May 26, 1959 W. C. PIERCE 2,888,290

DOOR WITH MAGNETIC CATCH

Filed Feb. 27, 1956

Fig. 1

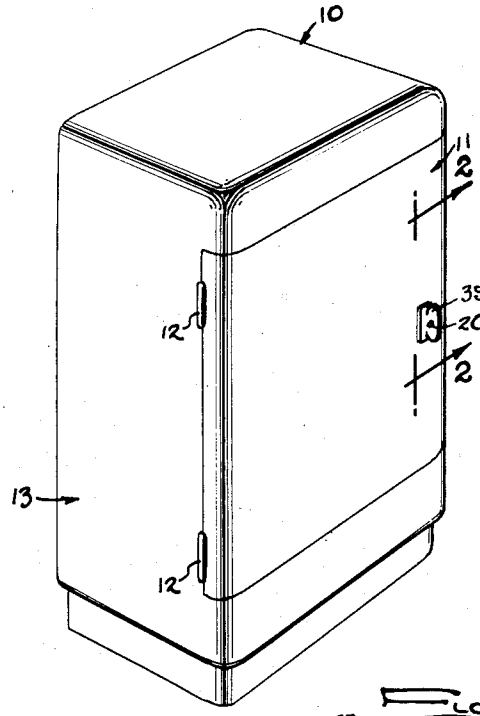


Fig. 2

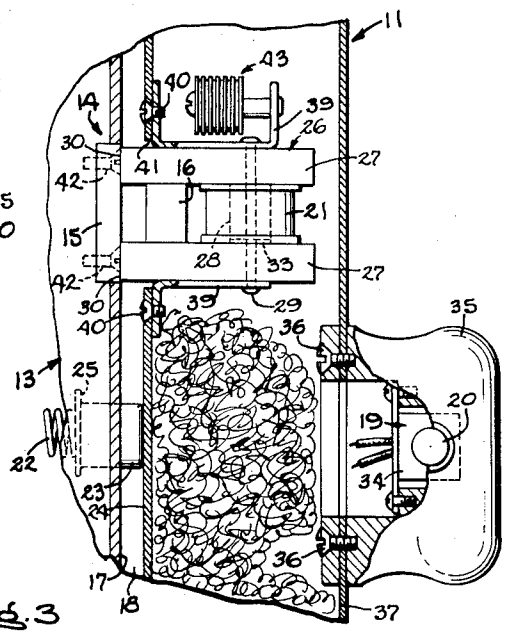


Fig. 3

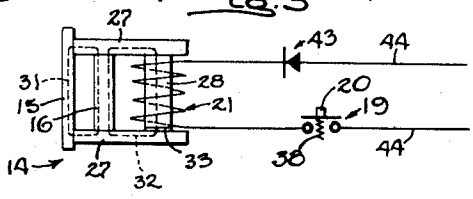


Fig. 4

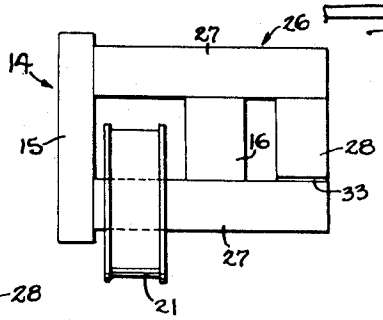
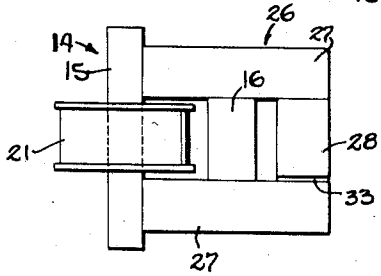


Fig. 5



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DOOR WITH MAGNETIC CATCH

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4 Claims. (Cl. 292—251.5)

This invention relates to doors which are held closed by force derived from permanent magnets and the primary object is to construct a door and a permanent magnet catch therefor in a novel manner for swinging of the door away from its closed position automatically in response to manual pressure exerted outside of the door and having a negligibly small value compared to the force of the magnet holding the door.

A more detailed object is to achieve such automatic operation by reducing the magnet holding force electrically and by correlating the holding force in a novel manner with a force biasing the door away from the closed position.

Other objects and advantages of the invention will become apparent from the following detailed description taken in connection with the accompanying drawings, in which

Figure 1 is a perspective view of a refrigerator with a door and catch embodying the novel features of the present invention.

Fig. 2 is an enlarged fragmentary sectional view taken along the line 2—2 of Fig. 1.

Fig. 3 is a schematic view of the catch and the energizing circuit for the winding.

Figs. 4 and 5 are schematic views of the catch showing alternative locations of the winding.

The invention is shown in the drawings for purposes of illustration embodied in a refrigerator **10** having a door **11** supported on hinges **12** on a frame or body **13** for swinging about the axis of the hinges and in an arcuate path to and from a closed position shown in Figs. 1 and 2. The door is held in this position by a magnetic catch **14** which comprises generally an armature **15** mounted either on the door or the frame and a permanent magnet **16** mounted on the other member and exerting an attractive force on the armature when the door is closed. In this instance, the door in its closed position is spaced from an outwardly facing surface **17** on the frame around the door opening therein to accommodate the usual sealing member **18** which is carried by the door and extends around the opening.

To achieve so-called "push-button operation," the present invention contemplates a novel arrangement of the door **11** and the catch **14** enabling the door to be opened automatically in response to a manual pressure of negligibly small value compared to the holding force exerted by the magnet. For this purpose, the attractive force of the magnet **16** on the armature **15** is varied electrically between high and low values under the control of a switch **19** which is operated by a manual actuator **20** from a point outside of the refrigerator. Also, the door is biased away from the closed position by a force correlated with and less than the high value of attractive force, but greater than the low value so that the door opens automatically when the attractive force is reduced to the low value. Variation of the magnetic force attracting the armature is effected by energization and deenergization of a winding **21** associated with the magnet

and the armature and operable, when energized upon actuation of the switch, to reduce the attractive force to its low value.

While the bias opposing the attractive force of the permanent magnet **16** and urging the door **11** away from its closed position may be derived in various ways, it is obtained in this instance from a coiled spring **22** acting in compression between the frame **13** and a cup shaped plunger **23** and urging the closed end of the latter outwardly through and beyond the frame surface **17** for abutment with an inner wall **24** of the door. When the door is closed to bring the pole faces into abutment with the armature **15** as shown in Fig. 2, the plunger is shifted inwardly by the inner door wall and the spring is compressed to exert on the door an outward force less than the attractive force on the armature when the winding **21** is deenergized, but greater than such attractive force when the winding is energized. Outward movement of the plunger is limited by abutment of an outturned flange **25** thereon with the frame.

The preferred form of catch shown in Figs. 2 and 3, includes a core **26** of magnetic material such as soft iron supporting the permanent magnet **16** and the winding **21** and comprising spaced parallel bars **27** and an apertured crosspiece **28** encircled by the winding and clamped between the bars adjacent one of their ends as by a rivet **29**. The magnet is a rectangular block of permanent magnet material spanning and clamped between the bars at a point adjacent but spaced from their other ends **30** which lie in a common plane and constitute pole faces. With this arrangement, the permanent magnet flux divides between a main flux path **31** extending through the pole faces and a shunt path **32** extending through the crosspiece **28** and by-passing the pole faces as shown by dotted lines in Fig. 3. To divert the major portion of the flux through the armature **15** when the latter spans and abuts the pole faces, the reluctance of the shunt path is increased by a magnetic restriction **33** in the form of a thin spacer of nonmagnetic material such as brass clamped between one of the core bars **27** and the adjacent end of the crosspiece **28**. Upon energization of the winding **21**, the resulting magnetomotive force opposes the permanent magnet flux in the main flux path **31** and diverts the same into the shunt path **32** thereby reducing the attractive force on the armature **15** to a low value less than the opposing force of the spring **22** when the door is closed. Alternative arrangements of the magnet **16**, the core **26**, the winding and the armature providing similar operation include location of the winding around one of the core bars **27** between the magnet and the pole faces **30** and location of the winding around the armature as shown schematically in Figs. 4 and 5.

To simplify the door opening operation and to avoid reduction in the effective bias of the spring **22** during such operation, the actuator **20** is arranged for closure of the switch **19** by a manual pressure exerted in a direction transversely of the arcuate path of the door **11**. The actuator preferably is located on the door in the normal position of a handle and, in this instance, is a push button projecting outwardly from a casing **34** of the switch and through one side of a hollow knob **35** enclosing and supporting the casing and secured rigidly as by screws **36** to an outer wall **37** of the door. The actuator button is yieldably urged as by a spring **38** (Fig. 3) outwardly to a switch open position and is movable back and forth along a path extending generally along a radius of the door path and therefore normal to the latter.

The winding **21**, the permanent magnet **16**, and the arrmature **15** may have various arrangements on the door **11** and the frame **13**, but it is preferred to locate the winding on the same one of these members as the switch

thereby simplifying the wiring. Herein, the core 26 with the magnet and the winding thereon is mounted within the door between the inner and outer walls 24 and 37 thereof by brackets 39 secured to the core bars 27 by the rivet 29 and having threaded holes receiving screws 40 which extend through the inner door wall 24. The core bars 27 project through an aperture 41 in the inner wall and past the sealing member 18 on the door for abutment of the pole faces 30 with the armature in the closed position of the door. The armature herein is a rectangular plate secured to the frame 12 as by screws 42 and having its outer surface flush with the frame surface 17.

Where, as in this instance, the catch 14 is used in a device such as the refrigerator 10 which is supplied with alternating current, direct current for energizing the winding 21 may be obtained from the same power source (not shown) as the refrigerator by interposing a rectifier 43 in series with the winding and the switch 19. The rectifier herein is of the dry plate type mounted on one of the core brackets 39. Current is supplied to the series connected winding, switch, and rectifier by conductors 44 (Fig. 3) which are extended through the interior of the door and between the latter and the frame in a well known manner at the hinged side of the door.

In the operation of the improved door 11 and catch 14, let it be assumed that the door is closed with the pole faces 30 abutting and spanned by the armature 15 and the plunger 23 shifted inwardly to compress the bias spring 22. The permanent magnet flux then threading the main path 31 through the armature attracts the latter with a greater force than that exerted outwardly by the bias spring and the door is retained in its closed position by the difference of such forces. To open the door, the actuator button 20 is simply pushed inwardly with a small manual pressure which need be only large enough to overcome the light switch spring 38 and close the switch 19. This completes the energizing circuit for the winding 21 to reduce the attractive force between the pole faces 30 to its low value which is less than the outward bias force. As a result, the door pops open automatically. Since the manual pressure of the actuator button is exerted transversely of the arcuate door path along which the biasing spring acts, the full amount of the spring force is available to swing the door open.

Upon release of the manual pressure on the actuator button 20 and movement of the same to its switch open position, the winding 21 is energized and the magnetomotive force of the permanent magnet 16 between the pole faces 30 is restored to attract the armature 15 when the door 11 is swung inwardly and approaches its closed position. During such movement, the inner door wall 24 engages the outer end of the plunger 23 while the pole faces still are spaced from the armature so that the magnetic attractive force on the latter is small. As the door is pushed inwardly farther and the spring 22 is compressed to increase its outward force, the attractive force on the armature increases at a greater rate until, in the final closing movement, the attractive force again exceeds the spring force to hold the door shut with the pole faces against the armature.

It will be apparent that, with the novel door and catch arrangement described above, the holding force on the door may be as large as desired by varying the size and magnetization of the permanent magnet 16. Yet, the manual force required for opening the door, being only large enough to close the switch 19, remains the same at a small, negligible value compared to the holding force on the armature 15. With the bias on the door less than the high value of attractive force exerted on the armature and greater than the low value of such force, the door is held securely in a closed position until the winding 21 is energized. Then the door swings open automatically upon momentary closure of the switch. Such automatic opening and the small force required to close the switch make it possible for the operator, for example, a housewife, to open the door conveniently even with both hands full of articles to be deposited inside the refrigerator enclosure. By virtue of the response to momentary actuation of the switch and the fact that the winding is deenergized except when the door is to be opened, the amount of power dissipated in the winding is extremely small.

I claim as my invention:

1. The combination of, a door frame, a door mounted thereon for movement toward and from a closed position along a predetermined path, means biasing said door away from said closed position, a magnetic catch having core and armature members providing a flux circuit and mounted on said door and frame members to abut each other when the door is closed, said circuit including a permanent magnet producing an attractive force between said core and armature members to overcome said biasing means when the door is closed, a winding incircling a part of said flux circuit and adapted when energized to reduce said attractive force and release the door to the action of said biasing means, an energizing circuit for said winding including a switch, and an actuator for said switch mounted on the exterior of said door for movement transversely of said door path to avoid reduction of the effectiveness of said biasing means during actuation of the switch.

2. A latch adapted to be mounted on relatively movable door and frame members and to hold the door member in a closed position with respect to the frame member, said latch comprising two laterally spaced elongated bars of magnetic material terminating at one of their ends in pole faces, a crosspiece of magnetic material spanning said bars adjacent their other ends and clamped between the bars to form therewith a core adapted to be mounted on one of said door and frame members, a block of magnetized permanent magnet material spanning and clamped between said bars between said pole faces and said crosspiece, an armature of magnetic material adapted to be mounted on the other of said door and frame members and spanning said pole faces so as to cooperate with said core to define two parallel flux paths both extending through said permanent magnet block and respectively extending through and by-passing the armature, the flux of said permanent magnet block dividing between said paths and the by-passing flux path having a magnetic restriction therein to divert the major portion of the permanent magnet flux through the armature to hold the armature against said pole faces and said door member in said closed position, a winding encircling said crosspiece, and a circuit for energizing said winding to produce a magnetomotive force opposing the flux of said block in said armature path and diverting the same into said by-passing path thereby reducing the attractive force between said core and the armature.

3. A latch adapted to be mounted on relatively movable door and frame members and to hold the door member in a closed position with respect to the frame member, said latch comprising two laterally spaced elongated bars of magnetic material terminating at one of their ends in pole faces, a crosspiece of magnetic material spanning said bars adjacent their other ends and clamped between the bars to form therewith a core adapted to be mounted on one of said door and frame members, a block of magnetized permanent magnet material spanning and clamped between said bars between said pole faces and said crosspiece, an armature of magnetic material adapted to be mounted on the other of said door and frame members and spanning said pole faces so as to cooperate with said core to define two parallel flux paths both extending through said permanent magnet block and respectively extending through and by-passing the armature, the flux of said permanent magnet block dividing between said paths and the by-passing path having a higher reluctance than the path through the armature to divert the major portion of the permanent mag-

net flux through the armature to hold the latter against said pole faces and said door member in said closed position, a winding encircling a part of one of said paths, and a circuit for energizing said winding to provide a magnetomotive force to divert the flux of said permanent magnet block away from said armature thereby to reduce the attracting force on the armature and permit said door member to be opened.

4. A latch adapted to be mounted on door and frame members and to hold the door member in a closed position with respect to the frame member, said latch comprising an armature adapted to be mounted on one of said members, a permanent magnet adapted to be mounted on the other member, a core of magnetic material also adapted to be mounted on said other member and providing spaced pole pieces, said pole pieces having pole faces opposing said armature and abutting the latter when said door member is in said closed position, said magnet bridging said pole pieces and said core having a portion bridging the pole pieces whereby the magnet, the core and said armature cooperate to define a first flux path extending through the magnet and the armature and a second and parallel flux path extending through the magnet but by-passing the armature, said magnet having a magnetomotive force large enough to provide sufficient flux in the path through said armature to attract and hold the latter against said pole faces to maintain said door member in said closed position, a winding encircling a part of one of said paths, and a circuit adapted to be connected to a source of direct current and connected to said winding to energize the latter and thereby reduce the flux through said armature.

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