefore, by the proper grouping of the gaps, the inductance may be varied between the limits represented by Figs. 1 and 2.

The method of varying the effective inductance of a retard coil or a transformer winding in accordance with this invention, is, therefore, to place the winding on a core which has the laminations arranged in any suitable manner, measuring the inductance of the winding and thereby ascertaining how much the actual inductance of the winding varies from the desired value and then rearranging the laminations of the core in such a manner that the air gaps in a plurality of laminations occur at different points in the core than they did with the first arrangement. For example, if the core is made up, as shown in Fig. 3, and it is found that the inductance of the winding on the core is too low, the F and L-shaped pieces, instead of being staggered four at a time, for example, may be staggered 3, 2, or 1 at a time, depending on how great an increase in inductance is desired. If, on the other hand, the inductance of the winding as measured with the arrangement of Fig. 3, is too high, the F and L-shaped pieces may be staggered 6, 7, 8 or more at a time, or may be arranged as shown in Fig. 1, with all the F-shaped pieces on one side of the core and all of the L-shaped pieces on the other side, depending on how great a change of inductance is desired.

This method of varying the inductance is of particular importance when it is inconvenient or impossible to vary the inductance of a winding by increasing or decreasing the number of turns thereof. For example, in the transformer shown in Fig. 1, winding 19 is underneath the secondary winding 20 and it would, therefore, be highly objectionable to unwind the secondary winding 20 in order to change the number of

turns of winding 19 or to add additional turns to winding 19 in any other manner. The method of this invention, however, does not require damaging the spool containing the carefully wound secondary and primary windings, since the spool may be readily removed from the center limb of the core of the transformer and the laminations of the core rearranged in any suitable manner without danger of damaging the transformer windings.

Fig. 4 illustrates how a transformer, constructed in accordance with this invention, may be used to advantage in a signaling system. 30 is a vacuum tube amplifier of the three-electrode type arranged in the usual manner for repeating signals between the associated line sections 31 and 32. In some instances it may be desirable to selectively amplify and impress on line section 32 one particular frequency or a narrow band of frequencies present in line section 31. One arrangement for doing this is to connect a condenser 34 in shunt to the primary winding 35 of the input transformer 36 of the repeater. The values of the capacity 34 and the inductance of winding 35 should be such that they form a circuit anti-resonant to the frequency desired to be selectively amplified. Since it is much cheaper and more convenient to employ a fixed condenser instead of a variable condenser in shunt to the primary winding, it follows that input transformers employed in connections such as Fig. 4, should necessarily be manufactured with approximately the same value of inductance for their primary windings so that when the primary winding of each transformer is connected in circuit with the fixed condenser, the two elements will be anti-resonant at the desired frequency. As pointed out above, the inductance of primary winding 35 may be adjusted to the desired value by a suitable arrangement of the laminations comprising its core 38.

While this invention has been described above in connection with the construction of a transformer employing a two-mesh core of magnetic material, it is to be understood that the methods of this invention are applicable to transformers of one mesh or several meshes, and although the core described in detail, has been illustrated as composed of F-shaped and L-shaped pieces, it is obvious that this invention can be employed with transformer laminations of other shapes.

The invention claimed is:

In the art of manufacturing inductances employing cores built up from laminations so sectioned that the laminations may be withdrawn from the winding and reinserted with the abutting joints of the sections at different points in the plane of the lamina-

tion, the method of adjusting the inductance of each unit to a required value comprising assembling the coil and the core using groups of laminations with the air-gaps in the layers coinciding within each group and alternating from group to group, measuring the inductance of the assembled coil, withdrawing lamination sections and reinserting them in reversed order to vary the number of contiguous layers with coinciding air-gaps, and continuing the measuring and rearranging procedure until the units have the required inductance values. 10

In witness whereof, I hereunto subscribe my name this 3rd day of April, A. D. 1922.

FRANK E. FIELD.