June 28, 1960 G. W. NAGEL ET AL 2,942,907

MAGNETIC LATCHING MECHANISM

Filed March 25, 1957 3 Sheets-Sheet 1

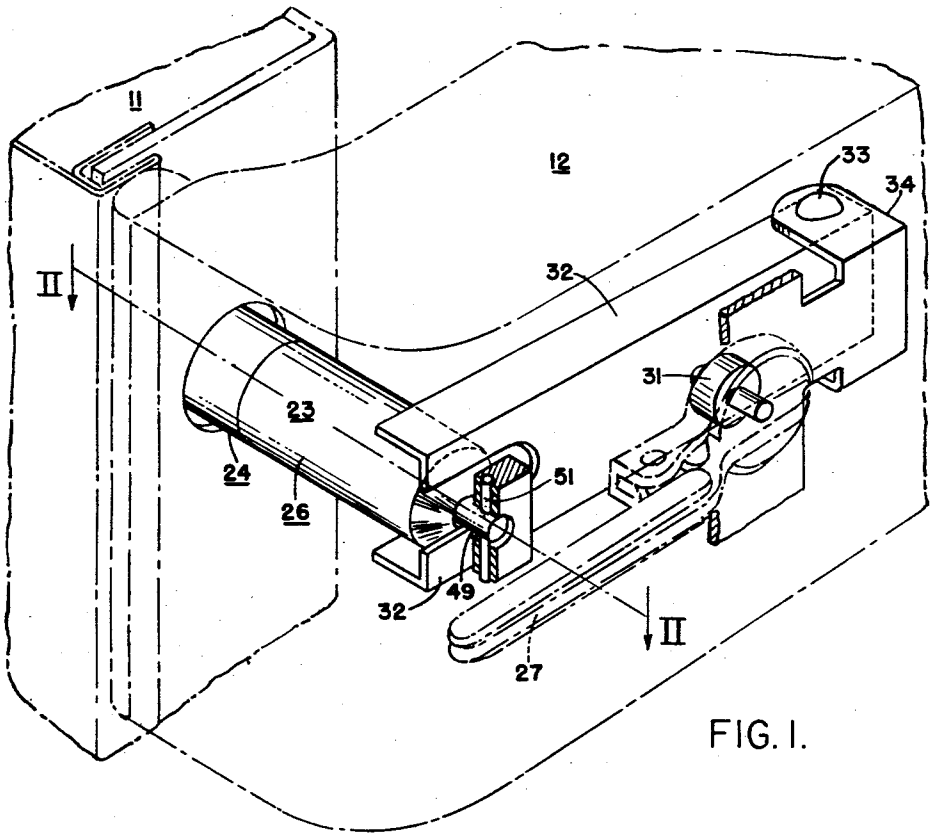


FIG. 1.

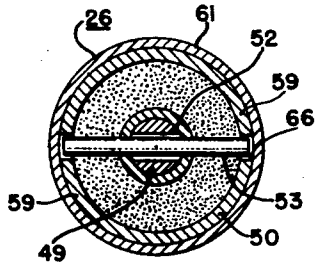


FIG. 6.

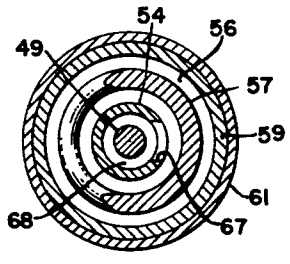


FIG. 7.

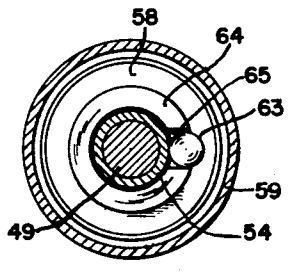


FIG. 8.

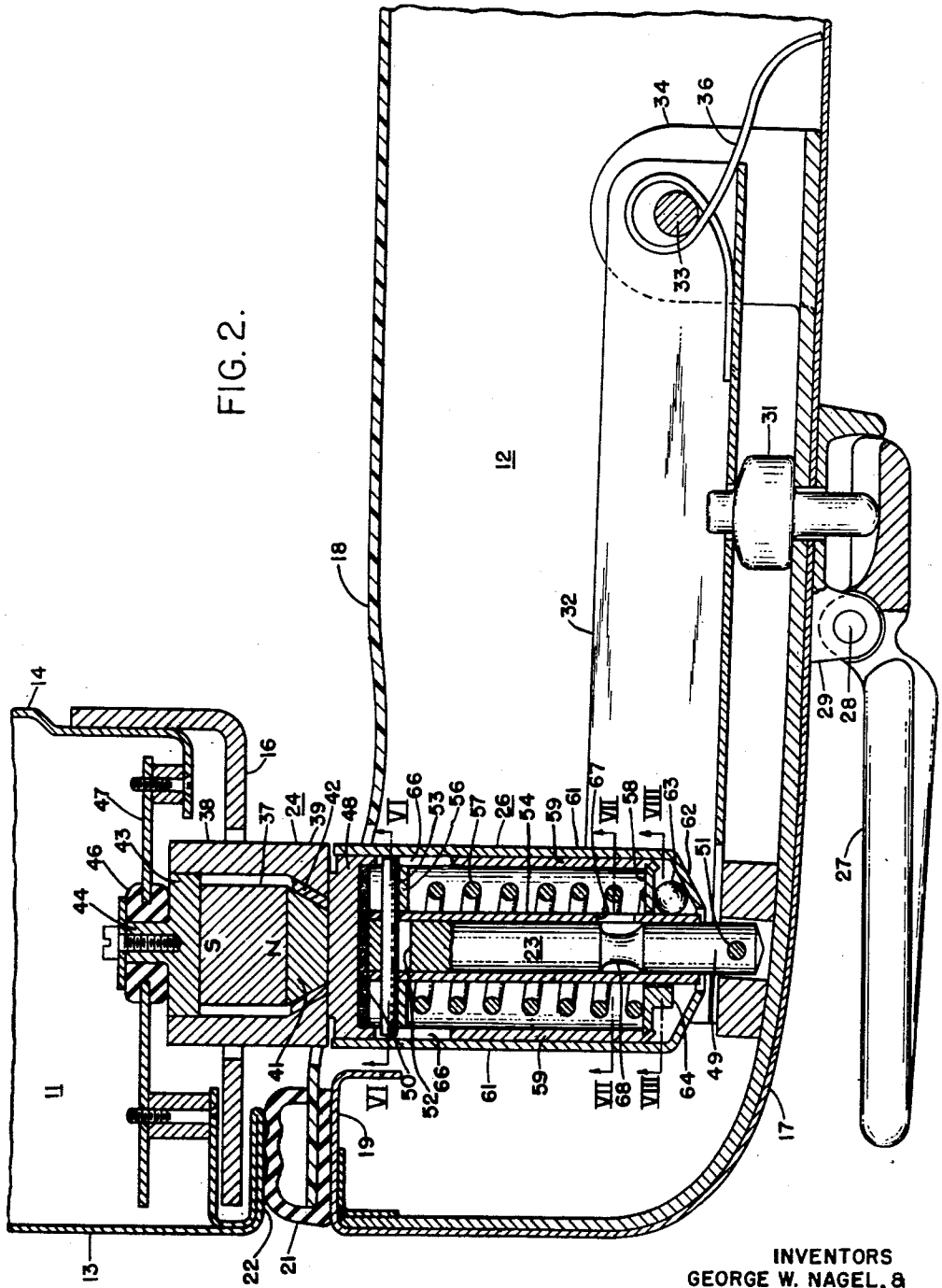
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MAGNETIC LATCHING MECHANISM

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FIG. 2.



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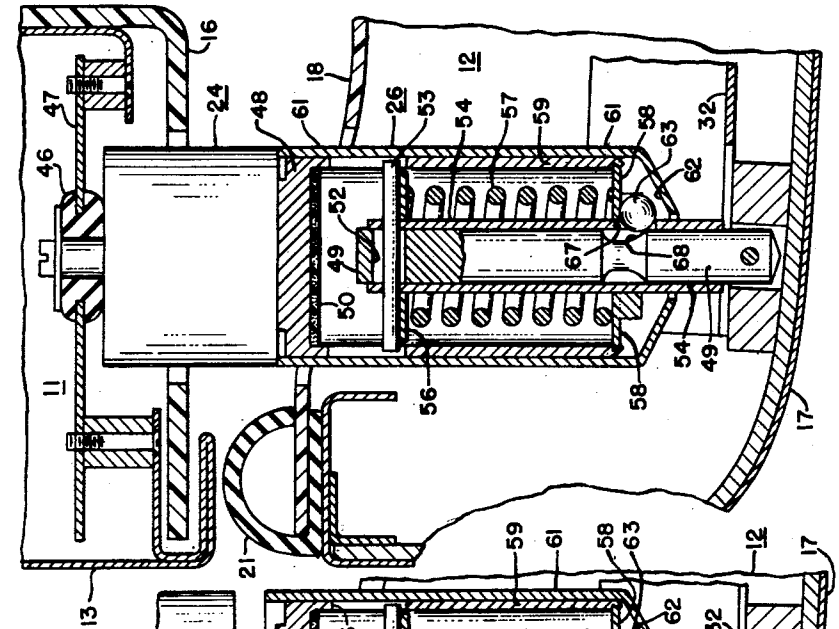
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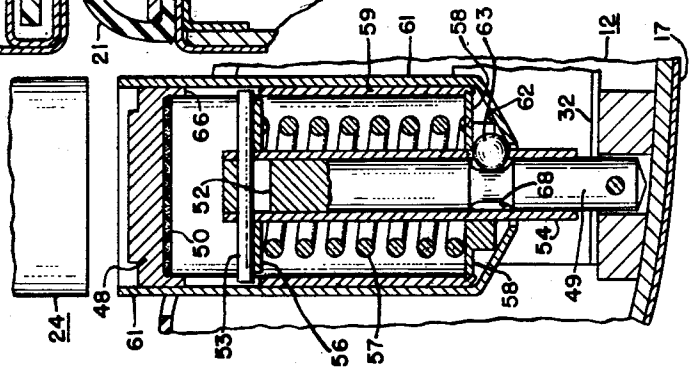
MAGNETIC LATCHING MECHANISM

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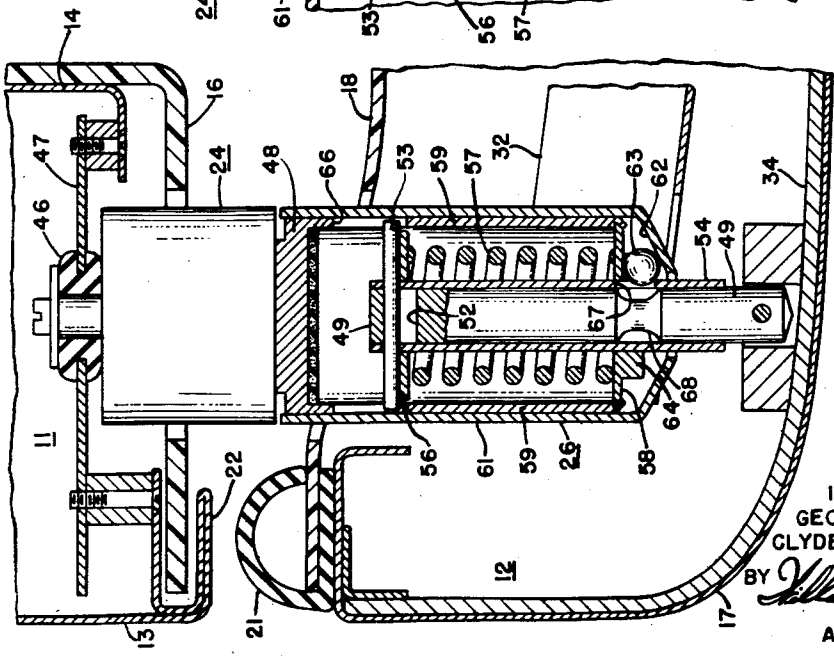
DOOR CLOSING, LATCH UNCOCKING.

FIG. 5.



DOOR OPENED, LATCH COCKED.

FIG. 4.



DOOR OPENING, GASKET SEAL BROKEN, LATCH ABOUT TO BE COCKED.

FIG. 3.

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MAGNETIC LATCHING MECHANISM

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3 Claims. (Cl. 292—251.5)

This invention relates to latching mechanisms for cabinet doors and more particularly to a permanent magnet latch structure suitable for use with heavy gasketed doors such as refrigerator cabinet doors.

One of the principal requirements of a latch mechanism for a gasketed closure such as a refrigerator door is that the mechanism provide a "pull-up" force to the door when closed to insure compression and complete seating of the door gasket. In the case of the domestic refrigerator, the mechanical latch mechanisms currently in use apply a continuous force to the closed door of the order of 35 pounds. Latch mechanisms for this service are also required to provide a force during the final range of door closing movement to effect initial compression of the gasket. Otherwise, the user finds it necessary to slam the door to compress the gasket. In all, such a latch mechanism may be called upon to supply a force of the order of 90 pounds while moving the door through its final one-quarter inch of movement, and to apply a uniform holding force to the door when it is closed.

Mechanical latch mechanisms have been designed to satisfy the above-mentioned requirements. However, such mechanisms are generally complicated and expensive to manufacture. On the other hand, magnetic latches have been proposed which are comparatively inexpensive. In general, however, the prior magnetic latches have not been capable of providing the necessary closing and holding forces for use with gasketed doors.

Accordingly, it is an object of this invention to provide an improved magnetic latch capable of effectively latching a gasketed door.

The permanent magnet latch structure contemplated by this invention may be briefly described as follows: The latch consists of two principal components namely, a magnet assembly and an armature assembly. One of these components is adapted to be mounted on the cabinet of a refrigerator or similar structure while the other is adapted to be carried by the door. In the preferred embodiment which will subsequently be described in detail, the magnet assembly is mounted on the cabinet and the armature assembly is mounted on the door in such a manner as to be engageable with the magnet assembly when the door is moved to its closed position. The armature assembly includes a spring for biasing the armature inwardly of the door and which, in effect, biases the door against the cabinet when the armature assembly is in contact with the magnet assembly and held thereagainst by magnetic force. The latch of this invention also incorporates means for moving the armature assembly relative to the door in which it is mounted to permit the door to be moved a short distance away from the cabinet to break the seal between the door and cabinet while the armature assembly is still held by the magnet assembly. Once moved to its projecting position relative to the door, the armature assembly is locked against the bias of the spring and a releasing member comes into play to separate the armature assembly from the magnet assembly and permit the door to be freely opened. Provision is also made for releasing the armature assembly locking means when the armature assembly contacts the magnet assembly as the door is moved toward closed position. Releasing the armature assembly permits the spring to retract the armature assembly into the door and pull the door up against the cabinet compressing the gasket into sealing engagement with the cabinet.

It is another object of this invention to provide an improved permanent magnet assembly for magnetic latches, which assembly will retain its magnetic properties for a long period of time.

It is a further object of this invention to provide an improved permanent magnet assembly with a sufficiently restricted magnetic field so as not to damage watch mechanisms which come in close proximity thereto.

These and other objects are effected by the invention as will be apparent from the following description taken in connection with the accompanying drawings, forming a part of this application, in which:

Fig. 1 is a phantom perspective view of a portion of a refrigerator cabinet showing the magnetic latch assembly of this invention;

Fig. 2 is a horizontal sectional view of the latch mechanism taken as indicated by the line II—II of Fig. 1;

Figs. 3, 4 and 5 are horizontal sectional views of the latch mechanism showing the mechanism in various stages of its sequence of operation;

Fig. 6 is a vertical sectional view of the latch mechanism taken along the line VI—VI of Fig. 2;

Fig 7 is a vertical sectional view of the latch mechanism taken along the line VII—VII of Fig. 2; and

Fig. 8 is a vertical sectional view of the latch mechanism taken along the line VIII—VIII of Fig. 2.

Referring to the drawings, the numeral 11 designates a refrigerator cabinet having a door 12 hingedly mounted on the front thereof. The walls of the cabinet 11 are defined by an outer shell 13 and an inner liner 14 mounted within and spaced from the outer shell. The space between the outer shell 13 and the inner liner 14 is filled with heat insulation (not shown) and the front of the wall space is closed by a thermal insulating breaker strip 16 extending between the front edges of the shell 13 and liner 14. The door 12 consists of an outer panel 17 and an inner panel 18 with heat insulation (not shown) disposed therebetween. Suitable means, such as screws (not shown), are provided for attaching the edge of the inner door panel 18 to the flanged edge 19 of the outer door panel, and for securing a resilient gasket 21 to the inner face of the door. When the door 12 is closed, the gasket 21 engages, and is compressed against, an inwardly turned flange 22 on the cabinet shell 13 as shown in Fig. 2.

The door 12 is held closed and is biased against the cabinet 11 by means of the magnetic latch structure of this invention. This latch is designated generally by the numeral 23 and consists of two principal elements or subassemblies, namely, the magnet assembly 24 and the armature assembly 26. In the preferred embodiment of the invention illustrated in the drawings, the magnet assembly 24 is mounted on the cabinet 11 and the armature assembly 26 is mounted on the door 12, though the position of these two assemblies can be reversed. It will be noted that the magnet assembly 24 and the armature assembly 26 are mounted in such a manner that they are in axial alignment with one another and have their face areas in abutment when the door 12 is in its closed position.

The magnetic latch 23 is actuated to open the door 12 by manually operable means carried by the door 12 and capable of applying an actuating force to the latch armature assembly 26. This manually operable means includes a handle 27 pivotally mounted at 28 to a support-

ing plate 29 carried on the outer surface of the outer door panel 17. Movement of the handle 27 is transmitted by a pin 31 to a lever 32, one end of which is pivotally attached at 33 to an inner supporting plate 34 carried on the inner surface of outer door panel 17. The opposite or free end of lever 32 is arranged to engage one end of the latch armature assembly 26. It can readily be seen that movement of the handle 27 in a counterclockwise direction (as viewed in Fig. 2) moves pin 31 inwardly of the door, causing a clockwise movement of lever 32 about pivot 33. The free end of lever 32 then engages latch armature assembly 26 and applies a force thereto for the actuation of the latch, as will be described later. Lever 32 and, consequently, handle 27 are biased to their inactive positions, as illustrated in Fig. 2, by a spring 36 at the pivotal connection 33 for lever 32.

The construction of the latch magnet assembly 24 and its mounting arrangement are best shown in Fig. 2. The magnet assembly 24 comprises a cylindrical shaped permanent magnet 37 encased in pole structure which includes a hollow cylindrical outer pole member 38 having a tapered opening 39 in the face thereof adapted to receive a tapered plug-like inner pole member 41 which is magnetically insulated from the outer pole member 38 by a frusto-conical separator 42 of non-magnetic material, such as brass. The other end of the outer pole member 38 is closed by a plug 43 having a boss 44 thereon by means of which the magnet assembly 24 is mounted on the cabinet 11. The outer pole member 38, the inner pole member 41 and the end plug 43 form a magnetic flux circuit for the magnet 37 and are, therefore, preferably constructed of metallic material having high magnetic permeability. The magnet assembly 24 is preferably resiliently mounted to the cabinet 11, as by means of a rubber grommet 46 surrounding the boss 44, and is carried by an insulating plate 47 extending between the cabinet shell 13 and the liner 14.

The magnet assembly 24 projects through an opening provided therefor in the breaker strip 16 and presents at its outer face two concentrically arranged magnetic poles which are spaced apart by the pole separator 42. It should be pointed out that the magnet assembly is capable of exerting a magnetic field sufficiently strong to maintain a refrigerator door in its closed and sealing position, and yet, is so constructed as to provide a low reluctance path for the magnetic flux from magnet 37 which prevents the magnet from becoming demagnetized when the magnet assembly 24 is open-circuited by the door 12 being opened. In this regard, the pole separator 42 is made of very thin material, of the order of 1/32 inch thick, and provides a low reluctance "air gap" between the magnet pole pieces 38 and 41. Thus, even when the magnet assembly 24 is open-circuited, sufficient magnetic flux flows through the pole members 38 and 41 to prevent the magnet from becoming demagnetized.

The magnet assembly 24 of this invention produces a strong, though concentrated and highly confined, magnetic field which reduces the likelihood of damage to watches or other delicate instruments worn or carried by persons actuating the latch. Some prior permanent magnetic latches produced a large stray magnetic field which could easily be accidentally entered by the hand of a person opening the door with which the latch is associated and presented a considerable hazard so far as damage to watches is concerned. As is well understood, the amount of stray magnetic field about a permanent magnet structure is proportional to the open circuit air gap in the magnetic circuit. The extremely small air gap, i.e., the space between the inner pole 41 and the outer pole 38 of the magnet assembly of this invention, insures a concentration of the magnetic flux between the two poles with little stray field. Furthermore, the fact that the outer pole 38 of this improved magnet assembly 24 completely surrounds, in concentric fashion, the inner pole 41, the possibility of stray flux paths existing in the area surrounding the magnet structure is further reduced.

The tapered interfitting portions of the outer pole member 38 and the inner pole member 41 simplify the manufacture of the magnet assembly 24. Both the tapered outer surface of the inner pole 41 and the inner surface of the outer pole member 38 defining the opening 39 may be easily manufactured to close tolerances by simple turning operations. Any variations in the dimensions of these parts is automatically compensated for during assembly by the relative axial shifting of the parts as they are forced together with the pole separator 42 therebetween. Accurate spacing between the two pole members is then easily maintained by careful selection of the thickness of the material employed for the separator 42. Any axial misalignment between the inner pole member 41 and the outer pole member 38 can be corrected by grinding the face of the magnet assembly 24 to provide a smooth flat surface thereon.

The magnet assembly 24 attracts thereto a portion 48 of the armature assembly 26 which will be termed the "armature." The armature assembly 26 is carried by a rod member 49 having one end loosely coupled to the door outer shell 17 by a pin connection 51. The rod member 49 extends along the axis of the generally cylindrical armature assembly 26 and has a diametric hole 52 drilled therethrough near its unsupported end. This hole 52 in the rod 49 loosely receives an elongated pin 53 which passes through and is closely confined by diametrically spaced openings in one end of a locking sleeve 54 slidably positioned over the rod member 49. The clearance between pin 53 and the rod hole 52 permits limited axial movement of the locking sleeve 54 on the rod 49. The outer extensions of pin 53 abut one face of a washer 56 loosely positioned around locking sleeve 54 and which serves as an abutment for one end of a compression spring 57 surrounding, in concentric fashion, the locking sleeve 54. The other end of the spring 57 abuts against an annular end wall 58 of an armature sleeve 59 which has its other end secured to the disc-shaped armature 48. The spring 57, being mounted within the armature assembly 26 in an axially compressed condition, biases the armature 48 inwardly of the door 12 and against the end of rod 49; actual contact between the armature 48 and the rod 49 being prevented by a shock-absorbing pad 50. The pad 50 may be constructed of rubber, leather or other material having cushioning qualities.

The spring 57, in biasing the armature 48 inwardly of the door, actually biases the door 12 against the cabinet 11 when the door is in closed position. This action can be readily comprehended if the armature 48 is considered as being stationary, as it would be if the door 12 were closed and the armature 48 held tightly against the magnet assembly 24. In this condition, the armature sleeve 59 and its end wall 58, being rigidly attached to the armature 48, would also be stationary. The spring 57, being compressed between the armature sleeve end wall 58 and the washer 56, transmits a biasing force through the pin 53 to the rod member 49 and therethrough to the door outer shell 17 in a manner to bias the door 12 toward the cabinet 11, compressing the gasket 21 into sealing relation with the cabinet.

The armature assembly 26 is encased within a cylindrical outer sleeve member 61 which is open at the one end surrounding the armature 48 and which is provided at its other end with a generally frusto-conical end wall 62 adapted to be engaged by the actuating lever 32 carried by the cabinet outer shell and forming a part of the actuating means for the latch. Sleeve member 61 functions as a releasing, or separating, member for the latch mechanism, as will be hereinafter described. It will be noted that the lever 32 engages this end wall 62 of the outer sleeve 61 in such a manner as to transmit thereto movement which is axial with respect to the rod member 49 which supports the armature assembly.

Forces which are applied to this end wall 62 of the outer sleeve 61 are transmitted to the armature sleeve 59 by a small metal locking ball 63 carried in the annular space between the locking sleeve 54 and the outer sleeve 61. This locking ball 63 bears against the end wall 58 of the armature sleeve 59 and is prevented from moving circumferentially about the locking sleeve 54 by an annular boss 64 extending from the face of the end wall 58 which is cut away at 65 to receive the ball 63 (see Fig. 8).

Relative rotative movement between the locking sleeve 54 and the armature sleeve 59 is prevented by an interlocking action between end extensions of the pin 53 and close fitting longitudinal slots 66 in the armature sleeve 59 (see Fig. 6). This interengagement between the pin 53 and the slots 66 does not restrict the relative longitudinal movement of the armature sleeve 59 with respect to the locking sleeve 54, but merely prevents these members from rotating with respect to one another. It can thus be seen that the path of movement for the locking ball 63 along the surface of the locking sleeve 54 is a longitudinally extending straight line.

The locking sleeve 54 has an opening 67 therein, the centerline of which lies in the path of movement of the locking ball 63. The rod member 49 is also provided with a circumferential recess 68 in the vicinity of this sleeve opening 67. The side walls of the recess 68 slope gently inwardly toward the bottom of the recess, providing cam-like surfaces in the recessed area. The sleeve opening 67 and rod recess 68 cooperate to form a detent into which the locking ball 63 enters when the armature assembly outer sleeve 61 is moved axially of the rod 49. The sloping inner surface of the sleeve wall 62 cams the ball 63 toward the centerline of the rod member 49 and assists the ball 63 in entering the opening 67 in locking sleeve 54 and the rod recess 68.

Operation

Assume the door 12 of the refrigerator is closed. The elements of the magnetic latch are in a static condition in the positions shown in Fig. 2 of the drawings. The operator grasps the handle 27, rotating it counterclockwise, and this motion is transmitted by means of the pin 31 to the latch actuating lever 32 which undergoes clockwise rotation about the pivot 33. The free or left-hand end of the actuating lever 32 engages the door mounted armature assembly 26 of the latch through the end wall 62 of the outer sleeve member 61, moving the outer sleeve to the position shown in Fig. 3.

This movement of the outer sleeve 61 is transmitted by means of the locking ball 63 to the armature sleeve end wall 58, compressing the spring 57 and moving the armature sleeve 59 and the armature 48 attached thereto. In other words, during this initial movement of the actuating lever 32, the outer sleeve 61 and the armature sleeve 59 move together as if mechanically interlocked, and continue to do so until the mechanism reaches the position illustrated in Fig. 3, wherein the locking ball 63 has moved up to and is about to enter the opening 67 in the locking sleeve 54.

This initial movement of the armature 48 relative to the door 12 and against the bias of the spring 57 moves the door 12 relatively away from the cabinet 11, decompressing the gasket 21 and breaking the seal between the gasket and the cabinet flange 22. The armature 48 is retained against the magnet assembly 24 by the magnetic attractive force between these two members, which force is greater than the forces applied to the door 12 by the user of the refrigerator in moving the handle 27.

This first range of movement of the elements of the armature assembly 26 is intended to break the seal of the door 12 with the cabinet 11. When a well sealed refrigerator cabinet is left standing for an appreciable length of time, the air therein becomes chilled and a partial vacuum is created within the cabinet which increases the force required to open the door. It will be noted that during this seal-breaking operation, the armature 48 of the latch remains in contact with the magnet assembly 24 and that no attempt is made to separate the armature 48 from the magnet assembly 24 until the cabinet seal has been broken. The forces required to break the cabinet seal are, therefore, not superimposed on the forces which must be applied to break the magnetic attraction between the armature 48 and the magnet assembly 24. The magnetic attraction between these latter two elements is overcome by forces associated with a second range of movement of the elements of the armature assembly 26.

Continued movement of the actuating lever 32 moves the elements of the armature assembly 26 from the position shown in Fig. 3 to that illustrated in Fig. 4. During this additional movement the following actions take place: The locking ball 63 is moved up to a position where it can pass through the locking sleeve opening 67 into the rod recess 68. This movement of the locking ball 63 is assisted by the cam-like inner surface of the outer sleeve end wall 62. Positioning of locking ball 63 within recess 68 locks together the locking sleeve 54 and the armature sleeve 59 as the locking ball 63 becomes wedged between the armature sleeve end wall 58 and the edge of the locking sleeve opening 67; a static, locked condition here exists by virtue of the armature sleeve end wall 58 and the locking sleeve 54 respectively engaging diametrically disposed points on the surface of the locking ball 63. This also locks the spring 57 in a compressed or cocked position.

Movement of the locking ball 63 into the recess 68 in rod 49 also permits slight relative movement of the outer sleeve 61 with respect to the armature 48 and its sleeve 59. This relative movement between outer sleeve 61 and the armature sleeve 59 is permitted by the shifting of the point of contact between the locking ball 63 and the sloping surface of the outer sleeve end wall 62; which action permits the end wall 62 to move closer to the armature sleeve end wall 58. This movement is readily apparent if the relative positions of the face of the armature 48 and the open end of the sleeve 61 are compared between Figs. 3 and 4 in the drawing. This movement of the open end of the outer sleeve 61 beyond the plane of the outer surface of the armature 48 forces the magnet assembly 24 and the armature 48 apart a small distance. The amount by which the armature 48 and the magnet assembly 24 are separated, though small, is sufficient to lower the attractive force between these members to a value which can be easily overcome by the operator of the latch in continuing to pull on the door 12 by means of the handle 27. Release of the armature 48 from the magnet assembly 24 permits the door to be opened and the armature assembly 26 remains in the cocked position shown in Fig. 4 so long as the door remains open. When the door handle 27 is released, the handle and the latch actuating lever 32 are returned to the position shown in Fig. 2 by the spring 36.

Fig. 5 illustrates the tripping action of the armature assembly 26 as the door 12 is swinging to its closed position. Initial contact between the armature assembly 26 and the magnet assembly 24 drives the outer sleeve 61 of the armature assembly back until its open end is flush with the face of the armature 48. The outer sleeve 61 slides freely through this movement since the actuating lever 32 has been returned to its rest position beyond the path of movement of the sleeve 61. It will be noted the elements are so arranged that the armature 48 contacts the magnet assembly 24 to initiate the tripping action of the armature assembly 26 just prior to, or near, the point in the door swing where the gasket 21 contacts the cabinet flange 22.

Engagement of the armature 48 with the magnet assembly 24 obviously stops movement of the armature 48 and the other elements of the armature assembly which are attached to or interlocked therewith. These elements

which are locked to the armature 48 are the armature sleeve 59, its end wall 58 and, through the ball 63, the locking sleeve 54, pin 53, washer 56 and, of course, spring 57 which is compressed between the armature sleeve end wall 58 and washer 56. The inertia of the closing door 12, however, tends to carry the door and armature assembly rod 49 on toward the cabinet. The rod 49 is free to move a short distance relative to the locking sleeve 54 by virtue of the loose fit between hole 52 and the pin 53. As the rod 49 is driven inwardly of the armature assembly 26, the cam-shaped side wall of the rod recess 68 kicks the locking ball 63 loose from its wedged position between the locking sleeve 54 and the armature sleeve end wall 58. The armature sleeve 59 is, therefore, unlocked from the locking sleeve 54 and spring 57 is free to expand and retract the armature 48 within the door. Since the armature 48 is held stationary by the magnet assembly 24, the expansion force of spring 57 is transmitted through washer 56 and pin 53 to rod 49 and, consequently, to the door 12, causing the door to move toward the cabinet 11, compressing and seating the gasket 21. The elements of the latch thereby return to the positions shown in Fig. 2.

The extent of the closing movement of the armature 48 with respect to rod 49 is limited by the engagement of the end of rod 49 with the cushioning pad 50 carried on the inner face of the armature 48 (see Fig. 2). Pad 50 absorbs any shock occasioned by the armature 48 being driven against the end of rod 49 in the event the armature assembly 26 is tripped accidentally while the door 12 is open. Furthermore, in constructing the latch of this invention, the elements are so designed that the movement of the armature 48 and pad 50 from the position shown in Fig. 5 to the position shown in Fig. 2 is sufficient to compress but not crush the gasket 21, and engagement of the pad 50 with the end of the rod 49 constitutes a stop for limiting compression of the gasket 21.

From the foregoing it will be apparent that this invention provides an improved latch structure utilizing magnetic holding means, which structure is particularly applicable to gasketed closures for refrigerators or the like.

It should also be apparent that, while the invention has been described with reference to a single preferred embodiment thereof, certain changes or modifications can be made therein without departing from the spirit of the invention. One such modification would be the reversal of the positions of the magnet assembly 24 and the armature 48. Obviously, the armature 48 could be secured to the cabinet 11 and a magnet assembly, similar to that shown at 24, secured directly to the armature sleeve 59 for movement therewith. Furthermore, the entire armature assembly 26 could, with but slight and obvious modifications, be mounted on the cabinet 11 instead of on the door 12 as shown and described. Other modifications and adaptations will be apparent to those skilled in the art.

What is claimed is:

1. In a magnetic latch structure including a magnet element and an armature element, one of said elements being carried by a cabinet structure and the other element being carried by a door structure for said cabinet structure, means mounting one of said elements on one of said structures for reciprocating movement normal to the plane of the door structure, a spring arranged to urge said one element to a retracted position within the structure to which it is mounted, manually operable means for moving said one element to a cocked position away from the structure to which it is mounted and toward the other structure, a separating member carried by the structure to which said one element is mounted, a locking member operable in one position to engage portions of said one element and said separating member for causing said separating member to move with said one element as said one element is moved to its cocked position, and means for moving said locking member to another position to permit movement of said separating member relative to said one element when said one element is moved to its cocked position, said manually operable means being adapted for moving said separating member relative to said one element and toward said other element when said one element is in its cocked position to separate said one element from said other element.

2. In a magnetic latch structure including a magnet element and an armature element, one of said elements being carried by a cabinet structure and the other element being carried by a door structure for said cabinet structure, means mounting one of said elements on one of said structures for reciprocating movement normal to the plane of the door structure between an extended position and a retracted position, a spring arranged to urge said one element toward the structure on which it is carried, a releasing member carried by the structure on which said one element is carried, manually operable means for moving said releasing member away from the structure on which it is carried, a locking member operative in one position to engage portions of said one element and said releasing member to lock said one element to said releasing member for movement therewith, said locking member being movable to a second position engaging portions of said one element and the structure on which said one element is carried to lock said one element against movement relative to the structure on which it is carried, and means for moving said locking member from its said one position to its said second position when said one element is moved to its said extended position, said locking member in its second position unlocking said releasing member to permit movement thereof relative to said one element and toward said other element whereby said releasing member separates said one element from said other element.

3. In a latch mechanism for a cabinet door, the combination of a magnet carried by the cabinet in a position to engage an armature carried by the door, a releasing member carried by the door, means for supporting said armature and said releasing member for reciprocating movement normal to the plane of the door, a spring carried by the door and arranged to urge said armature to a retracted position within said door, manually operable means for moving said releasing member away from said door, a locking member operative in one position to engage portions of said armature and said releasing member to lock said armature to said releasing member for movement therewith, said locking member being movable to a second position to engage a portion of said armature and a member which is fixed relative said door to lock said armature against movement relative to said door, and means for moving said locking member from its first position to its second position when said armature has been moved to a cocked position away from said door, said locking member in its second position unlocking said releasing member to permit movement thereof relative said armature and toward said magnet whereby said releasing member separates said armature from said magnet.

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