June 11, 1957 G. MUFFLY 2,795,112

PLURAL EVAPORATOR REVERSAL CONTROL MECHANISM

Filed Sept. 4, 1951 2 Sheets-Sheet 1

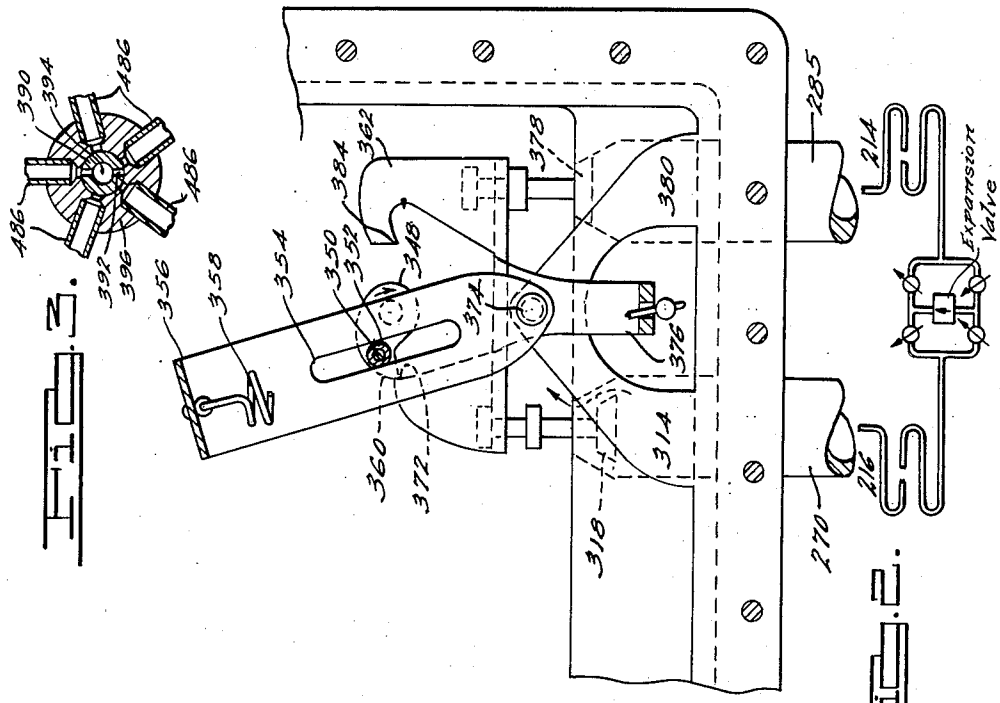


Fig. 2.

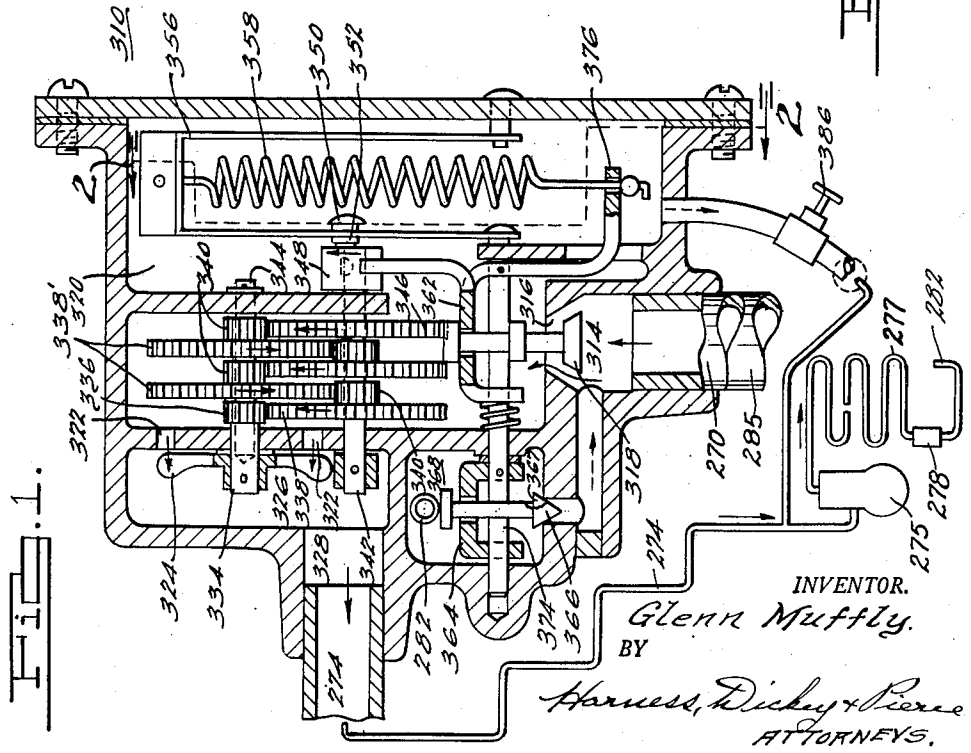


Fig. 1.

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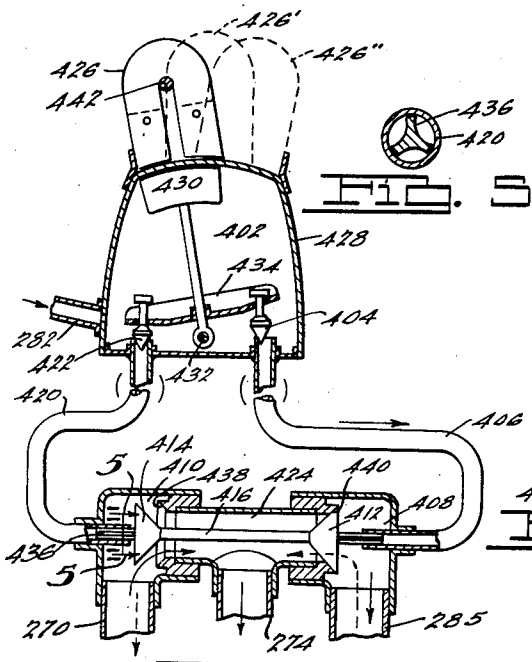


Fig. 5.

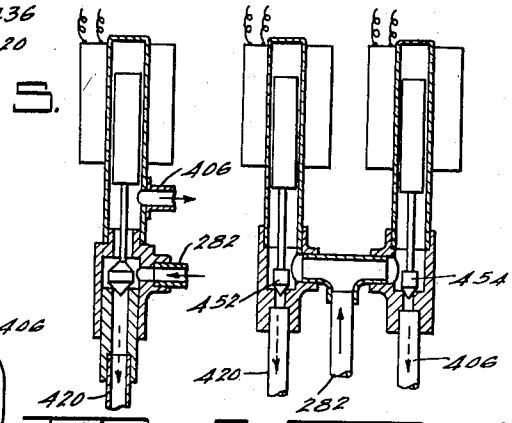


Fig. 6. Fig. 7.

Fig. 4.

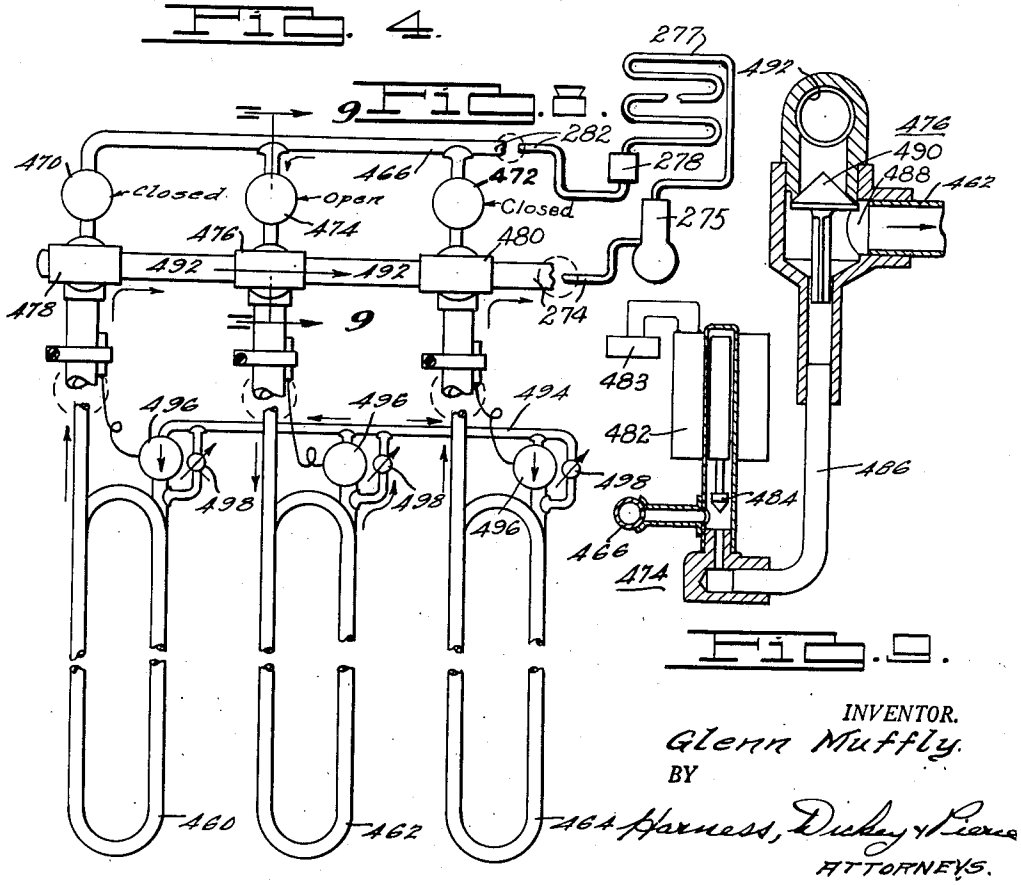


Fig. 8.

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2,795,112

PLURAL EVAPORATOR REVERSAL CONTROL MECHANISM

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Application September 4, 1951, Serial No. 244,964

10 Claims. (Cl. 62—3)

This invention has to do with valves for the control of refrigerant flow, particularly in ice-making systems and air conditioning systems of the reversible heat pump type. It includes improvements over my U. S. Patent No. 2,497,903, issued February 21, 1950; my copending U. S. application Serial Number 45,343, filed August 20, 1948, now Patent No. 2,654,227; my copending U. S. application Serial Number 50,101, filed September 20, 1948, now Patent No. 2,672,016; my copending U. S. application Serial Number 174,944, filed July 20, 1950, now Patent No. 2,774,223. The drawings and specification are in the main duplications of a part of my Canadian patent application Serial Number 618,079, filed July 14, 1951.

It is an object of this invention to provide a valve mechanism actuated by refrigerant flow which not only produces the desired periodic reversals of flow, but also causes cessation of liquid flow to provide the desired "pumping-out" periods.

Another object is to provide a readily accessible adjustment for varying the length of ice-making periods, thus modifying the diameter of the ice disks or causing ice to be released before the two opposed thin disks of ice join to form a thicker disk.

An additional object is to provide a suction vapor control valve having no outside connection with a control device and being actuated automatically in response to the shifting of liquid refrigerant flow and to changes in the relative vapor pressures within an evaporator which has just finished its defrosting or ice-releasing period and the active suction pressure of the system.

A still further object is to provide a system in which two or more evaporators are active in freezing ice while a lesser number of evaporators are being heated by the specific heat of liquid refrigerant flowing to the active evaporators, thus causing each evaporator to be active a greater percentage of the time.

Another object is to provide a control system suitable for use in shifting or reversing flow of refrigerant in various types of refrigerating or heat-pump apparatus.

In the drawings:

Figure 1 is a sectional view of a valve mechanism actuated by refrigerant vapor flow and designed to control both liquid and vapor.

Figure 2 is a fractional sectional view of Fig. 1 on the line 2—2 thereof.

Figure 3 is a sectional view of a rotary valve designed to be actuated by the pinwheel and gear train of Fig. 1.

Figure 4 is a sectional view of a magnetically actuated valve mechanism which may be used in place of the valve assembly seen in Fig. 1.

Figure 5 is a detail sectional view of Fig. 4 on the line 5—5 thereof.

Figure 6 is a sectional view of a solenoid valve having two outlets and usable in Fig. 4 to replace the upper valve assembly thereof.

Figure 7 is a sectional view of an assembly of two solenoid valves which may replace the two upper valves of Fig. 4.

Figure 8 is a diagrammatic view of an ice-making system employing three or more evaporators, showing a suitable arrangement of tubing and control valves.

Figure 9 is a detail sectional view of Fig. 8 on the line 9—9 thereof, showing a modification of the valves of Fig. 4 for use when ice is to be frozen by two or more evaporators at a time, as in a machine of larger capacity.

All of these figures show valve control devices adapted for use in connection with ice-making systems such as shown in my previous U. S. Patents and applications above mentioned. Typical refrigerant circuits for such systems are shown in Figs. 1, 2 and 8 of this application.

Figure 1 shows a valve assembly adapted for use in a system such as is shown by Fig. 4 of my copending U. S. application Serial Number 174,944 replacing valves 72, 84, 86 and 88 thereof and obtaining energy for their operation from refrigerant vapor flow on the order of my United States Patent 2,497,903 but controlling liquid as well as vapor and providing the "pump out" period.

In Figure 1 the low pressure refrigerant vapor flowing from the active evaporator enters the valve assembly 310 through the tube 270. It enters the chamber 314 and flows therefrom through the port 316 which is now open but will later be closed by means of the valve 318. The refrigerant vapor is free to flow within the chamber 320 and thence through the ports 322 which are so positioned that the flow of refrigerant vapor drives the pinwheel 324 as the vapor enters the chamber 326 from which it flows through the outlet port 328 to the suction tube 274 which leads to the compressor 275, which discharges into the condenser 277.

The pinwheel 324 is attached to the hollow stub shaft 334 carrying pinion 336 which drives the gear 338, which has a pinion 340 serving as its hub and rotating freely upon the shaft 342. The pinion 340 drives the gear 338' which is similar to the gear 338 and has attached thereto a similar pinion 340 which rotates freely upon the shaft 344. Several such assemblies of a gear and a pinion rotating together freely on one or the other of the two shafts provide a great reduction in gear speed until finally the driven gear 346 rotates at say one revolution per hour whereas the pinwheel 324 and its connected pinion 336 revolve at say, 1,000 R. P. M. The driven gear 346, unlike the other driven gears, is keyed to the shaft 342 or to a tubular extension of the cam 348 so that the cam is driven at the same speed as the gear 346. In case the gear 346 is keyed to the shaft 342 the cam 348 is also keyed to the shaft 342. Mounted on the cam is a crank pin 350 (Fig. 2) which may be provided with roller 352. This roller fits freely within the slot 354 of the U-shaped lever 356 which carries one end of the spring 358. This slot need not be straight as shown. It may have curved sides and be widened at the bottom to compensate for any inequalities in the rate of lever movement relative to cam rotation, but this is not necessary since the important timing occurs when the crank pin 350 and the point 360 of the cam are in approximately the same horizontal plane as the shaft 342. With the exception of the pinwheel 324 which rotates with the pinion 336 and of the gear 346, which carries the cam 348, each gear 338' is fixed to a pinion 340 and rotates freely on its shaft.

Figure 2 shows the rocker 362 in the same horizontal position as in Fig. 1, which means that the rocker 364 (Fig. 1) occupies a similar position in which neither the liquid valve 366 nor its similar mating valve 367, actuated by the opposite end of the rocker 364, is lifted from its seat. Since high pressure liquid refrigerant enters the chamber 368 through the tube 282 the pres-

sure within the chamber 368 aids gravity in holding the valves 366 and 367 closed.

In the position shown in Fig. 2, the cam 348 is rotating to the right and has almost reached the position at which the point 372 of the rocker 362 will fall off the point 360 of the cam. As point 372 is released the rocker 362 will move clockwise upon the shaft 374 due to the tension of spring 358 which is connected with the downwardly extending arm 376 of the rocker 362. This clockwise movement of the rocker 362 causes the closing of the valve 318 and the positive opening of valve 378 in case the latter has not already been opened by gravity due to the pressures within the two evaporators and their connected chambers 314 and 380 becoming substantially equalized. It will be noted that when the rocker 362 tilts clockwise in Fig. 2 the rocker 364 (Fig. 1) moves with it because both are keyed to the shaft 374. The movement of rocker 364 lifts the liquid valve 366 from its seat, allowing high pressure liquid refrigerant to flow through the tube 270 to the inactive evaporator while the corresponding valve 367 remains seated to prevent the flow of liquid through the tube 285 to the evaporator 214 which is now connected with the chamber 380 of the open suction valve 378.

It will be noted that when the rockers 362 and 364 are in their horizontal position all four of the valves 366, 367, 318 and 378 are free to open or close under the influence of fluid pressure differences across them. Since there is always high pressure liquid in the chamber 368 the valves 366 and 367 remain closed. The valve 378 remains closed as indicated in Fig. 2 until the pressure in chamber 380 falls to nearly the operating suction pressure, at which time gravity causes the valve 378 to open.

It is thus seen that refrigeration of one evaporator will continue and the other evaporator will be flooded with warm high pressure liquid refrigerant until the cam has rotated say 150° thus causing the lever 356 to swing to the right to a position at which the spring 358 will cause the rocker 362 to snap to the left. Since the point 360 of the cam now engages the point 384 of the rocker 362 the rocker is stopped at approximately its horizontal position as seen in Fig. 2 but the spring is urging it counterclockwise and after the cam has rotated about 30° more to the right to complete a half revolution the point 384 will fall off of the cam point 360 and the rocker will continue its movement to the left thus closing the suction valve 378 and opening the liquid valve 367 to cause hot high pressure liquid refrigerant to flow through the chamber 380 and the tube 285 to the evaporator 214 while vapor is withdrawn from the now active evaporator 216. These cycles as described will continue with substantially constant periods of ice-making, thawing off with hot liquid and pumping out of liquid in each evaporator so long as the compressor removes vapor at a substantially constant rate measured by volume while the expansion valve holds evaporator pressure within the desired operating limits. As in my United States Patent No. 2,497,903, the lengths of the operating periods will be substantially constant even when there is a marked change of evaporating pressure during each cycle as such change of pressure follows a substantially constant curve and the result is a substantially constant number of turns of the pinwheel 324 in a given period of time when this time period spreads over a main portion of an average ice-making period.

As noted above, the suction valves 318 and 378 are normally opened by gravity except when held closed by high side pressure, thus when an evaporator approaches the end of its pumping out period, the pressure in that evaporator drops to only a few pounds p. s. i. greater than that of the still active evaporator and the valve drops by its own weight. The seat area and weight of the valve may be calculated so that the valve opens at the desired pressure difference representing a pressure which corresponds to the desired amount of liquid refrigerant remaining in the evaporator which is now to become active. This does not mean that pressure is a measure of the percentage of liquid refrigerant in a container but it will be found that with a compressor of a given displacement the inactive evaporator will retain a substantially constant amount of liquid refrigerant at the time when its presssure drops to a given point.

Any desired gear ratio may be used between the pinwheel 324 and the cam 348 to provide a desired length of operating cycle for a given density and rate of flow for suction vapor. It is not necessary to change the gear ratio to adapt this valve mechanism to a compressor of slightly different displacement per minute or for use at a different suction pressure. Wide changes can be made in the speed of pinwheel 324 by twisting its vanes or substituting a pinwheel having vanes of different pitch or form. In selecting a pinwheel or adjusting vanes for a specific machine, it is preferred to adjust for a shorter cycle than desired and then make further adjustment during operation by means of the bypass valve 386, so that more less of the refrigerant vapor flows from the chamber 320 to the suction line 274 without passing through the ports 322. If the bypass valve 386 is tightly closed the valve mechanism will be operated at its shortest cycle for a given density and rate of flow of suction vapor. In such case the valve 386 may be opened occasionally to drain oil from the chamber 320 if this chamber is not so arranged so as to drain oil through the ports 322 to the suction tube 274. By selecting a pinwheel and gear ratio to provide a very short cycle it is possible to produce very thin ice which crushes easily. To make thicker pieces of ice or prolong the freezing period so that two pieces join to make still thicker disks it is then only necessary to open the bypass valve to the extent required to effect the desired lengthening of the cycle.

In Figures 1 and 2 the valves 318 and 378 are mechanically actuated in at least their closing direction, but as explained later in connection with Figs. 4, 8 and 9, the valves controlling suction ports may be actuated by fluid pressure, making it unnecessary to provide mechanical means to actuate the suction valves. This is particularly desirable where three or more evaporators are incorporated in one ice maker. Figure 3 illustrates a modification of Fig. 1 to fit a system such as shown by Fig. 8, but having five evaporators instead of three.

In Figure 3 the valve member 390 may be driven directly by the gear 346 through shaft 342 which is connected with 390 at its closed end. The radial hole or holes 392 receive liquid refrigerant from the bore 394 which is open to a chamber supplied with liquid through tube 282 as is chamber 368 in Figure 1. The valve member 390 is preferably tapered and driven from its smaller end so that the high pressure liquid refrigerant entering its bore 394 holds 390 tightly seated in the boss 396 which is a part of the housing enclosing the gear train and the pinwheel 324. The valves and cam-actuated mechanism of Fig. 1 are omitted and there need be but one inlet port for suction vapor so located as to drive the wheel 324. Any leakage past the rotary valve member 390 goes into the gear housing which forms part of the main suction passage, hence no refrigerant is lost. The radial ports in 396 and tubes connected therewith lead to valves which will be described later in connection with Figures 8 and 9.

Figure 4 shows another valve mechanism adapted for use in place of the valve mechanism of Figure 1. Liquid refrigerant flows through the tube 282, enters the chamber 402 and passes the open valve 404 to flow through the tube 406 into the chamber 408 from which it can exit only through the tube 285 leading to the inactive evaporator 214 (Fig. 2). After passing from the inactive (defrosting) evaporator through the expansion valve, as indicated by arrows in Fig. 2, this liquid refrigerant evaporates in the active evaporator 216 and returns through the tube 270 to the chamber 410. Due to the fact that

there is high pressure liquid refrigerant in the chamber **408** holding the valve **412** closed the valve **414** is held open because of these two valves being rigidly connected by the rod **416**. The refrigerant vapor cannot flow through the tube **420** because the valve **422** is closed and held so by the higher pressure of liquid refrigerant within the chamber **402**. Suction vapor after passing the valve **414** into chamber **424** exits through the main suction tube **274**.

This operation continues while ice is being frozen by one evaporator and ice is being released from surfaces associated with the other evaporator. In order to shift refrigerant flow so as to release the ice formed by the one evaporator and start freezing ice on surfaces associated with the other evaporator the magnet **426** is moved first to the position **426'** and after a short interval to the position **426''**. Inside of the casing **428**, which is preferably made of brass or other non-magnetic metal, the armature **430**, which is pivoted at **432**, follows the movement of the magnet carrying with it the rocker **434** and the valves **404** and **422**. Movement of the magnet to the position **426'** allows the valve **404** to close while the valve **422** remains closed. In this position there is no flow of liquid refrigerant to either of the evaporators and refrigeration continues in the evaporator associated with tube **270** while liquid flows to it from the idle evaporator connected with tube **285**.

This "pumping out" portion of the cycle is timed or otherwise controlled to terminate when the amount of liquid refrigerant remaining in evaporator associated with tube **285**, which has just finished its ice-releasing period, is proper for the start of refrigeration in it. At this time the magnet is moved from the position **426'** to the position **426''**, thereby opening the valve **422** while valve **404** remains closed. This allows the high pressure liquid refrigerant in the chamber **402** to flow through the tube **420** with such force that the fluted end **436** of the rod **416** is moved to the right causing valve **414** to close and valve **412** to open. The restriction at this fluted portion of the rod, shown in section in Fig. 5, is considerable with respect to the high rate of liquid flow at the instant of opening of valve **422** but is not sufficient to interfere with the normal rate of flow maintained during an ice-making period. The flutes in **436** will naturally stop short of valve **412** and **414** hence the liquid passage is nearly closed when the valve is open. We now have high pressure liquid refrigerant within the chamber **410** holding the valve **414** tightly closed against its seat **438** while valve **412** is securely held away from its seat **440**.

Refrigerant flow after reversal as above described is from the tube **282** past the open valve **422** through the tube **420** to tube **270** and through the evaporator with which it connects, which is thereby heated, to the expansion valve, from which it flows at reduced pressure into the evaporator which is now active, returning through the tube **285** to the chamber **408**, from which it can only flow past the valve **412** because of valve **404** being closed. Suction vapor now flows through the chamber **424** to the main suction tube **274** which leads back to the compressor. At the end of this ice-making period the magnet **426** is moved from the position **426''** to the position **426'** and then back to the original position **426**, which brings us back to the starting point. The magnet **426** is pivoted externally of **402** on extensions of the pivot **432** and may be moved manually or by means of a suitable mechanism connected with the pin **442**.

Figure 6 represents a solenoid valve which may be used in place of the liquid valve assembly shown in the upper portion of Figure 4. Such a solenoid valve lacks the feature of closing both liquid passages for the pumping out period, hence it is preferred to substitute two single-acting solenoid valves as shown in Figure 7, where the valve **452** corresponds to valve **422** and valve **454** corresponds to valve **404**. Suitable switch mechanism actuated thermostatically, by pressure changes or by clock means may be used to produce the same effects as the above-described movements of the magnet **426**. Any required number of solenoid valves, one for each ice-maker evaporator, may be manifolded together as in Fig. 7 to control systems such as seen in Figure 8.

Thus far I have described the use of my valve mechanism in connection with systems having two evaporators with only one evaporator active most of the time, but in larger systems it is desirable to employ several evaporators, each associated with an ice-making tank. This allows several evaporators to be active in making ice while a smaller number, usually only one, is heated to release ice. Such an arrangement is shown in Figure 8. Two of the three evaporators **460**, **462** and **464** are active in freezing ice while the third one is heated by high pressure liquid refrigerant for the purpose of releasing ice. In Figure 8 the arrows indicate refrigerant flow, showing liquid entering the manifold **466** from tube **282**. Since valves **470** and **472** are closed this liquid can only flow through the valve **474** and thence only through the valve **476** into the evaporator coil **462**. The valves **474** and **476** are seen in Fig. 9 in enlarged section in their respective positions as required for flow as traced above. At this time a similar view of valves **470** and **478** or of valves **472** and **480** would differ as follows:

Solenoid **482** would not be energized, thus allowing valve **484** to close and stopping flow of liquid to the valve assembly **476**, **478** or **480**, as the case may be. This reduces the pressure in chamber **488**, thus allowing the valve **490** to drop so that the corresponding evaporator **460**, **462** or **464** is connected with the suction manifold **492** and thereby to the main suction tube **274**, which leads to the compressor **275**. High pressure refrigerant vapor flows from the compressor into condenser **277** and liquid condensed therein collects in receiver **278** to feed tube **282**.

Considering Figure 9 as applied to the evaporator **462** near the end of its ice-releasing period, when the solenoid **482** is deenergized, its circuit being broken by suitable control means **483** responsive to the release of ice, to a temperature rise or to the lapse of ample time for ice to have released, the valve **484** will close. The liquid refrigerant within evaporator **462** continues to feed evaporators **460** and **464** through their respective expansion valves **496** until such time as the pressure within the evaporator **462** falls to nearly the operating pressure maintained within the manifold **492**. At this point there is very little pressure difference across the valve **490** and therefore it will open due to its own weight, whereupon flow will be reversed in the evaporator **462** and vapor will flow therefrom into the header **492** and thence to the suction tube **274**. Simultaneously liquid will flow from the manifold **494** through the expansion valve **496** of evaporator **462** causing it to resume refrigeration and thereby the formation of ice. We now have all three evaporators actively cooled, but soon one of the other evaporators **460** or **464** will start the ice-releasing portion of its cycle in response to closing of the switch which energizes the solenoid **482** of its liquid valve **470** or **472**. In case much time elapses between successive defrostings the header **494** is enlarged to store liquid, but in larger multiples the defrostings overlap.

Referring back to Fig. 3, this one valve, driven by the gear train and pinwheel of Fig. 1, may be used in place of five solenoid valves such as **470**, **472**, and **474** of Fig. 8 and **474** of Fig. 9. It delivers high pressure liquid refrigerant to one or more of five tubes **486** at a time. Each tube **486** leads to a valve assembly **476** as in Figure 9. This would serve five evaporators in place of the three seen in Figure 8. It is possible to use this arrangement of valves for any number of ice-making evaporators, either driving the valve member or members **390** (Fig. 3) with energy derived from vapor flow or by other means.

In connection with this arrangement attention is called to the fact that when one evaporator is being defrosted and say three evaporators are active all of the liquid refrigerant for the active evaporators is flowing through the one being defrosted, hence it causes ice to release in much less idle time.

An optional method of actuating the valve **390** or a switch to control valves **484** is to rotate the valve or a rotary switch by means of a ratchet device and a bellows responsive to temperature changes on the order of disclosures in my United States Patent No. 2,145,777 issued January 31, 1939. Such a bellows would be connected with a number of bulbs corresponding to the number of evaporators in the ice maker. The charge of volatile fluid would be such that all but the warmest bulb are filled with liquid. Each bulb is located adjacent to an ice-making area associated with one of the evaporators, preferably the last area from which ice is released. As this bulb is warmed up to a temperature which assures that all ice has been released from the surfaces served by that evaporator the ratchet wheel is moved to its next position, shifting the valve **390** to its next position to cause high pressure liquid refrigerant to flow into the next evaporator to release its ice.

The rotary valve of Fig. 3 is preferably so designed that only one evaporator is flooded with hot liquid refrigerant at one time, though it is permissible to have these defrosting periods overlap to some extent so that two evaporators are defrosting simultaneously during short periods. When a single ice maker of large capacity is equipped with more evaporators than can be handled by defrosting them one at a time and it becomes necessary to have several of them defrosting simultaneously the control may be made responsive to only a part of the evaporators and be arranged to shift two or more of them at a time. Another way to arrange the control of such a large machine is to connect two or more evaporators in parallel to each of the valves **476** (at tube **462** of Fig. 9) thus the two or more evaporators so connected will be defrosted simultaneously. Each solenoid **482** can be controlled by one evaporator of said two or more, or if the valve of Fig. 3 is used the number of radial outlets need only be equal to the number of valves **476**.

While Figure 8 shows three expansion valves **496**, it will be understood that a single expansion valve will serve with the addition of one more check valve for each evaporator on the order of my disclosure in United States application Serial No. 109,942, now Patent No. 2,672,017, filed August 12, 1949 and Fig. 4 of my U. S. application Serial No. 174,944. In this case each evaporator **460**, **462**, and **464** would have the outlet of the expansion valve leading to it through a check valve and the inlet of the expansion valve connected with three check valves, such as **498** of Figure 8, one allowing flow from the same end of each evaporator to the inlet of the expansion valve. The opposite end of each evaporator would connect with a valve **476**, as in Fig. 8.

I claim:

1. In an automatic ice maker, a plurality of evaporators, means forming a suction passage for flow of refrigerant vapor from said evaporators, rotary means actuated by the flow of said vapor for controlling flow of refrigerant liquid to said evaporators, and means for controlling flow of refrigerant vapor from said evaporators, the said two means being mechanically interconnected to effect the stoppage of liquid flow to one of said evaporators prior to the start of vapor flow from said evaporator, thus causing the liquid content of said evaporator to be reduced prior to the start of its next period of active operation as an evaporator.

2. In a refrigerating system, having a main suction conduit and a main liquid conduit, a plurality of heat exchangers each arranged to serve at one time to evaporate refrigerant at low pressure and at another time as a heating device heated by high pressure refrigerant, means for modifying the path of refrigerant flow in said system to cause said heat exchanger to shift from one to the other of said functions, the last said means including power actuated valve means for stopping the flow of high pressure refrigerant to one of said heat exchangers which is being heated while allowing refrigerant liquid to continue flowing from it to evaporate in another evaporator, and additional valve means actuated in response to a drop of pressure in said one heat exchanger to open its outlet to said suction conduit at a predetermined difference of pressure between said one heat exchanger and said suction conduit, thus causing the heat exchanger to start functioning as an evaporator.

3. In a refrigerating system, an evaporator having an outlet for refrigerant vapor, a suction conduit connected with said outlet, a high pressure refrigerant conduit, valve means controlling flow of refrigerant from said high pressure conduit to said outlet, and valve means for stopping refrigerant flow from said outlet to said suction conduit, the last said valve means being closable by flow of high pressure refrigerant caused by the opening of the first said valve means, and remaining closed until after the liquid content of the evaporator has been substantially reduced whereupon it opens.

4. In an ice-making system, a plurality of evaporators, means for defrosting one of said evaporators by flowing high pressure liquid refrigerant through it to be expanded in an active evaporator, means for stopping flow of said liquid to the defrosting evaporator, and control means for restarting the cooling of said defrosting evaporator as a result of its liquid content and therefore its internal pressure being reduced to a suitable condition for such restarting.

5. In an automatic ice maker, a refrigerating system including a plurality of evaporators connected in parallel to the low pressure side of said system, means for admitting high pressure liquid refrigerant to one of said evaporators at its normal outlet end, and valve means responsive to the admission of said liquid to stop flow from said evaporator to the low pressure side of said system.

6. In a refrigerating system adapted to circulate a volatile refrigerant within itself, valve means including a plurality of valves arranged to control fluid flow between separate portions of said system and thereby divide the system into high and low pressure sections, a plurality of evaporators of which any one may be connected in a high pressure or a low pressure section of the system according to which of said valves are closed, a fluid-driven motor within said system arranged to be actuated by refrigerant flow, and a power transmission mechanism connected with said motor to operate said valves in a sequence to first close a valve which stops flow of high pressure refrigerant to one of said evaporators while refrigerant continues to flow from it to a low pressure section of the system and after a material reduction of the refrigerant content of said evaporator to open another valve which allows flow of refrigerant vapor from said evaporator to a low pressure section of the system.

7. In a refrigerating system having high and low pressure sections charged with a volatile refrigerant, two or more evaporators, valve means for regulating the flow of said refrigerant to cause one of said evaporators to be defrosted by being filled with high pressure refrigerant in its liquid phase while liquid refrigerant flows from it to an active evaporator, then to stop the flow of high pressure refrigerant to said one evaporator while allowing liquid refrigerant to continue flowing therefrom into the low pressure section of said system, and then to open said one evaporator for vapor flow therefrom to the low pressure section of said system after a considerable reduction in its liquid content.

8. In a refrigerating system charged with a volatile refrigerant, an evaporator, means forming a chamber

having three ports of which a first one is connected with said evaporator, a suction conduit for vapor flowing from a second port of said chamber, a high pressure refrigerant conduit carrying liquid to the third port of said chamber, a valve adapted to close said second port, a valve controlling flow from said high pressure conduit to said evaporator for the purpose of defrosting it, and means actuated coincidentally with the starting of flow of high pressure refrigerant to said evaporator when the second said valve is opened to close the first said valve, said means also acting to close the second said valve and to provide for the later re-opening of the first said valve whereby the evaporator is caused to resume normal operation after being defrosted.

9. In a refrigerating system charged with a volatile refrigerant, an evaporator, a 3-way fitting having one port connected with the vapor outlet of said evaporator, a suction conduit leading from a second port of said fitting, a high pressure refrigerant conduit connected with the third port of said fitting, a valve adapted to close said second port, a valve in said high pressure conduit, means actuated in time with the flow of high pressure refrigerant to said evaporator when the second said valve is opened to close the first said valve, a second evaporator in said system arranged to be fed with liquid refrigerant from the first said evaporator while the first said evaporator contains high pressure refrigerant, and means acting to hold the first said valve closed until flow of liquid from the first said evaporator has reduced its liquid content and pressure to a point suitable for resumption of its operation as an evaporator.

10. In a refrigerating system employing a volatile refrigerant, a plurality of evaporators, means forming a

suction passage leading from a first one of said evaporators, a check valve located between said first evaporator and its suction passage, said check valve being closable by movement in the normal direction of flow from said first evaporator to said suction passage and biased in its opening direction during at least the active periods of said first evaporator, means for defrosting said evaporator by filling it with refrigerant at a higher pressure than usual and coincidentally closing said check valve, and control means for regulating the flow of said higher pressure refrigerant to a second one of said evaporators for evaporation therein while flow of refrigerant to the first evaporator is stopped, thereby bringing the refrigerant content of the first evaporator down to a normal quantity and reducing its pressure so that said check valve reopens to resume cooling of the first evaporator.

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2,359,780	Muffly	Oct. 10, 1940
2,368,675	Muffly	Feb. 6, 1945
2,407,794	Muffly	Sept. 17, 1946
2,444,514	Kubaugh	July 6, 1948
2,448,454	Muffly	Aug. 31, 1948
2,486,608	MacDougall	Nov. 1, 1949
2,497,903	Muffly	Feb. 21, 1950
2,542,892	Bayston	Feb. 20, 1951
2,590,499	Braswell	Mar. 25, 1952
2,654,227	Muffly	Oct. 6, 1953
2,672,016	Muffly	Mar. 16, 1954
2,672,017	Muffly	Mar. 16, 1954