March 6, 1951 G. MUFFLY 2,544,394

REFRIGERATOR WALL AND CLOSURE

Filed Dec. 7, 1945 4 Sheets-Sheet 1

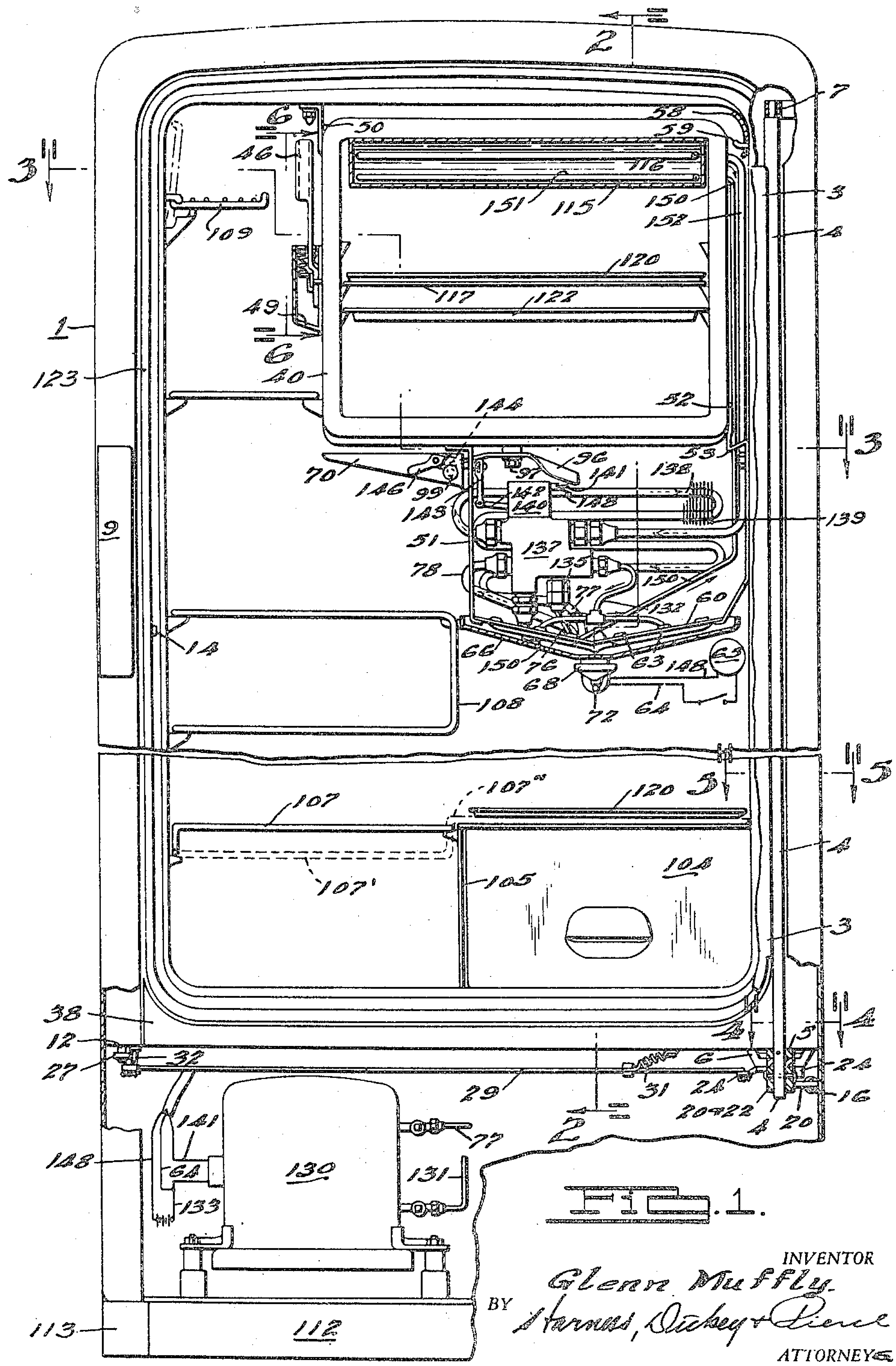

FIG. 1.

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REFRIGERATOR WALL AND CLOSURE

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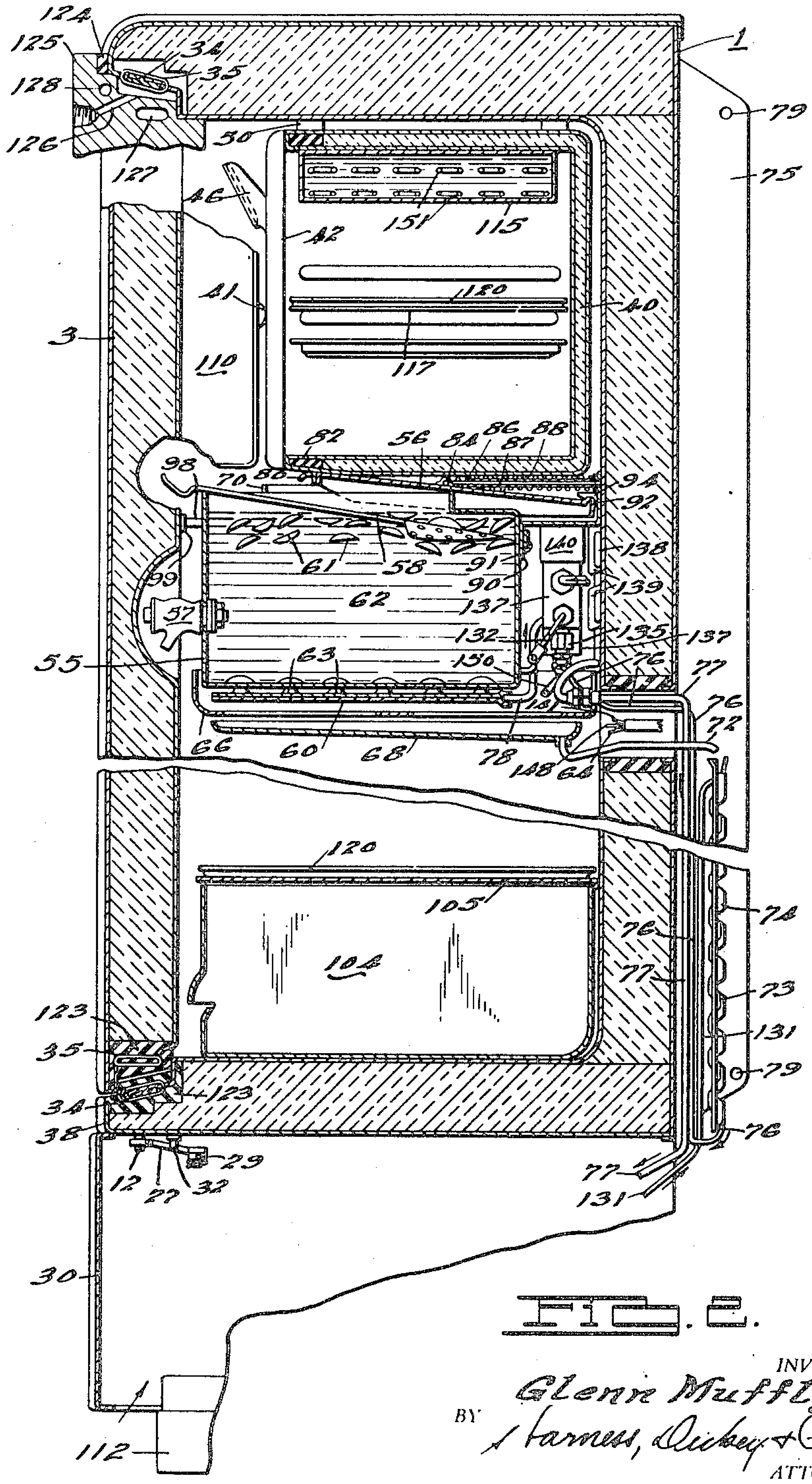

FIG. 2.

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REFRIGERATOR WALL AND CLOSURE

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FIG. 3.

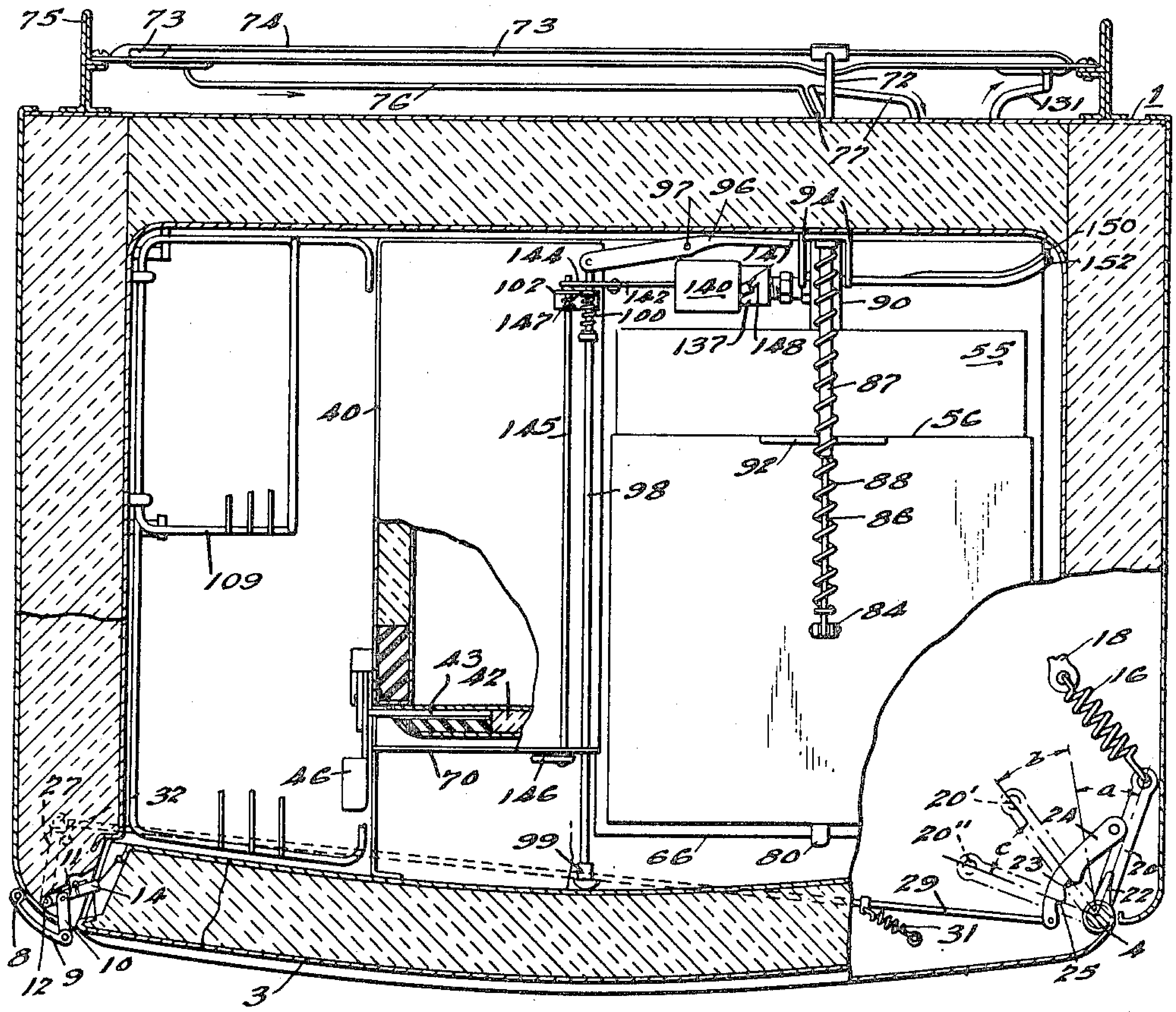

FIG. 4.

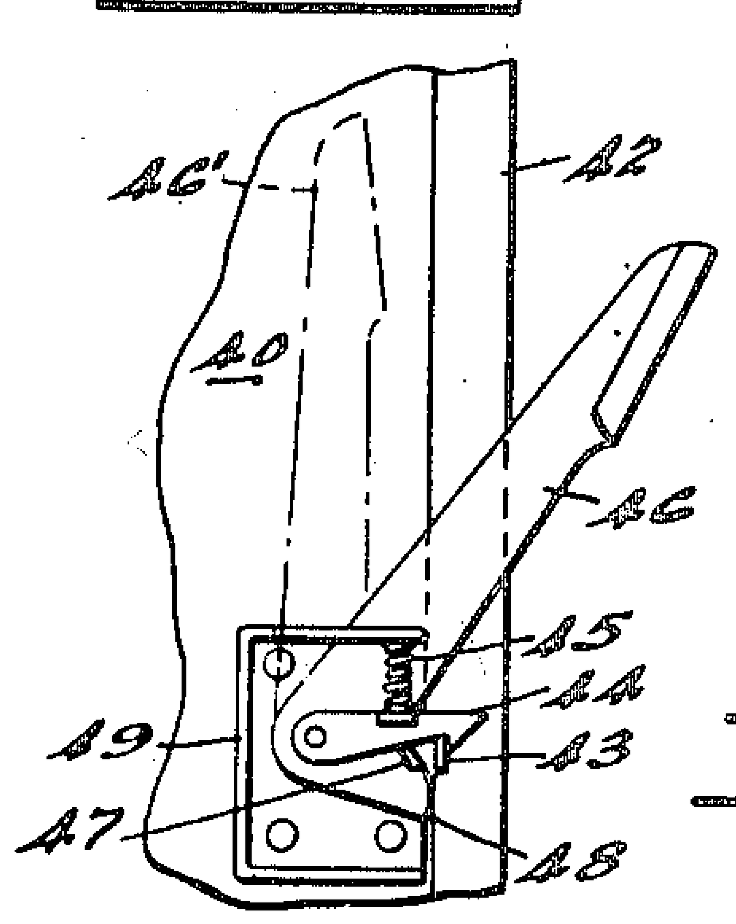

FIG. 6.

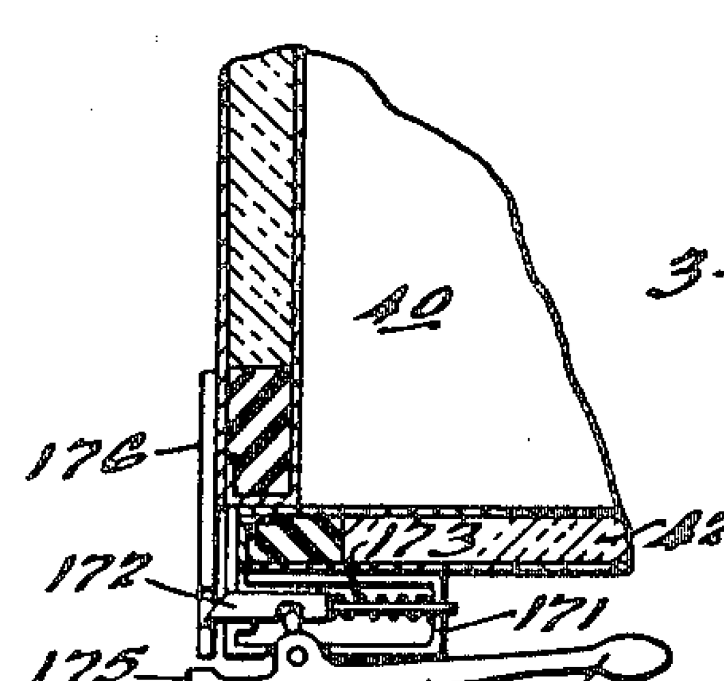

FIG. 7.

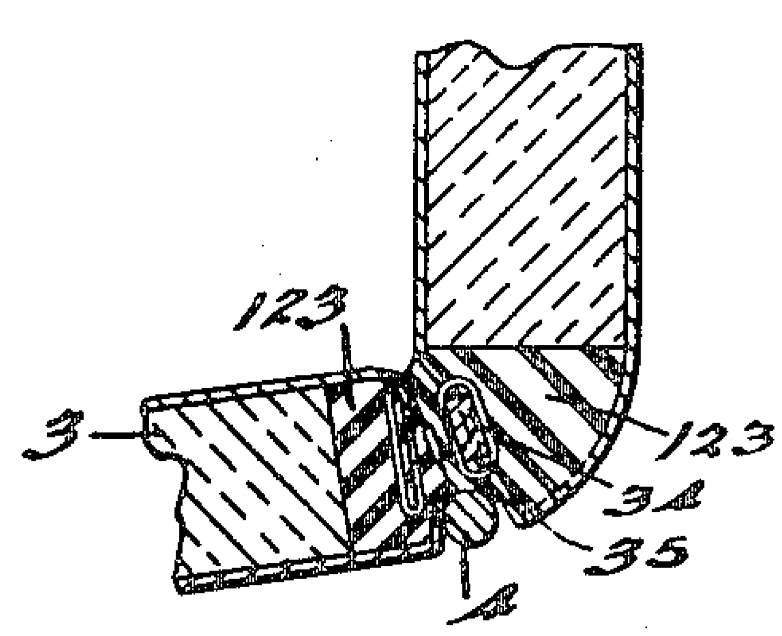

FIG. 5.

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REFRIGERATOR WALL AND CLOSURE

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FIG. 8.

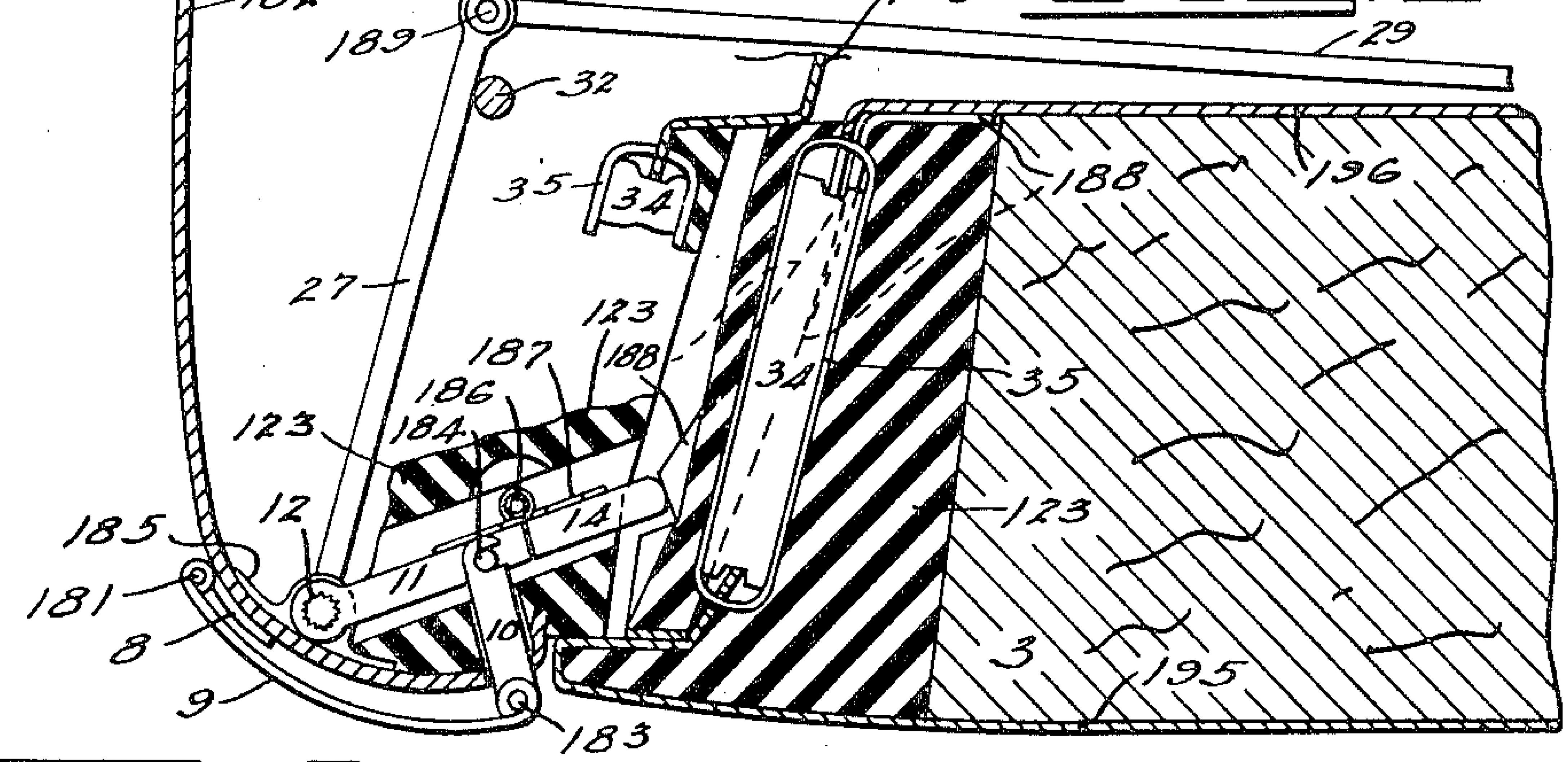


FIG. 9.

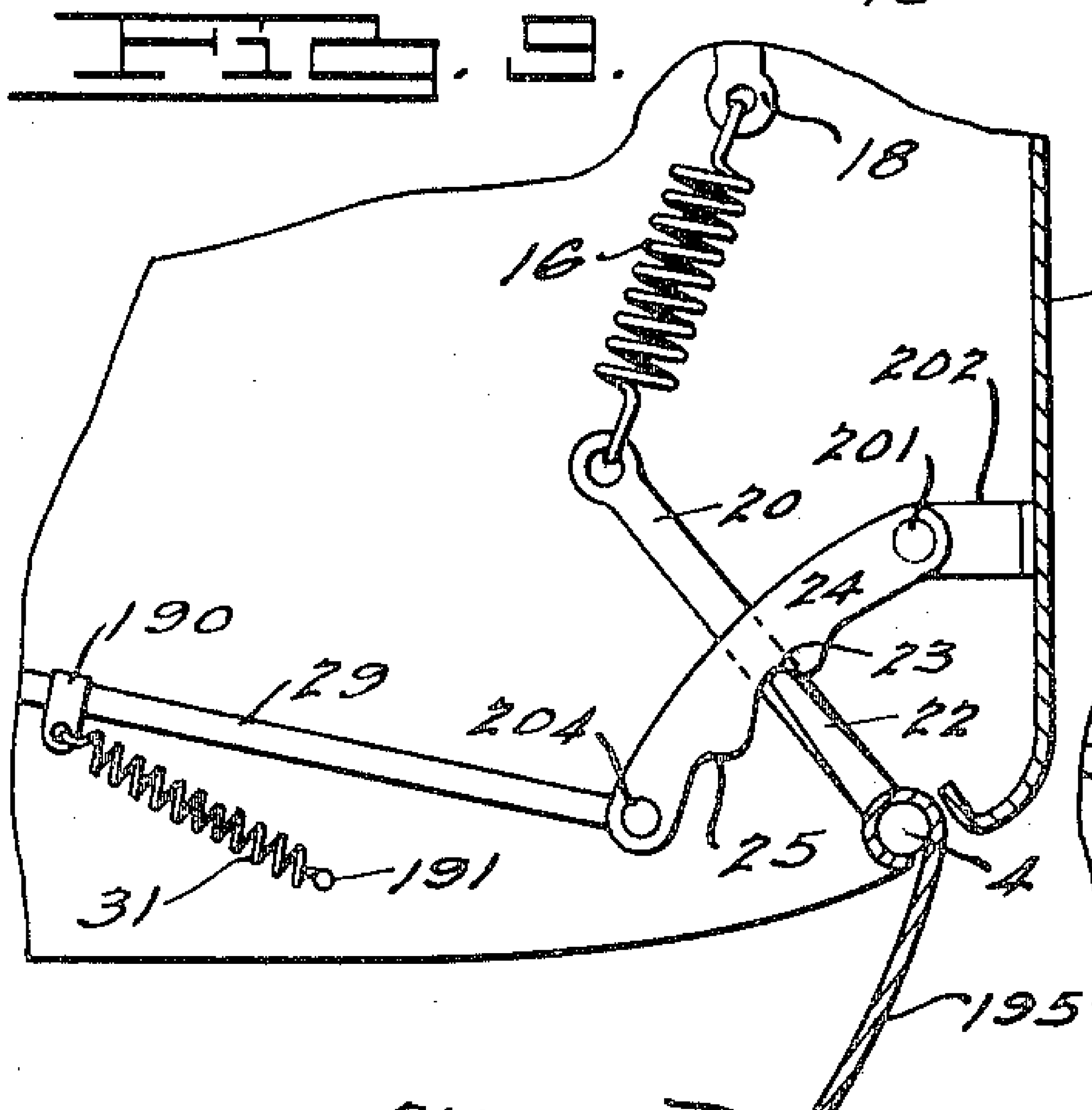
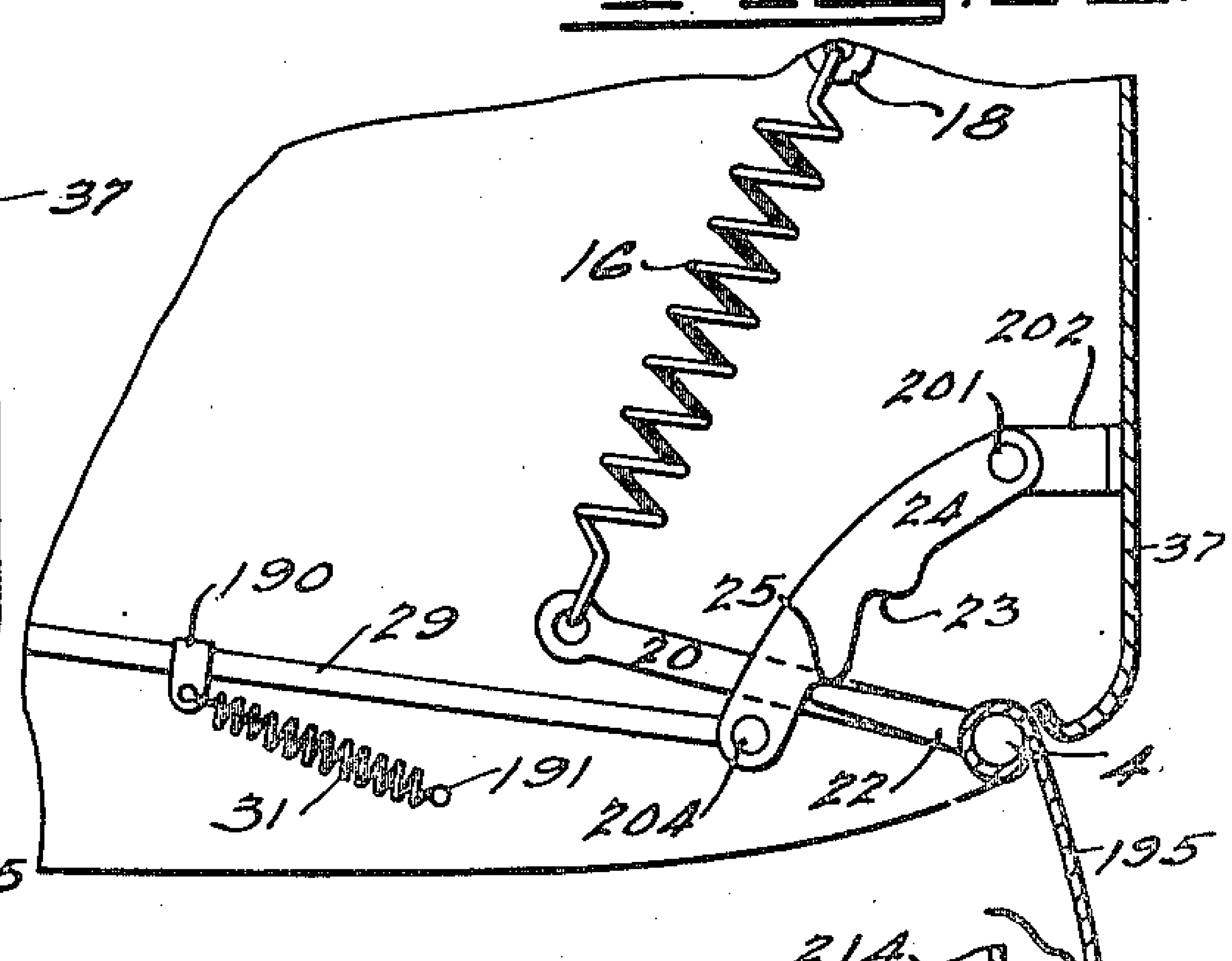


FIG. 10.



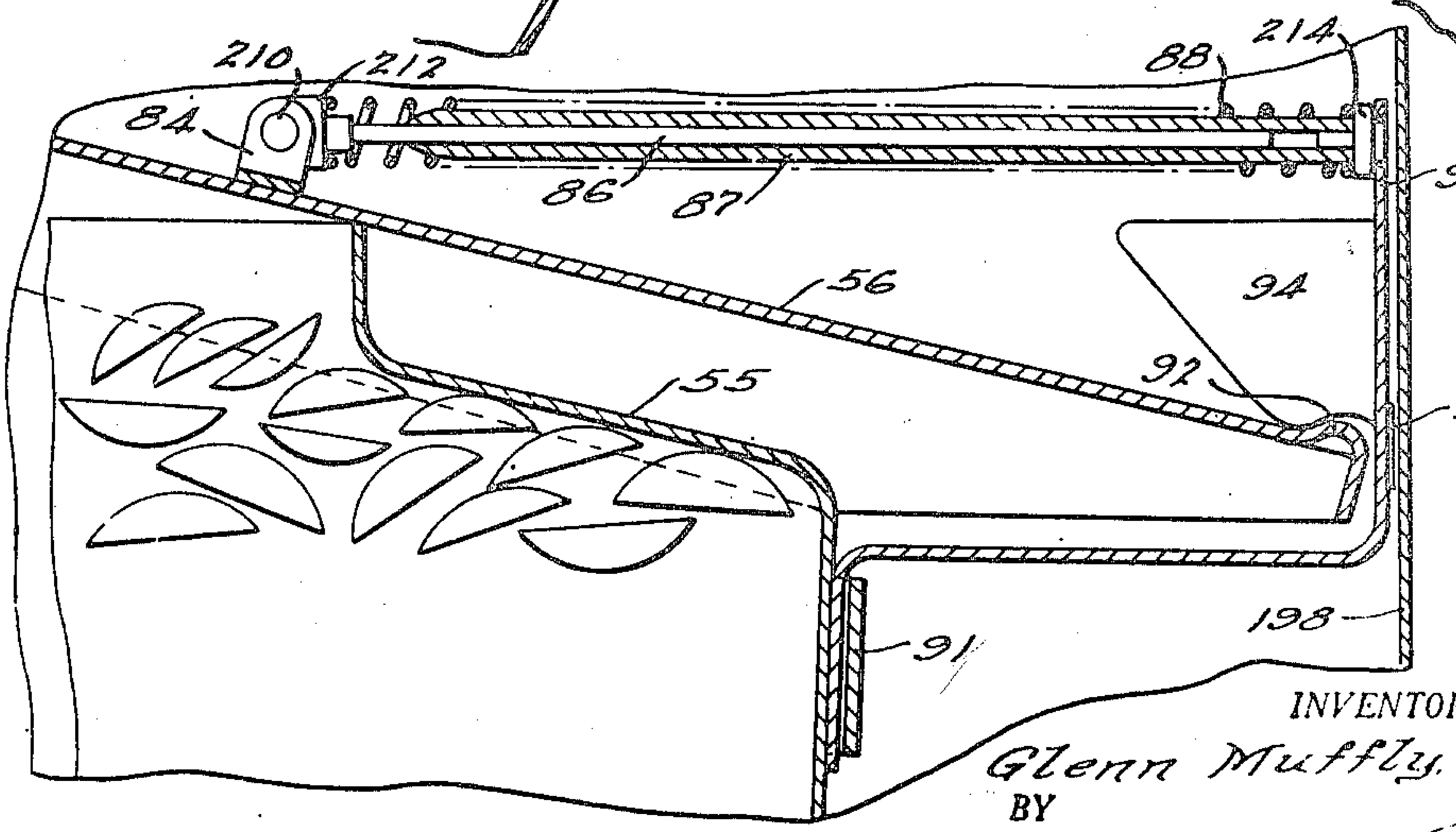


FIG. 11.

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UNITED STATES PATENT OFFICE

2,544,394

REFRIGERATOR WALL AND CLOSURE

Glenn Muffly, Springfield, Ohio

Application December 7, 1945, Serial No. 633,371

11 Claims. (Cl. 62—89)

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This invention pertains to refrigeration and particularly to mechanical refrigerators adapted for household use and is a division of my application for Letters Patent of the United States for Improvement in Refrigerator filed October 3, 1941 and Serially numbered 413,495, now Patent No. 2,410,672 issued November 5, 1946.

One of the objects is to provide a self-opening and self-closing outer door.

Another object is to provide operating means for such a door, employing spring means which acts at one time to open the door and at another time to close the door.

An additional object is to provide a door or cover for an inner receptacle of such a refrigerator which is self-closing as a result of closure of the outer door.

A further object is to provide a new type of frame or breaker strip for a refrigerator door or the opening which it is adapted to close, such nonconducting frame being molded in place in one piece.

Another object is to provide for assembly of inner and outer metal walls of a refrigerator or its door with suitable insulation between such walls, the metal walls being tied together in a manner to hold the insulation compressed and to obviate the necessity for adding a frame to provide structural strength.

Still another object is to provide a freezer door inside of the refrigerator with latch means effective both for securing the freezer door closed and for breaking an ice bond between the freezer door and the freezer walls.

An additional object is to provide a refrigerator door with a latch which does not project forward farther than the door itself, thus simplifying the packing of the refrigerator for shipment and eliminating the use of a projecting handle or other part which might catch on a person's clothing.

A further object is to arrange the internal enclosures of a refrigerator in a manner to provide better visibility of articles placed on shelves located below such enclosures.

Another object is to provide a removable shelf or tray for use within the main food compartment of the refrigerator or within the freezer compartment interchangeably.

An additional object is to provide a multiple-temperature cooling system employing two or more evaporators adapted to be cooled to different low temperatures and to provide in addition a dryer coil adapted to serve as an additional

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evaporator connected in series after which ever evaporator is active.

A still further object is to provide for the automatic removal of water condensed from the air within the refrigerator and for draining all such condensate through a common outlet to a readily cleanable condensate evaporator outside of the refrigerator.

Still another object is to provide for location of the door operating mechanism within the refrigerating machinery compartment of the refrigerator.

A still further object is to provide an evaporator within the refrigerator with extended surfaces which are so formed as to drain any moisture collected thereon into a moisture-collecting pan without the necessity for locating such a pan so that it interferes with the circulation of air over the evaporator and its extended surfaces.

The accompanying drawings illustrate only one design without going into modifications except that Figure 7 shows an alternative type of latch for the freezer door. In these drawings similar reference numbers are used for similar parts throughout, and all figures except Figure 7 are tied together by the broken lines which indicate where sectional views are taken or are enlargements of other figures.

Figure 1 is a front elevation of the refrigerator, showing the outer door broken away, the freezer door removed and the ice-water tank removed for a clearer showing of internal parts.

Figure 2 is a sectional view of Figure 1 taken on line 2—2 thereof, showing the ice-water tank in position and illustrating the method employed to reclose the cover of this tank. This view also shows a section of the half mold used in forming the door frame from plastic material.

Figure 3 is a horizontal sectional view of Figure 1 taken mainly on the line 3—3 thereof and including broken portions. This view shows the spring devices for actuating the outer door and for reclosing the ice-water tank cover. It also shows details of the main door latch and its connection with the door closing mechanism.

Figure 4 is a detail sectional view of Figure 1 taken on the line 4—4 thereof to illustrate the relationship between the hinge rod of the outer door of the outer panel immediately below the door.

Figure 5 is a sectional view taken on the line 5—5 of Figure 1 to illustrate the relationship of the hinge rod to the door and to the cabinet and further to show sections of the molded door frame and of the molded frame for the door opening, illustrating the change of section of these frames on the hinge side of the door as compared with the sections seen in Figures 2 and 3.

Figure 6 is a detail view of the freezer latch as seen from the line 6—6 of Figure 1.

Figure 7 is a fractional horizontal sectional view of the freezer and its door, showing a modified form of latch.

Figure 8 is an enlarged sectional view showing a part of Figure 3 in greater detail.

Figure 9 is a detail of Figure 3 showing the door spring mechanism with door partially open.

Figure 10 is similar to Figure 9, but showing the door fully opened.

Figure 11 is an enlarged detail view showing the part of Figure 2 which includes the spring and latch means for the cover of the ice-maker tank.

The cabinet 1 is fitted with a door 3 adapted to open the full front of the food space. The door is attached to the hinge rod 4 which is connected with a spring-actuated mechanism for both opening and closing the door, as below described.

The rod or shaft 4 carries a collar 5 which engages the bottom support bearing 6 in end thrust to support the weight of the door and the upper end of rod 4 has its bearing in support 7. At the left side of the door, as seen in Fig. 3 the hinge 8 supports the latch plate 9 which is pushed inwardly toward the cabinet to release the door. This moves the push rod 10 inwardly, moving the latch lever 11 in a counterclockwise direction together with the shaft 12, as viewed from above, thus withdrawing the hinged latch end 14 from engagement with the door, with is thereupon opened by the door spring 16. This spring is supported at one end by the fixed member 18 and acts upon the lever 20, which is secured to the hinge rod 4. This hinge rod is in turn secured to the outer wall member of the door, being free to rotate in bearings 6 and 7. Since the spring 16 is under tension when the door is closed, it acts in an opening direction on the door while the lever 20 moves through the angle a. The inertia of the door will thereupon stretch the spring 16 while the lever 20 and the door move through a slightly lesser angle, as seen in Figure 9 and indicated at b in Fig. 3, bringing the lever 20 to the position 20′. At this point the pawl 22, which is also secured upon the rod 4, has engaged the notch 23 of the ratchet quadrant 24, thus holding the door open with the spring 16 partially extended.

It will thus be seen that a user coming to the refrigerator with both hands full can open the door by merely touching the striker plate 9 with her elbow. While the door does not open wide, it opens far enough to provide ordinary access to the food compartment and it may be pushed to the 90° position of full opening (Fig. 10) without using the hands. When the door is so pushed the pawl 22 is moved into engagement with the second notch 25 in the quadrant 24. The lever 20 is at the same time moved to the dotted position 20″, further extending the spring 16.

To close the door from this full-open position it is only necessary to again depress the plate 9, which causes the shaft 12 to move counterclockwise as seen in Figs. 3 and 8, carrying with it the lever 27 and through the medium of pull-rod 29 moving the quadrant 24 away from the pawl 22. The plate 9 should preferably be held in its depressed position until the pawl 22 has passed the notch 23, then released before the door has fully closed, but the notch 23 is so formed that failure to do this will not prevent closing of the door. It will be noted that the angle c plus b is considerably greater than the angle a, hence the energy stored up in the spring 16 when the door is at its full-open position will impart sufficient momentum to the door to carry the lever 20 through the angle a and thereby load the spring 16 under tension with sufficient energy for reopening the door as above described. This mechanism is accessible through the opening closed by the unit compartment door 30.

As the door closes it engages the latch end 14, which is hinged upon the latch lever 11 in a direction to allow the door to close without moving the lever 11 and its associated parts. The hinge joining 11 and 14, is of a one-way type and provided with a spring acting to hold the part 14 in the position shown, with its arcuate end engaging the notch in the striker on the door. By means of a suitable angle and location of the notch surface, the latch end 14 is stopped by contact on its arcuate end rather than on one side, thus holding it slightly out of line with the lever 11, canted at an angle so that it holds the door securely closed. This angle is enough to allow for wear, but not enough to impose an excessive toggle load on the depression of the plate 9 for the next opening of the door.

The spring 31 is attached to the rod 29 and to a fixed support on the cabinet so as to be under some tension. It holds the lever 27 against its stop 32, thus establishing the normal position of the plate 9, the lever 11 and the quadrant 24. The spring 31 is located so as to pull at an angle upon the rod 29 and thus keep this rod from vibrating. The quadrant 24 is pivoted on the horizontal wall above the machinery compartment of the cabinet in a manner to allow the lever 20 to swing freely below it.

The notches 23 and 25 and the end of the pawl 22 are rounded or given a negative rake. This is not a great enough rake to allow the spring 16 to overcome the spring 31, but is sufficient to prevent injury to the parts in the event that the user forces the door in a closing direction instead of touching the plate 9. It is preferred that the negative rake of the notch 23 be greater than the negative rake of the notch 25, both because this notch has less spring tension to hold and so as to allow the user to push the door closed from its two-thirds open position without touching the plate 9.

The metal walls of the cabinet structure housing these latch parts are held apart by wood blocks 34 and tied together by wire ties 35, as seen in Figure 8. The hinge rod 4 passes outside of the welded joint between the right-hand outer sheet 37 of the cabinet and panel 38 below the door, as seen in Figure 4, but its lower end is concealed behind the unit compartment door 30. Panel 38 may be one piece with the sheet of metal below the bottom insulation, as shown, to reduce the length of joints to be welded. The door 3 may be removed from the cabinet by removing the door 30, disconnecting the spring 16 and lever 20, loosening the lower support 6 from the cabinet, opening the door and dropping it down to withdraw the upper end of the rod 4 from its support 7.

The freezer 40 is similar to one shown in my co-pending application, Serial No. 237,629, filed October 29, 1938, now Patent No. 2,359,780 granted October 10, 1944. It will be understood that the means for closing the freezer door disclosed in this prior application may be employed in connection with the present disclosure. A difference between the freezer and tank arrangement of the present application and that of the earlier application last mentioned above is that I have made the freezer wider and the ice-maker tank narrower. This is done to improve the visibility of the interior of the cabinet, particularly portions of shelves located below the ice-maker tank. The arrangement here shown places the ice-maker and the freezer in an inverted pyramid arrangement whereby the user is given an angle of vision which allows a clear view of the major portion of the food storage space.

The freezer **40** is an insulated enclosure which may be considered a small refrigerator within the main refrigerator. Closing of the outer door **3** causes it to engage the bumper **41** of rubber or other suitable material, thus closing the insulated door **42**, the latter being hinged at the right and fitted with a special latch which serves not only to hold the freezer door closed, but as a means for prying the door free when it is frozen shut. A freezer of this type should be held at a temperature considerably lower than that of the main food compartment and the latter should be held at a temperature above freezing with a high relative humidity. The air of the main food compartment of the refrigerator will therefore contain enough moisture to fall below its dew point at the junction of the freezer door and the fixed freezer walls. This causes frost to collect in the door joint, freezing the door shut. When the freezer door is opened after being closed for a considerable period it is necessary to break the ice thus formed, hence I have provided means for doing this.

Figure 6 is a fractional view showing a side elevation of the latch as it would be seen from the left as indicated in Figure 1. The freezer **40** is closed by the hinged door **42**, this door having rigidly attached thereto the latch plate or striker **43**. When the door is pushed shut this striker engages and lifts the latch member **44**, this latch or pawl being returned by the spring **45** to secure the door in its closed position. To open the latch the lever **46** is moved in the direction of its dotted position **46'** and the lug **47** lifts the latch **44** clear of the striker **43** so that the door may be opened. The cam surface **48** which is integral with lever **46** and located below lug **47** engages latch plate **43** and forces the door open after latch **44** has been lifted clear of striker **43**. Since the spring **45** is retained between the latch body **49** and the latch member **44**, while the latch member engages the lug **47**, it will be seen that the spring not only moves the latch down against the lug **47** but thereby moves the lever **46** forward to the position indicated by full lines in Figure 6. The purpose of cam **48** is to break any ice bond which may have been formed between the door **42** and the body of the freezer **40**. One continuous movement of the lever **46** rearwardly first lifts the latch and then forcibly pushes the door open far enough to break any ice bond. In order that the door **42** may be slammed or pushed closed without danger of damage that might result from inertia of the lever **46** I have provided for movement of the latch **44** independently of the lever **46** in an upward direction. The parts **44** and **46** are pivoted upon a common pin but not attached together except that the lug **47** on the part **46** provides a positive means for lifting the latch **44**.

With either type of latch, the freezer door is automatically closed by the closing of the outer door as disclosed in my application, Serial No. 237,629 filed October 29, 1938, the rubber bumper **41** finally pushing the door **42** closed to its latching position.

The insulating material for cabinet walls is preferably in board form or semi-rigid packages. This insulation is placed within the outer shell of the cabinet and then the cabinet liner is pushed into place. The blocks **34** of wood or other material, preferably having a low thermal conductivity but being substantially non-compressible, are forced into place between the edge of the liner and edge of the outer shell, as seen in Figures 2 and 5. Wires **35** are then tied or welded in place to hold these edges in position and secure the blocks **34**.

The freezer bracket **50** supports the freezer **40** while evaporator supports **51** and **52** depend from and are supported by the freezer. It will be noted that the support **52** is provided with a drip point **53** to insure that condensation formed on **52** or **40** does not fall upon food placed in the lower right-hand portion of the cabinet.

The ice and water tank **55**, which will be understood by reference to my several issued patents showing similar tanks used for making ice and storing it in flotation, is provided with a cover **56** and a faucet **57**. The ladle **58** for dipping ice from the tank is provided with a hook **59** upon which it normally hangs. The tank rests upon and is refrigerated by the evaporator **60**, thus forming ice blocks **61** from a portion of the water **62**. The evaporator is preferably formed of sheet metal and provided with a number of raised spots **63** which contact the bottom of the tank **55** for the purpose of refrigerating separated areas of the tank wall so that ice may be formed thereon and periodically released to float in the supply of water **62** which is stored in the tank **55**.

The ice discs **61** are released to float in the water during each idle period of the evaporator **60**, in accordance with the method disclosed in my several issued patents, particularly No. 2,145,773. The tank is provided with a cover **56** which can be lifted and pushed back to the position shown in Figure 2.

When the cover is opened, ice blocks **61** may be scooped out by means of a perforated spoon or ladle **58** which is shown in Figure 2. The handle of this ladle is provided with a hole so that it can be hung upon the hook **59** seen at the upper right-hand corner of Figure 1. The handle extends beyond this hole in a curved form so related to the curvature of the cabinet lining that the ladle can be hung on the hook in only one position. Thus no water can drip from the ladle onto food in the lower part of the refrigerator. The ladle preferably hangs clear of the cover **56** so that the cover may be opened while the ladle is in place and the ladle may be rehung upon its hook before the ice-maker tank cover is reclosed. This provides for allowing the ladle to hang in its position when the tank cover is opened merely to replenish the water supply. It will be noted that the tank extends considerably forward of the freezer door **42** and that the space above it in front of the freezer is clear when the door **3** is opened.

The cover **56** of the ice-maker tank is adapted to be opened by raising at the front and pushing rearwardly as shown in several of my issued patents, particularly No. 2,145,775 issued Jan. 31, 1939. In the present application I show an automatic mechanism for re-closing the tank cover, since it has been found that users sometimes neglect to do this. The wire **64** leads through the customary door-operated switch to lamp 65 below drip collecting pan 66. This pan drains into trough 68 and catches drip from the outside of the freezer with the aid of baffle 70. Drain tube 72 leads from trough 68 to the drip-evaporating channels 73 on condenser 74, seen in Figure 1. The condenser is carried by supports 75 and discharges liquid refrigerant through tube 76 to the evaporators located within the cabinet and vaporized refrigerant is withdrawn through tubes 77 and 78, 77 leading from an evaporator in the freezer 40 to be described later herein and 78 leading from the ice-maker evaporator 60.

To facilitate packing of the refrigerator without the bad practice of putting screws into the back of the cabinet and thereby endangering the air-tightness of the outer wall, which is necessary to maintain the insulating material in good condition, I have provided the holes 79 in the parts 75. Suitable screw hooks or bolts may thus be used to hold the refrigerator securely against the back of the packing case.

The cover 56 is provided with a handle 80 for lifting it, whereupon the cover is tilted upward against the freezer 40, which has a beveled portion 82 to allow clearance for a wider opening of the tank cover. Attached to the cover 56 by means of ears 84 is a rod 86 which slides within the tube 87, both being surrounded by the compression spring 88. The tube 87 is provided with a collar to act as a stop, the tube being freely fitted within a hole in the upper portion of the bracket 90 which is removably attached to the tank 55 by means of support 91. As the cover is pushed rearwardly the spring 88 is compressed to provide energy for re-closing the cover.

At the rear extremity of the cover 56 there is a rib 92 formed by embossing the metal of the cover or by adding a part to it and this rib is adapted to engage the ears 94 of the bracket 90, these ears being notched to receive the rib 92. The forms of the rib and of the notches are such that the cover is retained in its open position against the action of the spring 88, but this anchorage may be broken by a slight forward movement of the cover, whereupon the spring 88 acts to close the cover.

The required push for initiating the spring closing of the cover is provided by means of the rocker 96 (seen in Figs. 3 and 11), which is pivoted on the lower wall of the freezer 40 at 97 and connected with the push rod 98, which extends forward through the front vertical wall of the drip baffle 70 and is capped by the rubber bumper 99, adapted to be engaged by the inner wall of the cabinet door 3.

When the door is closed the button 99 is in contact with it and the rod 98 is thereby pushed to its rearward position, compressing the spring 100. When the door 3 is opened this spring moves the rod 98 forward and the rocker 96 is thereby moved counterclockwise until it is stopped by contact with a suitable stop or with the rear wall of the cabinet. If the ice-maker tank cover 56 is not opened, the reclosing of cabinet door 3 merely recompresses the spring 100, but if the cover 56 has been opened it is given a slight forward push by the lever 96 when the cabinet door is closed, thereby allowing the spring 88 to complete the closing of the cover 56.

The tank 55 is removable from the cabinet without disturbing any of the operating mechanism. After the tank is removed, as for washing, the cover 56 may be readily removed from the tank, whereupon the rod 86 is withdrawn from the tube 87 and the spring 88 is free. The tube 87 is freely removable from the bracket 90, since it is retained in position by the spring only, and the bracket 90 may also be removed from its support 91 on the tank. Since the rod 98 is required to move side-wise slightly with the movement of the lever 96 its rear support 102, which retains one end of the spring 100, is provided with an oversize or elongated hole to allow such movement.

The drawer 104, seen in the bottom of the cabinet, is arranged to slide within the cover or enclosure 105. Since the main food space of the cabinet is maintained in a high humidity condition because of being cooled by the exposed walls of the tank 55, by the non-frosting exterior walls of the freezer 40, by the periodically defrosted evaporator 60 and by a finned coil, none of which is continuously frosted, it is not necessary that the drawer 104 be made particularly air tight, though this may be done if it is desired to maintain the drawer at a still higher humidity than that of the main food compartment.

The shelf 107 is of L form and of such proportions that it may be inverted to hang in the position indicated by 107′ or it may be placed on top of the housing 105, as indicated by the dotted lines 107″. This latter position of the shelf is merely to provide for storing it out of the way when it is desired to place some bulky object in the large space at the left of the drawer 104.

The shelf 108 is of U form so as to provide a double shelf and prevent articles placed on its lower horizontal portion from sliding off. An additional shelf 109 is provided near the upper left-hand corner of the cabinet and preferably arranged so that it may be hinged to the position shown by dotted lines. This shelf is particularly useful for the storage of butter, since this corner of the refrigerator will be maintained at a somewhat higher temperature than the lower portions. It is desirable that butter for current use be stored at a higher temperature than is best for other food stuffs, and this refrigerator is designed to provide the desired higher temperature space without the use of heating or heat leakage means such as are resorted to in some present models.

The basket 110 is attached to the door 3 of the cabinet and swings with it so that the front upper portion of tank 55 is accessible when the door is opened.

The base 112 of the cabinet, seen in Figure 2, is set in at the front to allow toe room and for entry of air between it and door 30, as indicated by the arrow. The base 112 may also be set in at the sides of the cabinet to allow it to be placed closer to a wall on the right or left side. Removable corner pieces 113 may be furnished to fill the sides of the base so that the user may remove one to clear a quarter-round and set the cabinet closer to a wall, or may leave it on for appearance. This inset base and the corner pieces are also helpful in packing and moving the cabinet without damage.

The tank 115 is nearly filled with eutectic freezing solution 116 which is normally held in a frozen or nearly frozen condition.

In addition to providing the freezer with an adjustable shelf 117, I have provided means for facilitating the transfer of food stuffs contained in small dishes between the freezer and the main food storage compartment of the refrigerator as well as in and out of both. The tray or salver 120, preferably of glass, is designed to fit closely within the freezer and also to fit in a fore-and-aft position on a shelf of the main food compartment. The inside width of the freezer is only slightly less than the inside depth of the main food compartment, so that the tray will just go into the freezer while it provides somewhat more clearance for air circulation when placed in a fore-and-aft position on one of the shelves of the main food compartment.

If desired, the tray may be designed with an extending flange or with straight sides and made of the correct length to be supported by the ribs which normally support the shelf 117 in the freezer. Such a modified tray, adapted to serve as a removable shelf, is shown in place in the freezer in Figure 1 and identified as 122.

The plastic material 123 which aids the gasket 124 in effecting a substantially air-tight seal around the door is molded in place by the use of a mold form on the order of 125, which is clamped against the cabinet to form a substantially tight fit, as seen in Fig. 2. The plastic material 123 is poured or forced into the space defined by the outer metal wall, the liner, the insulating material and the mold form 125 through the sprue 126, which may be in multiple, including one or more risers or vents to insure complete filling of the cavity with the plastic material. The mold form 125 is provided with cores 127 and 128 which may be used to circulate hot or cold fluids as required to heat or cool the plastic material to expedite its hardening or to form a hard skin on its exposed side next to the mold form. The drawings are section lined to indicate use of a rubber compound, but it is to be understood that any suitable plastic material may be used.

A mold half similar to 125, but of female form to receive the door 3, is used in like manner to cast the plastic frame or breaker which joins the inner and outer metal walls of the door and seals the insulating material between them. It will be noted that blocks 34 are not required on the door, but the wires 35 are used to secure the metal walls of the door together after assembling them with the insulating material between, preferably in a press which holds these metal walls together while the wires are tied or welded. The door thus assembled is then placed in the mold form and the plastic material injected as above described.

It will be noted that the angle of the contact surfaces between the door and the cabinet walls is different on the hinge side of the door as compared with other sides of the door. These surfaces blend into each other at the corners of the door adjacent to the hinge and all of the corners are rounded. The object is to form a smooth door frame in the cabinet and a smooth frame on the door itself, each of these frames serving the triple purpose of a frame, of a seal connecting the inner and outer metal walls in an air tight manner, and of a compressible contact surface to minimize air leakage when the door is closed. These contact surfaces are at different angles relative to the cabinet walls at different sides, as above described, but preferably they approach uniformity with respect to the axis upon which the door swings. The contact areas are modified from the conventional form in order that each of these surfaces may approach a plane radial with respect to the axis of the door hinge. This provides for bringing the surfaces together with the minimum of slippage relative to each other. The plastic material is preferably such as to provide a smooth, tough skin where exposed and where the two plastic frames make contact. One or both of the plastic frames is preferably soft enough to be slightly compressible for the purpose of improving the air tightness of the joint between them when the door is closed.

This construction eliminates the use of the usual breaker strip with its attendant joints and corner pieces. Being molded in place, the plastic frame itself provides both the seal for the insulation and the finish around the door and around its opening in the cabinet. It further provides two pairs of mating annular gasket surfaces for better sealing of the door when it is closed. The exposed plastic surfaces are preferably so rounded and smooth as to minimize their tendency to collect dirt and to make it easier to wipe them clean.

The refrigerating system employed in cooling this cabinet includes a motor-compressor unit 130, preferably of the sealed type, which delivers compressed refrigerant vapor through tube 131 to the condenser 74. The liquid line 132 leads to the ice-maker evaporator 60. The wire 133 leads from the power source to the motor of 130. The liquid line 76 leads into heat exchange relation with the suction line 77 and thence to the expansion device 135, which is associated with the valve mechanism 137. This valve mechanism is similar to Figure 1 of my co-pending application No. 346,085, filed July 18, 1940, now abandoned, except that I have here shown the expansion device as a separate assembly.

The valve assembly 137 distributes refrigerant liquid to cool the ice-maker or the freezer, one at a time and the suction vapor from the active evaporator passes through the valve assembly 137 to the drier coil 138 and thence through suction tube 77 back to the compressor of unit 130. The coil 138 is equipped with fins 139, as seen in Figure 1.

The valve mechanism 137 includes an element which acts in response to changes of evaporator pressures to actuate a valve controlling the flow of vapor from the warmer evaporator 60 to the suction line 77, a liquid valve controlling the flow of refrigerant to the colder evaporator, and the switch 140. The assembly 137 also includes a check valve through which suction vapor passes from the colder evaporator as it enters the assembly 137, and a check valve through which liquid refrigerant flows from the expansion device 135 to the inlet of the warmer evaporator 60.

The cycling of the system is as follows: When the unit 130 is idle, a pressure rise within the colder evaporator causes the opening of the valve which controls the passage of vapor from the warmer evaporator to the dryer coil 138. In the event that the warmer evaporator reaches its preselected maximum pressure prior to the time that the colder evaporator reaches its preselected maximum pressure, the higher pressure in the warmer evaporator acts directly to unseat the valve which controls the flow of vapor from the evaporator 60 to the dryer coil 138.

In either case the higher pressure of the warmer evaporator thus becomes effective upon a bellows which actuates the switch 140, thus closing the circuit which starts the operation of the motor-compressor unit 130 and refrigeration is thus started in the warmer evaporator 60 associated with the ice-maker tank. As refrigeration proceeds and the temperature of the evaporator 60 falls, the suction pressure is thereby reduced and the bellows or other pressure-responsive member moves in the direction of reclosing the valve in the assembly 137 which controls the passage of vapor from the evaporator 60 to the dryer coil 138. As this valve nears its closing point with the compressor continuing to operate, there is a rapid drop of pressure in the suction tube 77 and evaporator 138. This reduction of pressure causes a further flexure of the pressure-responsive element, which is on the downstream side of the closing valve. Such action on the pressure-responsive element effects a complete closing of the valve and there is a further drop in the suction pressure until it reaches the point where the lower pressure vapor in the colder evaporator lifts the check valve which controls its admission to the assembly 137, to the pressure-responsive element and by way of the dryer coil 138 to the suction line 77. The system now operates to cool the colder evaporator in the freezer and the evaporator 138. This operation continues until the evaporating pressure in the colder evaporator has fallen to its preselected minimum, at which point the pressure-responsive element causes the switch 140 to open, thus stopping the operation of the unit 130.

As will be seen in Figure 1 of the prior application last mentioned above, there is a check valve arranged to allow flow of liquid refrigerant from the expansion device to the warmer evaporator and there is also a valve controlling the flow of liquid refrigerant from the expansion device to the colder evaporator. This second valve is mechanically opened coincidentally with the closing of the pressure-actuated valve in the passage between the warmer evaporator and the dryer coil 138.

The check valve in the suction passage leading from the colder evaporator is for the purpose of preventing warm refrigerant vapor flowing from the warmer evaporator to the colder one. Likewise the check valve between the expansion device and the warmer evaporator is to prevent flow of refrigerant from the warmer evaporator to the colder evaporator through their liquid connections with the valve assembly 137. The valve controlling flow of liquid from the assembly 137 to the colder evaporator is closed whenever the warmer evaporator is operating so as to prevent liquid refrigerant from flowing into the colder evaporator at that time.

The dryer coil 138 is provided with fins 139 having their lower edges cut at an angle. The fins may be of parallelogram shape as shown, or may have some other shape at their upper edges, but the lower edge is inclined so as to provide a drip point whereby any condensate collected thereon will drip into the pan 66. It will be noted that the valve assembly 137 and all of the connecting tubes are likewise arranged so that condensate will drip from them into the pan 66. In order to provide for collection of condensate from the outer surface of the freezer 40, a drip baffle 70 is arranged below the side of the freezer which extends beyond the drip pan 66.

The tube 76 is preferably not a so-called "capillary tube," but is a tube of smaller inside diameter than the usual liquid line. This small diameter liquid line does not restrict the flow of liquid refrigerant to the extent of causing it to be cooled by its own expansion, since that would defeat the purpose of the heat exchanger. On the other hand the inside diameter of the liquid tube 76 is small enough so that there will be a clean drainage of liquid refrigerant from it and the bottom of the condenser, which would not occur if the inside diameter of the liquid line were large enough to allow vapor bubbles to pass drops of liquid within the liquid line. At the end of an operating cycle all of the liquid within the condenser is pushed up through the tube 76 and the expansion device 135 into the low pressure side of the system. This relieves the motor-compressor unit 130 of the high pressure on its discharge side and allows for the use of a split-phase motor without providing any additional mechanism for unloading the compressor. While this effect could be obtained if the tube 76 were either of a capillary size or of the usual liquid line size, there would be a loss of efficiency in either of these cases.

If the liquid line which forms a part of the heat exchanger were of capillary size the object of the heat exchanger would be defeated, due to the high linear rate of flow through the capillary tube and because of the fact that partial evaporation of the liquid within the capillary tube cools the liquid by wasting some of its own refrigerating effect instead of by giving up its heat to the cold suction vapor. On the other hand if the tube 76 were of large enough diameter to allow liquid and vapor to pass each other within the tube, we would have this condition at the end of an operating period: There would be a quantity of liquid within the liquid line as the compressor stops and this liquid would run down in the tube while vapor from the condenser would pass through the capillary device 135. The liquid remaining in the bottom of the condenser and in the liquid line would then have to evaporate outside of the refrigerator and pass through the capillary device 135 in its vapor phase, thus carrying heat from the room into the refrigerator.

The control switch 140 which is connected with the motor of unit 130 through wire 141 is provided with a lever 142 designed to close the switch upon downward movement. By means of the rod 143, which is slotted at its upper end to allow some free movement of the pin located in the crank 144, a lost motion connection may be made between the lever 142 and the shaft 145. This shaft is fitted at its forward end with the handle 146. Clockwise rotation of the handle rotates shaft 145 against the resistance of the torsion spring 147, thus moving the arm 144 and after taking up any lost motion this movement opens the valve which admits vapor from the evaporator 60 to the dryer coil 138 and the suction line 77, then closes the switch so that the system starts operating to cool the ice-maker evaporator 60 and the evaporator 138.

The lamp 65, seen in Figure 1, is connected to one side of the power line 148 and through the wire 64 to the opposite side of the line. One of these wires is provided with a switch, which is indicated in Figure 1 but not described in detail. This switch is closed by the opening of the door and reopened when the door is closed by means commonly used in household refrigerators. The wire 133 from the current source leads to the motor of the motor-compressor unit 130 while the other line 148 from the current source leads to the switch 140 and to one side of the lamp 65. The opposite pole of the switch 140 is connected by means of the wire 141 with the other pole of the motor in the conventional manner. The motor-compressor unit 130, is mounted on rubber blocks or otherwise flexibly supported, as indicated in the lower portion of Figure 1, and includes a relay switch or starting circuit breaker, as usual.

The eutectic tank 115 is nearly filled with the eutectic freezing solution 116, leaving room for expansion when the solution freezes. This is a solution which freezes at a low temperature, preferably about 0° F. The quantity of the eutectic solution and its latent heat of fusion are such as to provide a substantial hold-over of refrigerating effect so that the freezer is maintained at its desired low temperature when the system is idle for a considerable length of time, as in a cold room. Liquid refrigerant is conveyed through tube 150 to evaporator coil 151 when the valve mechanism 137 has assumed the required position as above described to refrigerate this coil, the vaporized refrigerant flowing through tube 152 to the valve mechanism 137 and thence through coil 138 and suction tube 77 back to the motor-compressor unit 130. During operation of the evaporator coil 151 the eutectic solution freezes upon this coil, first at the bottom of the tank 115, since the refrigerant flows first through the lower legs of the coil 151. This method of freezing an eutectic solution from the bottom upwardly is covered in my issued patent, No. 1,827,097. Another fact contributing to the holding of a constant low temperature within the freezer 40 will be understood upon consideration of the method of operating the switch 140 and the valve mechanism 137. These mechanisms provide for starting refrigerating effect in the evaporator 151 whenever its temperature rises to a predetermined limit, regardless of what temperature may obtain within other portions of the refrigerator. This switch and valve mechanism are more fully described in my Patent No. 2,375,319 and my application S. N. 477,519 of which the original was filed July 18, 1940, now Patent No. 2,425,634 granted August 12, 1947. This system of control provides for starting operation of the system whenever either the freezer evaporator or the evaporator which cools the main food compartment of the refrigerator rises to its cut-in temperature. Refrigeration is thus supplied where needed instead of being controlled by a compromise method in response to some temperature between that of the main food space and that of the evaporator which cools the freezer or low temperature section of the refrigerator.

Since dew forms upon the outside of the tank 55 and frost forms upon the evaporator 60, this frost being periodically melted during idle periods of the evaporator, I have provided the drip collecting pan 66 to collect the water thus deposited. The pan 66 is provided with one or more openings for draining such water into the trough 68 located below it.

Moisture will also condense on the outer walls of the freezer 40. Most of this water will drain down over the tank cover 56 into the pan 66, but an additional drip baffle 70 is provided to catch the moisture draining from that portion of the exterior surface of the freezer extending to the left of the ice-maker tank and deliver it to the drip pan 66. Thus all moisture collecting on exposed cooling surfaces within the refrigerator will finally reach the trough 68 and be drained out the back of the cabinet through the tube 72 to the condenser 74 on the back of the cabinet and be thereby re-evaporated to ambient air. This method of drip dissipation is more fully described in my U. S. Patent No. 2,145,776, issued Jan. 31, 1939.

In Figures 2 and 3 I have shown an improvement in the drip evaporator associated with the condenser 74. The drain tube 72 conducts water from the trough 68 to the upper one of the several drip channels 73 which are formed integrally with the condenser 74, on its rear (outer) side. The condensate collected within the refrigerator flows from the uppermost of these channels 73 out its open left end as seen in Figure 3 into the channel 73 next below it and so on down the exposed side of the condenser. It has been found that in any ordinary operation of a refrigerator of this type, where the exposed cooling surfaces are either maintained above the freezing point or are defrosted at each cycle of the system, this type of drip evaporator will dispose of all condensate before any of it reaches the lowermost one of the channels 73.

The advantage gained by forming this drip evaporator on the side of the condenser away from the cabinet rather than on the side next to the cabinet, as shown in my U. S. Patent No. 2,145,776, is that the channels 73 are thereby made readily cleanable.

There is a natural convection flow of air upward on both sides of the condenser, between it and the cabinet and between it and the wall against which the refrigerator is placed. In order to insure that the refrigerator is not placed too close to the wall, I have formed the condenser suppports 75 so that they extend rearwardly of the condenser to contact the wall against which the refrigerator is placed. It will be seen that I have extended the supports 75 upwardly considerably farther than the condenser. This provides a vertical flue above the condenser so that when the refrigerator is properly placed against the wall of a room a flue is formed to provide an additional draft of thermal circulation drawing air from near the floor over the condenser and drip evaporator. The column of air above the condenser is lighter than ambient air, both because it has been heated by passage over the condenser and because water vapor has been added to it by the evaporation of drip water, water vapor being lighter than air.

The common practices with respect to gaskets on refrigerator doors are either to let the door gasket make contact with a flat surface such as the face of the cabinet and with step surfaces parallel with the face of the cabinet, or to have the gasket contact against angular surfaces which converge inwardly toward the center of the door opening at a uniform angle to the cabinet face on each side of the door. Both of these practices cause the gasket to slide upon its contacting surface, either at the hinge side of the door or at the opposite side, according to the practice followed. Unlike these common practices I have designed the contact surfaces of the door and of the cabinet so as to approach as nearly as is practicable to planes that radiate from the hinge axis of the door. This causes the door gasket, which in my case is a part of one or both of the molded breaker frames, to make contact with its mating surface without the objectionable sliding motion.

Both of the door frames, namely the molded frame of the door itself and the molded frame of the door opening, are formed, at least on the corners adjacent to the hinge side, with compound curves joining their contact areas. It will be seen that the contact surfaces of these frames may be in one plane at the latch side, the top and the bottom of the door, hence the junctions of these surfaces at the corners on the latch side of the door or of its opening may be in one plane and this plane will still be substantially radial with respect to the hinge axis of the door. In order that the contact surfaces of the frames on the hinge side may be substantially radial with respect to the hinge axis, these surfaces can not be in the same plane as the contact surfaces at the top, bottom and latch side of the door, hence it is particularly at the corners of the door and of its opening adjacent to the hinge side of the door that these compound curves are required to provide smooth, continuous contact areas and have the door close with the minimum of sliding movement between contacting surfaces.

As will be seen from the horizontal section of the door in Figure 3, the axis of the door hinge is so located that the door will swing open to allow substantially unobstructed access to the interior of the refrigerator without swinging beyond the plane of the outer wall of the cabinet on the right-hand side. This and the absence of a projecting latch on the door allow the door to open fully when the cabinet is placed in a right-hand corner of a room without requiring any extra clearance space for the opening of the door.

The freezer 40 and its door 42 are preferably made with molded frames somewhat as described for the outer door of the cabinet, but it is not so important to provide the freezer door with gasket means, since heat leakage at this point aids in cooling the main food space of the refrigerator instead of representing a loss of refrigerating effect to the room as in the case of the outer door. Since the freezer door will normally be frozen shut when left closed for a length of time, there will be very little air leakage around the freezer door except for a limited period after each time it is open. This freezing shut of the freezer door is my reason for preferring to make the contacting surfaces between the freezer 40 and its door 42 of metal or of a harder-surfaced composition than is used around the outer door of the cabinet. A soft material, such as is preferred to provide some gasket effect around the outer door, might be damaged by the forcible opening of the freezer door when it is frozen shut.

The modified freezer door latch seen in Figure 7 includes body 171, bolt 172 and spring 173, forming a conventional spring latch of the self-closing variety, which may be opened by means of the handle 174. The latch bolt 172 is arranged to slide within the latch body 171 against the action of spring 173 when handle 174 is pulled. I have added an extension 175 to this handle, so formed that it engages striker plate 176 after the bolt 172 has been withdrawn from the striker plate. It is thus seen that the user need only pull on the handle 174 to first withdraw the bolt 172 from the striker plate and then to use the handle 174 and its extension 175 as a lever to pry the door open by breaking the frost or ice around it. This one pull on the handle 174 will further open the freezer door 42.

The enlarged detail of door latch seen in Fig. 8 shows how the latch plate 9 is attached by means of the pin 181 to the hinge member 8, which is secured to the outer wall sheet 182 of the cabinet. At the opposite side of the latch plate 9, it is pivoted by means of the pin 183 to the push rod 10, which is in turn pivoted to the latch lever 11 by means of the pin 184. For convenience in assembly, the member 10 is notched to receive the pin 184 as the assembly comprising parts 11 and 14 is inserted in the cabinet wall, whereupon the upper splined end of the rod 12 is inserted in the member 11 from below and suitably retained at its lower end to maintain the spline engagement. The shaft 12 is supported by bearings 185, which are secured to the sheet 182. The members 11 and 14 are hinged together by the pivot pin 186 and are urged into alignment with each other by means of the coil spring 187.

As the door 3 closes, the striker 188 engages the member 14, flexing the spring 187 so that the latch member 14 snaps into the position shown in Fig. 8 to retain the door in its closed position. The spring 187 is not stiff enough to cause such closing of the door to produce any material movement of parts 11, 12, 27, 29, and 24 since their weight and the action of the spring 31 oppose such movement. It will be seen that the spring 31 (seen in Figs. 3, 9 and 10) urges the rod 29 to the right and this rod is pivoted at 189 to lever 27. The location of parts 11 and 14 is determined by the angular position of lever 27 when it engages the stop 32, which is attached to the cabinet.

Spring 31 is attached to the rod 29 by means of the collar 190 and attached to the cabinet by means of support 191.

The main cabinet door, of which a fraction is seen in Fig. 8, includes an outer sheet of metal 195 and an inner sheet of metal 196. These two sheets of metal are separated by the compression members 34, as previously explained, and are tied together by means of wires 35. At the latch position on the door 3 it is permissible that the member 188 be welded or otherwise attached to both sheets 195 and 196. The section of member 188 may be reduced, or a member of low thermal conductivity interposed between 188 and one or both of the sheets 195 and 196, if desired to further minimize thermal conductivity between these two sheets. It will be noted that the greater portion of the part 188 is buried within the molded insulating material 123 in the same manner as the members 34 and wires 35 are buried.

It will be seen that the outer sheet 195 of the door 3 makes contact with the molded plastic material 123 of the cabinet wall, while the cabinet liner 198 makes contact with the molded material 123, which forms the frame of the door, thus providing a double seal. The part 10 may be a sufficiently close fit within the molded material 123 of the cabinet wall to substantially prevent circulation of air into and out of the space enclosing the members 11 and 14.

Due to the fact that the pivot 186 is not far out of line between the center line of shaft 12 and the point at which 14 contacts 188, the pressure of 188 against 14, due to the force exerted by spring 16 urging the door in an opening direction, does not produce sufficient force in a counter-clockwise direction upon the shaft 12 to move the lever 27 away from its stop 32. For this reason, the contours of contacting surfaces of 14 and 188 may be such as to allow for wear and still hold the door tightly closed, as previously explained.

It will further be noted that the path of the pivot 186 upon counter-clockwise movement of part 11 is on an arc having its center at the center of the shaft 12, thus the first movement of part 11 in a counter-clockwise direction moves the pivot 186 away from the surface of 188, which is contacted by the part 14. This arrangement insures that the door is held snugly closed and yet allows easy movement of parts 11 and 14 when manual contact is made with the plate 9. In Fig. 8 I have shown sealing contacts between material 123 of the door with the cabinet liner 198 and of material 123 of the cabinet with the outer metal sheet 195 of the door. In accordance with the description herein of the shapes of these contacting surfaces, it is possible that it may be preferred to have the material 123 of the door make contact with material 123 of the cabinet at both the inner and outer contact areas. The choice will be governed to a large extent by production methods employed and the relative costs of the metal working dies of special contour and the permanent molds to produce the desired contours of the molded parts.

Fig. 9 may be considered as an enlarged detail of the lower right-hand corner of Fig. 3, showing the position of the spring 16, lever 20 and pawl 22 when the door 3 is in its partially opened position, previously mentioned as the one to which the door swings when released by depression of the latch plate 9. The ratchet quadrant 24, pivoted at 201 upon the fixed member 202, is urged toward the pawl 22 by means of the spring 31, its position being determined by the stop 32 and by 29 being linked to 24 by means of the pin 204. As the door swings open, due to the initial stress of the spring 16, force is released for reenergizing the spring 16 to the extent indicated in Fig. 9, so that the pawl 22 is retained in the notch 23 of quadrant 24 and the door stands open at an angle of approximately 60°.

Should the user wish to have the door more fully opened, she pushes it open and the pawl 22 engages the notch 25 of quadrant 24, retaining the door in its fully opened position, as seen in Fig. 10. The spring 16 is now stressed to a greater degree than it was when the door was closed, so that when the user depresses the plate 9, thus moving the quadrant 24 out of engagement with pawl 22, the spring 16 causes the door to swing fully closed and be retained in that position by means of the latch member 14 engaging the striker 188. The user will naturally release the latch plate 9 just prior to the full closing of the door, so as to allow the latch 14 to retain the door in the closed position.

Referring to Fig. 11, which shows an enlarged detail of Fig. 2, it is seen that the ears 84 on the tank cover 56 carry a pin 210 pivoting thereto the member 212 to which one end of the rod 86 is rigidly attached. Likewise, a member 214 attached to the end of the tube 87 forms the support and stop for this tube with reference to the bracket 90, which is supported on the tank by means of the support 91. The left-hand end of the tube 87 is preferably tapered or chamfered, so as to allow free movement thereover of the coils of the spring 88. As the rod 86 slides within the tube 87 with movement of the cover 56, the spring 88 urges the cover 56 toward its closed position, but the cover is here shown open and is retained in the open position by means of its rib 92 engaging the ears 94 of bracket 90. The form of this rib, the form of the ears 94 and the position of the line of contact between the cover 56 and the tank 55 when the cover is open are so related to the pivot point 210 and the action of the spring 88 that the cover will rest in the position shown in Fig. 11 regardless of the fact that the spring 88 is urging the cover toward its closed position.

In Fig. 11 we also see an end of the rocker 96 (seen in Fig 3), which is in position to make contact with the cover 56 upon a slight movement of the rod 98. When the rocker 96 contacts the cover 56 and moves it so that rib 92 is no longer retained by the notches in the bottom of the ears 94, the spring 88 acts to complete the closing of the cover 56 on the tank 55.

I claim as my invention:

1. A refrigerator, an outer door of said refrigerator, a smaller enclosure within said refrigerator, an access opening in said small enclosure, a closure for said opening, resilient means tending to close said opening by means of said closure, latch means for holding said closure in an open position, and means actuated by the closing of said outer door for releasing said latch means and allowing said closure to close.

2. A refrigerator, a main food space within said refrigerator, a smaller insulated enclosure within said refrigerator, a door for said inner enclosure, a door for access to said main food space and to the first said door, means for holding said inner door closed, and means for breaking an ice bond between the inner door and the fixed walls of said inner enclosure.

3. A refrigerator cabinet, a main food space in said refrigerator, a door for said main food space, means for cooling said main food space, a second insulated enclosure within said refrigerator, a door for said enclosure, means for cooling said enclosure, the contacting surfaces of the last said door and the stationary portion of said enclosure being formed of substantially solid and noncompressible material, and means for forcibly breaking an ice bond between the last said door and said enclosure walls.

4. A refrigerator cabinet, an outer metal wall of said cabinet, an inner metal lining of said cabinet, a door opening piercing both said outer wall and lining, thermal insulating material located in the space between said outer wall and lining, rigid means securing said lining to said wall adjacent the peripheral boundary of said opening; and a one-piece integral frame surrounding said opening at said boundary and encompassing said rigid means and joining said outer wall and lining.

5. The method of molding a frame for a refrigerator door opening comprising the steps of assembling an inner shell to an outer shell with thermal insulating material between said shells, of adding material to form a frame, and of employing portions of said shells extending beyond said insulation as portions of the mold for forming said frame.

6. A refrigerator cabinet, a rectangular door for said cabinet hinged upon a vertical axis, inner and outer sheets forming exposed surfaces of said door, tension means holding said sheets together, and a frame for said door comprising an endless piece of molded material having a relatively low thermal conductivity, said tension means being embedded in said molded material.

7. A refrigerator cabinet, a door hinged to said cabinet, and surfaces on said cabinet and on said door adapted to contact each other when the door is closed, said contact surfaces on the hinge side and the opposite side of the door being disposed in different planes, each approximately radial with respect to the hinge axis of said door.

8. A refrigerator cabinet, a door opening in said cabinet, a door adapted to close and at least partly fill said opening, latch means for said door, hinge means for said door, the plane of contacts between said door and the cabinet being at a different angle on the hinge side of the door from those on other sides of the door, said planes joining each other at corners adjacent to the hinge side of the door by means of continuous compound curves.

9. In a refrigerator cabinet, an outer metal shell, an inner metal shell, thermal insulation between said shells, a plurality of compression members braced between the forward edges of said shells to hold the inner shell against the insulation located between the rear walls of said

shells, and means for securing said compression members in place, including a frame member in which said compression members are embedded.

10. A refrigerator door, an outer metal wall of said door, an inner wall of said door, a thickness of thermal insulation material between said walls, a plurality of tension members joining the edges of said walls to secure said insulation in place and form a rigid structure, and a one-piece frame formed of a plastic material joining said walls and covering said tension members.

11. A refrigerator cabinet comprising an outer housing member, an inner housing member within and spaced from said outer member, the space between said members providing a chamber, thermal insulating material positioned within chamber, said material being sufficiently rigid to support said inner member, said members having registering openings to provide a means of access to said inner member, said members being provided adjacent the marginal edges of said openings with flange portions extending generally toward each other and partially across said chamber, said flange portions being spaced from said insulating material to provide a space therebetween, supporting members extending between the flange portions of said members whereby said inner member is mechanically supported by said outer member adjacent said openings, and a single unitary integral frame member extending around the peripheral boundary of said registering openings and between said housing members and encompassing at least a portion of said flange portions, said frame being structurally independent of said insulating material.

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