

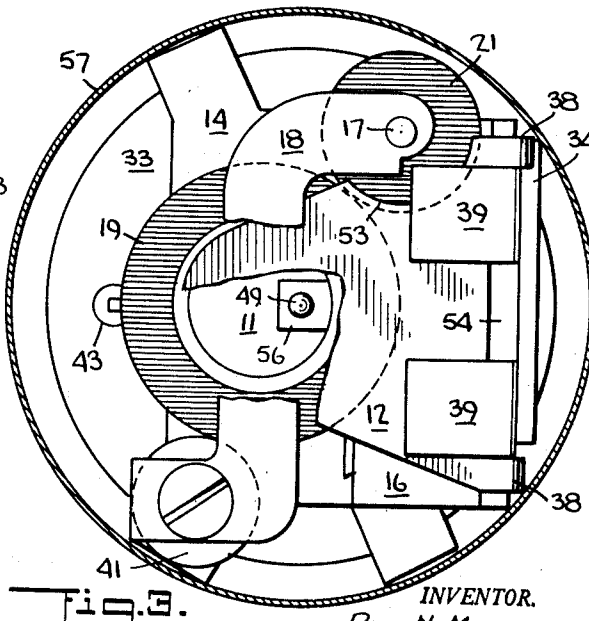
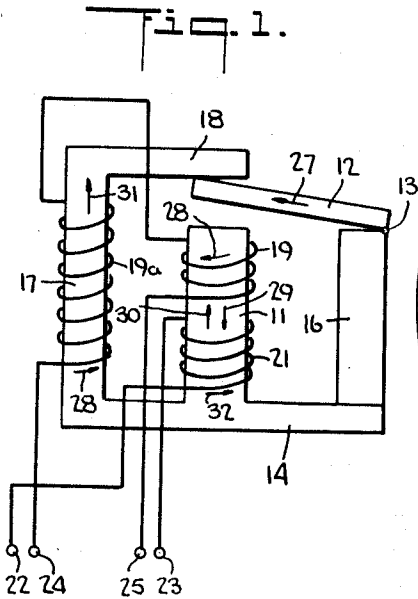
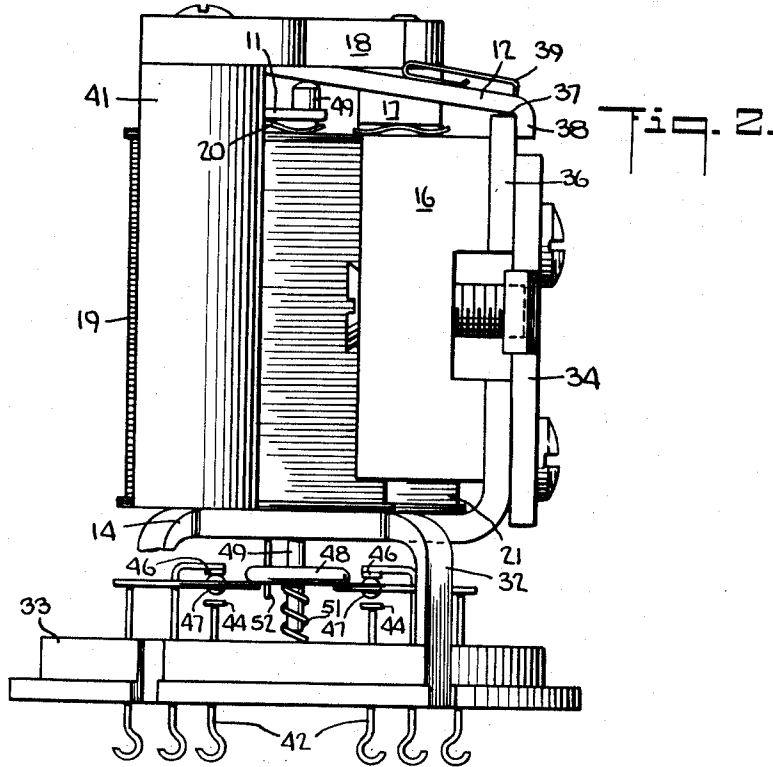
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MAGNETIC LOCK-UP RELAY

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MAGNETIC LOCK-UP RELAY

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This invention relates to electromagnetic relays of the type having a ferromagnetic armature and permanent magnetic means to hold the armature in certain positions. Such relays are known as magnetic lockup relays.

The relay of this invention comprises a main core and an armature located close enough to it to be attracted by the magnetic field of the core. This field is produced by an electrical current flowing in an operating coil that is wound on the core or on a magnetic structure of which the core is a part. A permanent magnet is located adjacent to the pivot point of the armature to cause magnetic flux to flow through the latter and through the main core once the armature has been attracted to the main core, thereby magnetically locking the armature against the main core even after the electrical current flowing in the operating coil has been turned off.

The relay is also provided with an auxiliary core of ferromagnetic material extending in close proximity to the armature and positioned so that the armature moves between the main core and the auxiliary core. The auxiliary core is also magnetically connected to the permanent magnet so that when the armature is returned to a position against the auxiliary core, the flux of the permanent magnet flowing through the armature and the auxiliary core will hold the armature there.

The invention will be further described in connection with the drawings in which:

FIG. 1 is a simplified diagrammatic representation of the electromagnetic parts of the relay;

FIG. 2 is a side view of the relay; and

FIG. 3 is an end view of the relay of FIG. 2.

In FIG. 1 the magnetic parts consist of a magnetically soft main core 11, an armature 12 rotatable about a pivot 13. The main core is magnetically connected to a magnetically soft member 14 to which are also connected a permanent magnet 16 and a magnetically soft auxiliary core 17 having an extension 18 located in proximity to the armature 12 and on the other side thereof from the main core 11. The cores 11 and 17 and the base 14 constitute a ferromagnetic core structure. An operating coil 19 is wound on the main core 11 and another section 19a of the same coil is also wound on the auxiliary core 17. A reset coil 21 is wound on the main core 11 and a second section of this coil may also be wound on the auxiliary core 17, if that is thought necessary. All or part of both the operating coil 19 and the reset coil 21 could be wound on the base part 14 of the core structure. The release coil is brought out to a pair of terminals 22 and 23 and the operating coil is brought out to a pair of terminals 24 and 25.

The operation of the parts shown in FIG. 1 is such that the armature 12 is held against either the main core 11 or the extension 18 of the auxiliary core by virtue of the magnetic flux of the permanent magnet 16 in the absence of flux generated by current flow in the coils 19 and 21. In the position shown magnetic flux from the magnet 16 flows through the armature 12 in the direction indicated by the arrow 27 and through the extension 18 and the auxiliary core 17 back to the permanent magnet 16. This flux will exert a force attracting the free end of the arma-

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ture 12 in contact with the extension 18. By comparison very little flux leaks across the air gap to the core 11.

When the terminals 24 and 25 are connected to a source of direct current polarized so as to make terminal 24 positive with respect to terminal 25, current flows through the coils 19 and 19a in the direction indicated by the arrows 28. This generates a magnetic flux in the main core 11 in the direction indicated by the arrow 29 and in the auxiliary core in the direction indicated by the arrow 31. The latter flux is opposed to the flux 27, and when the flux generated by the current flowing in the coils 19 and 19a slightly exceeds the flux 27, the armature 12 is no longer attracted to the extension 18 of the auxiliary core 17 but is instead attracted to the main core 11 and pivots about the point 13 so as to bring the armature into contact with the end of the main core. So long as the coils 19 and 19a continue to be energized the armature 12 will remain attracted to the main core 11 by virtue of the magnetic flux generated by the permanent magnet 16. This flux now flows through the armature 12 in the same direction as the flux 27 (as must be the case because a permanent magnet can only generate flux flowing in one direction) but this flux now flows back to the permanent magnet 16 by way of the main core 11 instead of by way of the extension 18 and the auxiliary core 17.

Flux flowing through the main core 11 and the armature 12 holds the armature 12 locked against the main core until a force in excess of that generated by this magnetic flux pushes the armature away from the main core 11. Such a reverse force is generated when the terminals 22 and 23 are connected to a source of direct voltage polarized so as to make the terminal 22 positive with respect to the terminal 23. This causes a current to flow through the coil 21 in the direction indicated by the arrows 32 and generates a flux in the direction opposite to that indicated by the arrow 29 in the main core 11. This latter flux is in such a direction as to oppose the flux from the permanent magnet 16, and it thus causes the armature 12 to be released from the core 11 and to be attracted instead to the extension 18 of the auxiliary core 17. Once the armature 12 has pivoted back against the extension 18, there is no need to continue to keep the coil 21 energized because the flux of the permanent magnet 16 will hold the armature 12 up against the extension 18 as described above.

In the relay shown in FIGS. 2 and 3 only the end of the main core 11 is shown; the remainder of the core is surrounded by the operating coil 19, which is held in place by a retaining spring 29 engaging a groove in the end of the core 11. Both the main core 11 and the auxiliary core 17 are supported by the base 14 of the core structure, which has several legs 32 that extend from the base to a contact support plate 33. The ends of the legs 32 fit into grooves in the plate 33 and are held in place to fix the relative positions between the contact section and the electromagnetic section of the relay.

One edge of the core structure base 14 is turned up and a non-magnetic plate 34 is attached to it. A permanent magnet 15 of Alnico or another material having a high coercive strength is attached to the plate to bridge the space between the core structure base 14 and an upper, ferromagnetic pivot member 36. The pivot member has an edge 37 that serves as a center about which the armature 12 pivots.

The armature is similar to that described in my United States Patent 2,913,548 and has a pair of tabs 38 bent almost at a right angle to the main part of the armature and hooked over the edge 37. The armature 12 is pressed against the edge 37 in one direction by the force exerted

by a reverse-bent spring 39 on one face of the armature. The same spring extends back between the tabs 38 and exerts a second force, almost at a right angle to the first force, on the edge of the armature between the tabs. The spring 39 is held in place by the plate 34.

The ferromagnetic extension 18 of the auxiliary core 17 extends over the armature 12 near the outer end of the latter. One end of the extension is firmly attached to the core 17 to provide as good a magnetic connection therewith as possible, and the other end is attached to a non-magnetic support member 41 which is staked or otherwise affixed to the core structure base 14.

A plurality of fixed contacts are attached to conductive pins 42, which are hermetically sealed by individual glass-to-metal seals 43 in a base, or header, 33. The contacts are arranged in two levels, the lower one closer to the header 33 being identified by reference character 44 and the other level by reference character 46. Between the two levels are individual movable contacts 47, one for each pair of fixed contacts 44 and 46. The contacts are arranged in a circle around the header 33, and the ends of the movable contacts extend under an insulating disc 48. This disc is attached to a rod 49 that extends up through the main core 11 into contact with the underside of the armature 12. A spring 51 is compressed between the header 33 and the disc 48 to spring-bias the latter upward (the position illustrated) to permit the movable contacts 47 to press against the upper contacts 46. This is the situation that exists when the relay is in its unlocked and unenergized state. In the energized state, the armature 12 is pulled down by the magnetic force of attraction of the core 11, and this forces the rod 49 and disc 48 downward, bearing against the inner ends of the contacts 47 and causing them to break connection with the upper fixed contacts 46 and to press against the lower contacts 44.

In order to prevent the disc 48 from rotating as it moves up and down in repeated cycles of operation, a guide pin 52 may be provided. This permits the contacts to be adjusted once with the assurance that an individual contact 47 will always be actuated by the same part of the rim of the disc 48. Then, even if the disc be askew or its rim not uniform, operation of the contacts will always be consistent.

FIG. 3 shows the relay looking down upon the ends of the main and auxiliary cores 11 and 17. In this view the armature 12 is shown to be approximately triangular in shape. In order to show the core 11 the armature 12 illustrated with a segment broken away at the outer end. The armature is made with a circular segment cut away along line 53 to clear the auxiliary core 17 and the extension 18.

The spring 39 has two main sections joined by a bridge 54 and is just slightly narrower than the distance between the tabs 38 at the corners of the armature.

The contact actuating pin slides in a pair of bushings 56, only the closer one of which appears in the drawing. These bushings are pressed into each end of a slot that is milled longitudinally along one side of the core 11. Such a structure is advantageous for mass production because it is the easiest way of forming a channel for pin 49, much easier than drilling a hole through the core. Such a hole, in addition to being difficult to drill, would frictionally engage the pin 49 throughout almost its entire length, as opposed to the bushings 56 which provide ample support and guidance for the pin 49 but engage it frictionally at only two limited areas.

Furthermore, this off-center location of the pin 49 in the direction toward the pivot axis of the armature 12 actually improves the layout of the contacts 44-47 since it places the pin at the center of the relay can 57 while permitting the core 11 to be offset. This offset allows the can 57 to clear the tabs 38 and at the same time permits the coil 19 to have a large diameter. This means that the coil 19 can have many turns of wire and thus make the relay very sensitive.

In the embodiment in FIG. 3 the diameter of the coil 19 is also limited by the necessity of leaving space for the auxiliary coil 21 and for the support post 41. It is possible to obtain somewhat more diametrical space for the coil 19 by winding the coil 21 on a different part of the core structure than on the auxiliary core 17. For example, instead of making the coil 19 substantially as long as the main core 11, it may have a shorter length, and the remainder of the length of the main core 11 can be taken up by the releasing winding 21, leaving the auxiliary core without any winding. Or the windings 19 and 21 may be wound about the core 11 in layers or in any other configuration that permits sharing the available space.

In one operating arrangement 4100-turn coils 19 and 19a having a resistance of 204.1 ohms were wound on the main core 11 and on the auxiliary core 17 and a 3900-turn coil 21 having an impedance of 364.8 ohms was wound on the core 17. The armature 12 was attracted to the core 11 when a direct current of 52 milliamperes was passed through the coils 19 and 19a and the strength of the permanent magnet 16 was such that a force of 65 grams was required at the end of the armature to pull the armature away from the core 11. However, the armature was released by passing only 10.8 milliamperes of direct current of the proper polarity through the coil 21.

The magnetically soft extension 18 is S-shaped so as to pass directly across the armature 12 in a direction parallel to the pivoting axis of the armature. Thus, when the armature is in its upper position there will be a line of contact between the armature and the extension rather than a point of contact, which could adversely affect operation of the pivot member 36. This also reduces the reluctance of the magnetic path through the extension.

What is claimed is:

1. A magnetic lock-up relay comprising a magnetic core structure including a main core and an auxiliary core; a ferromagnetic pivot member including a permanent magnet magnetically connected at one end to one end of both said main core and said auxiliary core and having at the other end an edge defining a pivot axis; an armature having a pair of tabs at one side bent at almost a right angle to the remainder of said armature and hooked over said edge to permit said armature to pivot about said edge, said tabs providing a low-reluctance coupling between said armature and said permanent magnet when said armature is rotated away from said main core; an L-shaped spring member attached to said ferromagnetic pivot member and extending over said edge and over said armature to hold said armature and to permit it to pivot and to move away from said edge to a limited extent; a first coil on said core structure to produce magnetic flux in said main core aiding the flux of said permanent magnet to cause said armature to pivot against said main core when said coil is energized by direct current of a predetermined polarity; the magnetomotive force of said permanent magnet being sufficient to hold said armature against said main core after the direct current in said coil has ceased; a second coil on said core structure to produce magnetic flux in said auxiliary core aiding the flux of said permanent magnet to cause said armature to pivot away from said main core when said second coil is energized by direct current of a predetermined polarity; and a ferromagnetic extension on the outer end of said auxiliary core extending over the outer end of said main core and over the free end of said armature to make contact with said armature along a line parallel to said pivot edge to prevent said armature from tilting away from said pivot edge when said armature is pivoted away from said main core, said permanent magnet providing magnetomotive force to hold said armature against said extension after the direct current in said second coil has ceased.

2. The relay of claim 1 in which said first coil is wound on said main core and at least a portion of said second coil is wound on said auxiliary core.

3. The relay of claim 1 in which said first coil is wound on said main core and a portion of said second coil is also wound on said main core to provide magnetic flux opposing the magnetic flux of said permanent magnet to assist in releasing said armature from said main core when said second coil is energized, and another portion of said second coil is wound on said auxiliary core to provide magnetic flux aiding the magnetic flux of said permanent magnet to assist in attracting said armature toward said extension.

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