

May 22, 1962

B. KUMM
ELECTROMAGNET

3,036,247

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2 Sheets-Sheet 1

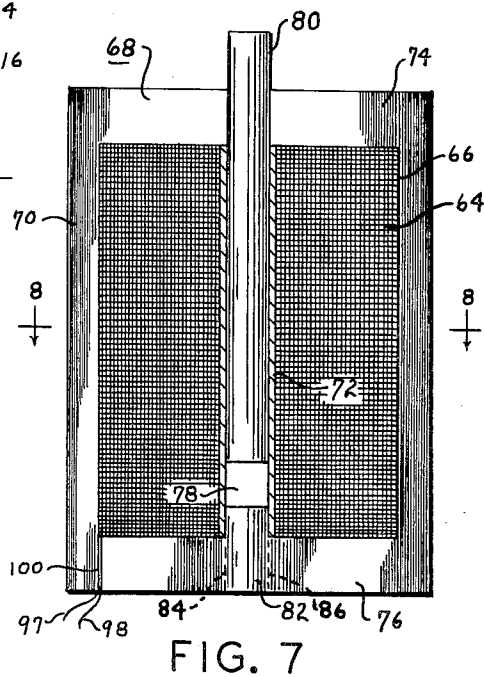
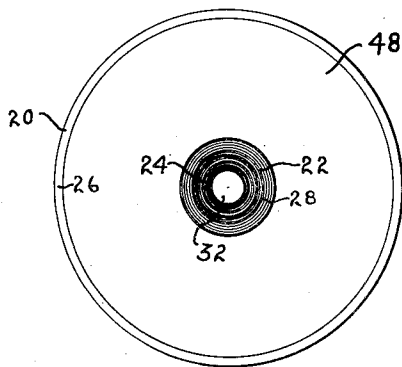
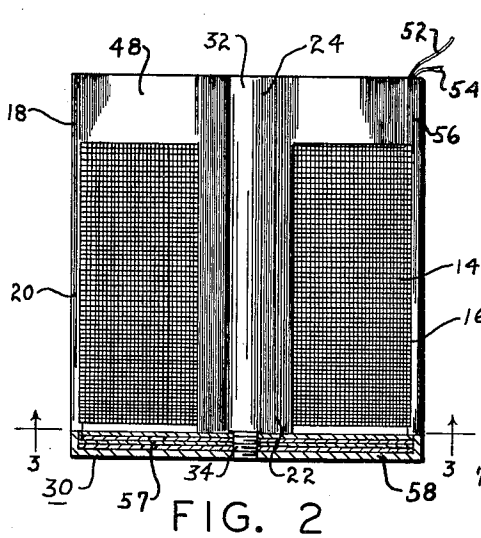
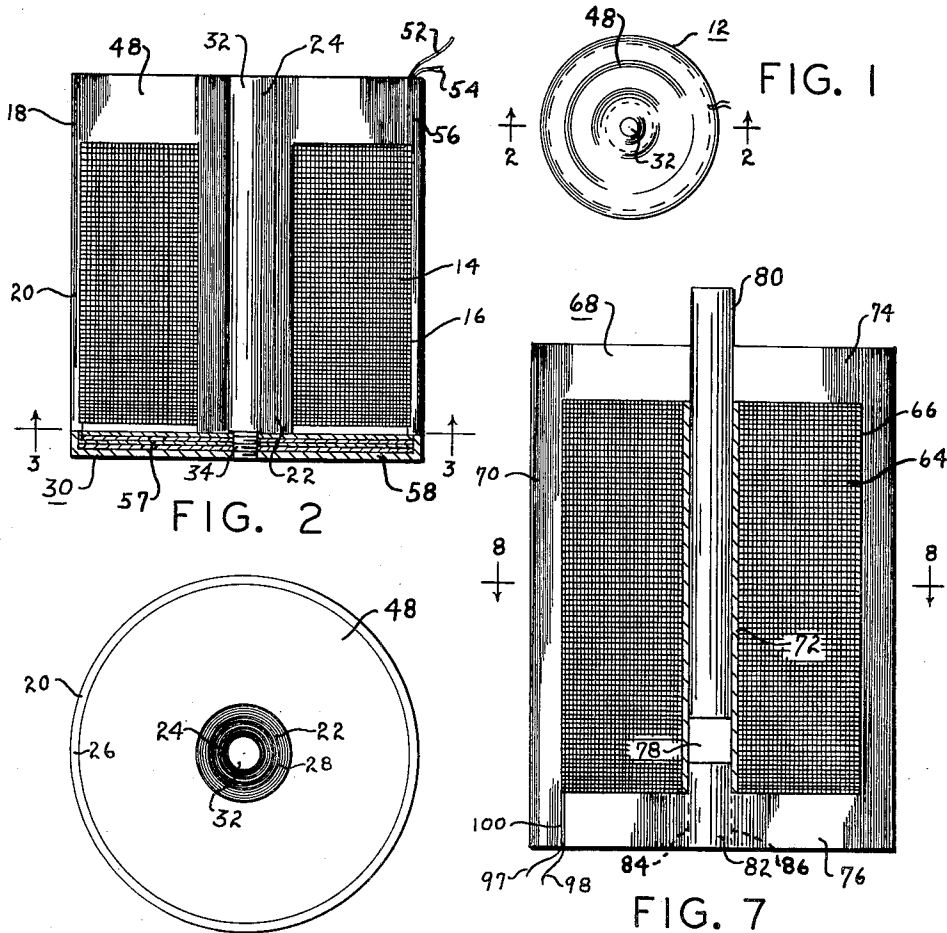


FIG. 3

FIG. 7

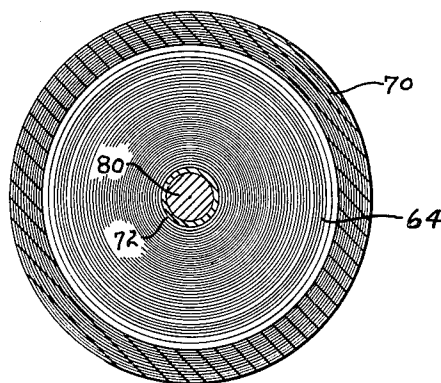


FIG. 8

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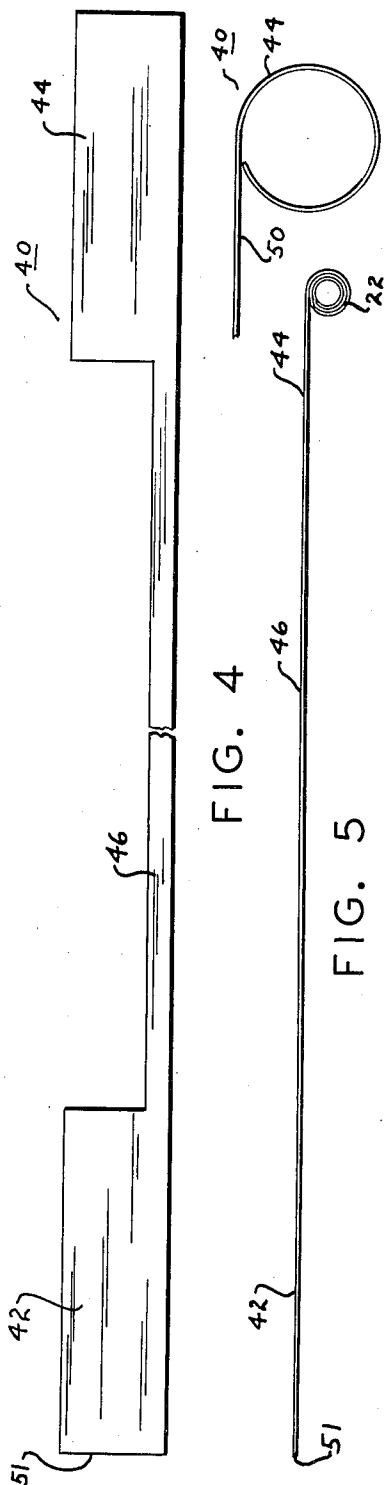


FIG. 6

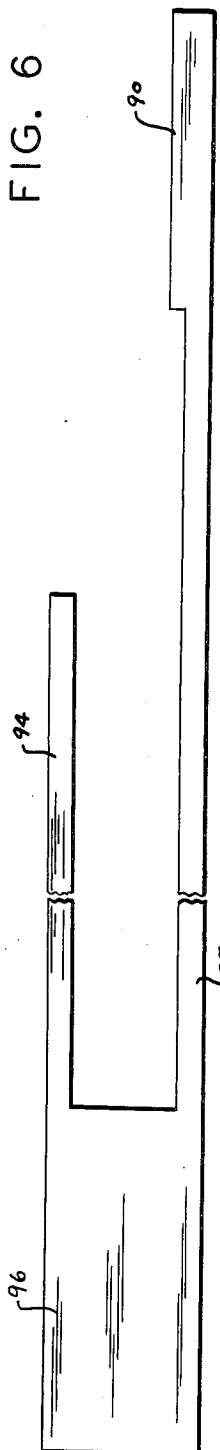
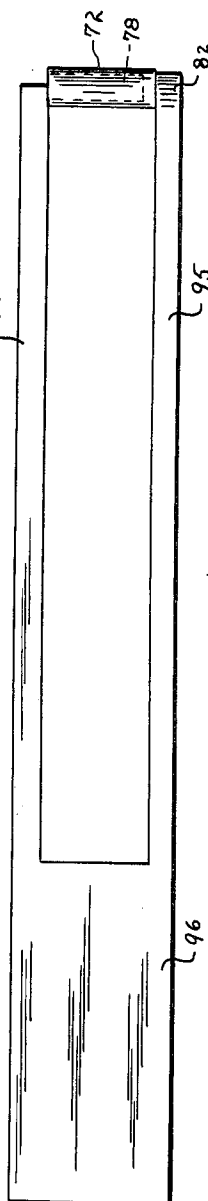


FIG. 10



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The present invention relates to electromagnets, and more particularly to an electromagnet having a special type laminated core construction, and to a method of fabricating the electromagnet.

The principal object of the invention is to provide an electromagnet which is so constructed and designed that it will operate over long periods of time and under adverse operating conditions with a relatively low rise in temperature and loss in operating efficiency.

Another object of the invention is to provide an electromagnet and a laminated core therefor which substantially reduce the eddy current and hysteresis losses.

Additional objects and advantages of the present invention will become apparent from the following description and accompanying drawings, wherein:

FIGURE 1 is a top plan view of a portative electromagnet embodying the present invention;

FIGURE 2 is an enlarged longitudinal cross sectional view of the electromagnet shown in FIGURE 1, taken on line 2-2 of the latter figure;

FIGURE 3 is a transverse cross sectional view of the present electromagnet taken on line 3-3 of FIGURE 2;

FIGURE 4 is a plan view of a strip of metal illustrating one step in the method of constructing the present electromagnet;

FIGURE 5 is a plan view of the same strip of metal seen in FIGURE 4 illustrating an intermediate step in the method of constructing the electromagnet;

FIGURE 6 is an enlarged fragmentary elevational view of the strip of metal of FIGURES 4 and 5, showing the details of the strip structure;

FIGURE 7 is a longitudinal cross sectional view similar to FIGURE 2 of a modified form of my electromagnet;

FIGURE 8 is a transverse cross sectional view of the electromagnet shown in FIGURE 7, taken on line 8-8 of the latter figure;

FIGURE 9 is a plan view of a strip of metal illustrating one step in the method of constructing the modified form of my electromagnet shown in FIGURE 7; and

FIGURE 10 is a plan view of the same strip of metal seen in FIGURE 9 illustrating an intermediate step in the method of constructing the electromagnet shown in FIGURE 7.

Referring more specifically to the drawings, FIGURES 1, 2 and 3 show a flat-faced armature magnet generally designated by numeral 12 and consisting of a coil 14 seated in an annular recess 16 of a cylindrical shaped core 18 having an outer pole 20 and an inner pole 22 with a central hole 24 extending longitudinally therethrough. The area of face 26 of the outer pole and the area of face 28 are equal and are on a common plane. An armature 30 is reciprocally supported at the end of the coil by a brass shaft 32 journaled in central hole 24, the armature being secured to the shaft by a threaded section on the reduced diameter portion 34 at the end of the shaft. The inner surface of the armature is flat and contacts the adjacent ends of the outer and inner poles 20 and 22 when the armature is attracted by the coil. The particular size and shape of the electromagnet shown in FIGURE 1 are not important to the invention and may be varied to satisfy requirements.

The present invention is primarily concerned with a

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laminated core construction consisting of a spirally wound coil of sheet steel 40 preferably within the range of thickness of .0001 to .0015 of an inch, initially cut or otherwise shaped to form the cylindrical space or recess for coil 14. The manner in which the coil is fabricated is illustrated in FIGURES 4, 5 and 6, electrical grade sheet steel being first cut to the required length and width to form a coil of the desired diameter and length, taking into consideration the size of central hole 24 in the final core.

In FIGURE 4 the strip 40 is cut to provide portion 42 for outer pole 20, portion 44 for inner pole 22 and connecting portion 46 for the end 48 of the core between the two poles. Since the cross sectional areas of the two poles are preferably the same, portions 42 and 44 of the strip are usually the same length. The sheet of steel is coated with an electrical insulating material 50, such as silicone, Teflon or the like, on one or both of the flat surfaces, either before or after the sheet is cut into the configuration shown in FIGURE 4. The sheet steel with the insulating coating is then wound tightly into the final core shape as seen in FIGURE 2 and the free end 51 of the outer pole portion is secured firmly in contact with the surface of the adjacent convolution by any suitable means and the end may then be ground so that it tapers smoothly into the general circular configuration of the core.

While it is preferable to form the core from a single piece of sheet steel in the manner just described, fabrication expedencies may require the core to be constructed of two or more parts, one part consisting of portion 44 for the inner pole which is wound into its final cylindrical shape, another part consisting of portion 46 for the intermediate end 48 which is wound onto the formed inner pole, and another part consisting of portion 42 for the outer pole which is wound around end 48. As an alternative, portions 42, 44 and 46 may be fully wound separately and then assembled by slipping end 48 in place on pole 22 and pole 20 in place on end 48. Any combination of these fabrication procedures may be used if desired.

In the embodiment of the present invention illustrated in FIGURES 2 through 6, coil 14 is wound of suitable insulated copper wire of approximately the size and shape of recess 16 with electrical leads 52 and 54 and is then inserted in the recess, first threading the two leads through a drilled hole 56 in end 48. The coil is sealed and secured firmly in place by pouring an insulating potting compound over and through the coil after it has been assembled in position in the recess. The armature 30 consisting either of a solid piece of soft steel or a plurality of discs 57 of electrical grade steel seated in a cup-shaped member 58 as shown, is mounted in place at the lower end, as seen in FIGURE 2, of the core and coil and is adapted to move toward and away from said end as the coil is energized and deenergized by an electrical current supplied through leads 52 and 54. The present electromagnet is adapted for either D.-C. or A.-C. circuits and can be satisfactorily used for a large number of diversified uses.

The modified form of the present invention illustrated in FIGURES 7 and 8, is similar in basic construction to the embodiment previously described herein; however, the construction has been changed to adapt it to the plunger type solenoid. This latter unit consists of a coil 64, disposed in a cavity 66 in a core 68, having an outer pole 70, a brass sleeve 72 and ends 74 and 76, the sleeve being provided with an axial hole 78 for receiving a reciprocating plunger 80. The plunger may be either a solid steel shaft or a laminated shaft of coiled sheet steel. A stop 82 is provided in the lower end of hole 78 and may be formed integrally with end 76 or as a separate insert identified by broken lines 84 and 86. The core is fabricated in much the same manner as core 18, i.e. the parts forming the pole, stop and end are first cut from a

sheet of steel, coated either before or after cutting with an insulating material, and the cut sheet rolled into the laminated core structure shown in FIGURES 7 and 8. If stop 82 is constructed as an integral part of the core, the sheet will appear in the form shown in FIGURE 9, consisting of a portion 90 for the stop, portions 94 and 95 for the ends, and portion 96 for the outer pole. If the stop is formed as a separate member the sheet will be the same as shown in FIGURE 9 without portion 90. If the present core is formed in one piece, the stop normally will be fully formed and the sleeve with the coil of wire wound thereon assembled in the position shown in FIGURE 10 and the coiling of portions 94, 95 and 96 completed to form the ends and outer pole. To facilitate the fabrication of this type of solenoid, the core may be formed in two or more pieces, as for example, forming the stop in one piece, and then winding the ends and outer pole around the stop, sleeve and coil, either as one piece, or two or three separate pieces. Lead wires 97 and 98 for the coil are shown extending through a bore 100 in end 76.

The same advantages of the present laminated core are found in both embodiments, consisting primarily in a reduction in power losses and operating temperatures from eddy currents and hysteresis in A.-C. circuits. As a result of the lower operating temperatures as compared with conventional solenoids of comparable size, the overall efficiency over long periods of time is substantially superior to conventional units, particularly where the solenoid is operating at 400 cycles and above.

While only two embodiments of my electromagnet are described in detail herein, various changes and modifications may be made without departing from the scope of the present invention.

I claim:

1. An electromagnet, comprising a core having an inner pole of coiled electrically insulated sheet steel with a central hole therethrough, an outer pole of coiled electrically insulated sheet steel spaced from and concentrically arranged with said inner pole, and having the same cross sectional area as said inner pole, said poles being coextensive, an end member of coiled electrically insulated sheet steel of substantially shorter length than said poles joined integrally to corresponding ends of said poles thereby providing a recess in said core between said poles, a coil of electrical conducting wire around said inner pole and in said recess, leads extending through said end member for connecting said coil with a source of electrical power, a shaft of non-magnetic material extending through said hole, and a disc-shaped member composed of a plurality of discs mounted on said shaft at the end of said core opposite said end member.

2. An electromagnet, comprising a core having an inner pole of coiled electrically insulated sheet steel, an outer pole of coiled electrically insulated sheet steel spaced from and concentrically arranged with said inner pole and having the same cross sectional area as said inner pole, said poles being coextensive, an end member of coiled electrically insulated sheet steel of substantially shorter length than said poles joined integrally to corresponding ends of said poles thereby providing a recess in said core between said poles, a coil of electrical conducting wire around said inner pole and in said

recess, leads extending through said end member for connecting said coil with a source of electrical power, and a magnetically attractable member reciprocally mounted at the end of said core opposite said end member.

3. An electromagnet, comprising a core having an inner pole of coiled electrically insulated steel, an outer pole of coiled electrically insulated sheet steel spaced from and concentrically arranged with said inner pole, said poles being coextensive and of substantially the same cross sectional area, an end member of coiled electrically insulated sheet steel of substantially shorter length than said poles joined integrally to corresponding ends of said poles thereby forming a chamber between said poles, a coil of electrical conducting wire around said inner pole in said chamber, and means movable on energization of said coil.

4. An electromagnet, comprising a core having an inner pole of coiled sheet steel of .0001 to .0015 inch in thickness and with a central hole therein, an outer pole of coiled sheet steel of the same thickness as said inner pole spaced from and concentrically arranged with said inner pole, said poles having the same cross sectional area and being co-extensive, an end member of coiled sheet steel of the same thickness as and of substantially shorter length than said poles, said coiled end member being joined integrally to corresponding ends of each pole thereby providing a recess in said core between said poles, a layer of silicone insulating material between the convolutions of said poles and end member, a coil of electrical conducting wire around said inner pole within said recess, leads extending through said end member for connecting said coil with a source of electrical power, and a disc-shaped member of magnetically attractable material reciprocally mounted at the end of said core opposite said end member.

5. An electromagnet, comprising a core having an inner pole of coiled sheet steel of .0001 to .0015 inch in thickness and with a central hole therein, an outer pole of coiled sheet steel of the same thickness as said inner pole spaced from and concentrically arranged with said inner pole, said poles having the same cross sectional area and being co-extensive, an end member of coiled sheet steel of the same thickness as and of substantially shorter length than said poles disposed between said poles, a layer of insulating material between the convolutions of said poles and end member, a coil of electrical conducting wire around said inner pole, and a member of magnetically attractable material reciprocally mounted at the end of said core opposite said end member.

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