

[54] **ELECTROMAGNETIC CONTACTOR**

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[51] Int. Cl. **H01h 45/00**

[58] Field of Search 335/132, 202, 192, 194, 335/258, 274; 267/159

[56] **References Cited**

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[57]

ABSTRACT

An electromagnetic contactor utilizing a pair of wire springs as resilient means for providing the returning force to the movable element including movable contact pieces and movable iron core of the electromagnetic device. The wire springs are set as compressed symmetrically with respect to the center of the movable element and inclined with respect to movable direction of the element, so that the returning force will be of a negative characteristic wherein the force gradually reduces as the movable element is attracted to fixed core. The arrangement is applicable both to vertically and horizontally split types of the contactor housing and a C-shaped wire spring is most preferable as the resilient means.

7 Claims, 14 Drawing Figures

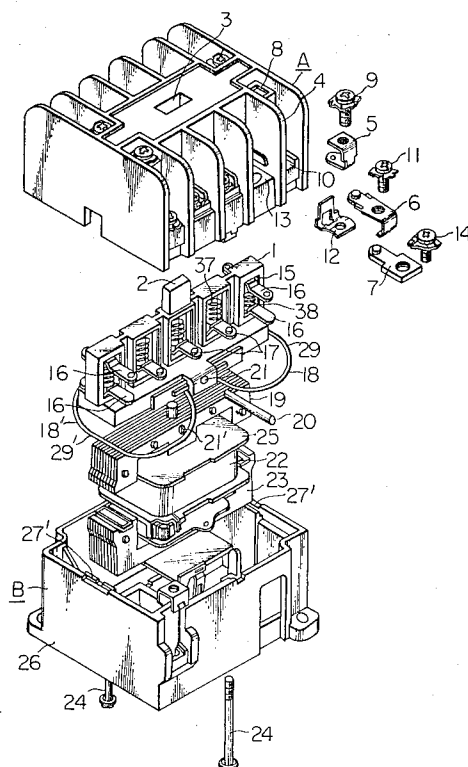


Fig. 1
PRIOR ART

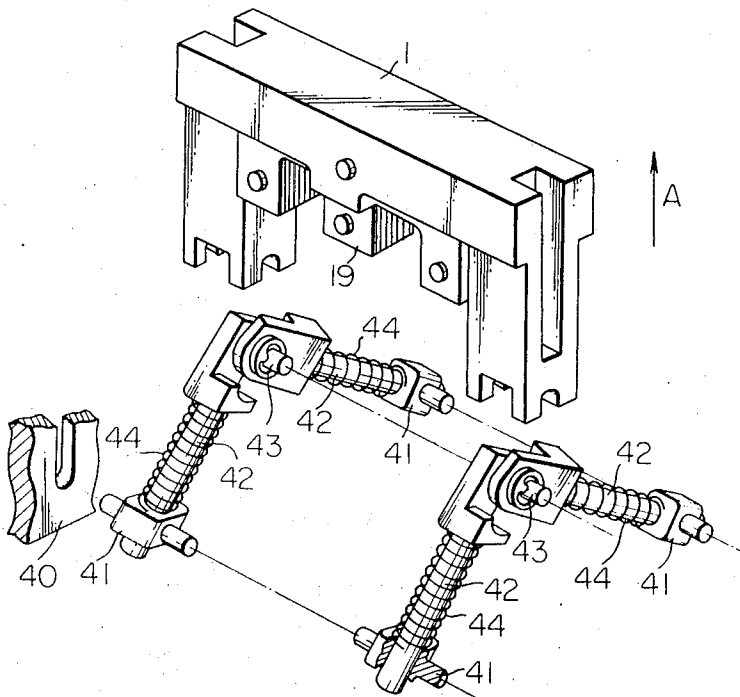


Fig. 2A

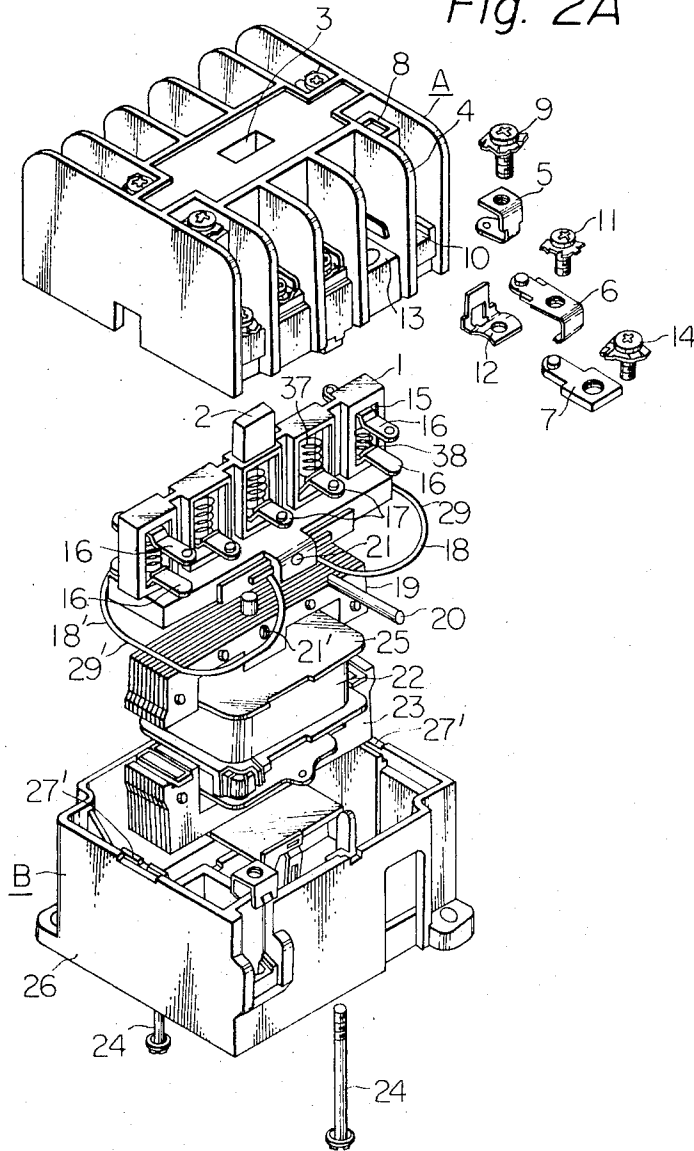


Fig. 2B

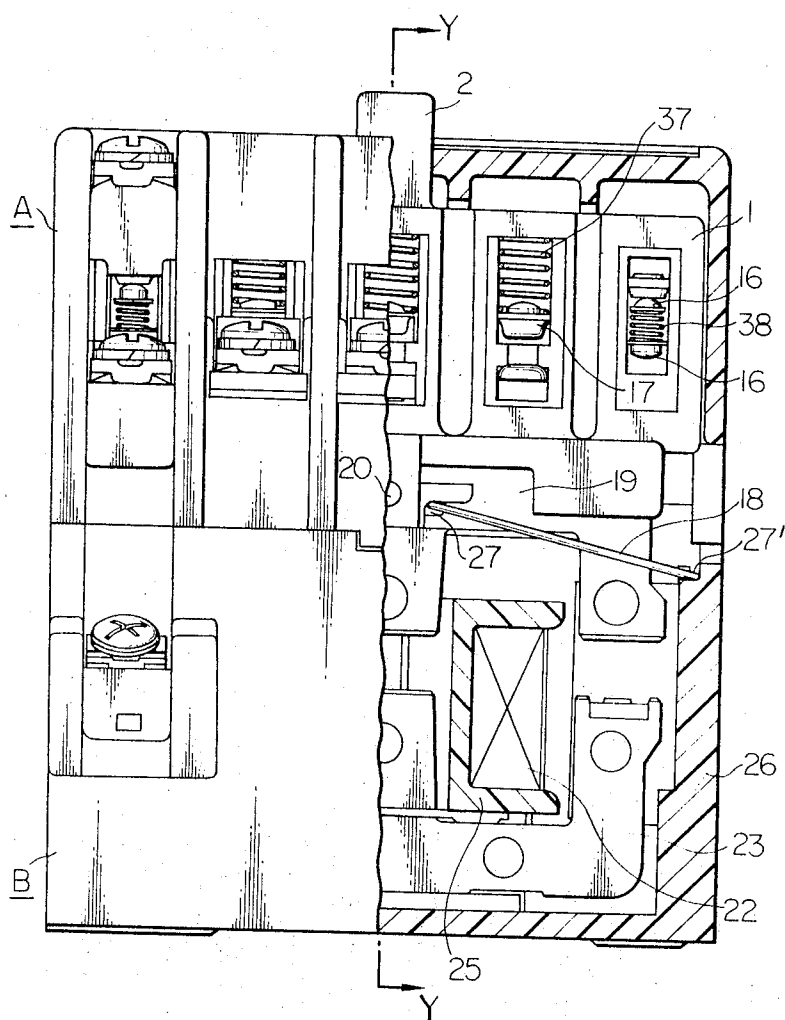


Fig. 2C

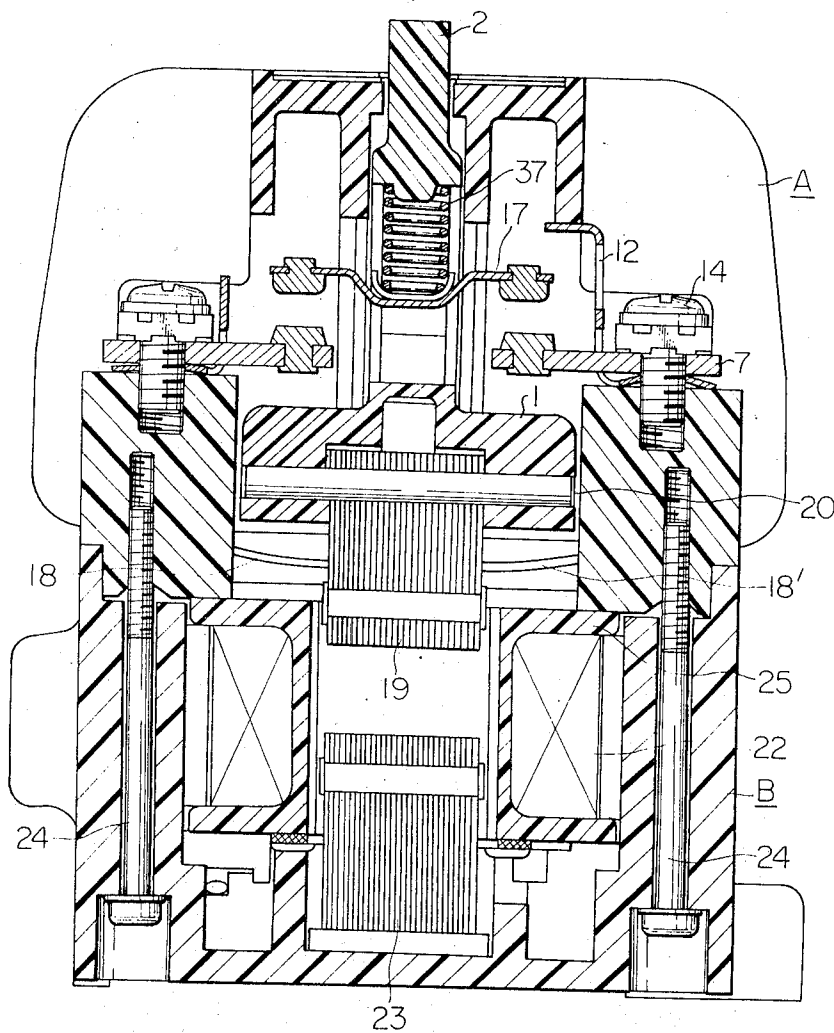


Fig. 3A

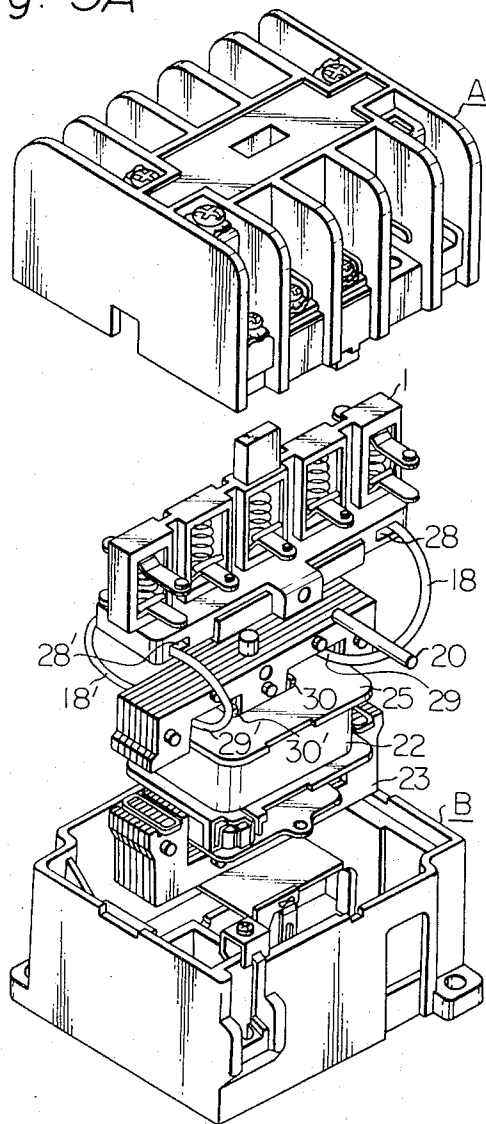


Fig. 3B

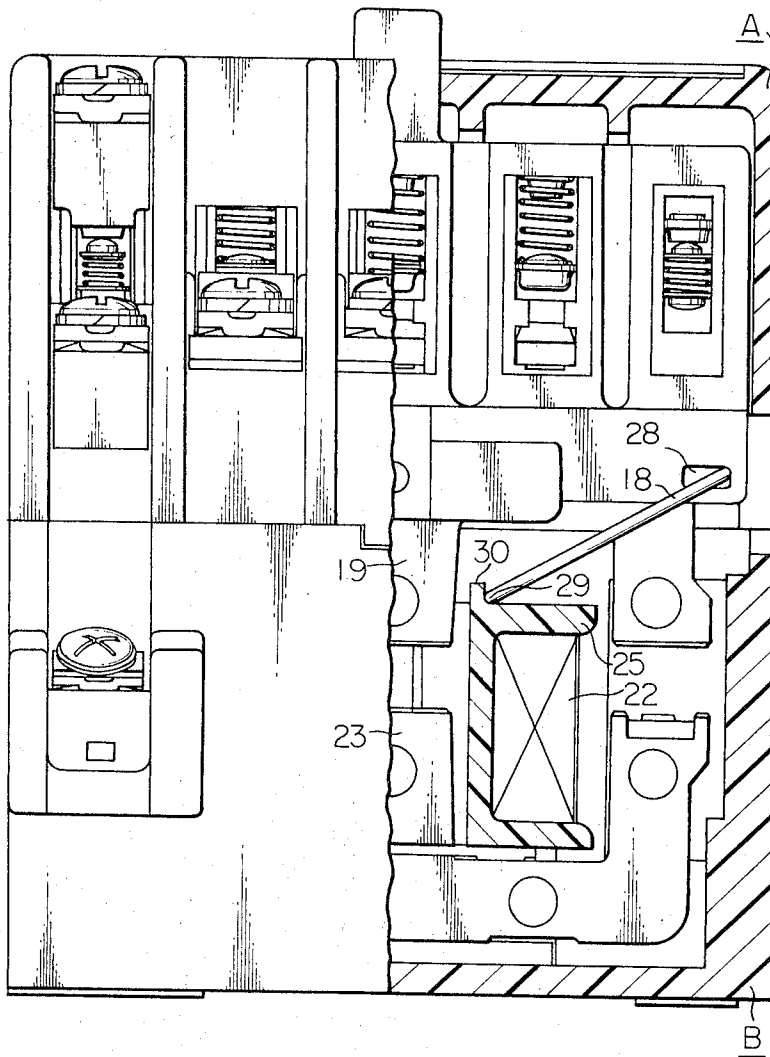
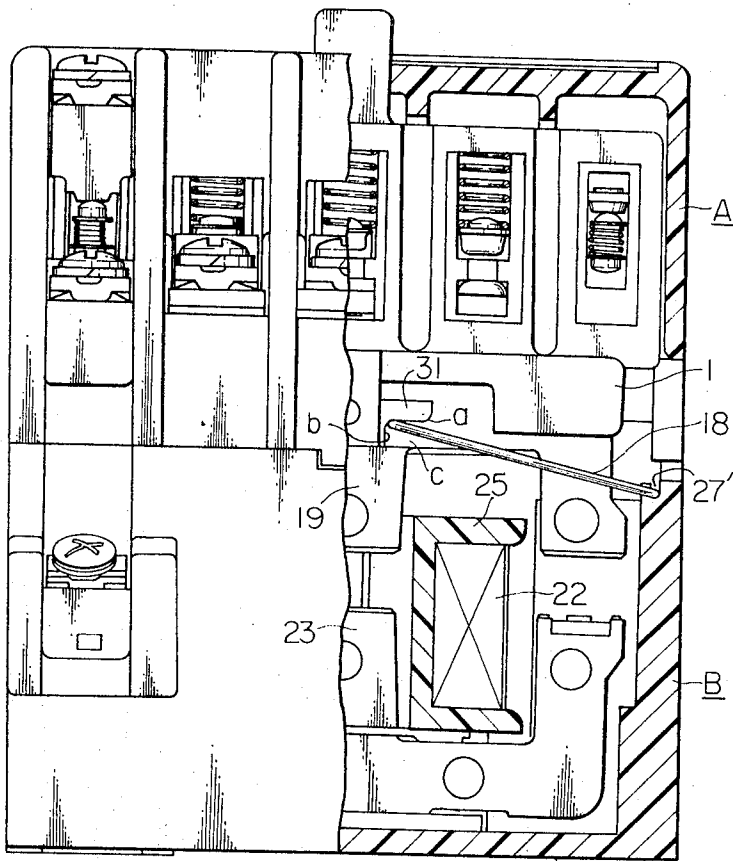


Fig. 4



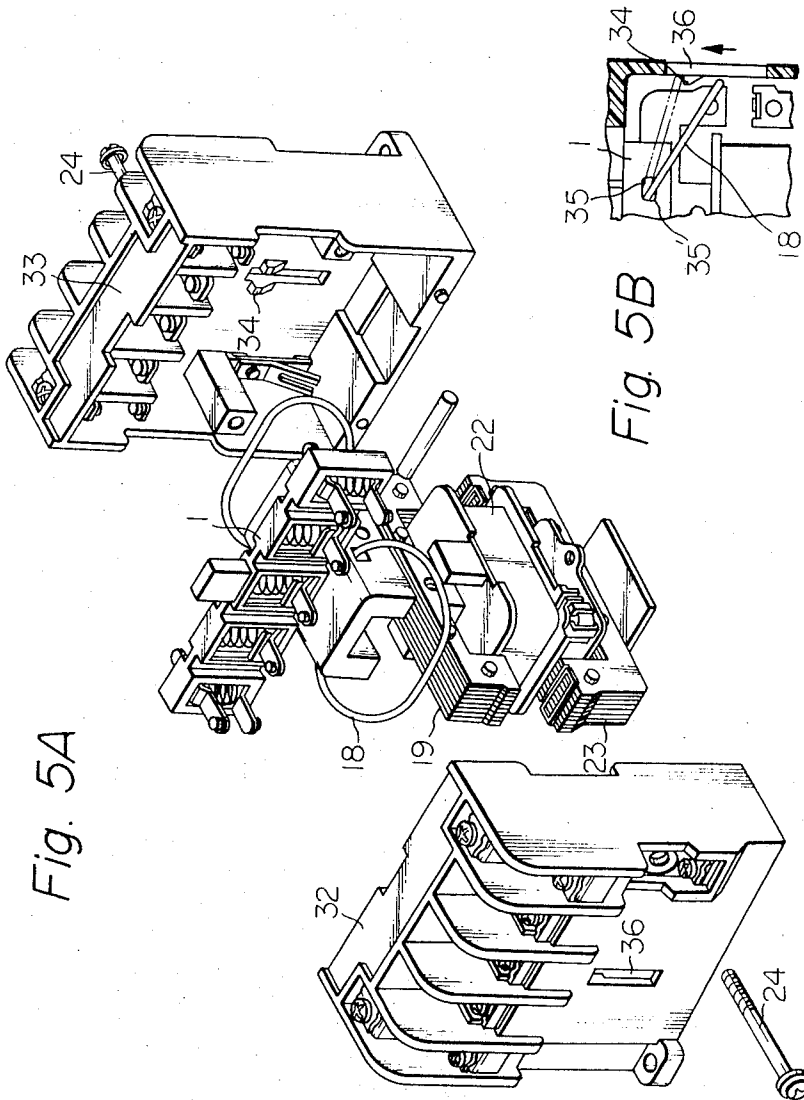


Fig. 6

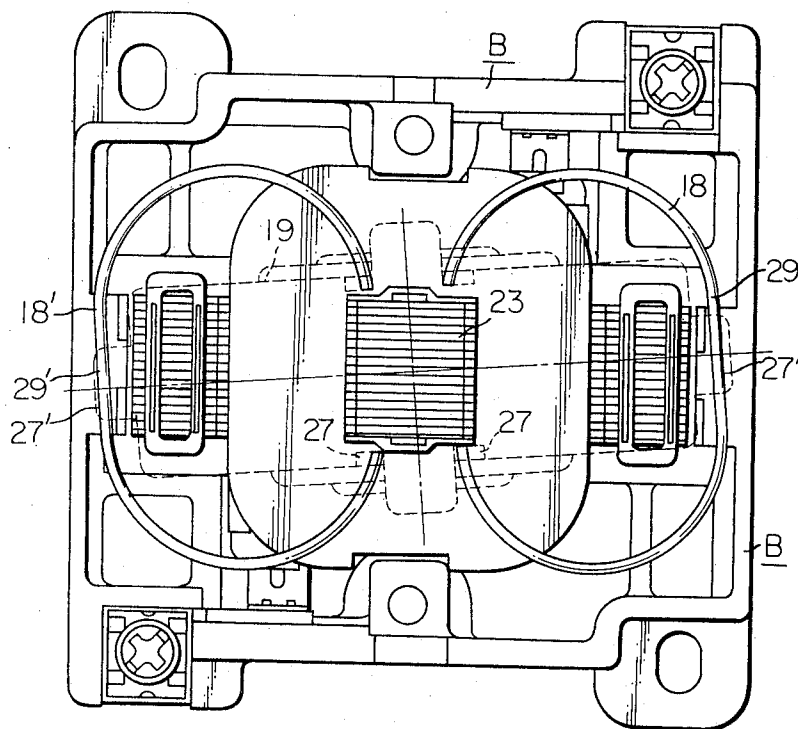


Fig. 7A

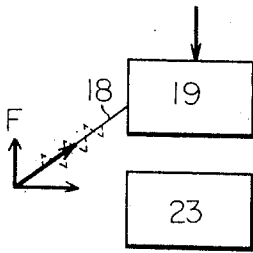


Fig. 7B

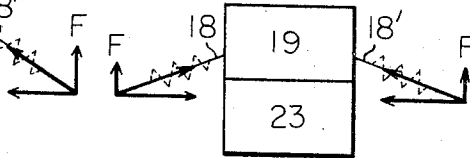


Fig. 7C

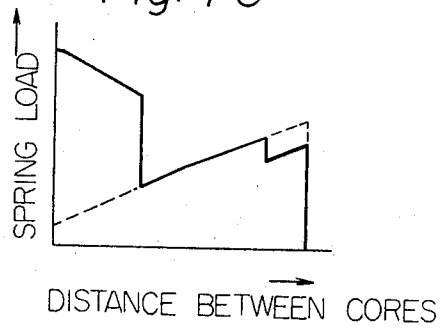
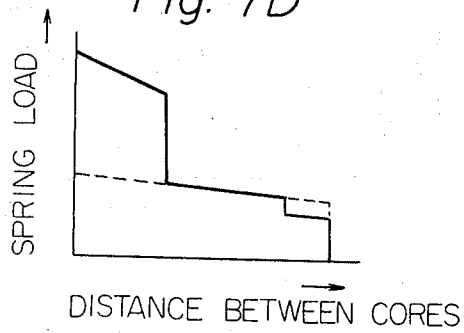


Fig. 7D



ELECTROMAGNETIC CONTACTOR

This invention relates to electromagnetic contactors. Electromagnetic contactors of various structures have been already suggested. Among them, there is an electromagnetic contactor wherein, as a movable iron core is attracted to approach a fixed iron core, a returning spring force will reduce, that is, the returning spring force has a negative characteristic.

Such electromagnetic contactor in which the returning spring force has a negative characteristics has such effects:

- i. that, as the returning force of the movable core is of a negative characteristic, the total spring force at the energized position can be reduced, whereby any hum of the electromagnet can be reduced;
- ii. that, as the returning force effected by the returning spring is reduced to be smaller in the total spring load at the energized position, the contact pressure can be made larger by that reduced amount of the returning spring force, whereby the switching capacity of the contactor can be made larger;
- iii. that there will be no hesitation of the movable core in the vicinity to contact closing position in operating and relaying motion, even when the exciting voltage is deteriorated; and
- iv. that the returning force at the non-energizing position is so large that the proofness against shocks and impacts is high.

However, generally, such electromagnetic contactor having a negative characteristic is so complicated in the structure as will be later described with reference to FIG. 1 that it has defects that the manufacturing cost becomes high and compact electromagnetic contactors can hardly be made with such structure. In the present invention, the spring structure is successfully improved so that it is made possible to solve the above mentioned problems.

A main object of the present invention is to provide a compact electromagnetic contactor wherein the spring structure of which the returning force is made negative is formed of a very simple member so as to render the space required therefor minimum.

Another object of the present invention is to provide an electromagnetic contactor which is simpler in the structure than any conventional product and can greatly reduce the number of component parts.

A further object of the present invention is to provide an electromagnetic contactor having a small number of component parts and thus easy to assemble.

Now, the present invention shall be explained with reference to the accompanying drawings, in which:

FIG. 1 shows in a fragmentary perspective view an example of conventional electromagnetic contactors having a negative characteristic as disassembled;

FIGS. 2A, 2B and 2C show an embodiment of the present invention, wherein FIG. 2A is a perspective view of the contactor as disassembled, FIG. 2B is a partly sectioned side elevation and FIG. 2C is a vertical section along line Y—Y in FIG. 2B;

FIGS. 3A and 3B show another embodiment of the present invention, wherein FIG. 3A is a perspective view of the same as disassembled and FIG. 3B is a partly sectioned side elevation thereof;

FIG. 4 shows a further embodiment of the present invention in a partly sectioned side elevation;

FIGS. 5A and 5B show a yet further embodiment of the present invention, wherein FIG. 5A is a perspective view as disassembled and FIG. 5B is a fragmentary sectioned view of the same.

FIG. 6 shows another embodiment of the present invention in a plan view with a part removed; and

FIGS. 7A to 7C are diagrams showing the operation of the present invention, and FIG. 7D is a diagram showing the operation of general conventional contactor.

Referring first to FIG. 1 showing exemplary one of the conventional electromagnetic contactors having a negative characteristic, such a conventional contactor is formed in such that a movable iron core 19 is normally subjected to a return biasing force effective in the direction shown by an arrow A, with a structure that each of a pair of levers 42 is mounted at one end slidably to a supporting member 41 rotatably pivoted to a fixing part of, for example, body case as indicated by 40, a coil spring 44 is inserted as compressed over each of the levers 42, and the levers 42 are joined at the other end by means of a pivoting member 43, so that the pivoting member 43 will be resiliently engaged to each end of a movable frame 1 supporting the movable core 19. In this arrangement, however, a large space has to be retained at both sides of the electromagnetic device or a fixed core for accommodating such return biasing means as above, and further the said means is of a complicated structure. Therefore, it is difficult to obtain a small and compact electromagnetic contactor.

The present invention is suggested to improve the above mentioned defects.

In the first embodiment of electromagnetic contactor according to the present invention shown in FIGS. 2A through 2C, A is a frame made of a synthetic resin, which forms an outer shell body of the contactor together with a body B also made of a synthetic resin. The frame A is provided with a space (see FIGS. 2B and 2C) inside it so that a movable frame 1 will be allowed to slide in the vertical direction inside the member. Said movable frame 1 is provided at its top with a test rod 2 and a space for receiving this test rod 2 is provided as a through hole 3 in the central upper part of the frame A. The frame member is provided with several partition walls 4 parallel with one another. Between these respective partition walls, three different types of fixed contact pieces 5, 6 and 7 are inserted respectively at a predetermined position for establishing normally closed and opened contacts in cooperation with movable contact pieces provided in the movable frame 1. One of the fixed contact pieces denoted by 5 is a normally closed contact piece located at each side-ward end of the frame A and is mounted at an upper part 8 with a terminal screw 9. Another one of the fixed contact pieces denoted by 6 is a normally opened contact piece mounted at a lower part 10 with a terminal screw 11, and a further one of the contact pieces denoted by 7 is for each of other normally opened contacts which are respectively mounted by a terminal screw 14 to each of the lower parts 13 between the parts 10 together with a metal fitting 12.

The movable frame 1 which is electrically insulative is provided with a plurality of through holes 15 parallel with one another. Two different types of movable contact pieces 16 and 17 are respectively inserted into predetermined one of these through holes 15 and are

resiliently supported within said through hole by a spring 37 or 38.

18 and 18' are substantially C-shaped wire springs having open ends and fitted to the movable frame 1 as inserted at the open ends into respective holes 27 (see FIG. 2B) provided symmetrically to the center on both sides of the lower part of the movable 1. A movable iron core 19 is accommodated in a space made in the bottom part of the movable frame 1 (see FIG. 2C). The movable core 19 and frame 1 are combined integrally with each other by inserting a pin 20 into matched through holes 21 and 21' made in the movable frame 1 and core 19, respectively.

A coil 22 and fixed iron core 23 are contained within the body B. The frame A is mounted on said body B and screws 24 are inserted and screwed into the body B from below so that the frame A and body B will be integrally combined with each other and a coil bobbin 25 placed in the body B will be pressed and fixed with the lower surface 39 (FIG. 2C) of the frame A. A groove 27' is made at the inside upper part of each side wall 26 of the body B so that, when the frame and body with the respective said components are coupled, an intermediate body part (the part opposite the open end) of the respective wire springs 18 and 18' will be inserted in said groove 27'. That is, it is a feature of the present invention that a pair of substantially C-shaped wire springs are fitted in position utilizing a space remained between the movable and fixed iron cores as engaged at the open ends with the movable frame and in the body parts with the grooves made in the respective side walls of the case body so that the combined resilient force of the wire springs will act with respect to the movable core in such that, with the engaging points as that case body side as fulcrum, the force will be always in diagonally upward direction, that is, in the direction in which the force will contribute to the returning force of the movable core while being gradually reduced. In order to achieve this, it is necessary that, as seen in FIGS. 2A-2C, the engaging point of the respective wire springs with the movable core is positioned always above the engaging point thereof with the body B as seen from side direction of the device or, in other words, always at the movable core side. With such a simple arrangement, the present invention enables it possible to render the diagonally upward directioned resilient force of the wire springs to be gradually reduced as the movable core is attracted toward the fixed core, whereby the movable core is provided with a returning force of a negative characteristic as will be later described with reference to FIGS. 7A and 7B.

FIGS. 3A and 3B show another embodiment of the present invention. The difference of this embodiment from the first embodiment is in the C-shaped wire spring supporting structure. In the present embodiment, the wire springs 18 and 18' are inserted at their open ends into respective holes 28 made in the movable frame 1 adjacent its both ends and are engaged in their body parts 29 and 29' with respective projections 30 provided on the upper surface and adjacent inner hole of the coil bobbin 25.

In FIG. 4 showing another embodiment of the present invention, as a modified supporting mechanism for the C-shaped wire springs, instead of the holes 27 in the first embodiment, a pair of projections 31 are made on each side surface of the movable frame so that the respective open ends of the wire springs will be simply en-

gaged in a spaced of the projections 31 defined by surfaces a-c so as to be movably fitted to the frame.

FIGS. 5A and 5B show another embodiment of the present invention. In this embodiment, the present invention is applied to a contactor having a structure in which the outer shell body is vertically dividable into two parts. In the drawing, the outer shell body comprises two halves 32 and 33 vertically divided, and the movable frame 1, movable iron core 19, fixed iron core 23 and coil 22 are contained in the inside space of these halves 32 and 33. Both body halves 32 and 33 are integrally combined with each other with screws 24. The wire springs 18 and 18' are engaged at their body parts with respective projections 34 provided on inside walls of the body halves 32 and 33. In order to make this engagement easy and positive in assembling the device, there is provided an aperture 36 in the respective side wall of the halves 32 and 33 at the position of the projection 34, so that the body part of the respective wire springs will be accessible from outside.

That is, as shown in FIG. 5B, the wire springs 18 and 18' are inserted and supported at the open ends in respective rectangular holes 35 made in the movable frame 1 and, at this time, the springs are suspended as inclined at an angle as the springs are in contact with the lower sides 35' of the holes 35, as shown with solid line in FIG. 5B, so that, after the assembly, the wire springs 18 and 18' may be easily engaged with the respective projections 34 by pushing the body part of the spring up in the direction indicated by the arrow with a proper tool inserted through the aperture 36.

In FIG. 6 showing another embodiment of the present invention, the pair of parallel grooves 27 for supporting the body parts 29 and 29' of the wire springs 18 and 18' are arranged as inclined at a certain desired angle with respect to the side walls of the body B, so that the movable core 19 will be stationary normally at the desired angle with respect to the fixed core 23 in the vertical plane to the moving direction of the movable core and, in case the movable core 19 is attracted to the fixed core 23, the movable core 19 will engage the fixed core 23 which making a slight rotary motion through said angle and, therefore, the impact force between the both cores will be reduced and at the same time a wiping action of the movable and fixed contacts will be obtained.

Now, the operation of the present invention shall be explained. When the electromagnet is energized, the movable core 19 will be attracted by the fixed cores 23 so that the movable contacts will come into contact with the fixed contacts against the resiliency of the wire springs 18 and 18'.

Referring to a spring load acted on the movable frame 1 including the movable core and movable contacts due to the resiliency of the wire springs 18 and 18' with reference to FIGS. 7A and 7C, it will be appreciated that a componential force F in said resiliency which acting in the returning direction of the movable core 19 is smaller in the state where the core 19 engages the fixed core 23 (FIG. 7B) than in the non-attracted state (FIG. 7A). Thus the total spring load characteristic curve of the wire springs and the contact springs 37 and 38 both acting in the returning direction of the movable frame 1 will be as shown in FIG. 7C, in the electromagnetic contactor according to the present invention, in which the curve shown by dotted line shows the returning force due to the wire springs.

Therefore, as compared with general conventional electromagnetic contactors which show such a positive characteristics of the return biasing force as shown in FIG. 7D, the present invention successfully achieves such effects that (i) the hum noise is reduced, (ii) the contact pressure is increased, (iii) any hesitation of the movable core is avoided and (iv) shock-proofness of the contactor is improved.

The features of the present invention are, therefore, that a spring structure for obtaining a returning force wherein the returning force at the energized position can be made smaller than the returning force at the non-energized position without taking a large space, thus a compact electromagnetic contactor having a high switching capacity can be obtained, the contactor can be manufactured at a lower cost since the number of component parts is small so as to simplify the assembly work, and the mechanical life is elongated since wearable components are less in number as compared with such the one as in FIG. 1.

While in the foregoing descriptions the wire springs 18 and 18' have been referred to as a substantially C-shaped spring, it will be appreciated that any wire spring in other shape than the C-shape which is resilient in the direction of the line connecting two opposing peripheral parts and mounted as compressed in said resilient direction in such manner as described will suffice the purpose of the present invention.

What we claim is:

1. In an electromagnetic contactor comprising a fixed element including an outer shell body made of an insulative material, a plurality of fixed contact pieces fixed inside said outer shell body at a first side thereof and a fixed magnetizable core and a coil member therefor fixed inside the outer shell body at a second side thereof opposing said first side; a movable magnetizable element including a movable frame having at one side a plurality of movable contact pieces respectively opposing said fixed contacts and a movable core fixed to the other side of said movable frame, said movable element being movable in the direction between said first and second sides in the outer shell body as attracted and nonattracted by electromagnetic energization and non-energization of the fixed core with respect to the movable core; and a pair of wire springs compressed between said movable element and said fixed element substantially at said second side, the improvement wherein said wire spring are substantially in a C-

shape arranged symmetrically with respect to the center of the movable element and inclined with respect to the movable direction of the movable element, so that the returning force on the movable element is away from the fixed core, said returning force being smaller at the attracted position of the movable element than at the non-attracted position thereof.

2. An electromagnetic contactor according to claim 1 wherein said C-shaped wire springs are engaged at the open ends with holes in the respective sides of the movable frame and in the body with grooves in the respective inside walls of the outer shell body.

3. An electromagnetic contactor according to claim 1 wherein said C-shaped wire springs are engaged at the open ends with holes in the respective sides of the movable frame and in the body with the coil member.

4. An electromagnetic contactor according to claim 1 wherein said C-shaped wire springs are engaged at the open ends with projections on the respective sides of the movable frame and on the body with grooves in the respective inside walls of the outer shell body.

5. An electromagnetic contactor according to claim 1 wherein grooves supporting the body-engaging end of said wire springs are so arranged that the movable elements will be stationary at a desired angle with respect to the fixed core in the vertical claim to the moving direction of the movable core in the non-attracted position.

6. An electromagnetic contactor according to claim 1 wherein said outer shell body is horizontally divided in the direction transversing the moving direction of the movable element into a frame part to which said fixed contact pieces are fixed and a body part to which said fixed core and coil member are fixed, said wire springs being respectively engaged at the open ends with hole in the respective sides of the movable frame and at the body parts with grooves in the respective sidewalls of said body part of the outer shell body.

7. An electromagnetic contactor according to claim 2 wherein said outer shell body is vertically divided into two parts in the same direction with the moving direction of the movable element, each of said vertically divided outer shell body parts having a vertical slit in the side wall, and an inward projection on said side wall adjacent said slit, so that said springs will be accessible through said slits so as to be pushed up into engaging position on said inward projection.

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