

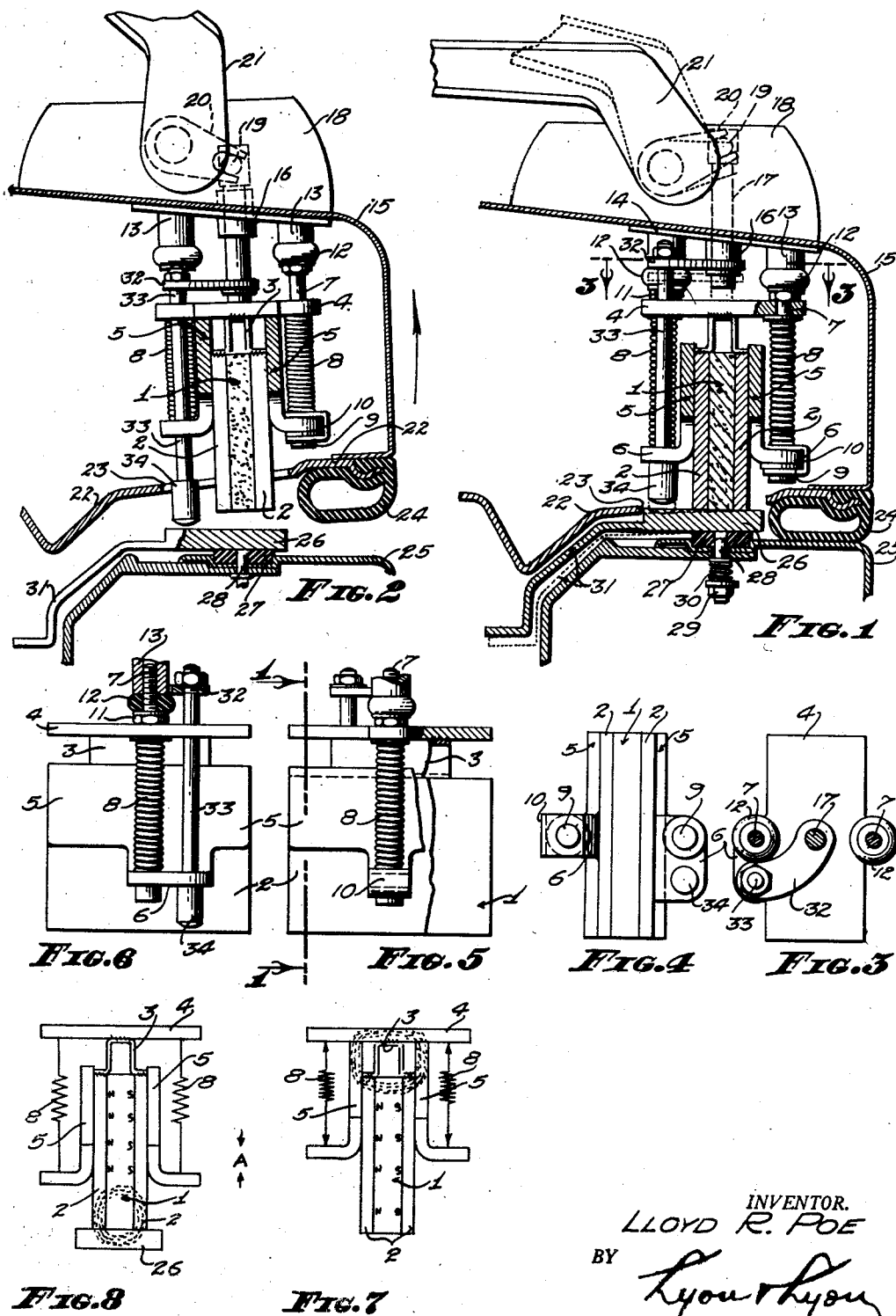
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L. R. POE

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MAGNETIC LATCH

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INVENTOR.
LLOYD R. POE
BY
Lyon & Lyon
ATTORNEYS

1

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MAGNETIC LATCH

Lloyd R. Poe, Los Angeles, Calif., assignor to Clark Hartwell, doing business as Hartwell Aviation Supply Company, Los Angeles, Calif.

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This invention relates to magnetic latches, that is, to latches wherein the holding force is dependent upon a strong magnetic field between the parts to be latched or connected, as distinguished from catches, bolt elements, or similar mechanically interlocking devices.

Included in the objects of this invention are:

First, to provide a magnetic latch for a door and a door frame wherein, mechanical movement occurring in the course of opening the latch stores energy in spring elements and a permanent magnet is employed to energize a magnetic holding means which restrains the spring elements, and wherein on bringing the latch into contact with a latch plate on the door frame, the magnetic holding means is short-circuited so that the energy stored in the spring elements is employed to draw together the door and door frame.

Second, to provide a magnetic latch which utilizes a permanent magnetic wafer wherein the magnetic force is directed transversely through the wafer between opposite surfaces, and wherein these surfaces are covered with fixed pole plates for concentrating the flux at opposite ends of the wafer so that upon shunting either of these ends a high density closed magnetic circuit is established.

Third, to provide a magnetic latch having fixed pole plates, a permanent magnetic wafer therebetween, and a shunt plate disposed in fixed spaced relation to the magnetic wafer, wherein a pair of movable pole plates are slidable along the surfaces of the fixed pole plates, to and from the shunt plate, to close and open a magnetic circuit.

Fourth, to provide a magnetic latch which incorporates a novel tiltable latch plate which on closure of the magnetic latch closes a magnetic holding circuit, the latch plate being accessible from within a closure equipped with the magnetic latch, so that one entrapped within the enclosure may tilt the latch plate to reduce the flux density of the holding circuit thereby to open the magnetic latch, thereby providing a latch which is particularly adapted for refrigerators and the like.

Fifth, to provide a magnetic latch which may be operatively connected to a control handle and which incorporates mechanical means for tilting a latch plate relative to a permanent magnetic latch unit, so as to reduce the flux density and facilitate opening of the latch.

Sixth, to provide a magnetic latch wherein a control handle is mechanically operable to compress spring elements, to store energy therein and effect closure of a magnetic circuit which maintains the springs compressed, for later release upon shunting the magnetic circuit.

With the above and other objects in view, as may appear hereinafter, reference is directed to the accompanying drawings in which:

Figure 1 is a sectional view, taken through 1—1 of Fig. 5, showing the magnetic latch incorporated in a refrigerator and adjacent portions of the refrigerator box and refrigerator door being shown fragmentarily; the magnetic latch being shown by solid lines in its latched

2

condition and by dotted lines during the initial step of opening the latch;

Fig. 2 is a view similar to Fig. 1, showing the latch and adjacent portions of the refrigerator door and box immediately upon opening the latch;

Fig. 3 is a sectional view of the latch, taken through 3—3 of Fig. 1;

Fig. 4 is an end view of the latch, taken of the opposite end thereof from Fig. 3;

Fig. 5 is a partial sectional, partial side elevational view of the latch with its mounting connection shown fragmentarily;

Fig. 6 is an elevational view similar to Fig. 5, taken from the opposite side of the latch, also with the mounting means shown fragmentarily;

Figs. 7 and 8 are diagrammatical views, illustrating the operation of the latch.

The magnetic latch utilizes a magnetic wafer 1 formed of ferro magnetic material. These are also known as ferrites magnets. A unique characteristic of this type of magnet is the fact that the magnet may be made in the form of a thin wafer so that the poles are disposed at the opposite surfaces of the wafer instead of the edges. These surfaces are covered by fixed or first pole plates 2 which have the effect of concentrating the magnetic flux around the margins of the wafer. The term "fixed" is intended to designate that the pole pieces 2 are fixed relative to the wafer.

A non-magnetic spacer member 3 joins each pole plate 2 to the corresponding edge of the other, and serves to support a bridging plate 4 of magnetic material in transverse spaced and fixed relation to the pole plates 2.

Slidably mounted on the surfaces of the pole plates 2, outwardly from the magnetic wafer 1, is a pair of movable or second pole plates 5. The term "movable" is intended to designate that the pole pieces 5 are movable relative to the wafer 1, pole pieces 2, and bridging plate 4, irrespective of whether the pole pieces 5 remain fixed in space, and the wafer 1, pole pieces 2, and bridging plate 4 move relative thereto, or vice versa. The pole plates 5 are movable along the surfaces of the fixed pole plates 2, to and from the bridging plate 4, so as to open and close a magnetic circuit through the bridging plate.

The ends of the movable pole plates 5 remote from the bridging plate 4 are bent outwardly to form lugs 6 through which extend connecting rods 7. These rods pass through the bridging plate 4 and are equipped with springs 8 interposed between the bridging plate 4 and the lugs, so as to urge the movable pole plates 5 away from the bridging plate 4. Either one or both of the connecting rods 7 may be provided with heads 9, which are held against the corresponding lugs 6 by clips 10, the purpose being to prevent longitudinal movement of the connecting rods 7 relative to the lugs 6, but to permit rotation.

The ends of the connecting rods 7 which protrude through the bridging plate 4 are screw-threaded and receive nuts 11, so that maximum spacing between the bridging plate 4 and the adjacent ends of the movable pole plates 5 may be adjusted.

The extended ends of the connecting rods 7 extend through yieldable washers 12 into bosses 13 provided on a mounting plate 14 for the purpose of fixing the position of the movable pole plates 5 relative to the mounting plate 14. Adjustment is permitted by reason of the screw-thread connection of the rods 7 with the bosses 13.

In the application of the magnetic latch illustrated, the mounting plate 14 is shown as installed within a refrigerator door 15. The mounting plate includes a guide 16 through which extends a slide bar 17 engageable with the bridging plate 4. The slide bar 17 protrudes through

the refrigerator door 15 into a suitable housing 18 or other enclosure.

The slide bar 17 is provided with a cross pin 19 for engagement by a lever 20 suitably connected with a handle 21, so that upon pivotal movement of the handle 21 the slide bar 17 may be moved axially to and from the bridging plate 4.

The refrigerator door 15 is provided with an inner wall 22 having an aperture 23 which exposes the edges of the magnetic wafer 1 and fixed pole plates 2 remote from the bridging plate 4. The margin of the refrigerator door 15 is provided with a yieldable seal 24 which engages the margin of the refrigerator frame 25.

Mounted on the refrigerator frame 25 in registry with the aperture 23 is a latch or hold plate 26. The latch plate 26 is preferably mounted on a yieldable pad 27 so that the latch plate is capable of limited tilted movement.

A stem 28 extends from the latch plate 26 through the yieldable pad 27 and refrigerator frame 25. The extremity of the stem 28 is provided with a tension nut 29, and the stem 28 receives a spring 30 so as to yieldably secure the latch plate 26 in place.

Clearance is provided between the inner wall 22 of the refrigerator door 15 and the refrigerator frame 25 so that an arm 31 may extend laterally from the latch plate 26 into the interior of the refrigerator. The arm 31 forms a tilting arm for emergency release of the latch, as will be brought out hereinafter.

Mounted on the slide bar 17 is a laterally directed arm 32 to which is attached a rod 33, which extends parallel with one of the connecting rods 7 through the bridging plate 4 and corresponding lug 6.

The rod 33 terminates in a head 34 disposed at one side of the magnet unit formed by the magnetic wafer 1 and fixed pole plates 2 for engagement with the latch or hold plate 26 so as to effect a tilting movement, as will be brought out hereinafter.

Operation of the magnetic latch is as follows:

When the latch is in its latching position, as shown in Fig. 1, the permanent magnet unit represented by the wafer 1 and fixed pole plates 2 is in engagement with the latch plate 26. The sizes of the magnet unit are such that a holding force ample to compress the marginal seal 24 is obtained. Actually, it is possible to provide a holding force of several hundred pounds. However, in the application illustrated, a holding force of eighty pounds is ample. In this position of the latch, the springs 8 are extended and the bridging plate 4 is separated from the movable pole plates 5.

In the course of opening the refrigerator door 15, the handle 21, in moving from the solid to the dotted line position shown in Fig. 1, causes the head 34 of the rod 33 to engage the latch plate 26 and tilt the latch plate relative to the permanent magnet unit. This reduces the strength of the magnetic circuit through the latch plate 26. Continued outward pull on the handle 21 causes the slide bar 17 to engage the bridging plate 4. Inasmuch as the bridging plate cannot move, because of its connection with the latch plate 26, through the spacer member 3 and fixed pole plates 2, the door is drawn outwardly from the refrigerator frame 25. The movable pole plates 5, by reason of their attachment to the door through the connecting rods 7, move with the door until they engage the bridging plate 4. The parts of the magnetic latch have now moved to the position shown in Fig. 2.

Upon engagement of the movable pole plates 5 with the bridging plate 4, a second magnetic circuit is established through the permanent magnet unit which shunts the magnetic circuit through the latch plate 26. The shunting of the circuit through the latch plate 26 combined with the tilting of the latch plate 26 reduces the magnetic circuit therethrough to such a low value that the refrigerator door is readily moved clear of the refrigerator frame 25.

In the process of opening the door, it will be observed that the springs 8 are compressed. They are held in their

compressed state by the magnetic circuit through the bridging plate 4 and movable pole plates 5 as long as the magnet unit is not shunted at the latch plate end thereof.

Upon closing the door, reverse action takes place. That is, the magnet unit comprising the magnetic wafer 1 and fixed pole plates 2 is in its extended position shown in Fig. 2, and upon engaging the latch plate 26 a magnetic circuit is established therethrough which shunts the circuit through the bridging plate 4 and movable pole plates 5 to reduce the flux density therein, so that the holding force is less than the force of the springs 8. The force of the springs 8 is then applied against the bridging plate 4 to retract the magnet unit. Inasmuch as the movable pole plates 5 are fixed relative to the door and the magnet unit is held by the latch plate 26, the door is drawn to its fully closed position.

The amount of relative travel between the refrigerator door 15 and the refrigerator frame 25 is determined by the travel distance of the pole plates 5 relative to the bridging plate 4. This travel distance may be regulated by adjusting the connecting rods 7.

The magnetic attraction between the magnet unit and the latch or hold plate 26 varies inversely as the square of the distance therebetween, whereas the change in force of the springs 8 are proportional to their compression. It will thus be seen that a substantial movement of the refrigerator door 15 may be provided while maintaining a maximum flux density and holding force between the magnet unit and the latch plate 26.

By reason of the fact that the only force holding the door 15 in its closed position is the magnetic force between the magnet unit and the latch plate 26, the door may be opened at any time if sufficient counterforce is exerted. Also, it will be observed that this force may be so predetermined as to be sufficient for closing purposes and yet insufficient to restrain a person who may be confined within the refrigerator.

Furthermore, by providing the tilting arm 31, which projects into the interior of the refrigerator, the force required to open the refrigerator door 15 from the inside may be materially lessened by a deliberate or accidental engagement of the tilting arm, so that the chances of one being actually trapped within the refrigerator is reduced to a minimum.

While a particular embodiment of this invention has been shown and described, it is not intended to limit the same to the exact details of the construction set forth, and it embraces such changes, modifications, and equivalents of the parts and their formation and arrangement as come within the purview of the appended claims.

I claim:

1. A magnetic latch, comprising: a permanent magnet unit; a latch plate adapted to close a first magnetic circuit therethrough; a bridging plate disposed in fixed spaced relation to said magnet unit; a pair of pole pieces included in said magnet unit, said pole pieces and bridging plate being relatively movable for mutual engagement to close a second magnetic circuit therethrough and shunt the circuit through said latch plate thereby to reduce the force required to separate said latch plate from said magnet unit.

2. A magnetic latch, comprising: a permanent magnet unit; a latch plate adapted to close a first magnetic circuit therethrough; a bridging plate disposed in fixed spaced relation to said magnet unit; a pair of pole pieces included in said magnet unit, said pole pieces and bridging plate being relatively movable for mutual engagement to form a second magnetic circuit; said magnetic circuits each forming a shunt for the other circuit; springs urging said pole pieces and bridging plate away from each other; mechanical means for effecting relative movement of said pole pieces and bridging plate toward each other; said second magnetic circuit being capable, when closed and unshunted by said first magnetic circuit, to remain closed against the force of said springs and to open under urge

5

of said springs when said first magnetic circuit is closed.

3. A magnetic latch for effecting closure between a door structure and a door frame structure, comprising: a pole means fixed in one of said structures; a permanent magnet unit movable relative to said pole means between an extended and a retracted position; a bridging member spaced from, fixed to, and movable with said magnet unit, said bridging member cooperating with said magnet unit and pole means to form a closed magnetic circuit when said magnet unit is in its extended position; spring means disposed to urge said magnet unit toward its retracted position and tending to open said magnetic circuit, said magnetic circuit, when closed and unshunted, having sufficient force to restrain said spring means; and a latch element on the other of said structures engageable by said magnet unit to form another magnetic circuit, each of said magnetic circuits forming a shunt for the other, whereby on engagement between said latch element and said magnet unit said spring means is released to urge said magnet unit toward its retracted position, thereby to draw said door and door frame structures toward each other.

4. A magnetic latch for effecting closure between a door structure and a door frame structure, comprising: a pole means fixed in one of said structures; a permanent magnet unit movable relative to said pole means between an extended and a retracted position; a bridging member spaced from, fixed to, and movable with said magnet unit, said bridging member cooperating with said magnet unit and pole means to form a closed magnetic circuit when said magnet unit is in its extended position; spring means disposed to urge said magnet unit toward its retracted position and tending to open said magnetic circuit, said magnetic circuit, when closed and unshunted, having sufficient force to restrain said spring means; a latch element on the other of said structures engageable by said magnet unit to form another magnetic circuit, each of said magnetic circuits forming a shunt for the other, whereby on engagement between said latch element and said magnet unit said spring means is released to urge said magnet unit toward its retracted position, thereby to draw said door and door frame structures toward each other; and a mechanical means for moving said magnet unit toward its extended position to effect loading of said springs and closing of the magnetic circuit through said bridging member and pole means, to shunt the magnetic circuit through said latch element and facilitate release from said magnet unit thereby to permit opening of said door structure.

5. A magnetic latch as set forth in claim 4, wherein: said latch member is tiltable relative to said magnet unit to reduce the force of the magnetic circuit therethrough; and said mechanical means includes a member engageable with said latch member to tilt said latch member as said magnet unit is moved toward its extended position, thereby to weaken further the magnetic circuit through said magnet unit and latch member and facilitate opening of said door structure.

6. A magnetic latch as set forth in claim 4, wherein: said latch member is tiltable relative to said magnet unit to reduce the force of the magnetic circuit therethrough; and a tilting arm extends from said latch member into an enclosure defined by said door structure and frame structure for panic engagement, to facilitate opening of said latch.

7. A magnetic holding device, comprising: a permanent magnet wafer; a pair of first pole plates on opposite sides of and fixed relative to said wafer; a bridging plate disposed in fixed spaced and transverse relation to said first pole plates; and a second pair of pole plates at the sides of said first pole plates opposite from said wafer and slidable relative to said first pole plates and bridging plate for coaction with said bridging plate to open and close a magnetic circuit through said wafer.

8. A magnetic holding device, comprising: a permanent magnet wafer; a pair of first pole plates on opposite sides of and fixed relative to said wafer; a bridging plate

6

disposed in fixed spaced and transverse relation to said first pole plates; a second pair of pole plates at the sides of said first pole plates opposite from said wafer and slidable relative to said first pole plates and bridging plate for coaction with said bridging plate to open and close a magnetic circuit through said wafer; and a holding plate adapted to be positioned across the ends of said first pole plates opposite from the bridging plate to form another magnetic circuit through said wafer, each magnetic circuit forming a magnetic shunt for the other circuit.

9. A magnetic holding device, comprising: a permanent magnet wafer; a pair of first pole plates on opposite sides of and fixed relative to said wafer; a bridging plate disposed in fixed spaced and transverse relation to said first pole plates; a second pair of pole plates at the sides of said first pole plates opposite from said wafer and slidable relative to said first pole plates and bridging plate for coaction with said bridging plate to open and close a magnetic circuit through said wafer; a holding plate adapted to be positioned across the ends of said first pole plates opposite from the bridging plate to form another magnetic circuit through said wafer, each magnetic circuit forming a magnetic shunt for the other circuit; and springs positioned to urge said movable pole plates and bridging plate away from each other, the magnetic circuit through said movable pole plates and said bridging plate having sufficient force when unshunted to restrain said springs and when shunted by said holding plate to release said springs, thereby to effect a predetermined relative movement of said first and second pole plates.

10. A magnetic holding device, comprising: a permanent magnet unit including a pair of pole plates and a wafer magnet sandwiched therebetween to establish regions of flux concentration at opposite ends of said pole plates; means for bridging between opposite ends of said pole plates to form a pair of magnetic circuits, each of which is a shunt for the other; and spring elements tending to open one of said magnetic circuits, the force of said circuit when unshunted being sufficient to restrain said spring elements and when shunted to release said spring elements.

11. A magnetic holding device, comprising: a permanent magnet unit including a pair of pole plates and a wafer magnet sandwiched therebetween to establish regions of flux concentration at opposite ends of said pole plates; means for bridging between opposite ends of said pole plates to form a pair of magnetic circuits, each of which is a shunt for the other; spring elements tending to open one of said magnetic circuits, the force of said circuit when unshunted being sufficient to restrain said spring elements and when shunted to release said spring elements; and mechanical means for effecting closure of said one magnetic circuit against the force of said spring elements.

12. A magnetic latch, comprising: a permanent magnet unit; a latch plate adapted to close a first magnetic circuit therethrough; a bridging plate disposed in fixed spaced relation to said magnet unit, a pair of pole pieces included in said magnet unit, said pole pieces and bridging plate being relatively movable for mutual engagement to close a second magnetic circuit therethrough and shunt the circuit through said latch plate thereby to reduce the force required to separate said latch plate from said magnet unit; means for tiltable mounting said latch plate; and means for tilting said latch plate to facilitate release of said latch plate from said permanent magnet unit.

13. A magnetic holding device, comprising: a permanent magnet wafer; a pair of first pole plates on opposite sides of and fixed relative to said wafer; a bridging plate disposed in fixed spaced and transverse relation to said first pole plates; a second pair of pole plates at the sides of said first pole plates opposite from said wafer and slidable relative to said first pole plates and bridging

plate for coaction with said bridging plate to open and close a magnetic circuit through said wafer; a holding plate adapted to be positioned across the ends of said first pole plates opposite from the bridging plate to form another magnetic circuit through said wafer, each magnetic circuit forming a magnetic shunt for the other circuit; means for tiltably mounting said holding plate; and means for tilting said holding plate.

5

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