April 5, 1949. H. W. JENCKS 2,466,592

SOLENOID WITH PLUNGER

Filed March 15, 1946 2 Sheets-Sheet 1

FIG. 1

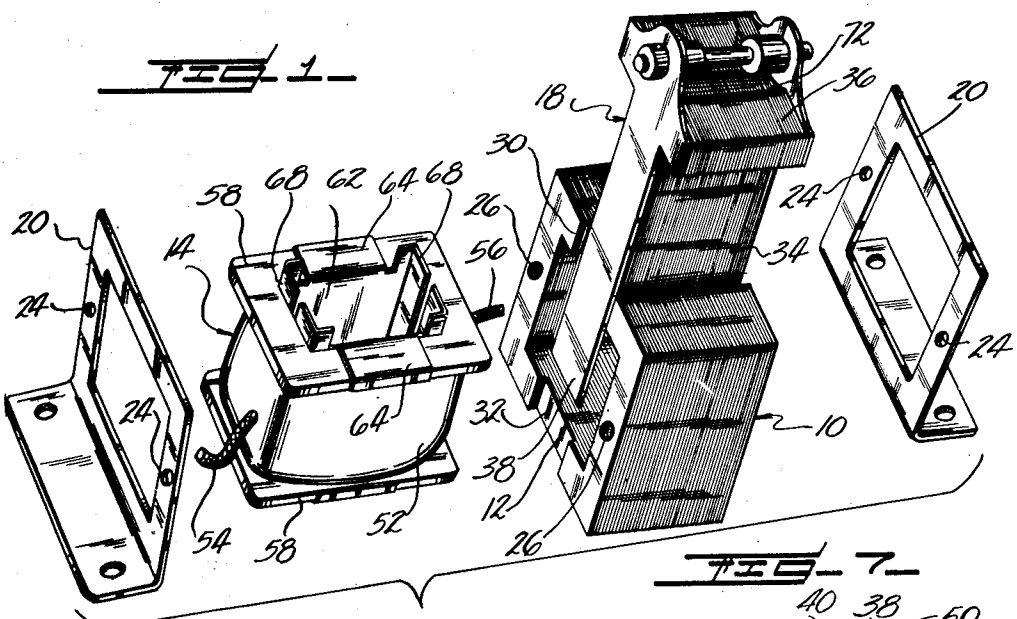


FIG. 2

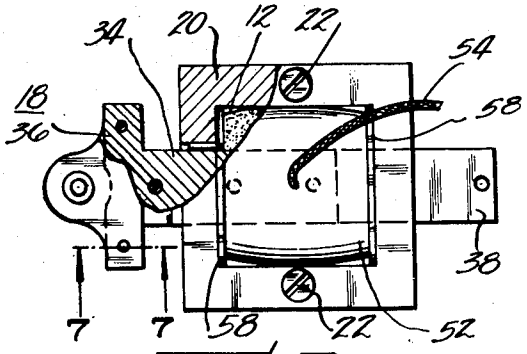


FIG. 3

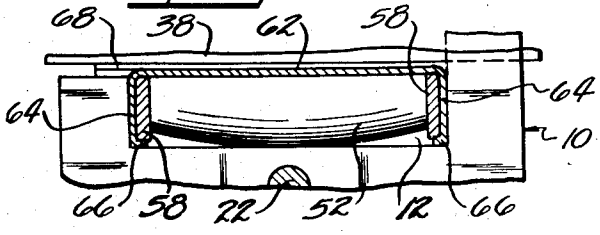


FIG. 7

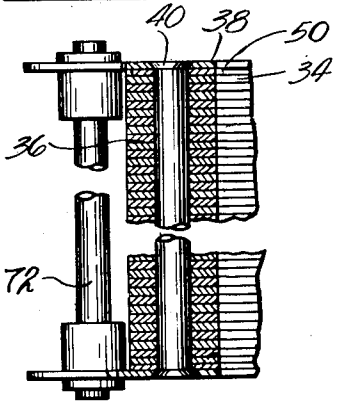
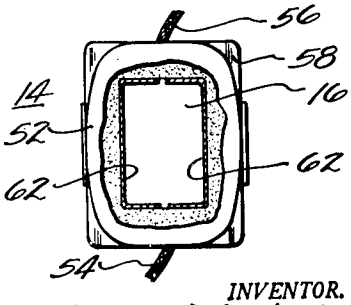


FIG. 8



INVENTOR.
HOLLIS W. JENCKS.
BY
Parker and Burton
ATTORNEYS.

April 5, 1949. H. W. JENCKS 2,466,592

SOLENOID WITH PLUNGER

Filed March 15, 1946 2 Sheets-Sheet 2

FIG. 3

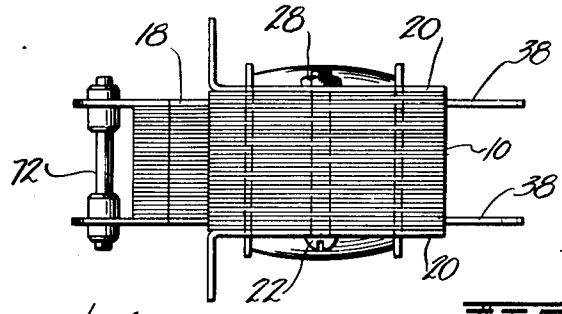
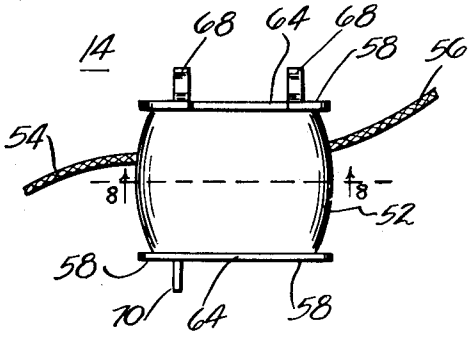


FIG. 4

FIG. 5



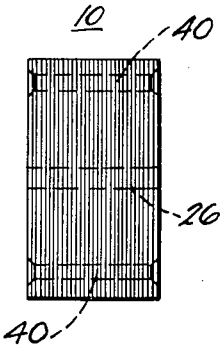
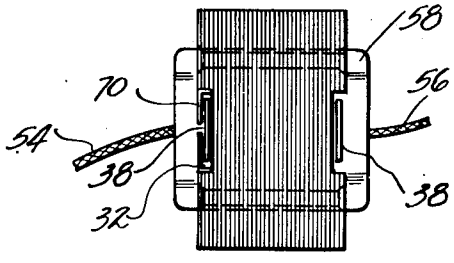
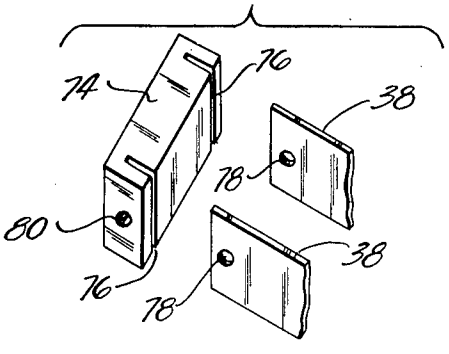


FIG. 6

FIG. 10





INVENTOR.
HOLLIS W. JENCKS

BY

Parker and Burton
ATTORNEYS.

Patented Apr. 5, 1949

2,466,592

UNITED STATES PATENT OFFICE

2,466,592

SOLENOID WITH PLUNGER

Hollis W. Jencks, Detroit, Mich., assignor to Carlos C. Cleverdon, doing business as Detroit Coil Company, Detroit, Mich.

Application March 15, 1946, Serial No. 654,562

12 Claims. (Cl. 175—341)

1

This invention relates to solenoid devices and particularly to plunger type electro-magnets suitable for use with either alternating or direct current.

An important object of this invention is to provide an improved device of the above character constructed for long usage and which is mechanically and electrically efficient in operation. Another object of this invention is to provide an improved electro-magnet device adapted for quick assemblage and disassemblage and which consists of relatively few parts capable of manufacture at low cost. Another object of this invention is to provide a novel combination of a coil unit and a core structure so shaped with respect to another that the coil unit is adapted for rapid insertion into and removal from either side of the core structure, and when inserted is self-operable to center in the core structure in proper alignment for receiving the plunger. A further object of the invention is to provide an improved coil unit having a novel metallic lining forming a guide or race for the shank of the plunger and arranged to extend beyond the coil unit into co-operating engagement with the core structure.

More specifically, it is an important object of this invention to provide a coil unit with a novel metallic lining functioning as a race for the reciprocating plunger and provided with extensions beyond the opposite ends of the coil, certain portions of the extensions being shaped to form a sliding fit with the inner walls of the core structure to facilitate the insertion and removal of the coil and other portions of which are shaped to form extensions of the race in the core tructure for guiding the plunger therein. A novel provision is the arrangement whereby an extendible section of the race cooperates with the core structure to provide not only a guide for an advanced portion of the plunger but also serves to limit the insertion of the coil unit into the core structure with the passage therethrough in proper alignment for receiving the plunger.

Various other objects, advantages and meritorious features will become more fully apparent from the following specification, appended claims and accompanying drawings wherein:

Figure 1 is an exploded perspective view of the parts of the electromagnetic device constructed in accordance with this invention,

Figure 2 is a side elevation of the electromagnet in asssembled condition,

Figure 3 is a side elevation of the assembled electromagnet at ninety degrees to that illustrated in Figure 2,

2

Figure 4 is a side elevation of the coil unit,

Figure 5 is a side elevation of the core structure showing the same in position to receive the coil unit of Figure 4,

Figure 6 is an end view of the electromagnetic device in assembled condition,

Figure 7 is an enlarged fragmentary sectional view of the head portion of the plunger along line 7—7 of Figure 2,

Figure 8 is a cross-sectional view of the coil unit, along line 8—8 of Figure 4,

Figure 9 is an enlarged fragmentary longitudinal sectional view through the assembled structure,

Figure 10 is a detail perspective view showing the adaptation of the device for push-type operations.

In the embodiment of the invention illustrated in the drawings, the electromagnetic device or solenoid comprises essentially three separable parts and auxiliary securing members. One part is a magnetic frame comprising a laminated core structure generally indicated at 10 of substantially rectangular shape. Removably insertable into the opening of the core structure from either side is a separate energizing coil unit generally indicated at 14 having a central passage 16 therethrough, opening out through the opposite ends thereof. The third part of the device comprises a movable plunger generally indicated at 18 built up of a multiplicity of relatively thin laminations of magnetic material. The assembly is completed by any suitable form of securing means, such as the two correspondingly shaped side plates 20—20 of rectangular formation and two bolt members 22—22 which extend through the core structure to secure the plates on either side thereof.

As shown in Figure 1, the side plates 20—20 follow the general contour of the core frame. Each is provided with a pair of holes 24—24 which align with a pair of holes 26—26 in the core structure which extend entirely therethrough on opposite sides of the frame opening 12. In assembled condition, as shown in Figure 3, the bolts extend completely through the holes 24 and 26, and by means of nuts 28 threaded to their extremities, the side plates are held in place against the core structure.

The core structure is provided in one end thereof with a slot 30 which traverses the width of the frame and opens into the central aperture 12 thereof. Each side face of the core structure in the end portion opposite to said slot is provided with a groove 32 which extends in align-

ment with the slot and opens into the aperture 12 and out through the end of the core structure. The grooves and slot are both wider than the thickness of the plunger in the plane of its laminations.

The plunger 18 is composed of a shank portion 34 and a widened head portion 36. In assembled condition the shank portion extends through the slot 30 into the aperture 12 of the core frame. The laminations of the plunger extend the length thereof. The opposite shorter sides of the plunger are enclosed between two corresponding metal guide strips 38—38 which serve to hold the laminations in assembled relation. These guide strips project equal distances beyond the end of the shank 34 opposite to the head 36 as shown in Figure 3. When properly mounted in the core structure, the guide strips extend through the grooves 32 in the opposite faces of the core structure and beyond the end thereof as shown in Figures 2 and 3. The assembled laminations of the plunger and the guide strips are secured together by countersunk rivets 40 as shown in Figure 7, which provide a smooth exterior surface,

The coil unit 14 is constructed in a novel manner for sliding fit into the rectangular aperture 12 of the core structure from either side thereof. The coil is formed in the usual manner with an insulated wire winding, indicated at 52, having two leads 54 and 56 forming opposite end sections of the winding. The outer surface of the wire-winding is enclosed with a sheath of insulative material such as flexible tape. Mounted on each end of the coil unit and extending perpendicular to the passage thereof is a flat sheet or plate 58 of insulative material. In the production of the coil unit, the winding is wound around a metallic insert or lining which, in cooperation with the insulated end plates, serves as a spool to support the winding operation and also serves as a race for guiding the shank portion of the plunger for reciprocating movement through the central passage of the coil. Each end plate 58 is provided with a rectangular aperture through which portions of the lining extend as hereinafter described.

Referring specifically to Figures 1 and 8, the metallic lining of the coil unit is formed of two inwardly facing channel members 62—62, which are slightly separated from one another to prevent the production of eddy currents therethrough. The two members 62—62 extend completely through the central passage 16 of the coil and project beyond the opposite ends thereof. Corresponding projecting sections of each member are bent or flanged outward and lie flat against the outside surfaces of the insulative end plates 58, while other corresponding projecting sections extend in alignment with the race in the passage of the coil unit and form an extension thereof.

The laterally extending flanged sections of the members 62—62 which are bent outward to lie flat against the end plates 58—58 are preferably formed by severing the projecting base portions of the channel formation of each member along lines closely adjacent to but slightly spaced from the corners. The central areas of the projecting base portions are then turned outwardly and downwardly against the outside surfaces of the insulated elements 58—58, leaving the corner sections in their original upright positions. The lateral extending flanges which are formed by this operation are indicated at 64. Such flanged sections lie against the outside surfaces of both end plate members 58—58, as illustrated by the

fragmentary view in Figure 9. As further illustrated in this figure the extremities of these flanges 62 are bent or crimped around the outer edges of the end plates 58—58 over which they lie as shown at 66, and since the flanges of both members 62—62 are similarly crimped, the two members are rigidly held in place in the coil unit in slight spaced apart relationship in the positions shown in Figures 1 and 8.

The corner sections of the lining members 62—62 projecting from one end of the coil unit are retained in their upright vertical relationship to the insulated end plate from which they extend. These corner projections are designated by reference numerals 68. They are four in number and L-shaped in cross section. The opposite end of the coil unit is only provided with two such corner projections, both of which are on one side of the passage 16 through the coil unit. These two corner projections are designated by the reference numerals 70.

The several projecting sections and laterally extending flanges of the lining members 62—62 have special functions in the assembly and operation of the solenoid. The flanges 64 on one end of the coil unit are so spaced from those on the other end that when the coil unit is inserted into the aperture 12 of the core frame they slidingly contact the inner walls thereof and resistingly hold the coil unit therein. It is preferred to construct the coil unit with the outside dimensions between the insulated plates 58—58 equal to the inside long dimension of the aperture 12. The thin flange sections superimposed thereon make the outside dimension of the coil unit between the insulated end plates slightly greater than the dimension of the aperture in which they are received, but when the unit is pressed into the aperture with force the coil winding and the end plates yield slightly inward to allow the flanges to enter the aperture. This close sliding fit assures the coil unit of being firmly held in the core structure yet upon the application of manual force it can be slid out of the aperture at any time. After the first several insertions and removals, the end plate members may take on a slight concavity as a result of the close fit.

The upright projecting members 68 of the lining members 62—62 fit into the slot 30 of the core frame as shown in Figure 9. In this position these sections form a race in the slot which is a prolongation of the race in the passage of the coil unit. The shank portion 34 of the plunger in the slotted opening 30 is thereby guided in its movement therethrough and prevented from lateral sidewise movement as it reciprocates therein. The extensions 68 also serve to keep the plunger shank out of contact with the core frame.

The two sections 70, which as previously described project from one side only of the passage in the coil unit are shaped to engage the core frame and center the coil unit therein with the passage 16 in proper alignment with the slot 30. Specifically, the sections 70 enter either one of the two grooves 32 of the core frame depending upon which side the coil unit is inserted into the core structure and abut the base of the groove as shown in Figure 6. The coil unit is predisposed before assembly with the projections 70 on the side thereof away from the core structure as shown in Figures 4 and 5. The abutting engagement of the extensions 70 with the groove occurs only after the coil unit is fully inserted into the core frame and projecting equal distances

from either side thereof. As viewed in Figure 6, the shorter inturned portions of the two sections 70 which abut the bottom of the groove are of such a depth as to bring the outer surfaces of the longer portions substantially flush with the side of the core frame. As a result, a narrow opening is provided between the flush portion and the base of the groove. Through this narrow opening one of the strips 38 of the plunger extends.

The upper end of the plunger 18 is provided with means for actuating an instrument. A cross bolt 72 extends between projecting flanges on the guide strips and a connecting rod or other operating element may be attached thereto and pulled by the plunger when the latter is drawn into the solenoid. For push-type operations, the opposite end of the plunger may be equipped with means for exerting a thrust on an operating member. In Figure 10, a block 74 is provided with a transverse pair of slots 76—76 into which the projecting ends of the guide strips are received. Aligned holes 78—78 in the guide strips are adapted to be brought into alignment with a drilled hole 80 in the block and a bolt assembly extending through the holes may be used to secure the parts together.

What I claim is:

1. A solenoid comprising, in combination, a laminated generally rectangularly shaped core structure having an aperture therethrough from one side to the other and having a slot in one end portion traversing the width of the core structure and opening into said aperture, a movable magnetic plunger having a shank portion, the sides of said core structure adjacent to the end opposite to said slot each provided with a groove extending in alignment with said slot, a pair of strips secured to the opposite sides of the shank portion of said plunger extending beyond the end thereof, a coil unit assembly removably mounted in the aperture of said core structure and provided with a central passage adapted to align with said slot of the core structure, said coil unit having a split metallic lining in said passage constituting an integral part of said coil assembly and forming a race therethrough for receiving and guiding the shank portion of the plunger, said plunger mounted in said core structure with the shank portion extending through said slot and into said race and with the strips thereon extending through said grooves and projecting beyond the core structure, said lining of the coil unit extending beyond one end thereof into said slot and forming a race therein for guiding the plunger shank and extending beyond the other end thereof for abutment with the side of the core structure to center of the coil unit in the core structure.

2. In an electro-magnet having a substantially rectangularly shaped core structure provided with a central opening therethrough from one side to the other side thereof of substantially rectangular formation and with a plunger receiving aperture in one end thereof extending to said opening, a coil unit having a passage therethrough opening out through the opposite end portions thereof and through which a shank portion of a plunger is adapted to reciprocate, a metallic lining in said passage forming a part of the coil unit serving as a race for guiding the reciprocating shank of a plunger, said lining having a length greater than said passage and portions projecting beyond both ends thereof, certain of said projecting portions being bent in the form of outwardly extending flanges and lying flat against one or both of the

opposite end portions of the coil unit, the overall dimension from the opposite end portions of the coil unit including said outwardly bent flanges being such that the coil unit is slidably insertable into the opening of said core structure with the flange portions contactually engaging the wall of the opening, certain of said projecting portions of the lining on one end of the coil unit forming an extension to said race and adapted to extend into said aperture of the core structure to form a raceway therein for the shank portion of a plunger extending therethrough.

3. The invention described in claim 2 wherein certain of the projecting portions of the lining on the other end of the coil unit opposite said aperture extend in alignment with said race for abutment with the side of the core structure to predeterminately position the coil in the core structure with the passage thereof in alignment with said aperture.

4. A coil unit for an electro-magnet comprising, in combination, a coil winding forming a hollow interior opened at both ends, a member of insulative material extending across each end of the winding having a central aperture therein in alignment with the hollow interior of the winding, a split metallic lining in the hollow interior of sai winding forming races for the shank of a reciprocating plunger and extending through the apertures in said members and projecting beyond the outer faces thereof, certain portions of the lining projecting beyond said members being bent outwardly to form flanges lying flat against the outer face of one or both of said members, and certain portions of the lining projecting beyond said members extending in alignment with the races in the interior of the winding and forming outer extensions thereof.

5. A coil unit for insertion in an opening of a rectangular core frame of an electro-magnet comprising, in combination, a coil winding forming a hollow interior opened at both ends, a member of insulation material extending across each end of the winding having a central rectangular aperture in line with the hollow interior of the winding, a rectangularly shaped metallic lining forming a race for the shank of a reciprocating magnetic plunger mounted in the hollow interior of said winding and having sections thereof projecting through said apertures beyond the outside faces of the members, certain of said projecting sections being bent outwardly in the form of flanges and lying flat against the outside face of either one or both of said members, and certain of said projecting sections extending in alignment with the surfaces of said race in the interior of the winding and being channel shaped to form extensions thereof.

6. An electro-magnet comprising, in combination, a substantially rectangular shaped laminated core structure having a substantially rectangular shaped central aperture therethrough from one side to the other and having a slot in one end thereof traversing the width of the structure and opening into said aperture, a reciprocating magnetic plunger having a shank portion extending through said slot into said aperture, a pair of strips forming part of said plunger enclosing the shank portion therebetween and projecting beyond the end of the shank portion, said core structure having the sides thereof adjacent to the other end recessed in line with said slot to form guiding grooves for the projecting portions of said strips, a removable coil unit having a pas-

sage therethrough from one end to the other and provided with a metallic lining in the passage forming a race for the strip enclosed shank portion of the plunger, said lining extending beyond one end of the coil unit and entering the slot of the core structure to form a race therein, said lining further having an inwardly facing channel shaped extension projecting beyond the other end of the core unit having the edge portions of the channel receivable in and abutting the base of one of said grooves of the core structure and simultaneously serving to position the passage of the coil unit in line with the slot of the core structure and to form a narrow opening for the reciprocating movement of the strip received in the groove.

7. An electro-magnet comprising, in combination, a laminated core structure of general rectangular formation having an opening extending therethrough from one side to the other side thereof and further having an aperture extending through one end thereof to said opening, an energizing coil unit having a central passage therein opening through the opposite ends thereof, said coil removably fitting the opening of said core structure and having the passage thereof aligning with the aperture of the core structure, a movable magnetic plunger having a shank portion extending through said aperture of the core and into the passage of said coil unit, said plunger having a widened head portion forming lateral shoulders adapted to strike the end of the core structure and limit the stroke of the plunger in one direction of its movement, a split metallic liner forming a fixed integral part of the coil unit and mounted in the passage thereof to provide a race for the shank of the plunger, said liner having flange portions lapping over one or both end portions of the coil and so arranged as to slidingly fit the inner walls of said opening of the core structure, said liner further having additional flange portions extending into said aperture of the core structure to provide a race therein for the shank of the plunger, and means on the coil unit abutting said core structure for predeterminedly setting the coil unit in the opening of the core structure with the passage thereof extending in alignment with said aperture of the core structure.

8. An electro-magnet comprising, in combination, a laminated core structure of general rectangular formation having an opening therethrough from one side to the other side thereof and further having an aperture in one end thereof extending to said opening, an energizing coil unit having a central passage therein opening through the opposite ends thereof and removably slidably fitting said opening of the core structure, a reciprocable movable plunger having a shank portion extending through said aperture of the core structure and into said passage of the coil unit, a sleeve shaped liner in said passage of the coil unit forming a fixed integral part of the coil unit and removable therewith, said liner forming a race for guiding the shank portion of the plunger in its reciprocable movement and provided with extending portions projecting beyond the open end of said passage at one end of the coil, said extending portions projecting in line with said race and entering said aperture of the core structure to form a raceway therein for the reciprocating shank of the plunger, and said liner further provided with an extending portion projecting beyond the other end of the coil unit shaped to abut the side of the core structure and predeterminedly position the coil unit within the opening of the core structure with the passage thereof in alignment with said aperture of the core structure.

9. An electro-magnet comprising, in combination, a laminated core structure of general rectangular formation having an opening therethrough from one side to the other side thereof and further having an aperture through one end thereof extending to the opening, an energizing coil unit having a central passage therein opening through the opposite ends thereof and being slidably removably received and mounted in the opening of the core structure, a movable magnetic plunger having a shank portion extending through said aperture of the core structure and into the passage of the coil unit, and a sleeve shaped raceway constituting a fixed integral part of the coil unit and lining the passage thereof to form a sliding guideway for the shank of the plunger, said lining projecting beyond one end of the coil unit and entering said aperture of the structure to form a sliding guideway therein for the shank of the plunger, and said lining projecting beyond the other end of the coil unit on one side of the passage thereof and abutting the core structure to properly locate the coil unit within the opening of the core structure with the passage thereof in alignment with said aperture.

10. In an electro-magnet having a generally rectangularly shaped core structure provided with a central substantially rectangularly shaped opening extending therethrough from one side to the other side thereof and further provided with a narrower end opening plunger receiving aperture traversing the width of the core structure and extending to said opening, a removable coil unit mounted in said opening of the core structure and provided with a passage therein through which the shank portion of a plunger received in said aperture is adapted to reciprocate, a sleeve shaped element in said passage of the coil unit forming an integral part thereof and removable therewith, said lining serving as a race for slidably guiding the reciprocating shank of the plunger, and opposed inwardly facing channel shaped extensions on said lining forming an integral part thereof and projecting beyond one end of the coil unit, said channel shaped extensions of the lining occupying a cross-sectional area less than said aperture and being received within the aperture upon sidewise movement of the coil unit into said opening to serve as a race in the aperture for guiding the shank portion of the plunger therein, and a projection carried by said coil unit abutting a side portion of said core structure and acting to center the coil unit in the opening of the core structure with the channel shaped extensions of the lining in alignment with the walls of said aperture to serve as a race therein for the shank portion of the plunger.

11. In an electro-magnet having a core structure provided with a central opening therein and further provided with a plunger receiving aperture in one end thereof extending to said opening, a removable coil unit provided with a passage therethrough and opening out through the opposite ends thereof, said aperture and said passage adapted to receive the shank of a reciprocable plunger, a sleeve liner in said passage of the coil unit forming a fixed integral part thereof and serving as a race for slidably guiding the reciprocating shank of the plunger, said liner having end portions thereof projecting beyond one end of the coil unit and entering said aperture of the core

structure to likewise serve as a race therein for the shank of the plunger, and means forming a fixed integral part of the coil unit abutting said core structure and acting to center the coil unit within the opening of the core structure with the liner in alignment with said aperture of the core structure.

12. In an electro-magnet, a laminated core structure of general rectangular formation having an opening therethrough from one side to the other side thereof and further having a narrower plunger receiving aperture traversing the width of the core structure and extending to said opening, a unitary removable and insertable coil assembly having a central passage therein and having an outside dimension such that it is sidewise received into said opening of the core structure, a sleeve liner in said passage of the coil assembly constituting a fixed integral part thereof and forming a race for slidably guiding the shank portion of a reciprocating plunger extending through said passage, said sleeve liner provided with extended portions aligning with said race and projecting beyond an open end of said passage, said extended portions of the liner entering the aperture of the core structure to form a race therein for the shank of the plunger therein, and a projection carried as a fixed integral portion of the coil assembly and abutting the core structure to form a stop for centering the coil assembly within the opening of the core structure with the sleeve liner and the extended portions thereof in alignment with said aperture of the core structure.

HOLLIS W. JENCKS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,696,615	Trombetta	Dec. 25, 1928
1,768,950	Frank	July 1, 1930
2,182,685	Weiler	Dec. 5, 1939
2,305,415	Goff	Dec. 15, 1942
2,344,751	Trombetta	Mar. 21, 1944
2,370,038	Iglehart	Feb. 20, 1945