

July 21, 1931.

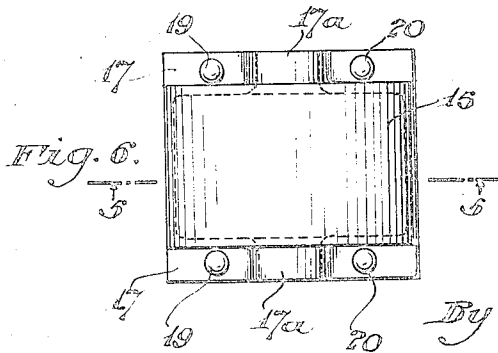
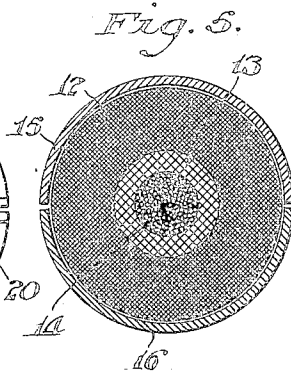
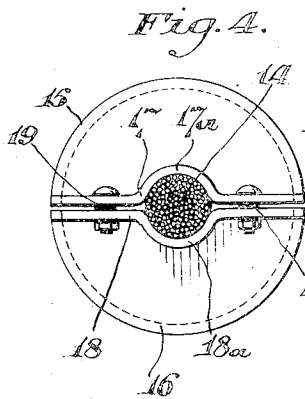
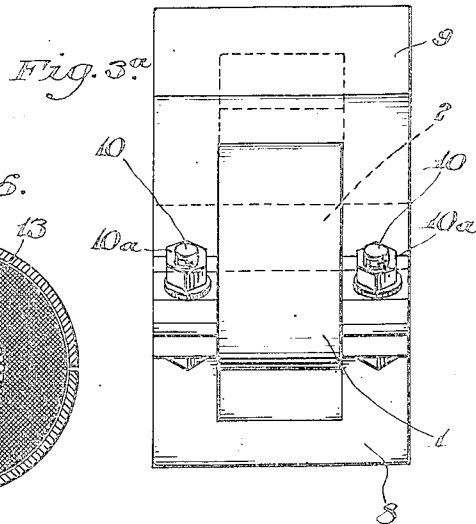
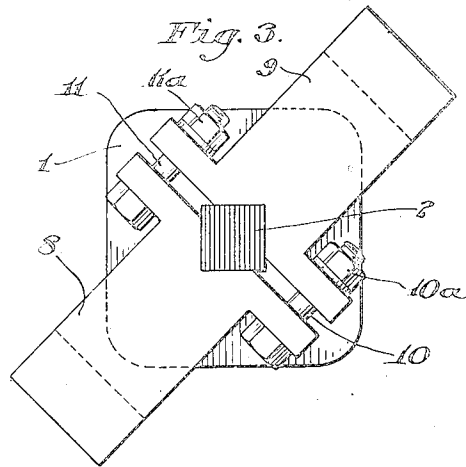
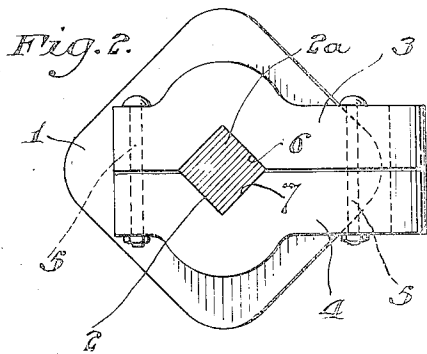
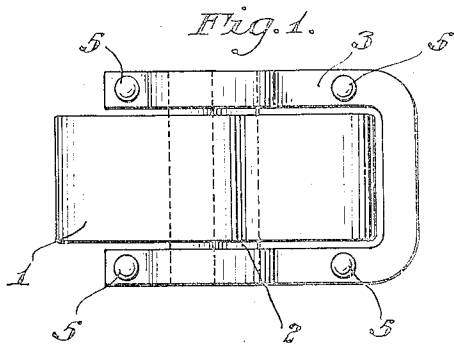
H. F. PORTER ET AL

1,815,380

MAGNETIC DEVICE

Filed Dec. 21, 1928

2 Sheets-Sheet 1



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July 21, 1931.

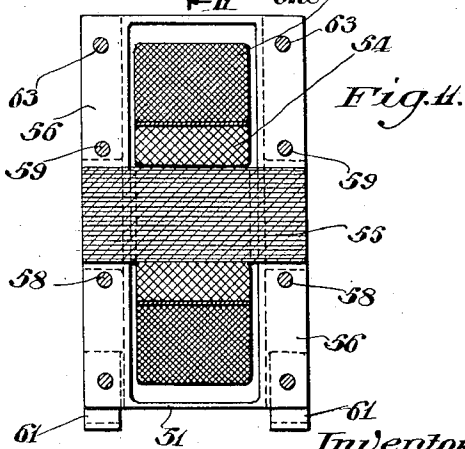
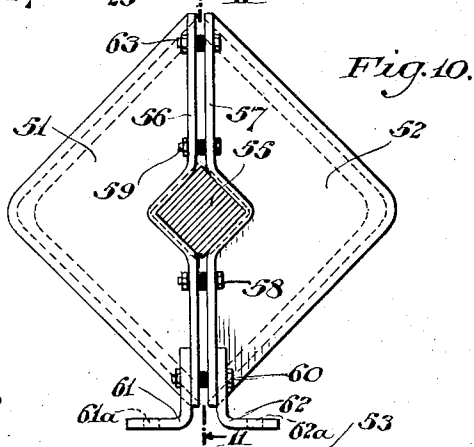
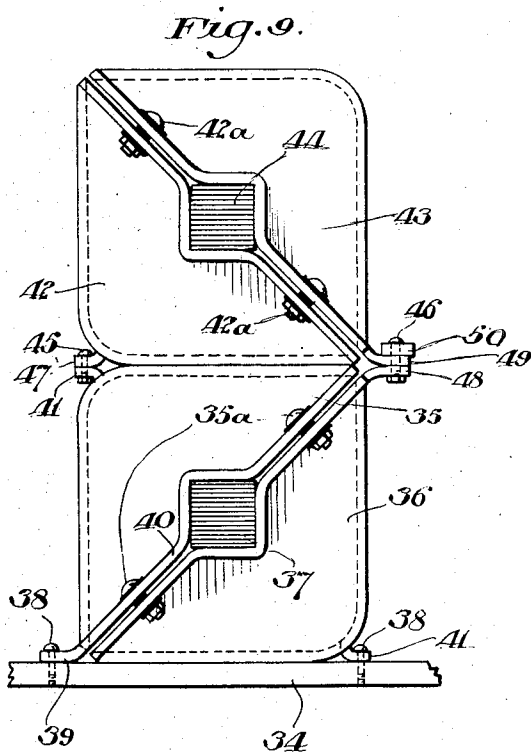
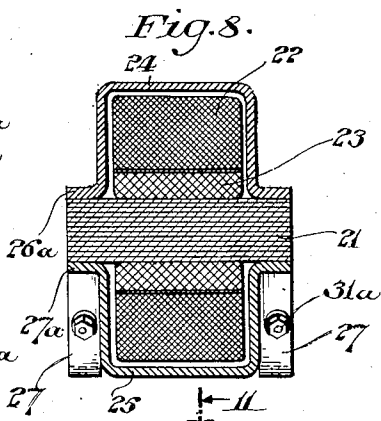
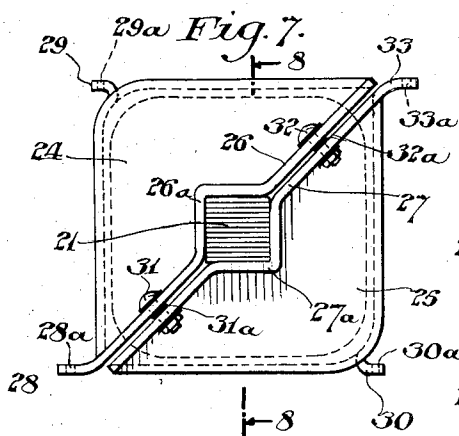
H. F. PORTER ET AL

1,815,380

MAGNETIC DEVICE

Filed Dec. 21, 1928

2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

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MAGNETIC DEVICE

Application filed December 21, 1928. Serial No. 327,565.

Our invention relates to magnetic devices, and more particularly to the core structures of transformers, inductances, choke coils, electro-magnets and the like.

5 In accordance with our invention, a winding or windings of a transformer, inductance, choke coil, electro-magnet or the like, is provided with a magnetic circuit a part of which, preferably a core element, in the form of a casting or solid, or suitably, and preferably subdivided, as into laminæ, wires, or the like, is of a material having good magnetic characteristics, and more particularly high initial permeability; and more particularly the laminæ, wires or the like are held in position by members of magnetizable material, preferably cheaper and of different permeability characteristics, completing with said part or core a magnetic circuit for flux produced by or influencing the winding or windings.

Further in accordance with our invention, the members of magnetizable material related to or holding the core and preferably clamping its laminæ, wires, or the like, in position are preferably of solid cross section and of material having poorer magnetic characteristics than those of said core.

Further, and more particularly in accordance with our invention, the core laminæ are composed of an alloy of iron or steel, copper and nickel, and the magnetizable members co-acting with the same comprise either iron or steel castings, forgings or sheet metal, said members also comprising clamping structure for forcing said laminæ together and into suitably low reluctance relation with said clamping members; more particularly, said members comprise shell-like structure enclosing the winding or windings and core, and have secured thereto elements for mounting one or more units with respect to each other and/or supporting structure.

Our invention further resides in apparatus of the character hereinafter described and claimed.

For an illustration of some of the forms our invention may take, reference is had to the accompanying drawings, in which:

Fig. 1 is a plan view of transformer structure.

Fig. 2 is an elevational view of the structure shown in Fig. 1.

Fig. 3 is a side or elevational view of a modified form of our invention.

Fig. 3a is an end elevational view of the structure shown in Fig. 3.

Fig. 4 is an end view of another modified form of our invention.

Fig. 5 is a cross-sectional view taken along the line 5—5 of Fig. 6.

Fig. 6 is a top or plan view of the structure shown in Fig. 4.

Fig. 7 is an end elevational view of another modified form of our invention.

Fig. 8 is a cross-sectional view taken along the line 8—8 of Fig. 7.

Fig. 9 is an elevational view of a plurality of structures secured to each other and mounted upon common supporting means.

Fig. 10 is an end view of another modified form of our invention.

Fig. 11 is a section taken along the line 11—11 of Fig. 10.

Referring to Fig. 1, the winding 1, generically representing the winding or windings of a transformer, choke coil, inductance, electro-magnet or the like, has core structure 2 extending centrally therethrough. As viewed in Fig. 2, core 2 comprises laminæ 2a of magnetizable material, and more particularly of material having relatively good magnetic characteristics. Laminæ 2a comprise strips extending through the central portion of coil 1, and appreciably beyond the same at both ends. The laminæ or strips are stacked in a group as illustrated, and are preferably composed of "A" metal, the trade-name for a commercial magnetic alloy of copper, nickel and iron, or equivalent, having relatively good magnetic characteristics, and in particular high initial permeability. The "A" alloy is fully described and claimed in a co-pending application Ser. No. 162, 245, filed January 20, 1927 by Harry F. Porter.

The ends of the core structure extending beyond coil 1 are engaged on opposite sides thereof by clamping members 3 and 4, each clamping member comprising a yoke-like

structure, and secured to the other clamping member, as by bolts 5. Members 3 and 4 have seats or notches 6 and 7 respectively for receiving the end portions of core 2. As illustrated in Fig. 2, when bolts 5 are adjusted to clamp members 3 and 4 together so as to grip the ends of the core, there will be exerted forces upon the core in direction diagonal thereto, and at an angle to the planes or faces of the individual laminæ. In other words, a camming or wedging action is exerted against the edges of the laminæ, which in practice are generally free of insulating material, thereby maintaining good magnetic contact, i. e., a union having low reluctance, between the core and clamping structures. We have found that the clamping structure above referred to not only efficiently maintains the laminæ of the core in position as a unit, but affords an efficient magnetic contact between the core and the other elements of the magnetic circuit comprising yoke members 3 and 4.

Members 3 and 4 are of magnetizable material, and together with core 2 complete a magnetic circuit for flux produced by the transformer winding 1. In order that the size and weight of the transformer unit may be reduced to a minimum, and its performance compare with units of greater weight and bulk, the core 2 is reduced to minimum size and weight by the use of superior magnetic material above referred to, thereby permitting yoke members 3 and 4 to be of relatively base magnetic material, such as steel castings, forgings or sheet metal forms, for example. It is further apparent that this construction permits easy and rapid assembly, and as well reduces the cost of manufacture.

Referring to Fig. 3, there is shown structure similar to that above described, except that a pair of yoke members 8 and 9 of baser magnetic material are clamped, as by bolts 10 and 11, to the core structure 2 thereby completely encircling the winding 1 and forming two magnetic circuits in parallel, core 2 being common to each of the circuits. As in the previous instance, forces diagonal to core 2 are exerted thereon when yoke members 8 and 9 are urged toward each other by adjustment of the nuts 10a and 11a upon the clamping bolts 10 and 11.

Referring to Figs. 4, 5 and 6, the winding, comprising primary and secondary transformer coils 12 and 13, is substantially enclosed, as is the core 14, by a pair of cup-like members 15 and 16 of baser magnetic material. Core 14 is preferably of magnetizable material of the character of "A" metal or equivalent above described, and comprises a bundle of small wires or rods placed longitudinally with respect to each other, and extending beyond the opposite ends of the transformer winding. Members 15 and 16 are of suitable baser magnetizable material and may comprise castings, forgings, etc., as

aforesaid. Preferably, however, the magnetizable material is pressed into the shape desired, which in the present instances is semi-cylindrical. Members 15 and 16 are spaced from each other and comprise flanges 17 and 18 respectively, extending transversely with respect to the ends thereof, and adapted to receive core 14 within recessed portions 17a and 18a. Clamping means, as bolts 19 and 20 engage flanges 17 and 18 to clamp the same together for relatively positioning members 15 and 16 and core 14. In order to further reduce eddy current losses, bolts 19 and 20 may be mounted within insulating bushings, thereby electrically separating members 15 and 16 except where in contact with the core. Due to the fact that the winding is substantially enclosed by a housing of magnetizable material, it will not be influenced by fields of nearby apparatus, and, conversely, there will be no substantial leakage flux outside of the unit, and the same may be positioned adjacent apparatus which is sensitive to stray magnetic fields without affecting the same. It will be apparent that core 14 may comprise laminated structure as described above instead of the bundle of fine wires or rods. In this event flanges 17 and 18 will be properly shaped so as to clamp the core in the manner illustrated in Figs. 2 and 3.

Figs. 7 and 8 illustrate structure similar to that described with reference to Figs. 4 to 6 inclusive. As in the previous instances, the core 21 comprises laminated structure and extends centrally through and beyond the winding, in this case comprising transformer coils 22 and 23. The winding and core 21, of "A" metal or equivalent, are substantially enclosed by a pair of co-acting shell-like, or cup-like members 24 and 25 of baser magnetizable material. Members 24 and 25 are similar in construction to each other, and comprise flanges 26 and 27 extending transversely from the end surfaces thereof. Flange 26 of member 24, for example, has a V portion 26a for receiving a part of core 21, and an extension or lug 28 extending beyond the outer edge of member 24. Lug 28 has an aperture 28a therein for a purpose hereinafter described. Lugs 29 and 30 disposed diagonally with respect to each other, are formed by struck-out portions of members 24 and 25 respectively. There are apertures 29a and 30a respectively in the lugs for a purpose hereinafter described. The magnetizable enclosing members 24 and 25 are maintained in relative position with respect to each other and core 21, and serve to clamp the laminæ of core 21 together by means of bolts 31 and 32 extending through the engaging flanges 26 and 27. Insulating bushings 31a and 32a electrically insulate members 24 and 25 from each other. Flange 27

has a lug 33 extending therefrom through which extends an aperture 33a.

Referring to Fig. 9, there are shown transformer or other units similar to that illustrated in Fig. 7 mounted with respect to each other and to a supporting base 34. The lower unit, comprising the magnetizable sections 35, 36 and core 37, of "A" metal or equivalent, clamped with respect to each other by the electrically insulated bolts 35a, is secured to base 34 by bolts 38 extending through lug 39 which is an extension of flange 40, and lug 41 which is a struck-out portion of member 36, as previously described. A second unit, comprising enclosing magnetizable members 42, 43 and a core 44, of "A" metal or equivalent, clamped with respect to each other by the electrically insulated bolts 42a, is mounted on top of the first unit by means of bolts 45 and 46 extending through corresponding lugs mounted on the adjacent structures. Bolt 45, for example, engages and holds together lugs 41 and 47, comprising the struck-out portions of members 35 and 42 respectively, and bolt 46 serves, in addition to clamping together the lugs 48 and 49 of members 36 and 43 respectively, to clamp a terminal board or panel 50 with respect to the said lugs. Terminal board 50 may have any suitable number of terminal posts mounted thereon for receiving conductors (not shown) leading from the transformer or other windings of the two units, and for connecting thereto conductors leading to other apparatus.

Fig. 10 shows transformer or other structure of the general character above described, wherein a pair of coating shell-like magnetizable members 51 and 52 enclose a winding comprising in this case transformer coils 53 and 54 (Fig. 11), and a laminated core 55 of "A" metal or equivalent. As in the previous constructions, flanges 56 and 57 extending transversely beyond the end sides of the shell-like members have angular or recessed portions for receiving and clamping together the laminæ of core 55. Flanges 56 and 57 are clamped together by bolts 58 and 59, electrically insulated from members 51 and 52, for exerting the required compressive force upon core 55. Secured to the lower ends of flanges 56 and 57 by means of a magnetically insulated bolt 60, are angle members or lugs 61 and 62 having apertures 61a and 62a respectively, extending there-through. By means of this construction, the unit shown in Fig. 10 may be mounted upright upon a supporting base by screws or bolts extending through apertures 61a and 62a into such supporting means. Bolts 60 and 63, which are each magnetically insulated from the magnetic structure by suitable bushings, at the outer ends of the flanges serve also to maintain members 51 and 52 in proper position with respect to each other.

It shall be understood that a reasonable degree of departure may be made from the above described constructions without departing from the spirit of our invention, and by way of example the material of the magnetic circuit external to the core may be of any suitable magnetizable material, and may be formed or shaped, although it is preferably pressed, in any practical manner. Further, by way of example, the core and cooperating structure may be of the same magnetic material, whether it be superior or noble, or comparatively base. It shall be further understood that the material comprising the laminæ of the core structure may also be of any superior or noble magnetic material, although we have found that "A" metal gives very satisfactory results.

While for purposes of subdivision there have been hereinbefore referred to laminæ and wires, for the core structure or element of nobler magnetic characteristics, especially as concerns high initial permeability, it shall be understood that other forms of subdivision may be resorted to, such as small pieces, fillings, granules, etc., suitably retained in a casing or tube of suitable material, and not effecting a short or closed circuited secondary of low resistance, held or clamped as are the various core elements hereinbefore described. It shall further be understood that castings or solid pieces of "A" metal, or equivalent noble magnetic material, may be utilized as and when suitable in lieu of the subdivided cores hereinbefore described.

While for the purposes of description of a preferred use we have hereinbefore more particularly referred to a transformer structure comprising primary and secondary windings, it shall be understood that our invention is equally applicable to inductances, choke coils, electro-magnets and the like, having one or more windings, and, more particularly, our structure herein described is suitable for the magnetic circuit of a choke coil or smoothing reactor generally of the character and for the purposes described in Porter co-pending application Serial No. 309,086, filed September 28, 1928.

In the operation of transformers, as well as in chokes or smoothing reactors, where such electro-magnetic structure is to be used in connection with comparatively low alternating flux densities, it is essential that the magnetic circuit have what is known as high initial permeability. In other words, for a constant density of direct current flux in the magnetic circuit, the initial or alternating current permeability should be higher than that of the ordinary ferrous materials.

By reason of the higher initial permeability, the flux density within the magnetic circuit of the transformer, for example, is accordingly higher when the transformer

winding is traversed by comparatively weak alternating currents, than in the case where the magnetic circuit is of material having poorer magnetic characteristics. It follows, therefore, particularly with respect to transformers, that the range of magnitude of fluctuating or alternating currents to be reproduced in the secondary circuit of the transformer is appreciably increased, particularly with respect to the lower magnitudes, where the initial permeability of the magnetic circuit of the transformer is comparatively high. The transformer accordingly operates at higher efficiency, since weak sound-representing currents are reproduced, which ordinarily would be absent.

By a combination of high grade or noble with low grade or base magnetic material as hereinbefore described, there are retained the advantages and operating characteristics of the high grade or noble magnetic material to an extent for most practical purposes approximately that obtainable by use of the high grade or noble magnetic material throughout.

In structures of the character hereinbefore described the reluctance of that portion of the magnetic circuit constituted of the low grade or baser magnetic material is or may be of any suitable magnitude with respect to the reluctance of that part of the magnetic circuit formed by the high grade or noble magnetic material; in general the reluctance of that portion of the circuit formed by the low grade or baser magnetic material is lower than the reluctance of that part of the magnetic circuit formed by the higher grade or noble magnetic material.

What we claim is:

1. A magnetic device comprising coil structure, a core within said coil structure comprising laminations of noble magnetic material, and field structure of solid cross-section disposed exteriorly of said coil structure to form a path for the flux traversing said laminated core and whose reluctance is less than the reluctance of said core.

2. A magnetic device comprising coil structure, a core disposed within said coil structure comprising laminations of noble magnetic material, and field structure of solid cross-section and of baser magnetic material disposed exteriorly of said coil structure and traversing by substantially all of the flux traversing said core.

3. A magnetic device comprising coil structure, a core within said coil structure comprising laminations of noble magnetic material, and field structure of solid cross-section and of baser magnetic material disposed exteriorly of said coil structure to form a path for the flux traversing said laminated core and whose reluctance is less than that of said core.

4. A magnetic device comprising coil struc-

ture, a core disposed within said coil structure consisting of a stack of laminations, solid field pieces having adjacent ends angularly recessed to receive an end of said stack and traversed by substantially all of the flux traversing said core, and means clamping said field pieces to exert pressure on said stack diagonally thereof to insure low reluctance connection of said core laminations and said solid field pieces.

5. A magnetic device comprising coil structure, a core disposed within said coil structure and projecting therefrom consisting of a stack of laminations, a pair of cup-shaped field members substantially completely surrounding said coil structure having adjacent ends angularly recessed to receive the ends of said stack and traversed by substantially all of the flux traversing said core, and means clamping said cup-shaped field members to exert pressure of said stack diagonally thereof to effect low reluctance connection of said core to said field members.

6. A magnetic device comprising coil structure, a core disposed within said coil structure consisting of a stack of laminations, a pair of cup-shaped solid field members substantially completely surrounding said coil structure having parallel flanges provided with angular depressions to receive the ends of said stack and traversed by substantially all of the flux traversing said core, and means to clamp said stack between said depressions with separation between the parallel portions of said flanges.

7. A magnetic device having a winding traversed by current whose direct current component is large relative to the alternating current component, a core within said winding comprising laminations of noble magnetic material having high initial permeability, and field structure of solid cross-section disposed exteriorly of said winding and forming a closed magnetic circuit with said laminated core, said field structure traversed by substantially all of the flux traversing said core and having lower reluctance than said core.

8. A magnetic device having a winding traversed by current whose direct current component is large relative to the alternating current component, a core within said winding comprising laminations of noble magnetic material having high initial permeability, and field structure of baser magnetic material and of solid cross-section disposed exteriorly of said winding and forming a closed magnetic circuit with said laminated core, said field structure traversed by substantially all of the flux traversing said core and having lower reluctance than said core.

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