

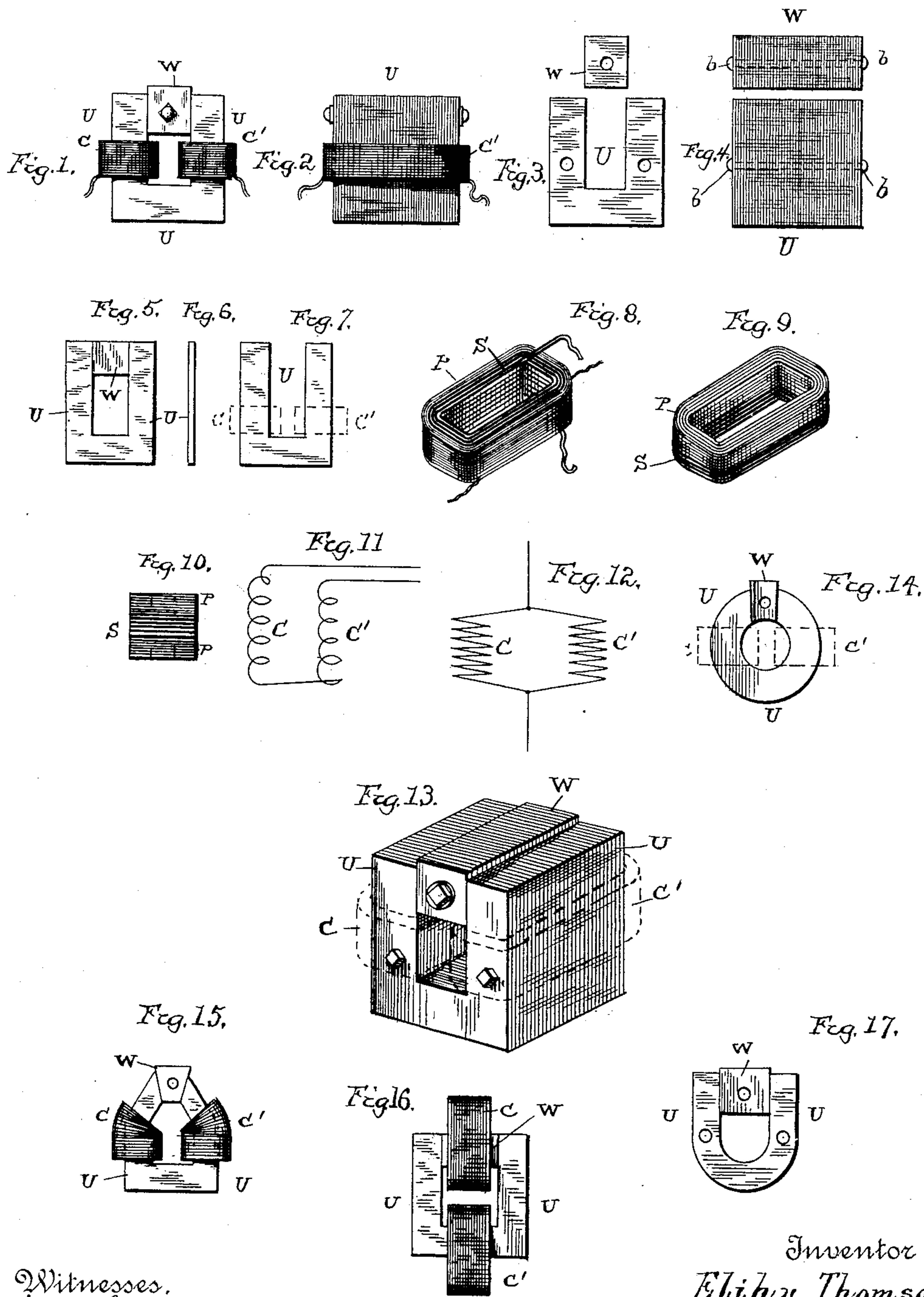
(No Model.)

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INDUCTION COIL AND SELF INDUCTIVE APPARATUS

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INDUCTION-COIL AND SELF-INDUCTIVE APPARATUS.

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To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, and a resident of Lynn, in the county of Essex and State of Massachusetts, have invented a certain new and useful Improved Induction-Coil and Self-Inductive Apparatus, of which the following is a specification.

My invention relates to the construction of those forms of electro-magnets in which the coil or coils are applied to a closed magnetic circuit of iron, which in general may be defined as of endless form and as having its circumferential axis passing through or threading the coils.

My invention relates more particularly to those forms of magnet in which the endless core is a laminated core—that is, consists of a number of plates of iron piled upon one another to form a laminated structure to which the electric coil or coils are applied—and the object of my invention is to secure ease of construction, simplicity, efficiency and facility of repair, and at the same time to obtain a perfect closure of the magnetic circuit which passes through the center of the coils.

I am aware that it has been heretofore proposed to make circular or ring electro-magnets in one or more sections for the purpose of facilitating the application of the coils, the magnetic circuit being completed after application of the coils by a bridge or armature of iron completing the gap or gaps through which the coils are applied.

My present invention relates to the particular manner of completing the magnetic circuit, as will more particularly hereinafter appear, and, generally speaking, may be said to consist in closing a gap or notch left in the laminated core for application of the coils by means of a magnetic laminated plug or stopper having a width or diameter in the direction of the magnetic axis that is substantially the width of the gap or notch and forced or driven tightly into the notch or gap, so as to completely close the magnetic circuit, such plug or stopper having its laminations parallel to the laminations of the main body of the core.

My invention applies obviously to electro-magnets or electro-magnetic structures hav-

ing either one or more coils connected to the same or different circuits and used for any electro-magnetic or magneto-electric apparatus, and applies therefore to self-inductive or reactive coils as used on alternating-current circuits, induction-coils, compensating-coils in which either coil becomes primary and secondary according to circumstances, as well as to many other kinds of apparatus, though I have herein illustrated my invention more particularly as applied to the construction of the special devices named.

It is of course immaterial, so far as concerns the general purposes of my invention, what geometrical form the completed closed magnetic circuit forming the core of the coils may take, whether curved or angular or a combination of curved and angular portions. For the sake of illustrating my invention I have, however, confined the subsequent description principally to the form of core which may be described generally as a horseshoe or U-shaped core, the gap or opening between the legs of which is filled by an inserted plug or stopper fitting tightly therein, as will presently appear.

My invention, in addition to the general feature of construction, consists in certain improved details, to be more particularly specified in the claims at the end of this specification.

In the accompanying drawings, forming a part of this specification, Figures 1 and 2 are elevations of a self-inductive or induction coil constructed in accordance with my present invention. Figs. 3 and 4 show the iron or core part separately. Figs. 5 and 6 are side and edge views of one of the separate plates of the core. Fig. 7 illustrates a manner of applying the coils to the core. Fig. 8 shows a preferred winding when the device is to be used as an induction-coil. Figs. 9 and 10 illustrate modifications in the distribution of the coils. Figs. 11 and 12 are diagrams illustrating modifications in the connections of the coils. Fig. 13 is a perspective view of the device embodying my invention, the coils being shown in dotted lines. Figs. 14, 15, and 17 illustrate modifications in the geometrical form of the iron core or magnetic circuit threaded through the coil. Fig. 16 shows a

modification in the location of the coils upon the magnetic circuit.

In Figs. 1 and 2, U U U is a pile of sheets or plates of iron with or without insulating-
5 paper or other insulating material between. In most cases it is preferred to insulate them from each other, as with paper, mica, hard varnish, &c. The pieces, Fig. 3, which form the main body of the core may be stamped
10 out in the form of a notched plate having two limbs and piled together as in Fig. 4, and also bolted or firmly held by bolts *b b*, passing through openings or holes in the sheets.

The parts U U of the core, it will be seen,
15 consist, virtually, of a laminated body of metal, whose two limbs are substantially parallel, and which limbs may be joined by the insertion of a magnetic plug or stopper consisting of a bundle or collection of small flat
20 pieces, W, Figs. 3 and 4, insulated from each other flatwise by suitable means—such as paper between the sheets—and held together by binding-bolts *b b*, passing through openings in the pieces, or by other means.

It will be evident that upon the insertion
25 of the bundle of pieces W between the limbs of the core U U in the manner shown there is formed a hollow square or rectangle composed of iron, with parallel laminae or plates insulated more or less perfectly from each other.
30 Each piece, with its accompanying piece W, acts separately as a closed magnetic circuit, and the magnetic circuit so formed is illustrated, so far as a single sheet is concerned,
35 in Fig. 5, the sheet itself being shown on edge in Fig. 6. The joints so formed between the laminae of the plug and the ends of those making up the core form what may be termed
40 "butt-joints." An advantage occurring from this feature of construction is that the whole magnet core or circuit may be practically solid iron, less the space taken up by the thin layers of insulating-paper or such like material.

In order to produce the structure, Figs. 1
45 and 2, it is necessary that the coils of insulated wire C C' be placed so as to surround the limbs of the main part of the core U U U, as shown in the figures. This is best done by
50 separately winding the coils and slipping them, either singly or together, over the limbs, as in Fig. 7, C' C', after which the short-circuiting plug or bundle W, Figs. 1, 3, and 4, is forced into place. It is very desirable that
55 the fit of the piece W be made very tight or close, so that it will require some considerable pressure to force it into place, after which it will not move unless pulled out by mechanical force applied for that purpose. By making
60 the fit sufficiently tight or close I secure the absence of the humming or noise which might otherwise be produced by the alternations of magnetism, and also produce a well-closed magnetic circuit. The particular structure
65 shown in Fig. 1, which embodies my invention and secures these ends, might be described as consisting of a laminated horseshoe-mag-

net with the laminated keeper W inserted between the opposing edges and the polar
70 ends and tightly forced into position.

The manner of winding the coils is not very important, the chief end being to so construct them that they are capable of being slipped over the core, and also that they may be kept
75 thoroughly insulated from one another and from the core. This is done in the usual way by the interposition of varying thicknesses of materials of an insulating nature, according to the requirements of the case. The coils themselves may be wound upon a frame or
80 mold, taking the form as shown in Figs. 8 and 9, and of as many turns of wire as are needed, or of different sizes of wire, or of the same size, wound together or superposed, so
85 as to form primary and secondary coils, or coils which are interchangeably primary and secondary.

When a single coil is used on each limb, such coil may be placed thereon for the purpose of obtaining its self-inductive effect or
90 reaction in a circuit; or a primary may be wound upon one limb and a secondary placed on the other limb, in which case the primary and secondary coils would become separate and the structure acquire new and different
95 properties from what it would possess if the coils were adjacent or superposed on one portion of the core.

In Fig. 8 a coil is shown as composed of an interior secondary, S, outside of which is a
100 primary, P.

In Fig. 9 the primary P is above the secondary S, so that the two coils are adjacent but not superposed.

In Fig. 10 the secondary S is shown placed
105 between the two faces of the primary P P. Numerous changes of this character can be made, and do not affect the working of the apparatus outside of the conveniences of construction.
110

In any case in which there are coils placed on both legs the connections of the two corresponding coils may be made in series or in multiple arc, as desired. Thus, if but two
115 coils are used, C' C', Fig. 11, they may be connected in series as they are shown for their combined self-inductive action, or they may be connected, as shown in Fig. 12, in multiple arc, thus lessening the self-inductive action and increasing the current-carrying
120 capacity.

If the core has several windings which are to be connected into different circuits, any two corresponding coils on the two limbs may be likewise connected in series or in multiple.
125 Modifications in the winding would naturally suggest themselves to the engineer in accordance with the work to be accomplished, and are therefore made no part of the present case.
130

Fig. 13 shows in a very complete way the relations of the various parts of the core itself and the coils C C', the latter being shown by dotted lines.

It will be evident that should it be necessary to change, replace, or reinsert one or the other of the coils on the limbs of the core U U it is only necessary to pull out the bundle of small laminæ W, thus allowing all the coils to be readily removed or replaced, and that the reinsertion of the plug or laminated piece W restores the closure of the magnetic circuit through the axis of the coils.

While in the preceding figures I have shown the main core-pieces as square or rectangular in form, it is obvious that the form might be varied as indicated in Fig. 14. Here the core is made up of plates in the form of washers or rings, and the notch through which the coils are threaded has its magnetic circuit closed as before by the closely-fitting plug or stopper W, inserted after application of the coils and having its laminations arranged as before described.

Fig. 15 shows another configuration of the main body or core piece. The plug or bundle W is here shown as having sharply-tapering sides, so as to be of pronounced wedge shape. It can be inserted, as already described, between the properly-shaped opposing faces of the main core-pieces at the notch or gap.

It is well to have the taper of the plug small, so that it may remain firmly seated. In the case of a large taper it is well to provide a bracing or some other device for holding it in position.

Fig. 16 shows that the positions of the coils on the core may be modified, so that one coil is upon the main core-piece U U and the other is around the portion of core-piece consisting of the bundle of laminated pieces W. This, however, is a more difficult construction and is without any special advantage.

Fig. 17 shows that the pieces U U may be a true U-shaped or horseshoe piece, between whose limbs the block piece or bundle W of laminations is inserted after the manner of a plug or stopper.

I have in a former application, filed May 31, 1887, No. 227,445, described induction-coil apparatus in which the main core-pieces have been notched pieces very similar in outline to that shown; but in the present application it will be seen that but one such assemblage of pieces is used, and that the magnetic circuit-closing piece W has its laminations or the pieces of which it is made parallel in plane with the pieces in the main core U U. This permits making the sheet-iron pieces by punching and allows utilization of the portions cut out of the notch in making the magnetic circuit-closing piece W, thus giving a considerable saving of material. The construction also secures the placing of the magnetic limbs in as perfect a relation as possible magnetically, and produces a perfect closure of the magnetic circuit.

What I claim as my invention is—

1. In an electro-magnet having a closed magnetic circuit threading its coils, a laminated core-piece having a notch or gap for application of the coils closed by a driven laminated plug or stopper whose laminations are parallel to and in magnetic connection with those of the body of the core and form a butt-joint with the same, as and for the purpose described.

2. A horseshoe electro-magnet having coils placed upon the legs of the horseshoe and a core-piece for said magnet made up of a bundle or pile of plates of general U form, in combination with a laminated plug or stopper driven or forced into the gap between the legs of the horseshoe, with its laminations parallel to and in direct magnetic contact with those of the core to form a closure of the magnetic circuit threading the coils, as and for the purpose described.

3. The combination, with the laminated magnet-core having a gap or notch, of a closing-piece for the magnetic circuit consisting of a tapered laminated plug or stopper forced or driven tightly into the gap or notch, with its laminæ parallel to and forming magnetic contact with the ends of the laminæ for the core by butt-joints.

4. In an induction or self-inductive coil, a magnetic circuit threading the coil or coils and composed of a number of discontinuous plates or laminæ of iron piled up together and insulated flatwise, in combination with a magnetic circuit-closing plug or block composed of iron laminæ of a width adapted to fit tightly into the gap in the continuity of the first-named plates and driven or forced tightly into place in the socket formed by the gap, the laminations of both sets of plates being in substantially the same plane.

5. An induction or self-inductive coil constructed of a laminated core in U shape, coils slipped over the limbs of the laminated core, and a magnetic circuit-closing plug or stopper driven or forced into the socket formed by the notch or opening between the legs of the core, as and for the purpose described.

6. An electro-magnet having an endless core formed in two parts, one of which is the greater portion of said core, while the other consists of a plug or stopper driven into place in an opening or gap between the ends of the larger piece, said plug and gap being accurately fitted to one another, so that the plug when driven in place will be tightly held, and will form a complete closure of the endless magnetic circuit for the core.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 10th day of October, A. D. 1888.

ELIHU THOMSON.

Witnesses:

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