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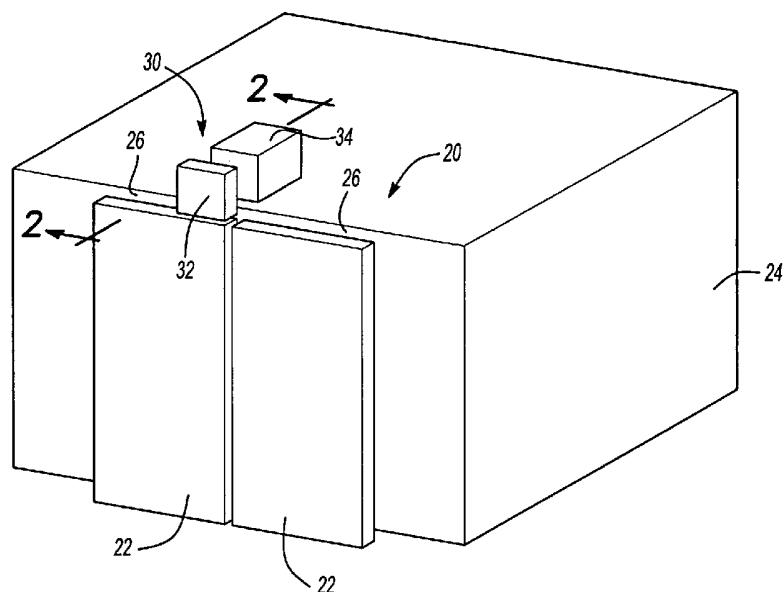
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(54) Title: ELECTROMAGNETICALLY OPERATED ELEVATOR DOOR LOCK



(57) Abstract: An electromagnetic door lock assembly (30) includes a first portion (32) supported relative to hoistway doors (22) and a second portion (34) supported for movement with an elevator car (24). The first and second portions cooperate so that electromagnetic interaction between them unlocks a set of hoistway doors (22) for access to the car (24), for example. In disclosed embodiments, a first portion (32) of the actuator has at least one stationary electromagnetic portion (36A, 36B) and at least one moveable portion (38). The second portion (34) that moves with the car (24) includes at least one stationary electromagnetic portion (44). Magnetic interaction between the first and second portions (32, 34) causes selected movement of the moveable portion (38) for selectively locking or unlocking the doors (22).



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ELECTROMAGNETICALLY OPERATED ELEVATOR DOOR LOCK

5 Field of the Invention

This invention generally relates to elevator systems. More particularly, this invention relates to door locking systems for elevators.

Description of the Related Art

10 Elevators typically include a car that moves vertically through a hoistway between different levels of a building. At each level or landing, a set of hoistway doors are arranged to close off the hoistway when the elevator car is not at that landing and to open with doors on the car to allow access to or from the elevator car when it is at the landing. It is necessary to have the hoistway doors locked when the
15 car is in motion or not appropriately positioned at a landing to prevent an individual from opening the hoistway doors, exposing the hoistway. Conventional arrangements include mechanical locks for keeping the hoistway doors locked under appropriate conditions.

 Conventional arrangements include a door interlock that typically integrates
20 several functions into a single device. The interlocks lock the hoistway doors, sense that the hoistway doors are locked and couple the hoistway doors to the car doors for opening purposes. While such integration of multiple functions provides lower material costs, there are significant design challenges presented by conventional arrangements. For example, the locking and sensing functions must be precise to
25 satisfy codes. The coupling function, on the other hand, requires a significant amount of tolerance to accommodate variations in the position of the car doors relative to the hoistway doors. While these two functions are typically integrated into a single device, their design implications are usually competing with each other.

 The competing considerations associated with conventional interlock
30 arrangements results in a significant number of call backs or maintenance requests. It is believed that elevator door system components account for approximately 50% of elevator maintenance requests and 30% of callbacks. Almost half of the callbacks due to a door system malfunction are related to one of the interlock functions.

There is a need in the industry for an improved arrangement that provides the security of a locked hoistway door, yet avoids the complexities of conventional arrangements and provides a more reliable arrangement that has reduced need for maintenance. This invention addresses that need with a unique elevator door lock
5 assembly.

SUMMARY OF THE INVENTION

An exemplary embodiment of this invention is an elevator door lock assembly that includes an electromagnetic actuator that selectively locks or unlocks the
10 assembly.

In one example, a locking member for locking a hoistway door is moved between a locking position and an unlocked position by the electromagnetic actuator. In this example, the electromagnetic actuator includes a first electromagnetic member supported for movement with an elevator car. A second electromagnetic member is
15 associated with the locking member. Magnetic interaction between the first and second members when the elevator car is appropriately positioned relative to the hoistway doors is operative to move the locking member in a selected direction.

In one example, the first and second electromagnetic members are ferromagnetic cores and a magnetic flux in one of the cores influences the other and
20 causes movement of the locking member responsive to the presence of the magnetic flux. By appropriately controlling power to the assembly, the magnetic flux can be controlled and the door lock can be manipulated into an opened or closed position in a reliable manner.

The various features and advantages of this invention will become apparent to
25 those skilled in the art from the following detailed description of the currently preferred embodiments. The drawings that accompany the detailed description can be briefly described as follows.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 schematically illustrates selected portions of an elevator car and associated hoistway doors.

5 Figure 2 is a partial cross-sectional view of an electromagnetic actuator as included in the embodiment of Figure 1 taken along the lines 2-2 in Figure 1.

Figure 3 is a perspective illustration schematically showing a portion of the embodiment of Figure 2 in a locked position.

10 Figure 4 is a cross-sectional illustration similar to Figure 2 showing the example assembly in an unlocked condition.

Figure 5 is a perspective illustration corresponding to Figure 4, schematically showing the components of Figure 3 in an unlocked position.

Figure 6 is a partial cross-sectional illustration of another example embodiment in a locked condition.

15 Figure 7 shows the embodiment of Figure 6 in an unlocked condition.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 schematically shows an elevator door assembly 20 that includes hoistway doors 22 that are supported in a known manner at a landing within a building, for example. An elevator car 24 includes car doors 26 that cooperate with the hoistway doors 22 to provide access to the car 24 when it is appropriately positioned at the landing.

20 The example embodiment includes an electromagnetic door lock assembly 30 having an electromagnetic actuator for selectively locking or unlocking the hoistway doors 22. As schematically shown in Figure 1, a first portion 32 is supported relative to the hoistway doors 22 to remain at the landing. A second portion 34 is supported for movement with the car 24 through a hoistway, for example. In one example, the second portion 34 is supported on a portion of the car frame. Other examples include supporting the second portion 34 on the cabin structure or as part of the door operator components.

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When the second portion 34 and the first portion 32 are appropriately aligned (i.e., when the car 24 is properly positioned at the landing), the electromagnetic actuator controls the operating condition of the door lock assembly 30. In a discussed example, the electromagnetic actuator unlocks the door assembly to provide access to
5 or from the car 24.

Referring to Figure 2, one example embodiment of an electromagnetic door lock assembly 30 is shown. The first portion 32 has at least one stationary electromagnetic portion and a moveable portion. In this example, two stationary portions 36A and 36B are positioned relative to a moveable portion 38 to facilitate
10 door lock operation as will be described. In one example, the stationary portions 36A and 36B and the moveable portion 38 comprise magnetic cores. In one example, the magnetic cores are made of a ferromagnetic material. In a specific example, the cores are made from steel.

The moveable portion 38 cooperates with a strike member 40 that provides a
15 door lock function to prevent the hoistway doors 22 from being opened under appropriate conditions. The moveable portion 38 in this example acts as a latch member that cooperates with the strike member 40 for selectively locking the doors.

In the example of Figure 2, the second portion 34 includes another electromagnetic member 44, which in this example is another magnetic core. In one
20 example, the electromagnetic member 44 is made of a ferromagnetic material. In this example, the electromagnetic member 44 is made of steel. One example embodiment comprises steel laminations while another example comprises milled, solid steel. A coil 46 is appropriately associated with the core 44 so that current flowing through the coil 46 induces magnetic flux in the core 44 in a known manner.

The example of Figure 2 includes a control 48 that is schematically shown as a circuit for powering the coil 46 under appropriate conditions. A switch 50 closes the
25 loop of the example circuit so that a power source 52 is coupled with the coil 46 so that current flows through the coil 46. In one example, the source 52 is a battery dedicated to the door lock assembly 30. In another example, the power source 52 is a
30 power source already associated with the car 24 and includes a rectifier and filter to provide appropriate DC power for current flow in the coil 46.

In the position shown in Figure 2, the switch 50 is open so that no current flows through the coil 46. Accordingly, there is no magnetic flux flowing through any of the magnetic portions. In this condition, the moveable portion 38 is biased by gravity, in this example, into a locked position. As can be appreciated from Figures 2 and 3, the moveable portion 38 is resting on a support 54 such that a latching arm 56 is positioned to engage the strike member 40, which prevents movement of the hoistway doors 22.

Also in this condition, there are air gaps 60 between the stationary portions 36A and 36B on the one hand and the moveable portion 38 on the other hand.

Figure 4 shows the embodiment of Figure 2 with the switch 50 closed so that current flows through the coil 46. At this point magnetic flux 62 flowing through the electromagnetic member 44 and the stationary portions 36A and 36B causes movement of the moveable portion 38 into the position shown in Figures 4 and 5. Specifically, the magnetic flux 62 seeks a path of least resistance, which results in minimizing the air gaps 60 between the stationary portions 36A and 36B on the one hand and the moveable portion 38 on the other hand. In other words, the magnetic flux 62 causes the moveable portion 38 to move into the unlocked position shown in Figures 4 and 5. In this example, the moveable portion 38 pivots about a pivot axis 64 between the locked position shown in Figures 2 and 3 and the unlocked position shown in Figures 4 and 5. As can best be appreciated from Figure 5, the latching arm 56 is clear of the strike member 40 so that the lock does not prevent movement of the hoistway doors 22.

In this example, the switch 50 is closed responsive to the car 24 arriving at the landing and responding to a call, for example so that the car doors 26 will open. In order for the hoistway doors 22 to open, the lock assembly 30 must be unlocked and the magnetic cooperation between the first portion 32 and the second portion 34 unlocks the doors. As can be appreciated from this example, the lock assembly 30 has an electromagnetic actuator that selectively locks the doors 22 when deenergized and unlocks the doors 22 when energized as the car is appropriately positioned, for example.

Figures 6 and 7 show another example embodiment. In this example, the first portion 32' includes a different configuration of stationary and moving portions. In

this example, stationary magnetic portions 66A and 66B are positioned relative to an armature 68 that effectively rotates between a locked position shown in Figure 6 and an unlocked position shown in Figure 7. In this example, when the switch 50 is closed, the flux 62 causes the armature 68 to move into a generally horizontal position as shown in Figure 7 so that a locking bolt 70 is removed from a striker recess 72, allowing the doors 22 to be moved. The magnetic flux 62 causes the armature 68 to move into the position shown in Figure 7 to minimize the air gaps 76 and 78 between the armature 68 and the stationary portions 66A and 66B, respectively.

In this example, the end 74 of the armature 68 associated with the locking bolt 70 is heavier than an opposite end so that the armature 68 is biased by gravity into the locked position shown in Figure 6 whenever the coil 46 is not energized.

Some embodiments have single actuators and locking members like the disclosed examples that are the exclusive locking mechanism. Other examples include more than one locking member, more than one actuator or more than one of both. Choosing an appropriate number will become apparent to one skilled in the art who has the benefit of this description to satisfy packaging constraints or redundancy criteria, for example.

The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from the essence of this invention. The scope of legal protection given to this invention can only be determined by studying the following claims.

CLAIMS

We claim:

1. An elevator door lock assembly, comprising:
5 an electromagnetic door lock actuator.
2. The assembly of claim 1, including a locking member for locking a hoistway door, a first portion supported for movement with an elevator car and a second portion associated with the locking member, and wherein magnetic interaction between the
10 first and second portion is operative to move the locking member.
3. The assembly of claim 2, wherein the second portion has a stationary portion and a moveable portion that is moveable between a first position corresponding to one of a locked position or an unlocked position of the assembly and a second position
15 corresponding to the other of the locked position or the unlocked position of the assembly and wherein the magnetic interaction is operative to move the moveable portion from the first position to the second position.
4. The assembly of claim 3, wherein the locking member moves with the
20 moveable portion.
5. The assembly of claim 4, wherein the second position includes a minimum air gap between the stationary portion and the moveable portion and the first position includes a greater air gap.
25
6. The assembly of claim 3, including a winding associated with the first portion and wherein current in the winding induces magnetic flux in the second portion that causes the moveable portion to move into the second position.
- 30 7. The assembly of claim 6, including a switch that controls current supply to the winding responsive to the first portion being in a selected position relative to the second portion.

8. The assembly of claim 2, wherein the first and second portions each comprise a magnetic core.
- 5 9. The assembly of claim 1, including a locking member that is moveable between a locked position and an unlocked position responsive to the electromagnetic actuator.
- 10 10. The assembly of claim 9, wherein the electromagnetic actuator includes a first portion and a second portion and wherein a magnetic flux associated with the first and second portions causes movement of the locking member.
11. The assembly of claim 10, wherein the locking member is biased into the locked position and the magnetic flux moves the locking member against the bias.
- 15 12. The assembly of claim 10, wherein the first portion is supported for movement with an elevator car and the second portion is associated with a hoistway door.

13. An elevator door assembly, comprising:
at least one hoistway door;
a locking member that is moveable between a locked position where the
locking member is operative to prevent movement of the hoistway door from a closed
position and an unlocked position; and
an electromagnetic actuator that selectively moves the locking member to
selectively allow movement of the hoistway door.
14. The assembly of claim 13, including at least one elevator car door that is
selectively moveable into a generally aligned position with the hoistway door and
wherein the electromagnetic actuator includes a first portion associated with the
elevator car door and a second portion associated with the hoistway door and wherein
a magnetic flux associated with the first and second portions causes movement of the
locking member.
15. The assembly of claim 14, wherein the magnetic flux becomes operative to
move the locking member when the car door is in the generally aligned position.
16. The assembly of claim 15, including a winding associated with the first
portion and a control that controls a supply of current to the winding responsive to the
car door being in the generally aligned position.
17. The assembly of claim 15, wherein the second portion includes a stationary
portion and a moveable portion that moves responsive to the magnetic flux and
wherein movement of the moveable portion causes movement of the locking member.
18. The assembly of claim 15, wherein the locking member is biased into the
locked position and the magnetic flux moves the locking member against the bias.

19. A method of unlocking an elevator door, comprising:
electromagnetically moving a locking member between a locked and an
unlocked position.

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20. The method of claim 19, including aligning an elevator car door with a
hoistway door and then unlocking the hoistway door.

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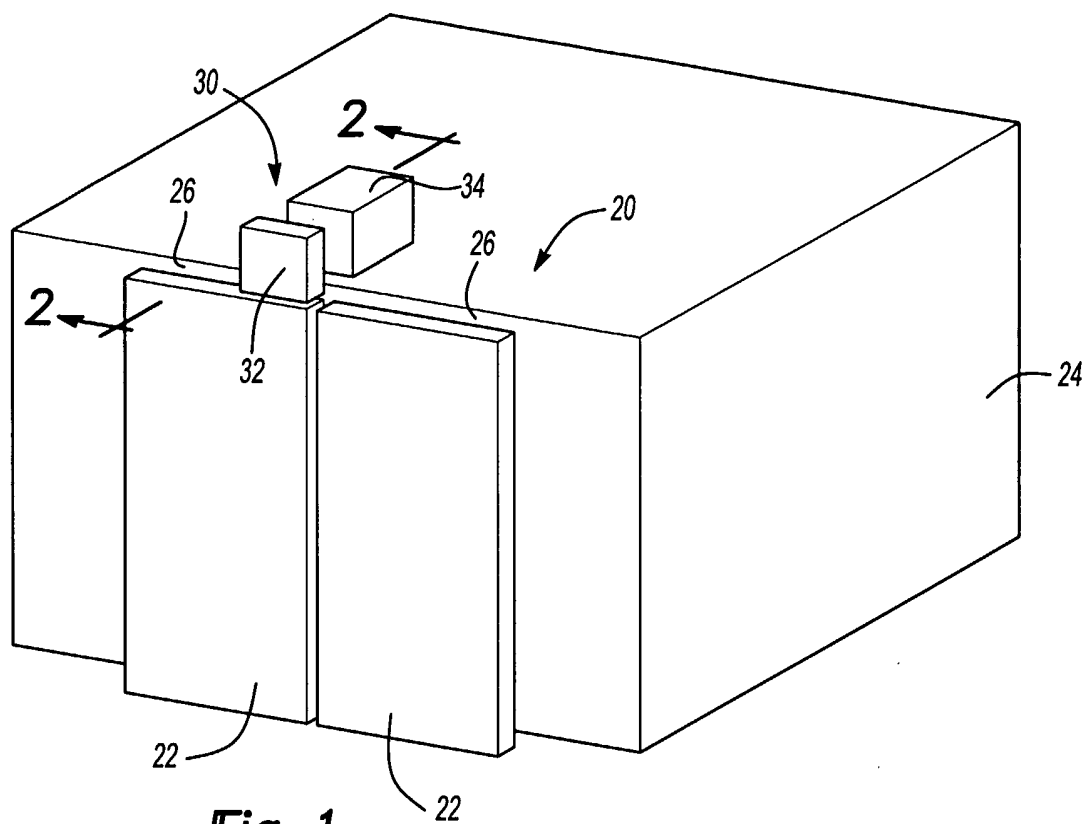
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Fig-1

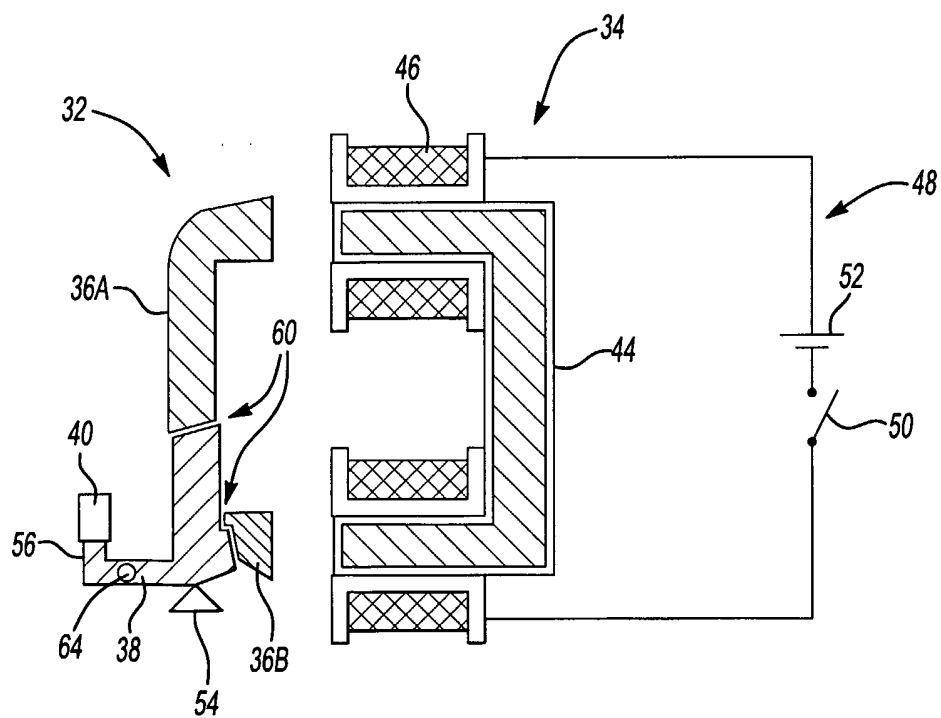
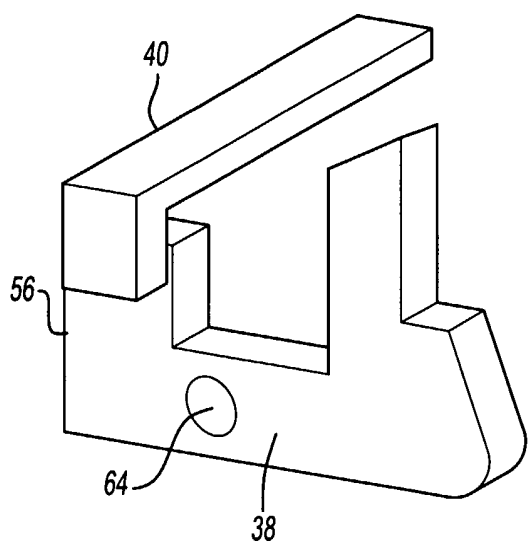
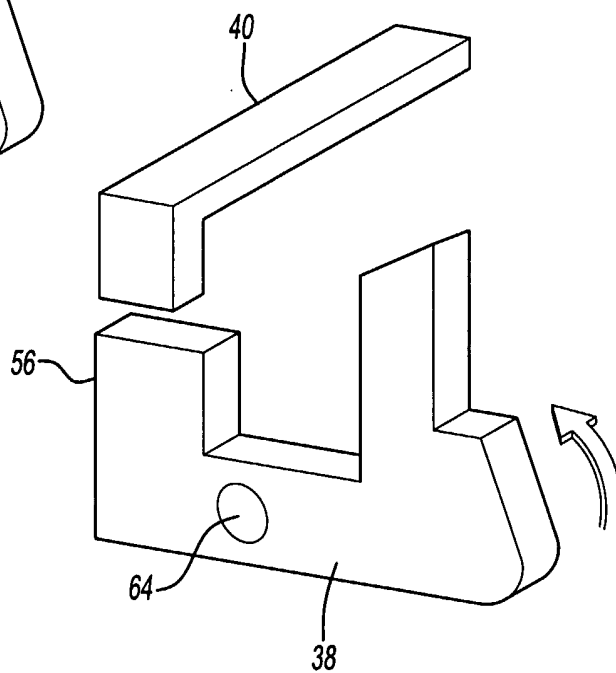
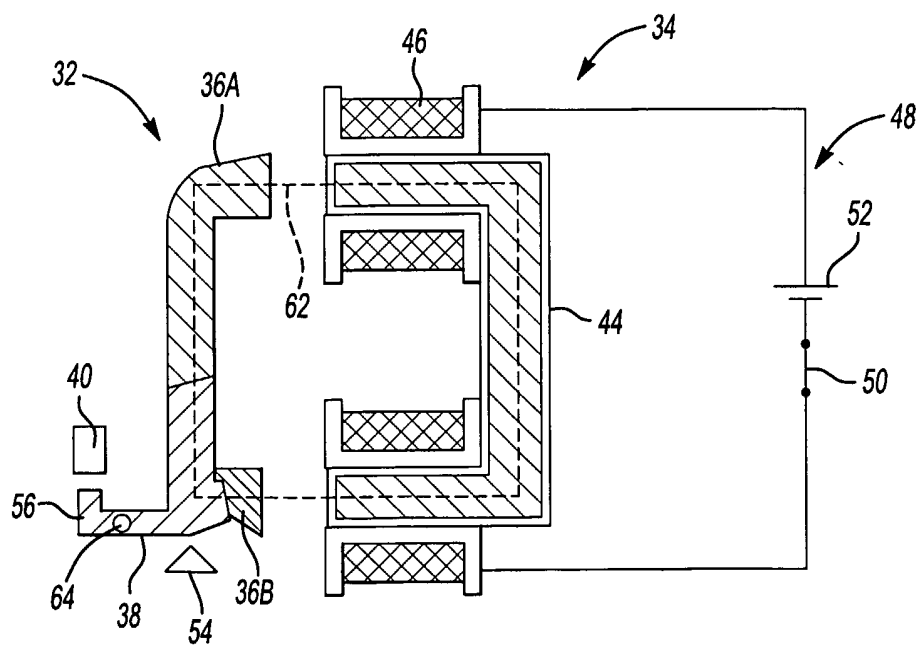
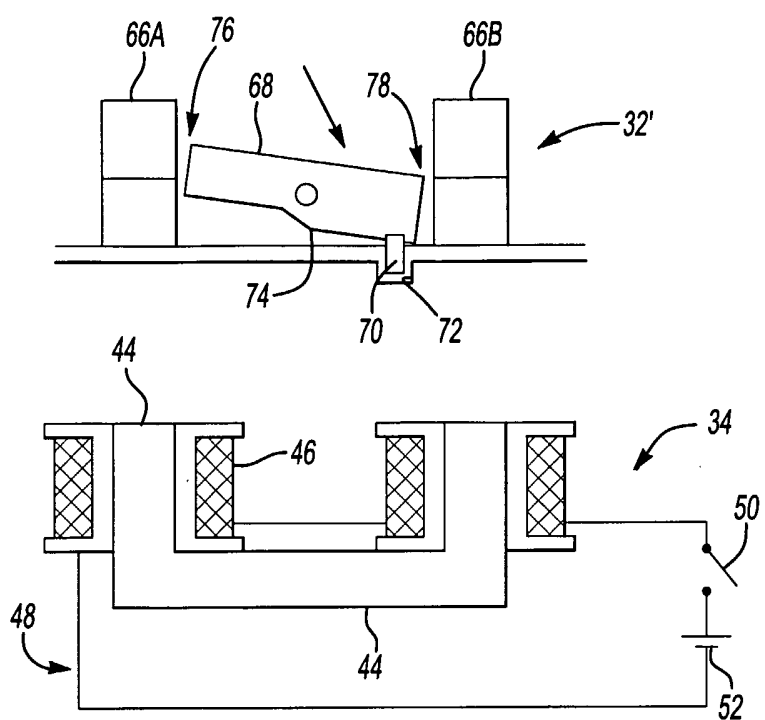


Fig-2

2/3

**Fig-3****Fig-5****Fig-4**

3/3

**Fig-6****Fig-7**