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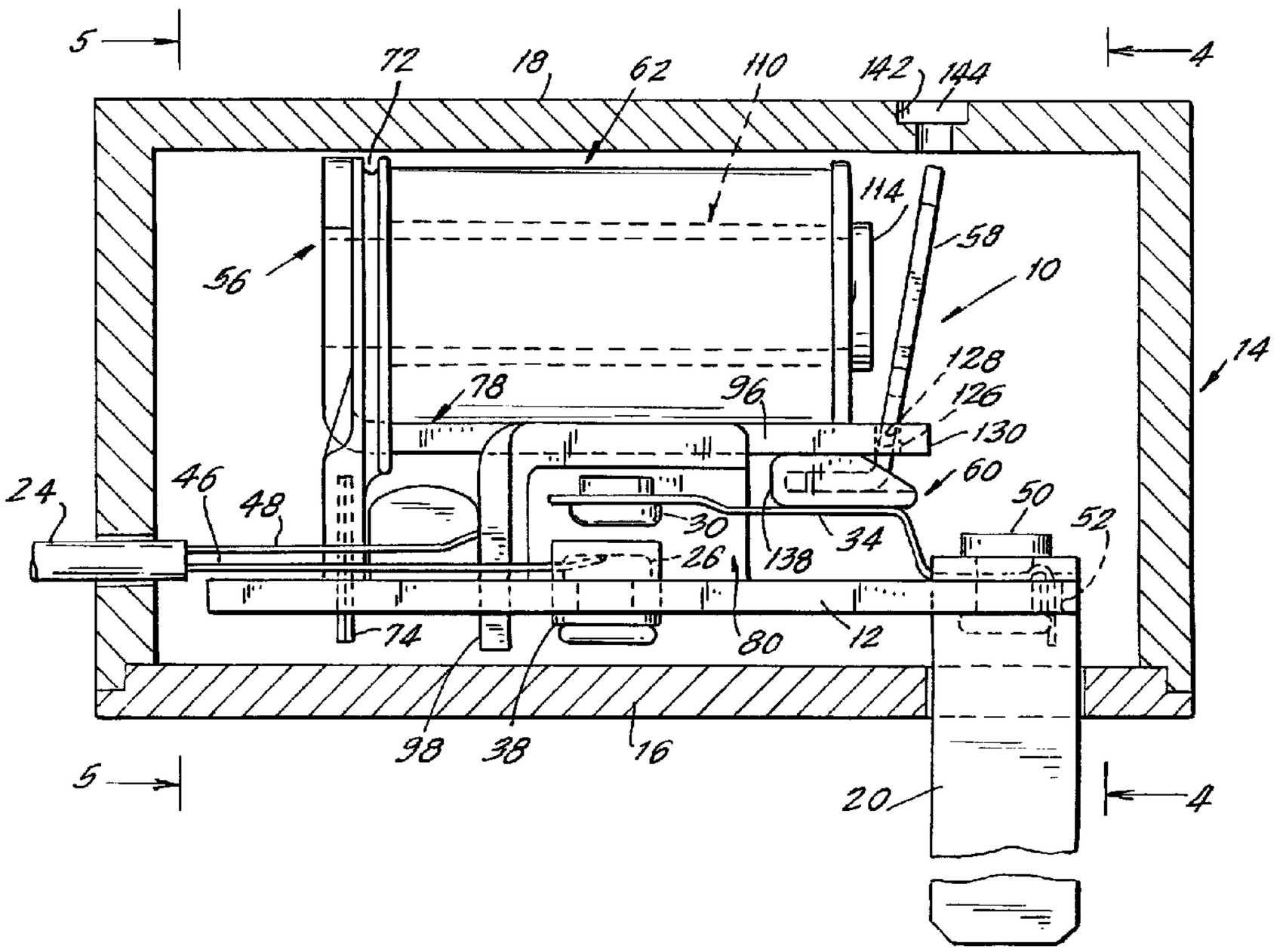
(54) **DISJONCTEUR**

(54) **CIRCUIT BREAKER FOR USE IN WALL MOUNTED PLUG**



(57) A circuit breaker includes a normally open switch having first and second contacts and a movable leaf spring supporting the first contact, The leaf spring is normally oriented in a first position wherein the first contact is not in electrical contact with the second contact. The leaf spring is deformable into a second position wherein the first contact is an electrical contact with the second contact. An armature is movable between an open and a closed position and is located adjacent an electric coil which generates a magnetic field which moves the armature into the closed position when the coil is energized. The leaf spring biases the armature into its open position when the coil is not energized. The armature causes the leaf spring to deform into the second position, so as to place the first contact into electrical contact with the second contact, when the coil is energized.

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ABSTRACT OF THE DISCLOSURE

A circuit breaker includes a normally open switch having first and second contacts and a movable leaf spring supporting the first contact. The leaf spring is normally oriented in a first position wherein the first contact is not in electrical contact with the second contact. The leaf spring is deformable into a second position wherein the first contact is an electrical contact with the second contact. An armature is movable between an open and a closed position and is located adjacent an electric coil which generates a magnetic field which moves the armature into the closed position when the coil is energized. The leaf spring biases the armature into its open position when the coil is not energized. The armature causes the leaf spring to deform into the second position, so as to place the first contact into electrical contact with the second contact, when the coil is energized.

CIRCUIT BREAKER FOR USE IN WALL MOUNTED PLUG

The present invention is directed towards an electromechanical circuit breaker, and more particularly, an electromechanical circuit breaker which is particularly useful in wall mounted plugs.

It has become increasingly common to utilize ground fault interrupter circuits in household appliances to protect against hazardous electric shock to the consumer. Such ground fault circuits are particularly important in connection with appliances operated around water, such as wet/dry vacuums and appliances utilized in the bathroom.

An integral part of a ground fault interrupter circuit is an electromechanical circuit breaker which interrupts the application of electric power to the load whenever a fault condition is detected. When such a circuit breaker is used in connection with a household appliance, it is particularly important that the circuit breaker be small, inexpensive, simple, and reliable. The use of a compact circuit breaker is particularly important when it is mounted in a standard wall plug holding the male plug blades which fit into a standard female wall receptacle.

While the circuit breaker of the present invention is particularly useful in connection with ground fault interrupter circuits housed in a wall mounted plug, the present invention is not limited to such applications.

The circuit breaker of the present invention comprises:

a normally open switch including first and second contacts and a moveable leaf spring supporting the first contact, the leaf spring is normally oriented in a first position wherein the first contact is not electrical contact with the second contact and is deformable into a second position wherein the first contact is in electrical contact with the second contact;

an armature moveable between an open position and a closed position;

an electrical coil for generating a magnetic field which moves the armature into the closed position when the coil is energized;

a support member upon which the coil is mounted and wherein the armature is hingedly connected to the support member; and

a cam member coupled between the armature and the leaf spring.

The leaf spring biases the armature into its open position when the coil is not energized, the armature causing the leaf spring to deform into the second position, so as to place the first contact into electrical contact with the second contact, when the coil is energized.

Preferably the cam member has a cam surface which contacts the support member. The cam member is moved into

the first position by the leaf spring when the coil is not energized. When the cam member is in its first position, the armature will be moved into its open position and the normally open switch will be open. The cam member is moved into a second position by the armature when the coil is energized. In this position, the cam member causes the leaf spring to move into its second position so as to close the normally open switch.

In the preferred embodiment, the armature is removably coupled to the support member by a tongue and groove arrangement and the tongue is normally biased into the groove by the leaf spring. The conductive core extends through the coil and cooperates with the support member and armature, which are also formed of conductive materials, to define a magnetic path for flux generated by the coil when the coil is energized.

The coil is preferably wound on a nonconductive bobbin which is supported on the support member. The conductive core extends through the bobbin and is separated from the coil by the bobbin.

A support member is preferably mounted on a circuit board via an insulation member which supports the support member at a position spaced from the circuit board.

In the preferred embodiment, the circuit breaker and circuit board are housed in a wall plug housing having a viewing opening therein. A portion of the armature which lies adjacent to viewing opening

when the armature is in one of the open and closed positions is preferably painted with a highly visible paint so as to provide a visual indication through the opening of whether the normally open switch is in the open or closed position.

For the purpose of illustrating the invention, there is shown in the drawing a form which is presently preferred, it being understood, however, that the invention is not limited to the precise arrangement and instrumentality shown.

Fig. 1 is a side view of the circuit breaker of the present invention located in the housing of a wall plug, part of the housing of the wall plug being broken away, with the circuit breaker in the open position.

Fig. 2 is a top view of the circuit breaker of Fig. 3, the top portion of the plug housing being broken away.

Fig. 3 is a cross section of the circuit breaker and plug housing taken along lines 3-3 of Fig. 2.

Fig. 4 is a front view of the circuit breaker of Fig. 1 taken along lines 4-4 of Fig. 1.

Fig. 5 is a rear view of the circuit breaker of Fig. 1 taken along lines 5-5 of Fig. 1.

Fig. 6 is an exploded isometric view of the circuit breaker of Fig. 1, without the winding coils.

Fig. 7 is an isometric view of the actuator illustrated in Fig. 6.

Fig. 8 is a side view of the circuit breaker of the present invention located in the housing of a wall plug, part of the housing of the wall plug being broken away, with the circuit breaker in the closed position.

Referring now to the drawings wherein like numerals indicate like elements, there is shown in Fig. 1 a circuit breaker constructed in accordance with the principles of the present invention and designated generally as 10. In the present embodiment, circuit breaker 10 is mounted on a circuit board 12 which also supports electronic components forming part of the ground fault interrupter circuit which drives the circuit breaker 10.

In the preferred embodiment, the circuit board 12 and the electronic components thereon, including the circuit breaker 10, are mounted in a plug housing 14 of a wall mounted plug.

The circuit board 12 is mounted to the plug housing 14 in any suitable manner. The plug housing 14 preferably includes a base portion 16 and a cover portion 18. The circuit board 12 is initially mounted on the base portion 16 of the housing 14 and then the

cover portion 18 is coupled to the base portion 16 to form an enclosure housing the circuit breaker 10.

The circuit breaker 10 is coupled between a pair of plug blades 20, 22 (Figs. 1 and 4) which are adapted to be inserted into a standard female wall receptacle and a power cord 24 which extends through an opening in housing 14, and is coupled to a load such as a household appliance.

As best viewed in Figs. 1, 2 and 5, the circuit breaker 10 includes a pair of stationery contacts 26, 28 and a pair of moveable contacts 30, 32 coupled to respective leaf springs 34, 36. The stationery contact 26, movable contact 30 and leaf spring 34 together define a first normally open switch. The stationery contact 28, the movable contact 32 and the leaf spring 36 together define a second normally open switch. The first normally open switch is coupled between the plug blade 20 and a first lead 46 of power cord 24. The second normally open switch is coupled between the plug blade 22 and the second lead 48 of the power cord 24. In the normally open position, these switches cut off power to the load coupled to power cord 24. In the closed position (illustrated in Fig. 8), the switches couple electrical power to the load.

Stationery contacts 26, 28 are preferably defined by respective eyelets which are riveted to circuit board 12 along with respective lugs 38, 40. Each of the lugs 38, 40 includes an annular portion which is located below circuit board 12 and has an opening through which its respective stationery contact is riveted. The lugs 38, 40 also include a laterally extending I shaped portion which extends along the

bottom of circuit board 12 and then up through respective openings 42, 44 (Fig. 2) in the circuit board 12 to a position located above the circuit board. Respective leads 46, 48 of the power cord 24 are connected to the portion lugs 38, 40 located above the circuit board 12 by any suitable means, for example by soldering.

Referring to Fig. 1, leaf spring 34 is coupled to plug blade 20 by an eyelet 50 which extends through the circuit board 12 and is riveted thereto. The rightmost end of the leaf spring 34 as viewed in Fig. 1 extends through an opening 52 in the circuit board 12 to provide a more stable connection to the circuit board. The leaf spring 36 is similarly coupled to the circuit board 12 by a corresponding eyelet 54 (Fig. 2).

The spring force in leaf springs 34, 36 cause them to be located in the positions illustrated in Figs. 1 and 3 in the absence of any externally applied forces. In this position, the moveable contacts 30, 32 will be spaced from the stationery contacts 26, 28, respectively.

When power is to be applied to the load coupled to power cord 24, a relay 56 forming part of the circuit breaker 10 is energized by the circuitry (e.g. a ground fault control circuit) coupled to circuit board 12 causing the armature 58 to pivot from the open position illustrated in Fig. 1 to the closed position illustrated in Fig. 8. In this position, the cam member 60, which is coupled to the bottom end of armature 58, rotates from its generally horizontal orientation illustrated in Fig. 1 to its oblique

orientation illustrated in Fig. 8 and deforms leaf springs 34, 36 into the position illustrated in Fig. 8. This moves the moveable contacts 30, 32 into firm contact with the stationery contacts 26, 28, respectively. In the preferred embodiment, the cam member 60 is designed to ensure that there is an over deformation in the leaf springs 34, 36 (that is, they are deformed beyond the position required to first place moveable contacts 30, 32 into contact with stationery contacts 26, 28) in order to ensure a strong contact between the moveable contacts 30, 32 and stationery contacts 26, 28, respectively.

The detailed structure and operation of relay 56 will now be described in more detail with particular reference to Figs. 3 and 6.

The relay 56 includes a plastic bobbin 62 having a cylindrical section 64 on which the coil 66 is wound. Opposite ends of the coil 66 pass through a slot 68 formed in the back wall 70 of bobbin 62 and into the channel 72 formed at the rear of the bobbin 62. One end of the coil 66 extends down the left side of the channel 72 and is electrically connected to pin 74. The remaining end of coil 66 extends down the right side of channel 72 and is connected to pin 76. As best shown in Figs. 1 and 3, pins 74, 76 extend through the circuit board 12. While not shown, the pins 74, 76 are connected to respective circuit board leads which are energized when the coil 66 is to be activated.

The plastic bobbin 62 is supported on a metallic frame 78 which in turn is supported by a plastic insulation piece 80 which sits on the top surface of circuit board 12.

The insulation piece 80 includes a planar support surface 82 and a pair of lateral edge guides 84, 86. The width of the portion of the support surface 82 located between lateral edge guides 84, 86 is equal to the width of the base section 96 of the metallic frame 78 which is seated on the insulation piece 80 to closely hold the frame 78 in place. The planar support surface 82 is maintained at a location above the circuit board 12 (so as to insulate the coil 28 from the circuit board) by a plurality of legs 88, 90, 92 extending downwardly from the support surface 82. A domed opening 94 is formed in the rear bottom portion of insulation piece 80 to permit the lead 48 of the power cord 24 to pass under the coil 66 so that it may be soldered or otherwise coupled to lug 40.

The metallic frame 78 includes a base section 96 which is received on the planar support surface 82 of insulation piece 80. A pair of downwardly projecting pins 98, 100 are formed integrally with the base section 96 and wrap around corresponding surfaces 102, 104 formed along the sides of insulation piece 80. As best shown in Figs. 1 and 3, the pins 98, 100 extend through corresponding openings (unnumbered) in circuit board 12 and are connected to circuit board 12 in any appropriate manner.

The metallic frame 78 includes a rear section 106 having an opening 108 formed therein. Opening 108 receives the rear end of the metallic core 110 extending through a corresponding opening 112 in bobbin 62. The metallic core 110, the metallic support plate 96 and the metallic armature 58 cooperate to

define a magnetic path for the flux generated by the coil 66 when current is passed through the coil. The magnetic flux will be concentrated at the front face 114 of the metallic core 110 forming a strong magnetic field which will draw the armature 58 from the open position illustrated in Fig. 1 to the closed position illustrated in Fig. 8.

As best shown in Figs. 3, 6 and 7, the armature 58 is fixedly coupled to plastic cam member 60 and is hingedly coupled to the metallic frame 78. The armature 58 includes a foot portion 116 and a face portion 118. Foot portion 116 is fitted into a slot 120 formed in cam member 60. Part of the metal forming the foot portion 116 is cut and forced upwardly to form a projection 122. As the foot portion 116 is forced into the slot 120 in cam member 60, the upper wall 119 of cam member 60 will be deformed upwardly until the projection 122 is received in the slot 124 formed in the rear of cam member 60. As a result of this snap-fit arrangement, the cam member 60 is securely attached to the foot portion of 116 of armature 58.

As best shown in Figs. 6 and 7, an inverted U-shape opening is formed in face portion 118 of armature 58 to form an upwardly projecting tongue 126. The tongue 126 is received in a corresponding groove 128 formed in a narrow projection 130 extending from the front end of metallic frame 78.

As best shown in Figs. 1 and 3, the cam member 60 is pressed against the bottom of base section 96 of metallic frame 78 by the spring force of leaf springs 34, 36. As a result of the spring force, the tongue 126 formed in the face portion 118 of armature

58 is forced up through the groove 128 in frame 78. Since the upper and lower faces 132, 134 (Fig. 6) of the cam member 60 are aligned parallel to one another, and since the face portion 118 of armature 58 forms an oblique angle with the foot portion 116 thereof, the face portion 118 of armature 58 will be spaced from the front face 114 of core 110 whenever the coil 66 is not energized. When electrical current flows through the coil 66, the armature 58 pivots about a pivot point defined by the bottom portions 115 of the U-shaped opening in armature 58 and the bottom 117 of projection 130. As a result, the face portion 118 of armature 58 is drawn into contact with the front face 114 of core 110 causing the rear lower edge 138 of cam member 60 to rotate counterclockwise as viewed in Figs. 1 and 3 thereby deforming leaf springs 34, 36 into the position illustrated in Fig. 8 and moving moveable contacts 30, 32 into firm contact with stationery contacts 26, 28.

As best seen in Figs. 1 and 6, the top of the front face 118 of armature 58 defines an indicator section 140 which is preferably painted with an easily visible color, such as iridescent orange. As best viewed in Fig. 1, a viewing opening 142 is formed in housing 14 at a location corresponding to the location of indicator section 140 when armature 58 is in the open position illustrating Fig. 1. In the preferred embodiment, a viewing lens 144 is located in the viewing opening 142. This lens may be a magnifying lens so as to make it easier to view the indicator section 140 through the opening 142.

When power is being applied to the load, the armature 58 is located in the closed position

illustrated in Fig. 8 and the indicator section 140 is moved away from the viewing opening 142. The user will not see the brightly colored indicator section 140 which will inform him that power is being applied to the load.

When power is cut off from the load, the armature 58 returns to the open position illustrated in Fig. 1 and the user can view the indicator section 140 through the viewing opening 142. In this position, the viewer will see the brightly colored paint located on the indicator section 40 which will let the viewer know that the circuit breaker is open and that power is disconnected from the load.

In the preferred embodiment, the viewing opening 142 is placed at the location of the indicator section 140 when the armature 58 is in the open position. Alternately, the viewing opening 142 can be located at the position of the indicator section when armature 58 is in the closed position. In such case, a bright color such as green is preferably used to indicate an OK condition -- that is, that the circuit breaker is closed and power is being applied to the load.

The foregoing structure provides a very simple, reliable, and inexpensive circuit breaker with the minimum of moveable parts. The circuit breaker can be constructed very compactly so as to fit within the housing of a wall plug while retaining full electrical capacity, low manufacturing costs, and reliable, fully automatic operation.

The present invention may be embodied in other specific forms without departing from the spirit

or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification, as indicating the scope of the invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A circuit breaker comprising:
a normally open switch including first and second contacts and a moveable leaf spring supporting said first contact, said leaf spring normally being oriented in a first position wherein said first contact is not in electrical contact with said second contact and being deformable into a second position wherein said first contact is in electrical contact with said second contact;
an armature moveable between an open position and a closed position;
an electrical coil for generating a magnetic field which moves said armature into said closed position when said coil is energized;
a support member upon which said coil is mounted and wherein said armature is hingedly coupled to said support member; and
a cam member coupled between said armature and said leaf spring;
wherein said leaf spring biases said armature into the open position when said coil is not energized, said armature causing said leaf spring to deform into said second position, so as to place said first contact into electrical contact with said second contact, when said coil is energized.

2. The circuit breaker of claim 1, wherein said cam member has a cam surface which contacts said support member, said cam member being moved into a first position by said leaf spring when said coil is not energized and being moved into a second position by said armature when said coil is energized.

3. The circuit breaker of claim 1 or 2, wherein said armature is removably coupled to said support member by a tongue and groove arrangement and wherein said tongue is normally biased into said groove by said leaf spring.

4. The circuit breaker of claim 1, 2 or 3, further including a conductive core extending through said coil and wherein said support member and said armature are formed of conductive materials and cooperate with said core to define a magnetic path for flux generated by said coil when said coil is energized.

5. The circuit breaker of claim 4, further including a non-conductive bobbin on which said coil is wound, said bobbin being supported on said support member, said core extending through said bobbin and being separated from said coil by said bobbin.

6. The circuit breaker of any one of claims 1 to 5, wherein said support member is mounted on a circuit board via an insulation member which supports said support member at a position spaced from said circuit board.

7. The circuit breaker of any one of claims 1 to 6, further including means for enhancing the visibility of said armature so that said armature provides a visual indication of whether said normally open switch is in said open or closed position.

8. A combination, comprising:

(A) a circuit board having electronic components coupled thereto; and

(B) a circuit breaker mounted on said circuit board, said circuit breaker comprising:

(i) a normally open switch including first and second contacts and a moveable leaf spring supporting said first contact, said leaf spring normally being oriented in a first position wherein said first contact is not in an electrical contact with said second contact and being deformable into a second position wherein said first contact is in electrical contact with said second contact;

(ii) an armature moveable between an open position and a closed position;

(iii) an electrical coil for generating a magnetic field which moves said armature into said closed position when said coil is energized;

(iv) a support member upon which said coil is mounted and wherein said armature is hingedly coupled to said support member; and

(v) a cam member coupled between said armature and said leaf spring;

wherein said leaf spring biases said armature into said open position when said coil is not energized, said armature causing said leaf spring to deform into said second position, so as to place said first contact into electrical contact with said second contact, when said coil is energized.

9. The combination of claim 8, wherein said cam member has a cam surface which contacts said support member, said cam member being moved into a first position by said leaf spring when said coil is not energized and being moved into a second position by said armature when said coil is energized.

10. The combination of claim 8 or 9, wherein said armature is removably coupled to said support member by a tongue and groove arrangement, and wherein said tongue is normally biased into said groove by said leaf spring.

11. The combination of claim 8, 9 or 10, further including a conductive core extending through said coil and wherein said support member and said armature are formed of conductive materials and cooperate with said core to define a magnetic path for flux generated by said coil when said coil is energized.

12. The combination of claim 11, further including a non-conductive bobbin on which said coil is wound, said bobbin being supported on said support member, said core

extending through said bobbin and being separated from said coil by said bobbin.

13. The combination of any one of claims 8 to 12, further including an insulation member for supporting said support member at a position spaced from said circuit board.

14. The combination of any one of claims 8 to 13, further including means for enhancing the visibility of said armature so that said armature provides a visual indication of whether said normally open switch is in said open or closed position.

15. A wall plug having a circuit breaker mounted therein, comprising:

(A) a housing;

(B) a pair of plug blades extending from a position inside said housing to a position outside of said housing;

(C) a power cord extending from a position internally of said housing to a load, said power cord having first and second power leads; and

(D) a circuit breaker located in said housing for selectively electrically coupling said plug blades to said power cord, said circuit breaker comprising:

(i) a pair of normally open switches, each of said switches being coupled between a respective said plug blade and a respective said power lead, each of said switches including:

(a) first and second contacts and a moveable leaf spring supporting said first contact, said leaf spring normally being oriented in a first position wherein said first contact is not in electrical contact with said second contact and being deformable into a second position wherein said first contact is in electrical contact with said second contact;

(b) one of said first and second contacts being electrically coupled to its respective said plug blade, the other of said first and second contacts being electrically coupled to its respective said power lead;

(ii) an armature moveable between an open position and a closed position;

(iii) an electric coil for generating a magnetic field which moves said armature into said closed position when said coil is energized;

(iv) a support member upon which said coil is mounted and wherein said armature is hingedly coupled to said support member; and

(v) a cam member coupled between said armature and said leaf spring;

wherein said leaf springs biasing said armature into its open position when said coil is not energized, said armature causing said leaf springs to deform into their respective second positions, so as to place each of said first contacts into electrical contact with its associated second contact, when said coil is energized.

16. The wall plug of claim 15, wherein said cam member has a cam surface which contacts said support member, said cam member being moved into said first position by said leaf springs when said coil is not energized and being moved into a second position by said armature when said coil is energized.

17. The wall plug of claim 15 or 16, wherein said armature is removably coupled to said support member by a tongue and groove arrangement and wherein said tongue is normally biased into said groove by said leaf springs.

18. The wall plug of claim 15, 16 or 17, further including a conductive core extending through said coil and wherein said support member and said armature are formed of conductive materials and cooperate with said core to define a magnetic path for flux generated by said coil when said coil is energized.

19. The wall plug of claim 18, further including a non-conductive bobbin on which said coil is wound, said bobbin being supported on said support member, said core extending through said bobbin and being separated from said coil by said bobbin.

20. The wall plug of any one of claims 15 to 19, wherein said support member is mounted on a circuit board located in said housing via an insulation support member

which supports said support member in a position spaced from said circuit board.

21. The wall plug of any one of claims 15 to 20, further including a viewing opening formed in said housing for viewing the position of said armature so that said armature provides a visual indication of whether said normally open switches are in said open or closed position.

22. The wall plug of claim 21, further including means for enhancing the visibility of said armature.

23. The wall plug of claim 22, wherein said means for enhancing comprises an easily visible paint placed on at least a portion of said armature.

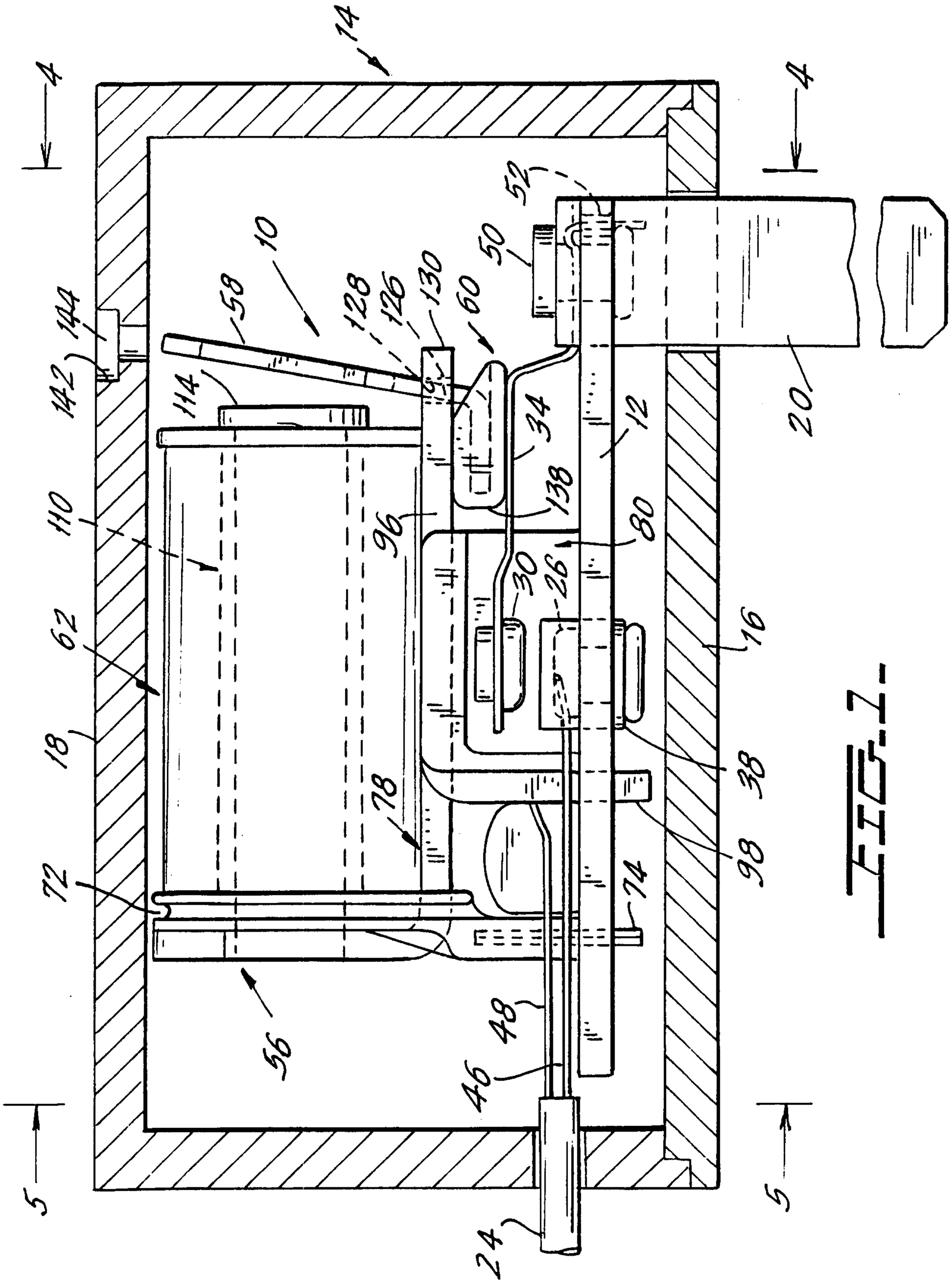
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FIG. 1

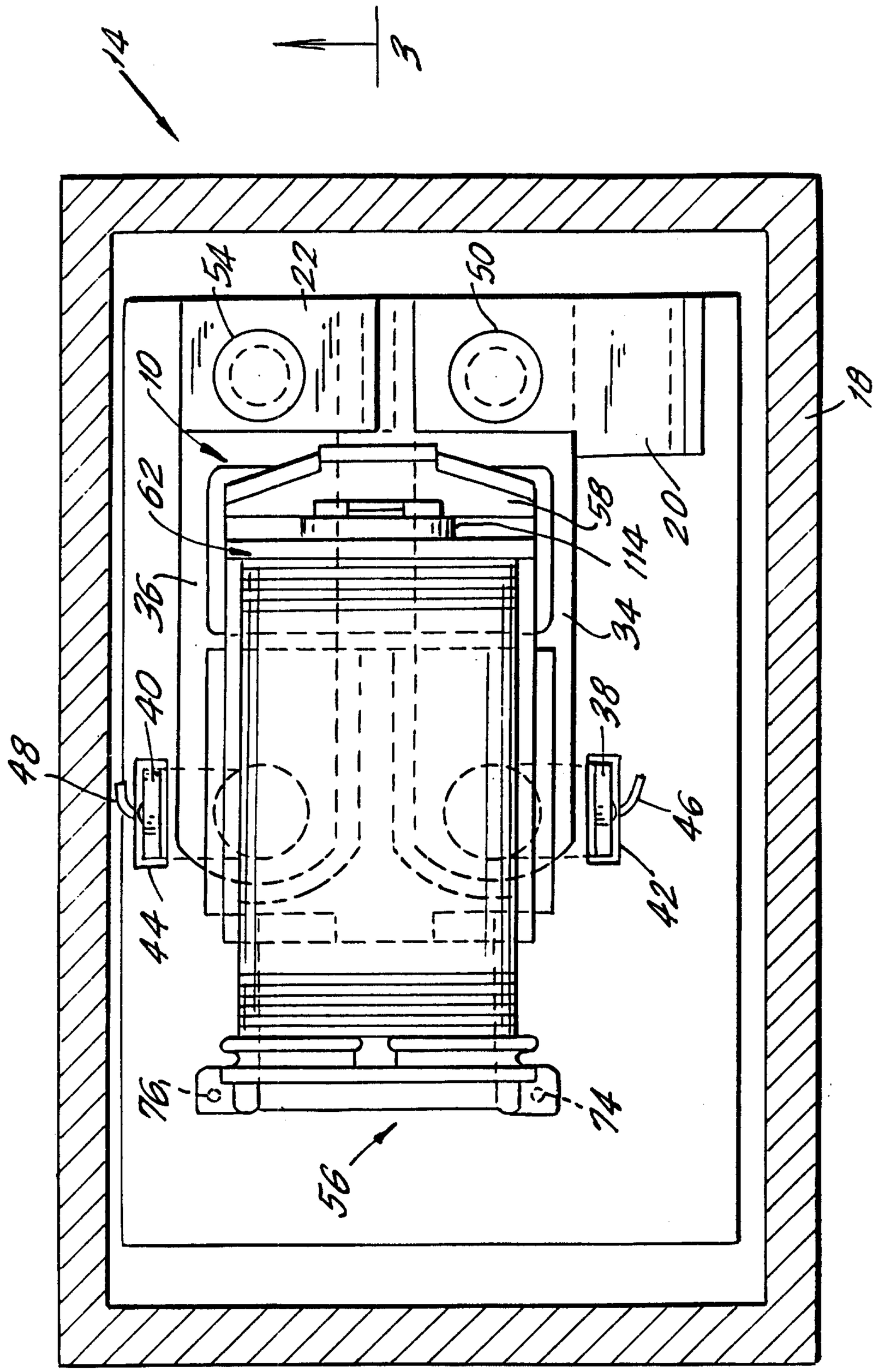

FIG. 2.

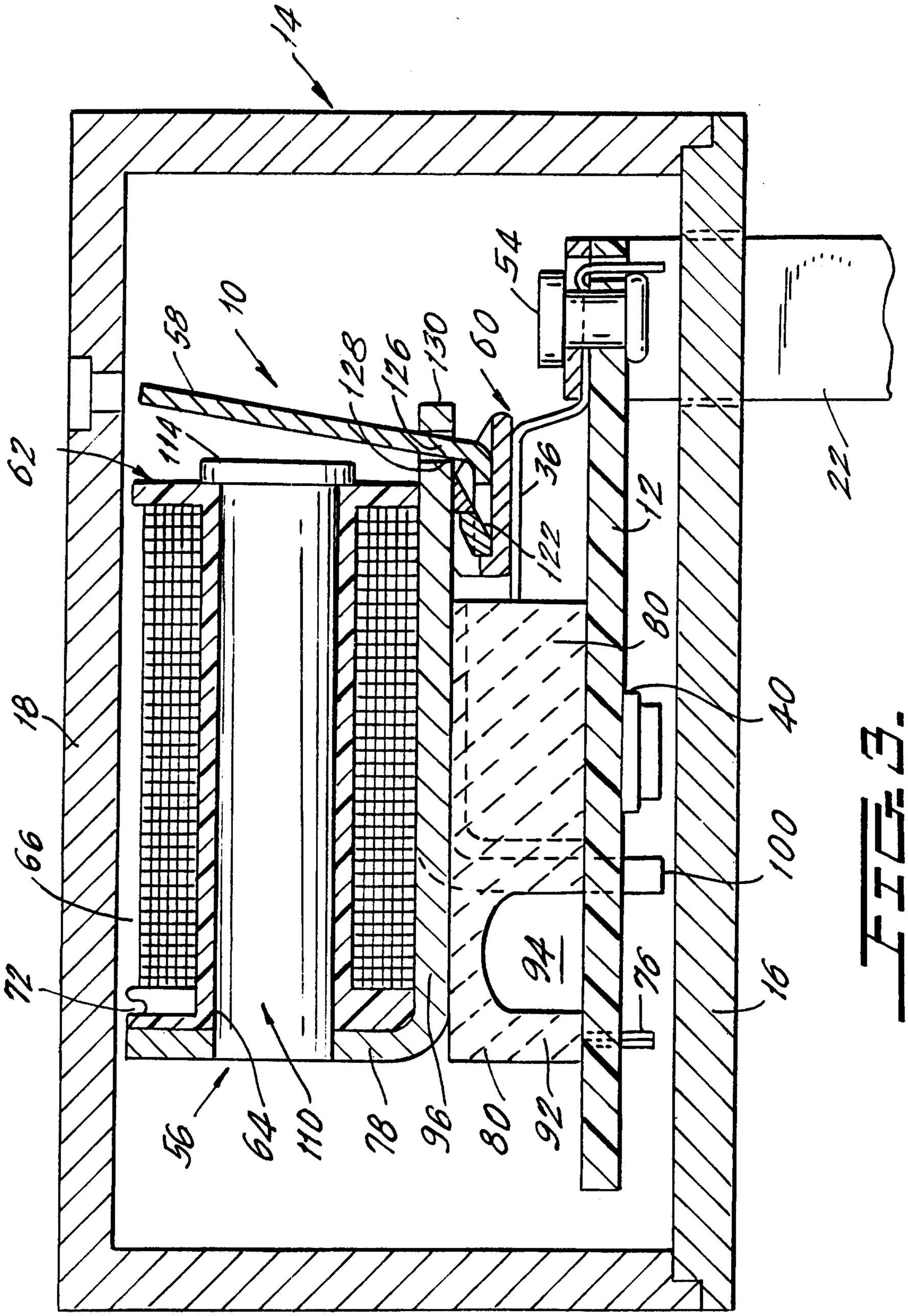
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FIG. 3.

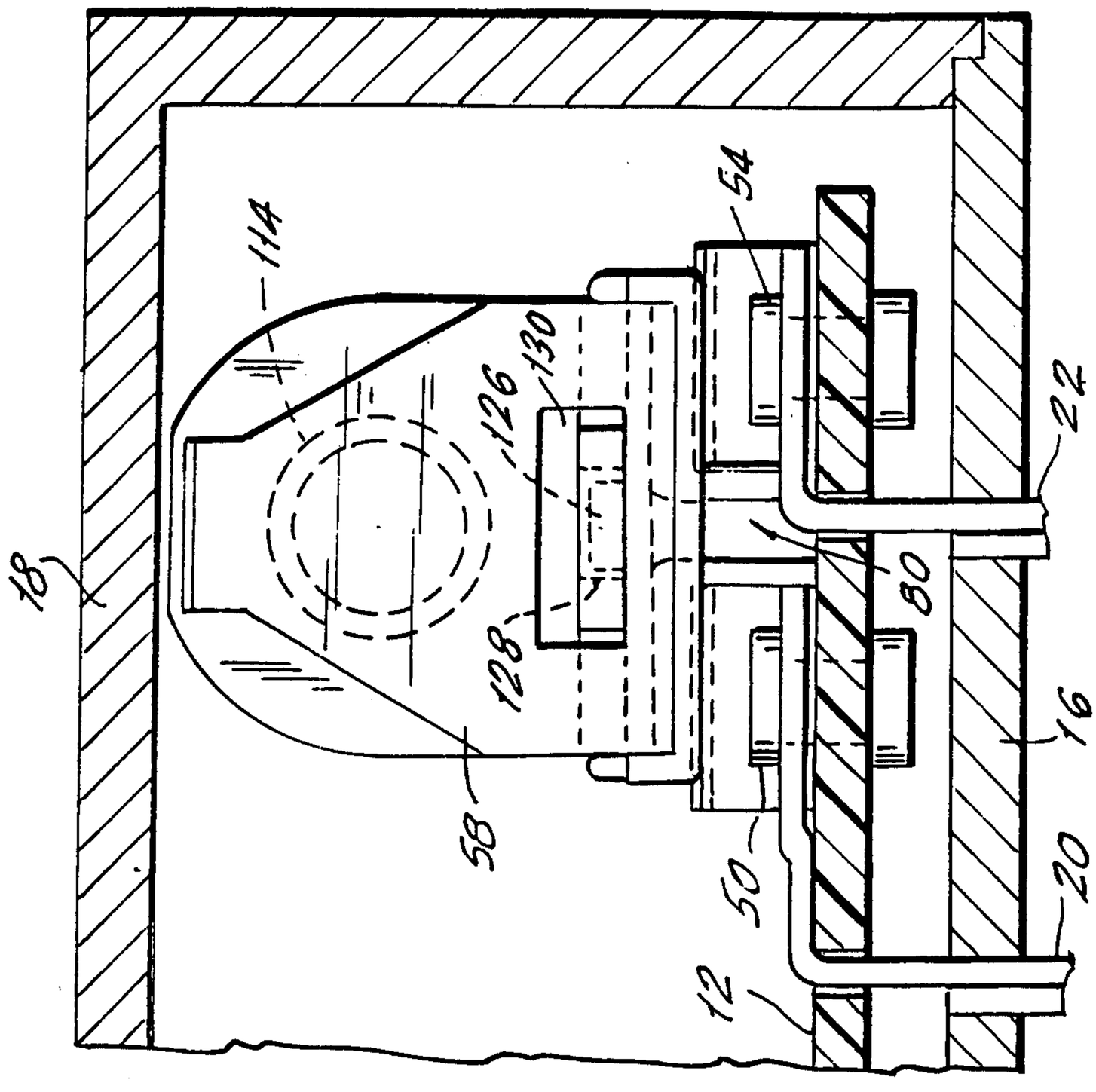
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FIG. 4.

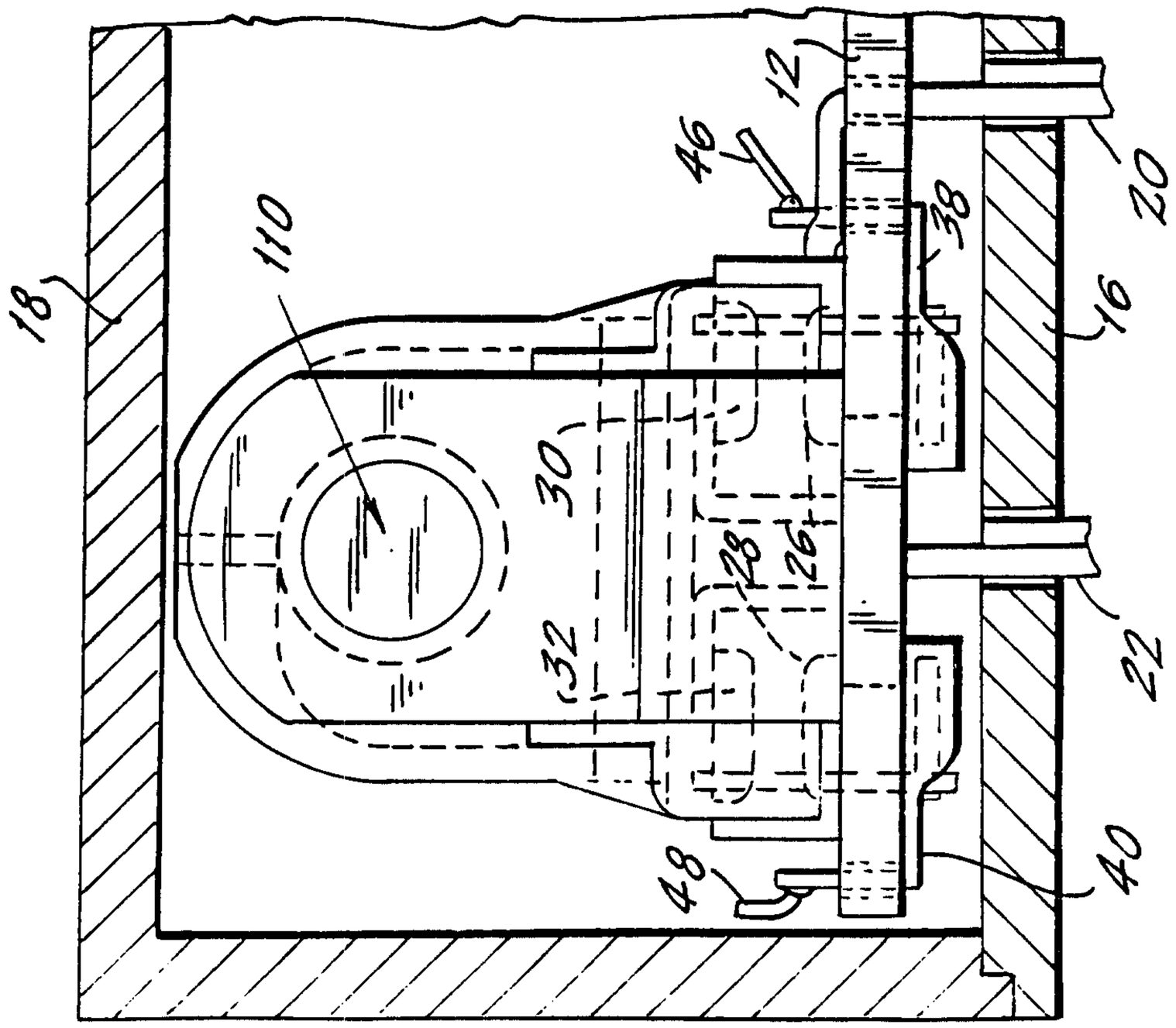
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FIG. 5.

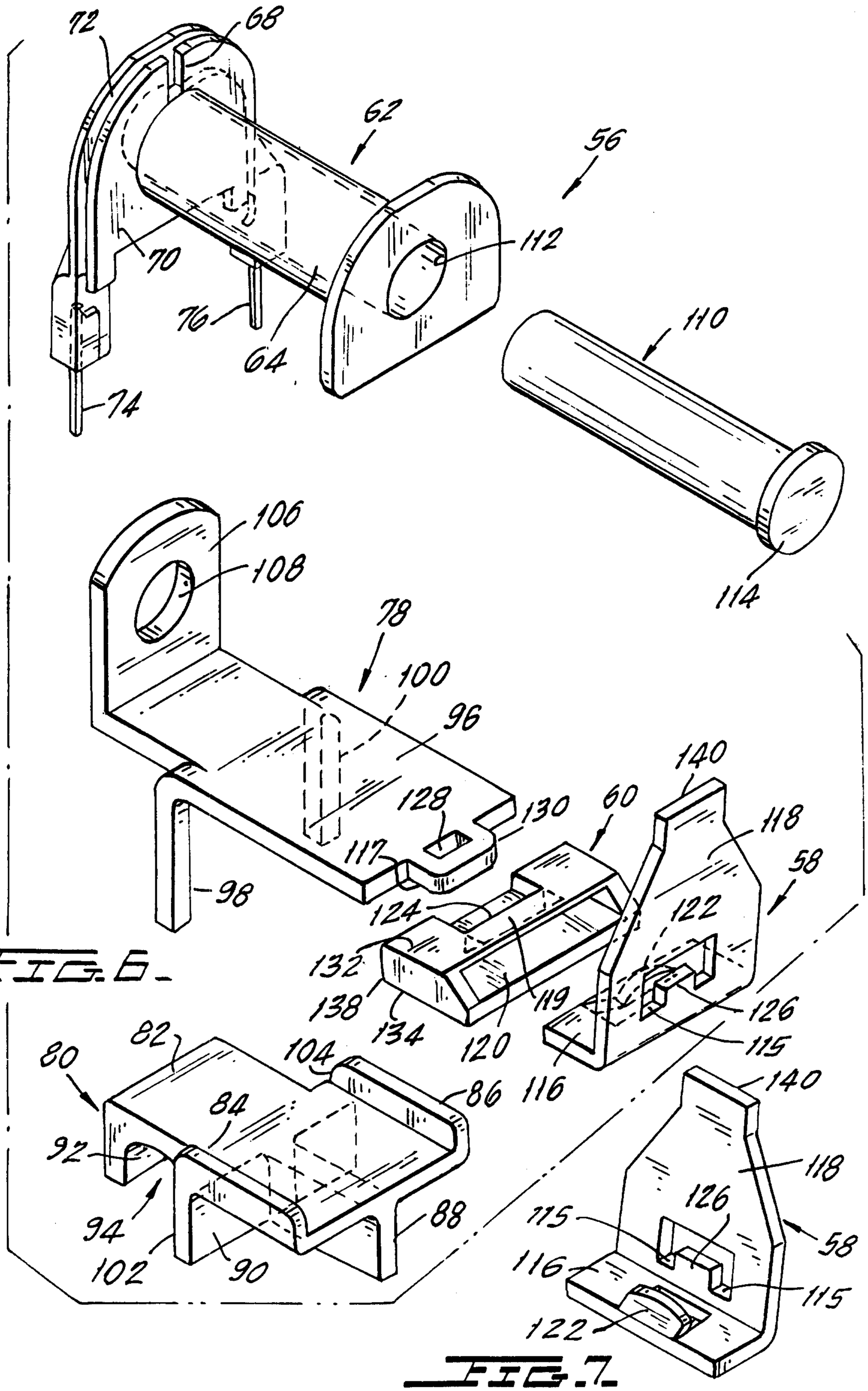
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FIG. 6

FIG. 7

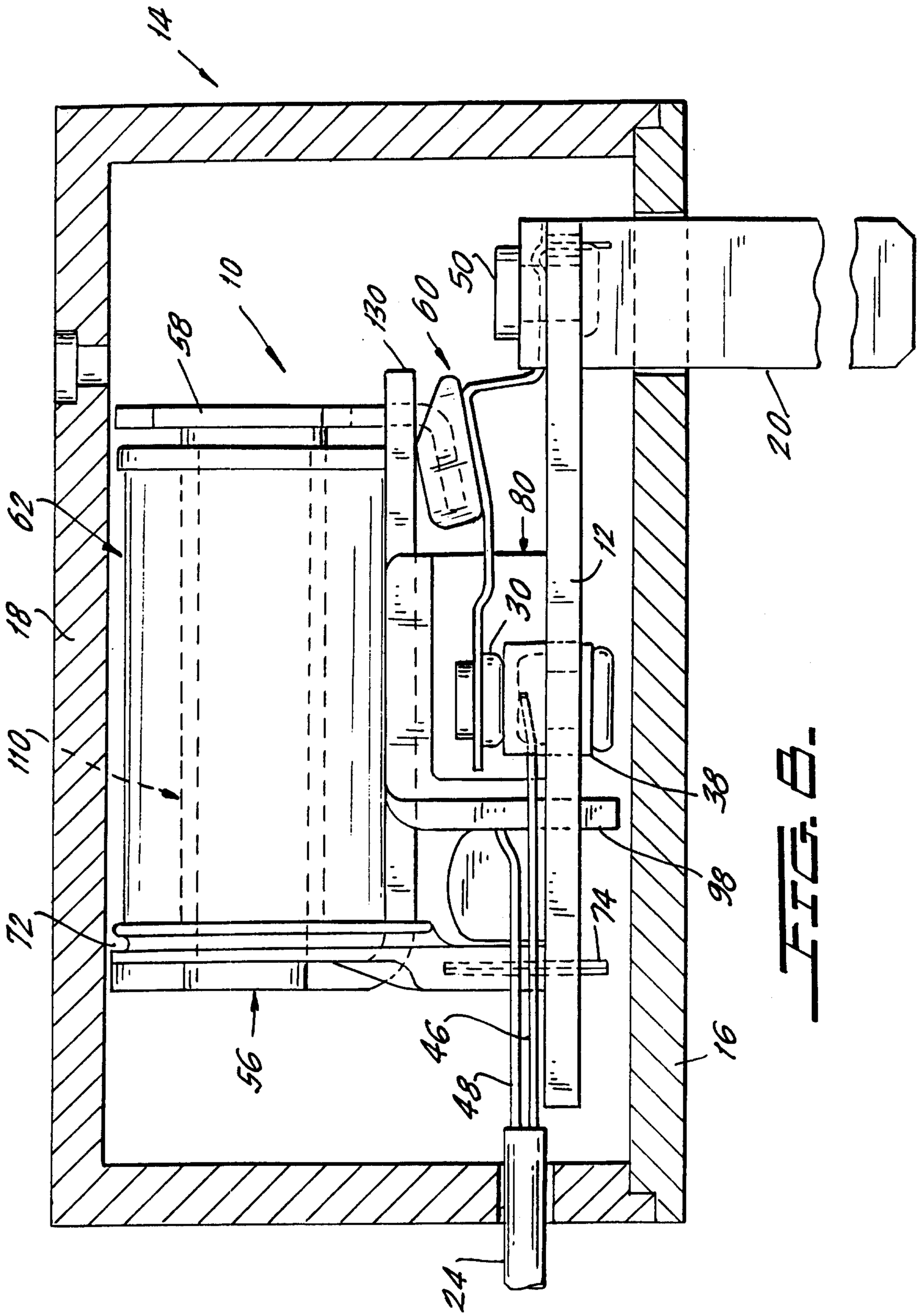
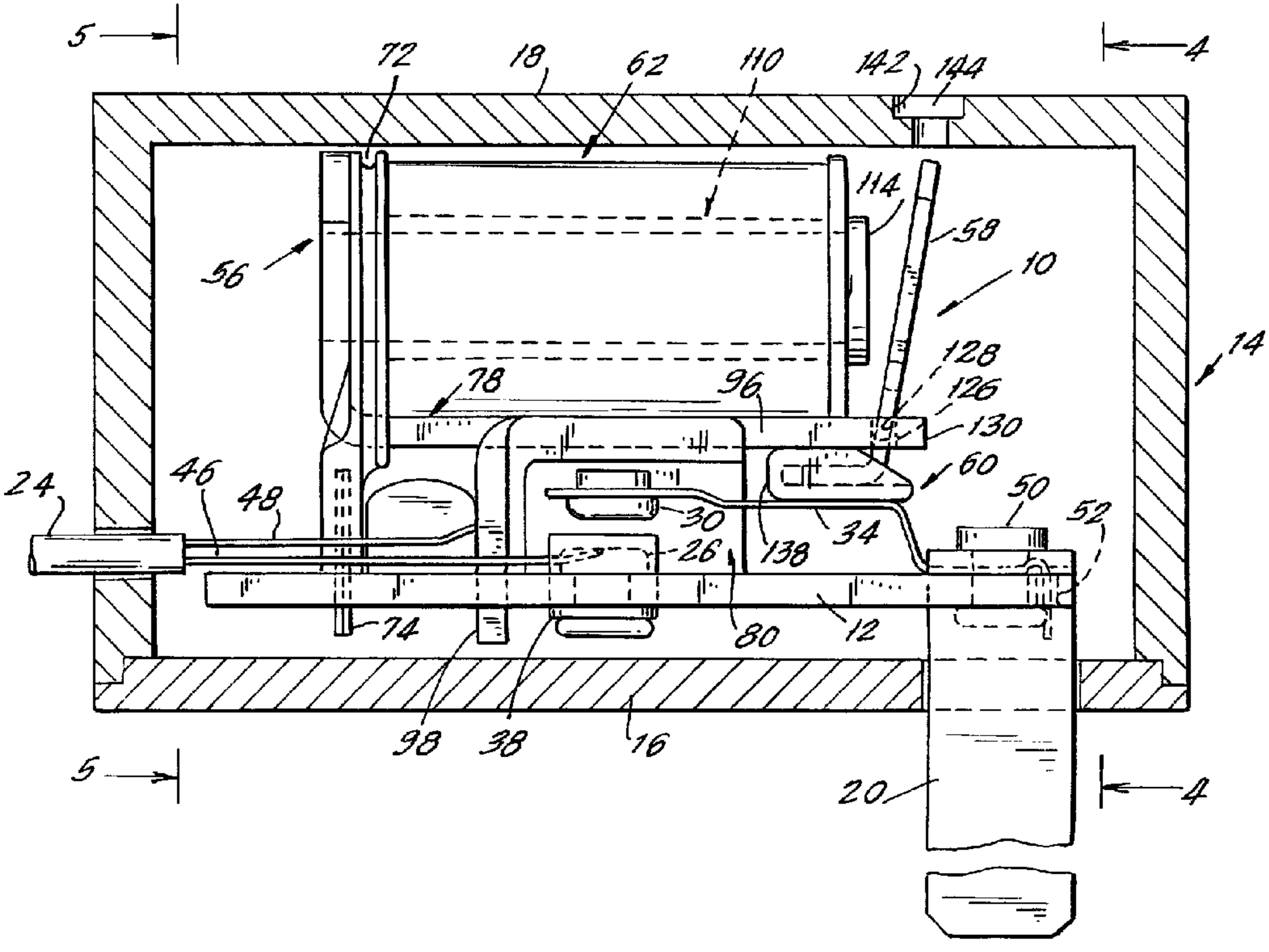


FIG. 8.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