

May 9, 1944.

L. H. MATTHIAS

2,348,556

MAGNET STRUCTURE

Filed Nov. 5, 1941

3 Sheets-Sheet 1

FIG. 1.

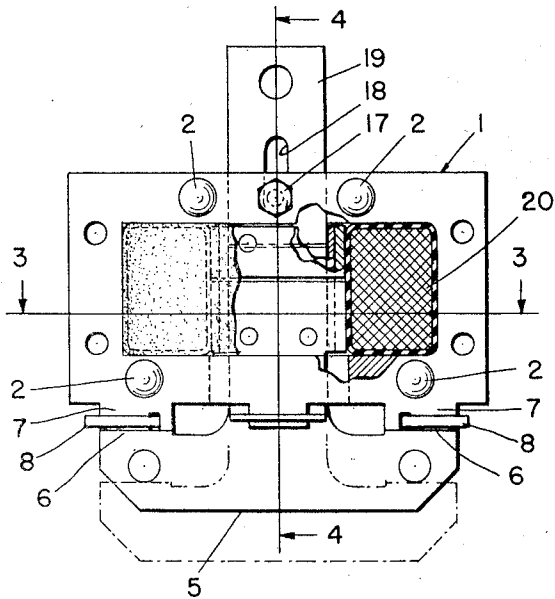


FIG. 2.

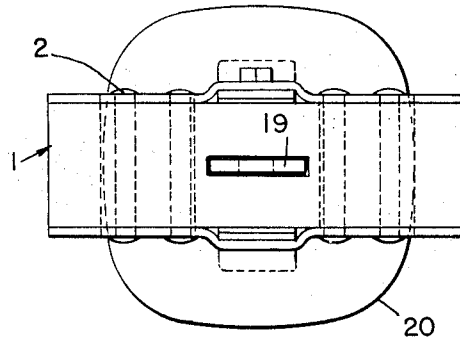


FIG. 3.

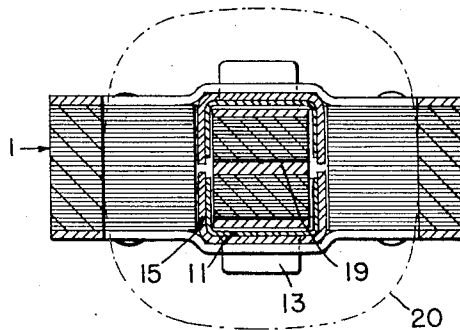


FIG. 4.

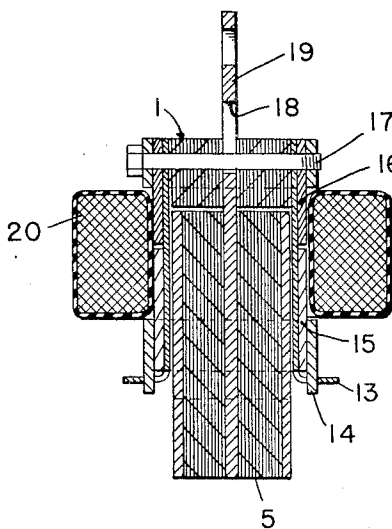
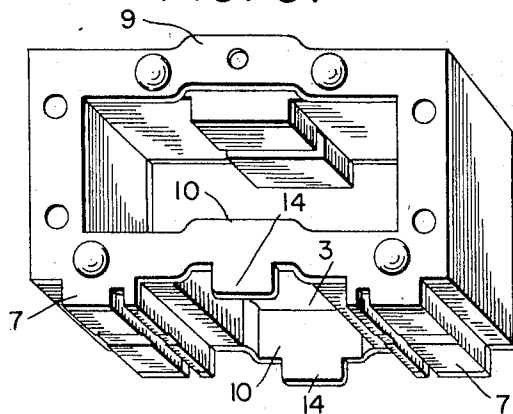


FIG. 5.



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FIG. 6.

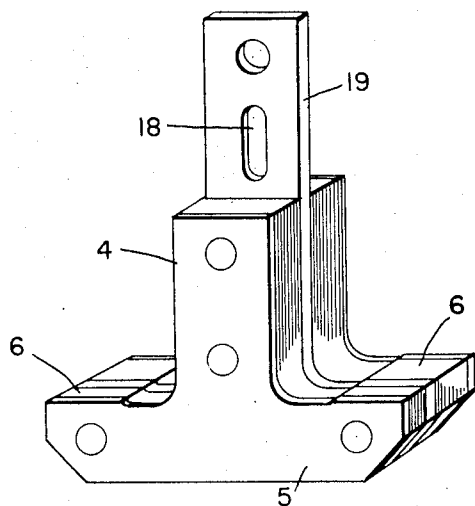


FIG. 7.

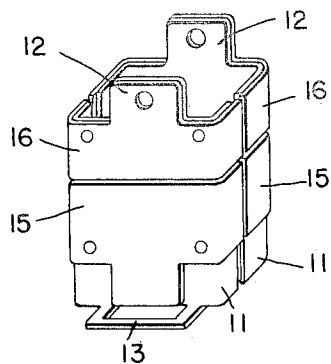


FIG. 9.

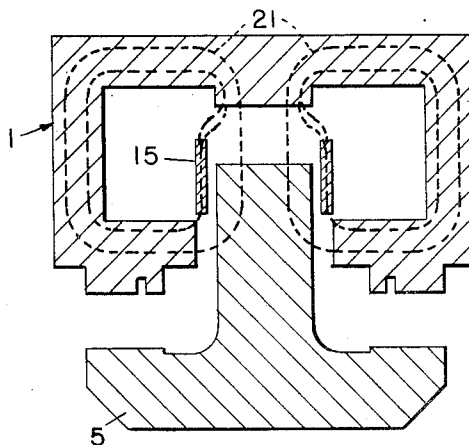


FIG. 8.

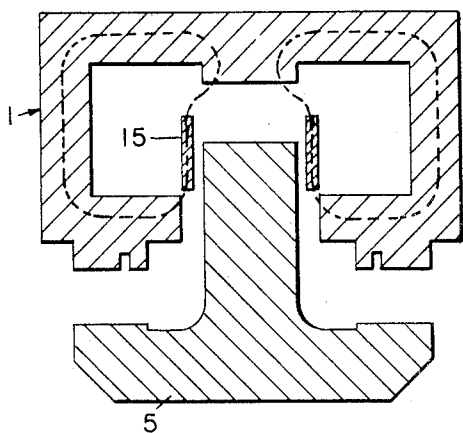


FIG. 11.

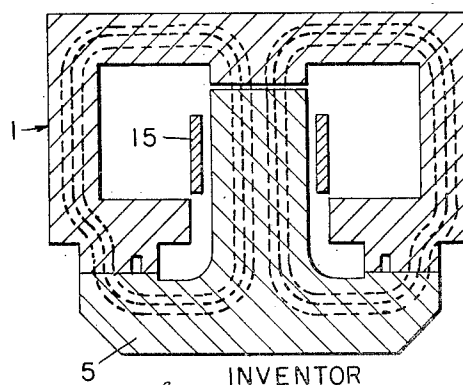
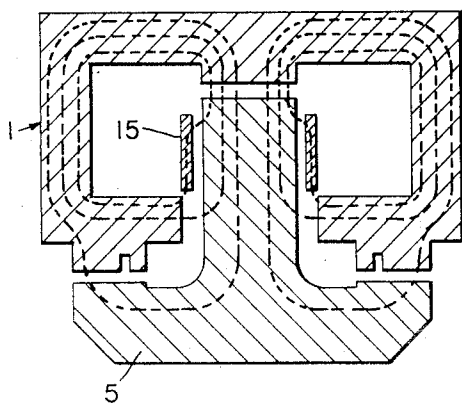


FIG. 10.



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FIG. 12.

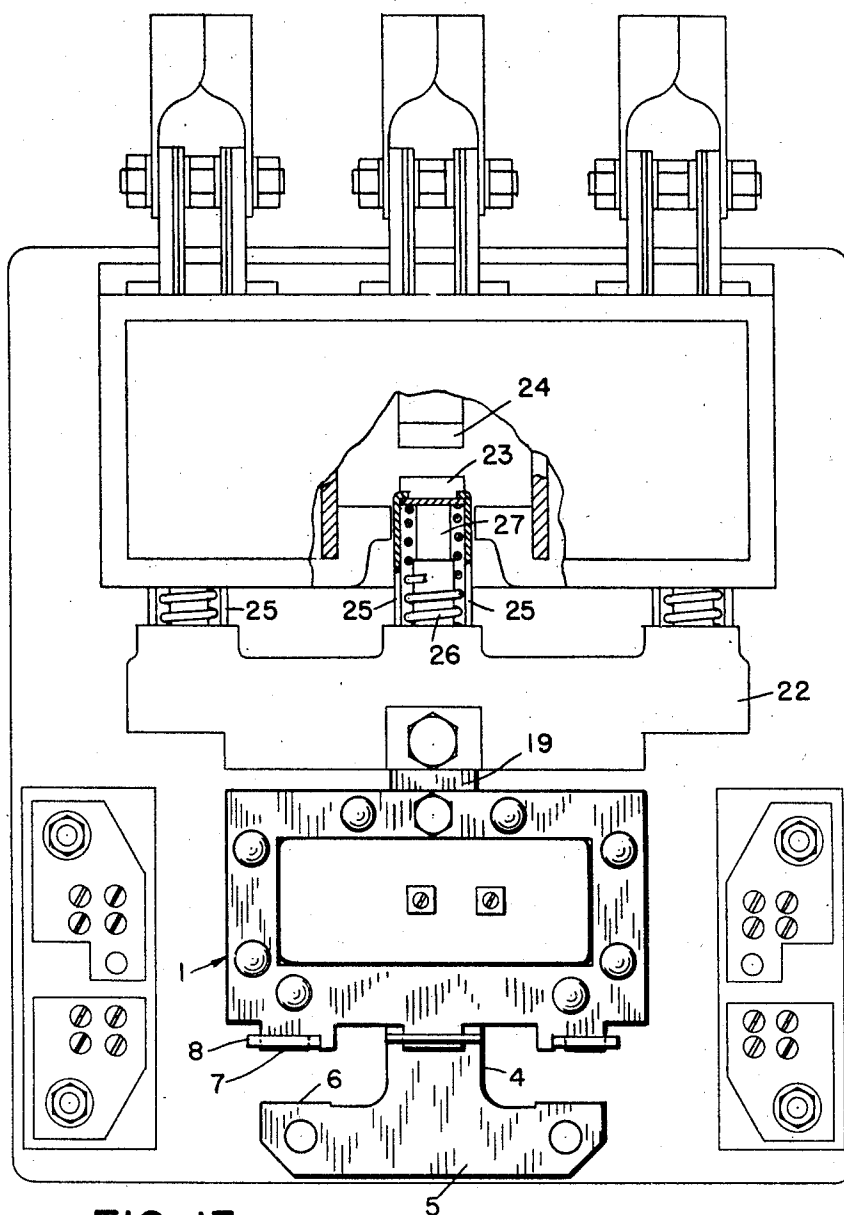
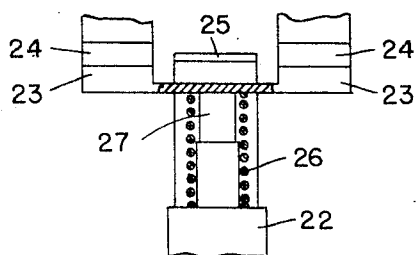


FIG. 13.



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MAGNET STRUCTURE

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Application November 5, 1941, Serial No. 417,907

3 Claims. (Cl. 200—94)

This invention relates to electromagnetic actuators of the type commonly employed for actuating switches, for opening and closing valves, for shifting mechanical control instrumentalities and the like, and resides in an improvement therein in which the relatively attractable portions of an electromagnetic field structure are arranged in relation to a magnetic by-pass which is effective to divert deficient closing flux, but a part only of adequate closing flux when said field portions are in separated position and which is ineffective to divert any of the flux when the field portions are in attracted position.

Electromagnets employed for actuating switches and the like are ordinarily arranged to act against a bias, caused either by gravity or by resilient reaction, and are usually called upon to hold electrical contacts in engagement under a substantial amount of contact force. Such magnets, furthermore, are called upon to have sufficient travel so that the contacts can be separated sufficiently to effectively interrupt the current. Such magnets therefore must have a substantial attractive force sufficient to overcome the bias over a substantial range of movement and, further, to have a large attractive force in a nearly closed position in order to overcome the reaction of spring-backed contacts.

Magnets designed to meet the above requirements, as heretofore constructed, have the undesirable property of responding to excitation voltages substantially below the rated voltage of the exciting coil. If the coil be designed so as to produce insufficient flux to move the armature at moderately reduced excitation voltages, then the attractive force at rated voltage is very little more than sufficient for the duty required and the action of the magnet and switch is sluggish.

A further, more important defect of such constructions is that in a certain range of reduced excitation voltage the armature will move against the bias until the contacts come into engagement and then insufficient attractive force is available to cause the armature to move against the additional bias of the contact backing springs to a sealing position. Under these conditions the required contact force is not established and the contacts sometimes overheat to the point of destruction. Little can be done by strengthening or weakening the excitation coil to overcome this difficulty, since strengthening the coil merely further reduces the voltage at which the undesirable condition occurs, while further weakening of the coil merely brings the excitation voltage at which the undesirable condition exists closer to the rated voltage of the coil.

In the electromagnet of this invention the above difficulty is avoided and a magnet is provided which will respond only to excitation voltages which are high enough to ensure an adequate attractive force sufficient to cause the armature to move to sealing position, thus ensuring that the contacts or the like will engage with the full force intended. The manner in which this desirable result is obtained will be apparent from the description which follows.

This invention is hereinafter described by reference to the accompanying drawings wherein there is set forth by way of illustration and not of limitation a specific instance of an embodiment of the apparatus of this invention.

In the drawings:

Fig. 1 is a front elevation of an electromagnet constructed in accordance with this invention, parts thereof being shown broken away;

Fig. 2 is a plan view of the magnet shown in Fig. 1;

Fig. 3 is a plan view, in section, viewed through the plane 3—3 indicated in Fig. 1;

Fig. 4 is a side elevation, in section, viewed through the plane 4—4 of Fig. 1;

Fig. 5 is a perspective view of the stationary portions of the field structure of the magnet shown in Fig. 1;

Fig. 6 is a perspective view of the armature or movable field portion of the magnet shown in Fig. 1;

Fig. 7 is a perspective detail view of the armature guiding sleeve and magnetic by-pass;

Fig. 8 is a diagrammatic front elevation, in section, showing the magnet parts in open position under conditions of inadequate excitation. The flux paths are roughly indicated by dotted lines;

Fig. 9 is a diagrammatic front elevation, in section, showing the magnet parts in open position under conditions of adequate excitation. The flux paths are roughly indicated by dotted lines;

Fig. 10 is a diagrammatic front elevation, in section, showing the magnet parts in partially closed position with adequate excitation. The flux paths occurring under such conditions are roughly indicated by dotted lines;

Fig. 11 is a diagrammatic front elevation, in section, showing the magnet parts in closed or sealed position. The flux paths under such conditions are indicated by dotted lines;

Fig. 12 is a front elevation showing the relationship of the magnet parts of this invention to a switch having resiliently-backed contacts; and

Fig. 13 is a fragmentary detail view, partly in section, showing the way in which the movable contact engages the stationary contacts.

The electromagnet of this invention may be embodied in any of the several forms in which a movable part is arranged to be drawn to a stationary part in response to magnetic flux established by a coil. The invention is herein illustrated and described as applied to the particular type of such general class of magnet structures which is shown and described in Reissue Patent 20,094, issued September 1, 1936, upon the application of Gustav O. Wilms and Albert J. Dawe.

The magnet type selected to illustrate the invention is shown herein in the drawings as being provided with a roughly rectangular stationary field piece 1, composed of laminations secured together by rivets 2. The lower side of field piece 1 is broken to provide a passage 3 within which the tongue 4 of a T-shaped armature member 5 is slidably received. The T-shaped head of the armature is provided with pole meeting faces 6 which are positioned to come into engagement with pole pieces 7 which project downwardly from the lower side of the field piece 1. The pole pieces 7 are slotted, as appears more clearly in Fig. 5, to accommodate shading rings 8 located as shown in Fig. 12.

The two outer laminations of the field piece 1 are formed of material of substantial thickness and strength and are bent outwardly at 9 and 10 to provide means for securing an armature guide and magnetic by-pass assembly made up of the parts shown more clearly in Fig. 7. The armature guide and by-pass assembly is in the form of a split rectangular sleeve comprising two identical separable inwardly facing U-shaped parts. Each of the U-shaped parts is provided with a smooth interior guiding sleeve portion 11 formed of nonmagnetic material. Projecting upwardly from the upper end of each of the guiding sleeves 11 is a lug 12 adapted to be accommodated within the outwardly bent portions 9 of the outer field piece laminations. Integrally formed with the lower ends of the sleeves 11 are laterally bent perforated ears 13 which are adapted to pass over and surround the downwardly projecting lugs 14, which are formed as a part of the outer field piece laminations.

Secured to the exterior of the sleeves 11 are by-pass collar segments 15. The collar segments 15 are composed of mild steel or other suitable magnetic material. Above the by-pass collar segments and likewise secured to the sleeves 11 are nonmagnetic dummy collars 16 of the form and shape more clearly appearing in Fig. 7.

In assembling the magnet, a coil 20 is put in place within the central opening in the field piece 1. The sleeve and by-pass assembly is then inserted, thus holding the coil 20 in place. The tongue 4 of the armature 5 is then passed into the sleeve until the center lamination of the armature extends through the apertures provided therefor in the upper side of the field piece. Assembly bolt 17 is then passed through the entire field structure, sleeve lugs 12, and through an elongated slot 18 formed in the upwardly projecting center lamination 19. The magnet assembly is thus completed in a form which permits the armature 5 to move between the position shown in full lines in Fig. 1 and the position shown in dotted lines therein.

The parts of the construction described, which perform magnetic functions, are the field piece 1, the armature 5, and the by-pass collar segments 15. The relative locations of these parts are diagrammatically represented in Figs. 8 to 11, inclusive, for the purpose of illustrating the type

of rearrangement of flux paths which occurs when the apparatus of this invention is in use. In Fig. 8 the armature is shown in extreme open position. A magnetic flux path is diagrammatically indicated as passing through the field piece 1 and the by-pass collar segments 15, both of which are stationary parts fixed with reference to one another. This is the type of condition which prevails in a magnet of this invention when excitation is less than that which will produce a condition approaching saturation in the by-pass 15. This quantity of excitation also is a quantity which is insufficient to produce an adequate attractive force if it were permitted to act upon the armature. For example, if line voltage is low and the coil 20 is thus inadequately excited, the flux circuit is largely confined to that illustrated in Fig. 8. The by-pass collar segments are constructed of material having appropriate magnetic properties to permit the carrying of a good part of a maximum inadequate flux without saturation. This reduced quantity of flux prefers the circuit indicated because the reluctance thereof is less than for any flux circuit passing through the armature. In Fig. 9, however, there is diagrammatically indicated the flux path conditions prevailing in a magnet of this invention when excitation is increased beyond that for which Fig. 8 is typical. In this case, part of the flux enters the armature and passes therefrom to the field piece, thus applying an attractive force to the armature, as roughly indicated by the dotted lines 21. When excitation is increased to the point where the attractive force exerted upon the armature 5 is sufficient, the armature moves in response thereto toward the field piece 1.

With the armature 5 in movement, as soon as the upper end of the tongue 4 rises above or into the vicinity of the upper level of the collar segments 15, a circuit of greatly reduced reluctance passing through the armature comes into existence. The reluctance of this circuit is far less than for any circuit through the stationary by-pass and the flux paths shift to a configuration roughly indicated in Fig. 10. Thereupon the entire attractive force of the magnet becomes effective and the armature continues to move with substantially increased force until the closed position shown in Fig. 11 is reached. In the final, or closed position, the flux paths become largely established through the course shown in Fig. 11.

It will be evident from an inspection of Figs. 8 to 11, inclusive, that excitation which is sufficient to place the armature 5 in motion must be substantial in amount and therefore will be productive of a high final closing force. In this way it is possible to design a magnet which is entirely insensitive to low line voltages and, at the same time, one which closes with high attractive force under every condition of excitation which is sufficient to cause a closing movement. Not only are conditions of inadequate closing force thus avoided, but the minimum voltage at which response is obtained is consistent and remains so over the life of the magnet.

For the actuation of any instrumentality where substantial travel is required, this property of responding only to adequate excitation is a property of decided advantage. In the case of switches, this advantage is of marked importance for reasons which have been stated above. To more clearly illustrate the cooperation between the magnet of this invention and spring-backed switch contacts, a magnet of this invention is

shown in Fig. 12 in relationship to an electric switch. As appears in this figure, the upwardly projecting center lamination 19 of the magnet armature is secured to a thruster bar 22 composed of insulating material. Mounted upon the thruster bar 22 are upwardly projecting spring-backed contacts, one set of which is shown in the broken away portion of the figure. The movable contacts 23, as appears more clearly in Fig. 13, are in pairs arranged to bridge between a corresponding pair of stationary contacts 24. The movable contacts 23 are joined by a cross-bar which is secured to and guided by a telescopic sliding sleeve 27. Side guiding supports 25 serve to retain and prevent lateral displacement of the movable contacts. A preloaded spring 26 urges the cross-bar of the contacts 23 upwardly against the inwardly turned ends of the guiding members 25. When the armature 5 moves to closed position, the contacts 23 engage the stationary contacts 24 a short distance before the travel of the armature is complete. The final movement of the armature to sealing position thereupon compresses the spring 26, causing the contact assembly to assume the position shown in Fig. 13, thus setting up the required contact force.

Referring now to Fig. 10, it will be observed that with the magnet of this invention it is possible to provide a spring-backed contact which is brought into compression only after the armature has moved to the point where the by-pass has been eliminated as an instrumentality which interferes with the attractive force. Such is the arrangement shown in Fig. 12. It is apparent, therefore, that the by-pass 15 need not impair or lessen to any extent the forcefulness of the engagement of the contacts. While such an arrangement is of particular value where the magnet of this invention is employed for actuating switches of the type illustrated, it is, nevertheless possible to apply the magnet of this invention to duties where actual work is done over a much larger portion of the magnet stroke, if such is desired.

While this invention has been herein described by reference to a specific embodiment of the same, it is intended that the protection of Letters Patent to be afforded hereby be not unnecessarily limited by such description, the intention being that such protection extend to the full limit of the inventive advance disclosed herein as defined by the claims hereto appended.

What I claim as my invention is:

1. In a magnetically operated electric switch the combination comprising a field piece and support, a coil, an armature movable to and from open and closed positions with respect to said field piece and biased to open position, a pair of contacts one being associated with said armature for movement thereby, the other being associated with said field support, said pair of contacts being adapted for yielding pressure engagement throughout a portion of the travel of the armature adjacent the closed position thereof, and a

magnetic by-pass disposed along side of a portion of the path of travel of the inner end of said armature adjacent the open position thereof for diminishing the attractive force exerted upon said armature when in open position, said by-pass terminating short of that part of travel of said armature within which said contacts are in engagement so as to render said by-pass ineffective to diminish the attractive force exerted upon said armature while said contacts are in engagement.

2. In a magnetically operated electric switch the combination comprising a field piece and support, a coil, an armature movable to and from open and closed positions with respect to said field piece and biased to open position, a pair of contacts one being associated with said armature for movement thereby the other being associated with said field support, a spring disposed to act upon one of said contacts so as to cause resilient yielding engagement between said contacts throughout a portion of the travel of said armature adjacent the closed position thereof, and a magnetic by-pass disposed along side of a portion of the path of travel of the inner end of said armature adjacent the open position thereof for diminishing the attractive force exerted upon said armature when in open position, said by-pass terminating short of that part of the path of travel of said armature within which said contacts are in engagement so as to render said by-pass ineffective to diminish the attractive force exerted upon said armature while said contacts are in engagement.

3. In a magnetically operated electric switch the combination comprising a field piece and support, a coil, an armature movable to and from open and closed positions with respect to said field piece and biased to open position, stationary contacts associated with said field support, movable contacts adapted to engage said stationary contacts, loose connection means for mounting said movable contacts upon said armature, springs interposed between said movable contacts and said loose connection means for resiliently urging said movable contacts toward the limit of accommodation of said loose connection means, said springs being adapted to be deflected to maintain resilient contact pressure between said stationary and movable contacts throughout a portion of the armature travel adjacent the closed position thereof, and a magnetic by-pass disposed along side of a portion of the path of travel of the inner end of the armature adjacent the open position thereof for diminishing the attractive force exerted upon said armature when in open position, said by-pass terminating short of that part of the path of travel of said armature within which said contacts are in engagement so as to render said by-pass ineffective to diminish the attractive force exerted upon said armature while said contacts are in engagement.

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