

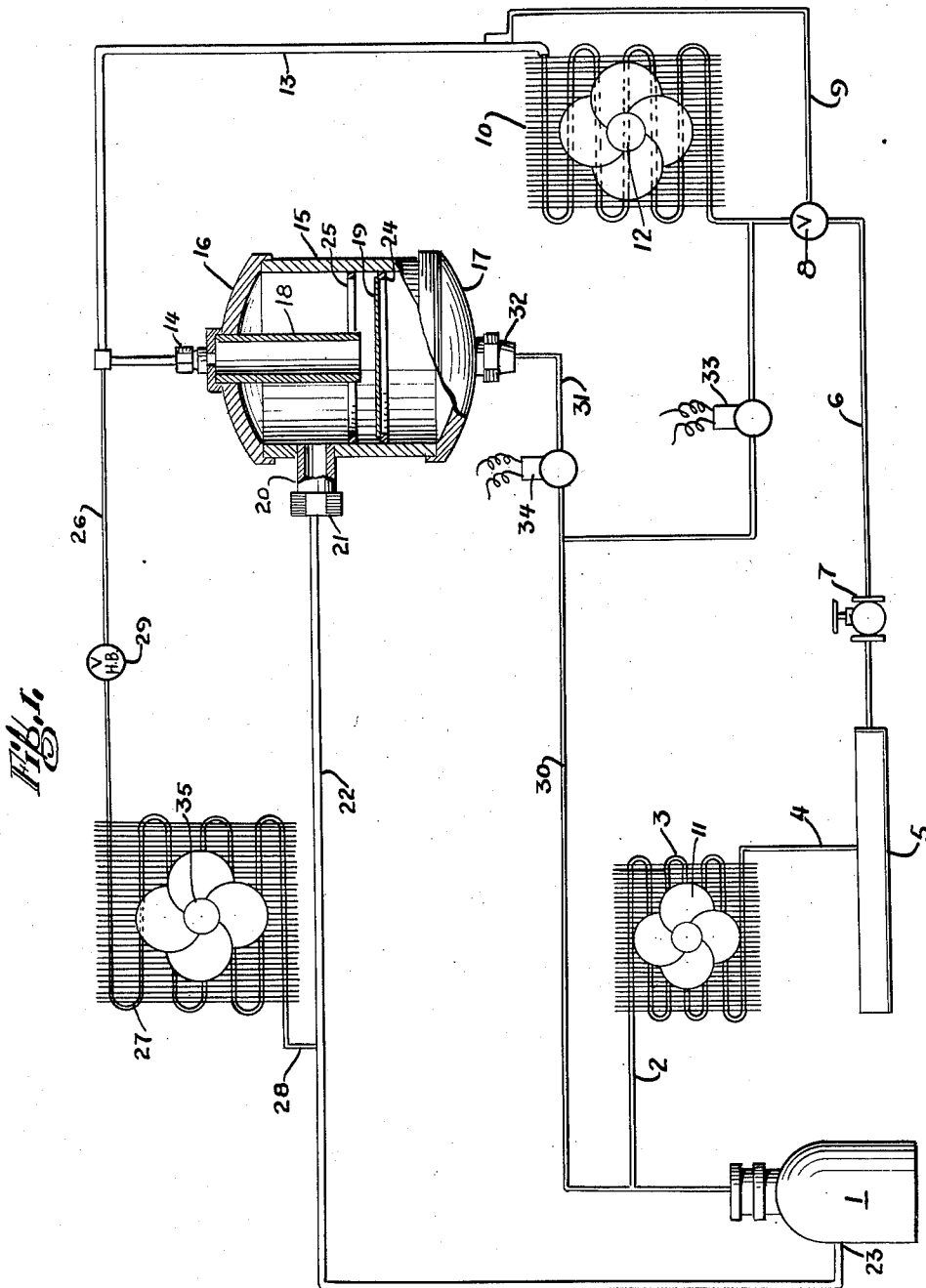
June 30, 1959

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FLUID FLOW CONTROLLING VALVE AND HEAT EXCHANGE
SYSTEM EMPLOYING THE SAME

2,892,318

Filed March 15, 1956

3 Sheets-Sheet 1



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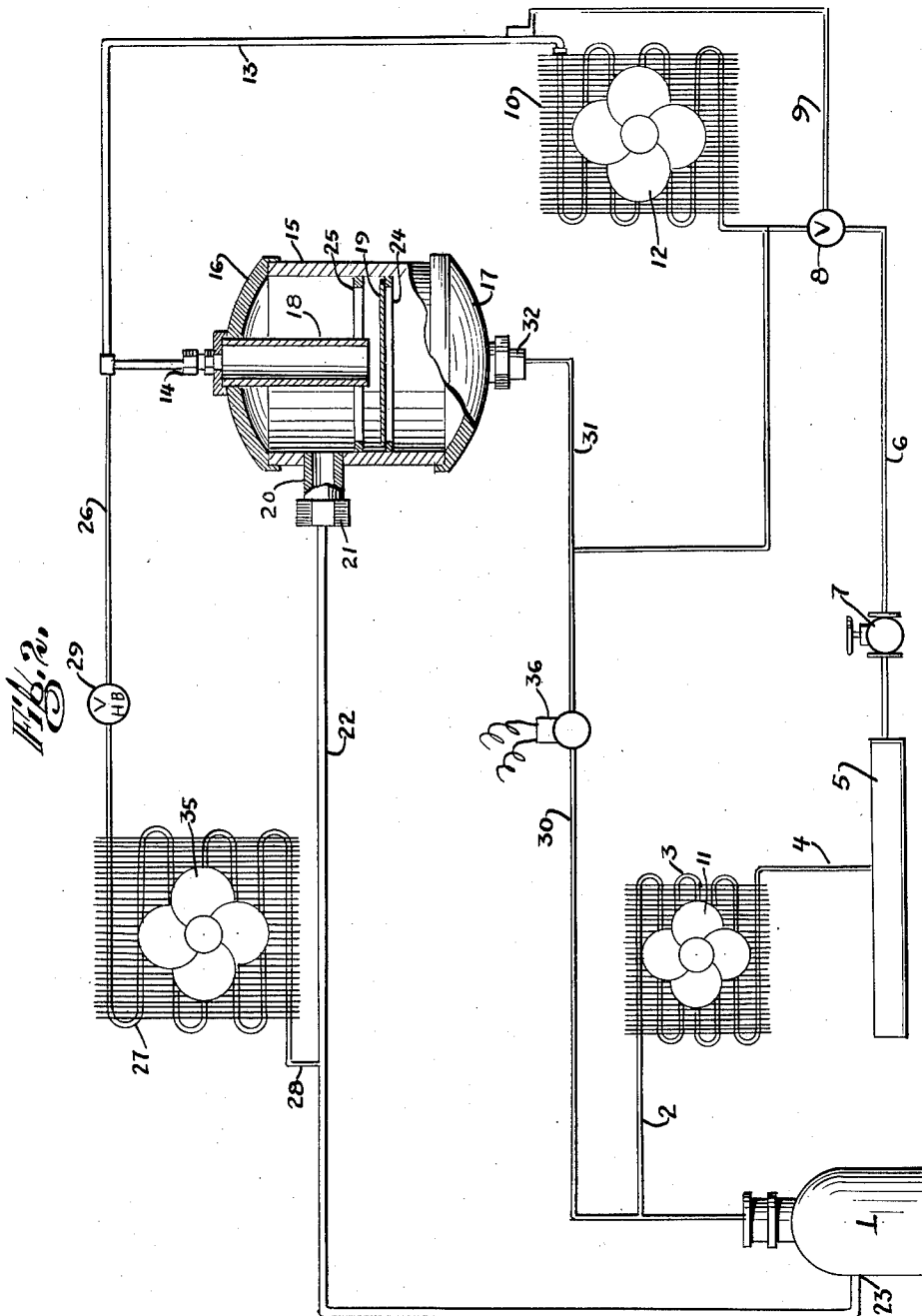
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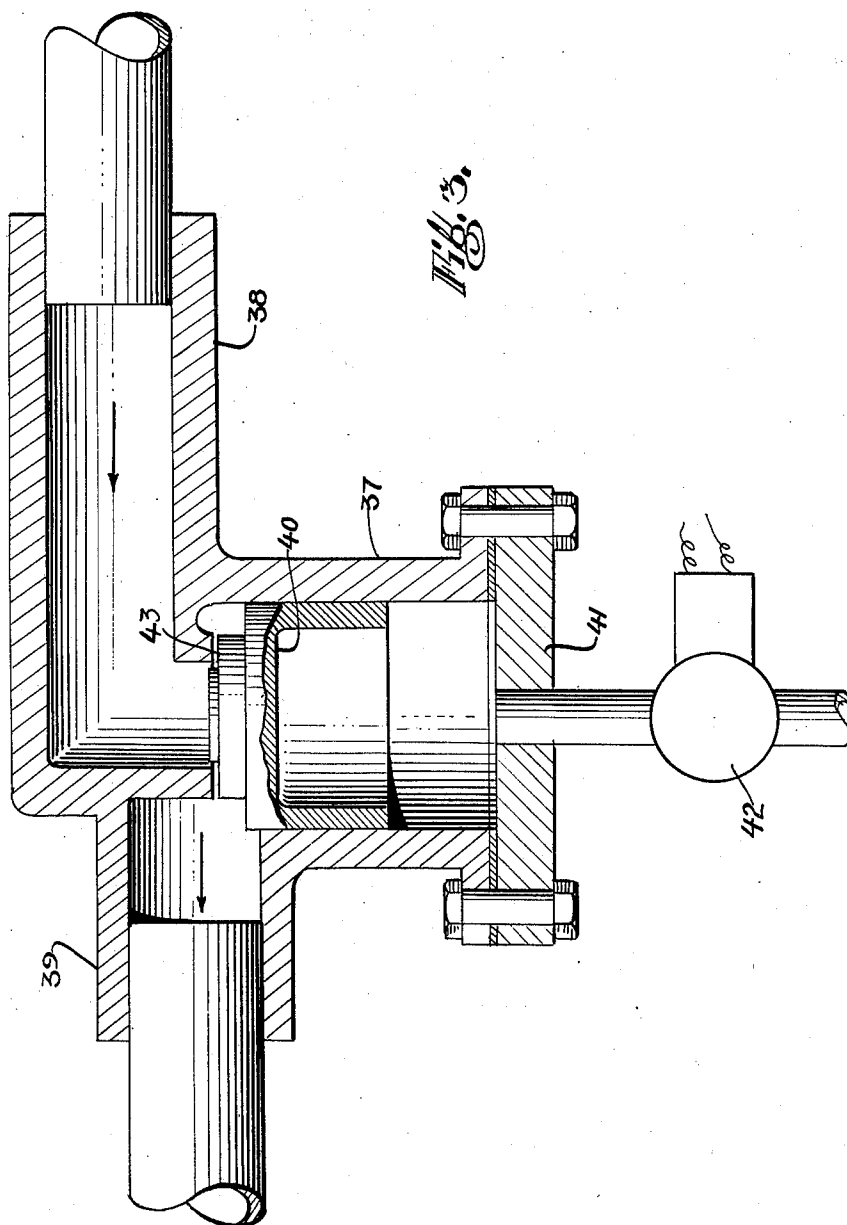
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FLUID FLOW CONTROLLING VALVE AND HEAT EXCHANGE SYSTEM EMPLOYING THE SAME

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Application March 15, 1956, Serial No. 571,730

17 Claims. (Cl. 62—151)

This invention relates to a fluid flow controlling valve and heat exchange system employing the same as a high side operated low side valve, and has for an object to provide such a valve which is adapted to be closed by fluid pressure and opened by gravity, for regulating flow therethrough.

Another object is to provide such a valve which is adapted for instantaneous closing upon the application of fluid pressure and retarded opening, upon release of the pressure, under the influence of the force of gravity.

Another object is to provide such a valve in which the closing and opening are effected by a free or floating element cooperative with the valve inlet.

Another object is to provide a system, such as a compression type refrigeration system fitted with hot gas defrosting means, in which the valve serves as a booster valve and the suction refrigerant flow from evaporator outlet to compressor intake passes freely through the booster valve during refrigerating cycles, while the initiation of each defrosting cycle operates a pilot valve that instantly closes the booster valve and compels the said flow to traverse a by-pass or branch conduit.

Another object is to provide such a system in which the hot gas stream from the compressor discharge that accomplishes the defrosting of the evaporator also serves to close the booster valve when the opening of the pilot valve permits access of the gas stream to the booster valve.

Another object is to provide such a system in which the booster valve imposes a minimum of friction pressure drop upon the refrigerant suction flow to the compressor and thereby enhances the operative efficiency of the latter.

Another object is to provide such a system in which the booster valve is adapted to substantially instantaneous closing and slow or retarded opening at the initiation and termination, respectively, of defrosting cycles.

Another object is to provide such a system in which the bulk size of the booster valve may be lessened due to the high pressure of the normal hot gas stream from the compressor discharge which functions to close the valve.

Another object is to provide such a system in which a pilot valve of extremely small size and port area suffices for the immediate closing of the booster valve at the outset of defrosting cycles.

Another object is to provide such a system in which a pilot valve of the solenoid type may be employed and serve to close the booster valve on energization of the solenoid for the comparatively brief defrosting periods, while permitting the booster valve to open on deenergization of the solenoid for the much more extended refrigerating periods.

Another object is to provide such a system in which the valve that inaugurates and causes cessation of defrosting cycles also suffices to pilot the booster valve.

A further object is to provide certain improvements in the form, construction and arrangement of the several elements of the system whereby the above named objects

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and others inherent in the invention may be efficiently attained.

Practical embodiments of the invention are exhibited in the accompanying drawings, in which—

Fig. 1 diagrammatically represents a refrigeration system according to the invention with the booster valve shown mostly in vertical section and in great relative enlargement to afford a better exposition of its construction and mode of operation;

Fig. 2 similarly represents a modification in which a single solenoid valve performs to control defrosting cycles and to pilot the booster valve; and

Fig. 3 represents, in vertical section, a modified form of booster valve, on an enlarged scale.

In brief summary, the invention comprehends the provision of a fluid flow controlling valve possessed of the characteristics hereinabove set forth, as well as a heat transfer system of the compression type which includes compressor, condenser, receiver (which may be combined with the condenser), evaporator (with its expansion valve), and hot gas defrosting means, all arranged in operative connection, and with two courses for refrigerant flow from evaporator outlet to compressor intake—one direct and the other through a by-pass or branch conduit, together with the valve of this invention serving as a booster valve interposed between the evaporator and the compressor for controlling the courses of flow from evaporator to compressor; the said booster valve being operatively subject to the hot gas defrosting means and being designed to minimize friction pressure drop in the refrigerant flow to the compressor intake during refrigerating cycles, and, by fluid pressure closing, to instantly direct the flow course through the by-pass or branch conduit upon initiation of defrosting cycles and, by retarded gravity opening, upon release of the fluid pressure, to again allow direct flow from evaporator to compressor upon cessation of defrosting cycles.

Referring to Fig. 1 of the drawings, the compressor is denoted by 1 and its discharge is connected by a conduit 2 with the condenser 3 that empties through pipe 4 into the receiver 5. A refrigerant supply conduit 6, fitted if desired with a service valve 7, establishes communication through thermostatic expansion valve 8, controlled by the usual feeler bulb and capillary marked collectively 9, with the evaporator 10. The elements so far recited may be of any approved type and construction as they, per se, do not constitute features of the present invention. The condenser and evaporator are shown as fitted with the customary fan and motor units 11 and 12 respectively.

A suction conduit 13 leads from the evaporator outlet and is coupled at 14 to the inlet of the booster valve. The latter consists of a cylindrical body portion 15 which may be formed of standard metallic tubing and is fitted with a top 16 and bottom 17 that may be metal stampings peripherally flanged and secured in any suitable manner, e. g., spot welding or soldering, to the body portion.

The inlet of the booster valve is formed with an inwardly projecting tube 18, which may be of standard material, and a circular disc 19, which may be of heavy sheet metal or a thicker stamping, is positioned loosely within the body portion 15 and adapted to move into and out of tight seating contact with the inner end of the tube 18 for closing and opening flow passage through the valve from the said inlet tube to the outlet tube 20 that is properly fixed, as by welding or soldering, in the side of the body portion 15, and to which is coupled at 21 a continuation 22 of the suction conduit which connects directly with the compressor 1 at its intake 23.

The movement of the disc 19 is restricted by annular stops 24, 25, which are secured to the interior of the valve body portion 15, as by welding or soldering; the

lower stop 24 serving to limit movement of the disc away from the inlet tube 18, while the upper stop limits opposite movement of the perimeter of the disc but permits tight seating on the inner end of the tube 18. The disc 19 is heavy enough to respond well to the influence of gravity, and its diameter is slightly less than the inner diameter of the body portion 15 for the purpose of permitting fluid passage therebetween, as will be hereinafter described.

A by-pass or branch conduit 26 sprouts from suction conduit 13 and, for the purpose of describing a useful embodiment of the invention, is here shown as leading to the inlet of a reevaporator 27, like that of U. S. patent to Otto J. Nussbaum, No. 2,530,440, issued November 21, 1950, or of any other suitable type, such as shown in U. S. patent to Israel Kramer, No. 2,718,764, issued September 27, 1955. The outlet of the reevaporator is connected at 28 with the continuation 22 of the suction conduit. A pressure and temperature reducing device, such as a hold back valve 29, is interposed in branch conduit 26 between booster valve and reevaporator. Such hold back valve is a well known commercial article that serves to restrict fluid flow therethrough in obedience to pressure conditions at its outlet, i. e. toward the reevaporator, and is adjustable to close completely at a predetermined selected pressure.

The discharge of compressor 1 is connected by a defrosting conduit 30 with the inlet of evaporator 10, and by a branch conduit 31 with a central aperture in the bottom 17 of the booster valve to which it is coupled at 32. Solenoid valves 33 and 34 perform to open and close the said conduits 30 and 31, respectively, and they are suitably controlled, as by an electric timer (not shown), either preset to open and close valves 33 and 34 at fixed intervals, or governed by some preferred operating condition of the system, all of which is so well understood by those skilled in this industry as to require neither illustration nor further description. See, for instance, U. S. patent to Israel Kramer, No. 2,440,146, issued April 20, 1948, and U. S. patent to George Frie, No. 2,463,027, issued March 1, 1949.

In operation, during refrigerating cycles the hot gas from the discharge of the compressor is condensed in the condenser 3 and deposited in the receiver 5 from which it flows through supply conduit 6 to the thermostatic expansion valve 8 where its pressure and temperature are reduced for cooling effect in the evaporator 10, all as is usual and well understood in this industry. From the evaporator 10 the refrigerant, now largely in gaseous phase, flows through suction conduit 13 to inlet tube 18 of the booster valve, which latter is in the open position illustrated in Fig. 1, and thence through outlet tube 20 to the continuation suction conduit 22, from which the gaseous refrigerant enters the compressor intake for recompression and recirculation through the system as just described. During the refrigerating cycle it will be understood that solenoid valves 33 and 34 are closed.

Upon the incidence of a defrosting cycle, the electrical control opens solenoid valves 33 and 34, whereupon the hot refrigerant gas from the compressor discharge flows through the defrosting conduit 30 and valve 33 to the inlet of the evaporator 10 wherein it melts the frost upon the evaporator and the usual drip pan (not shown) associated therewith. Concurrently, the flow just described of hot gas travels through pilot valve 34 and branch conduit 31 to enter the bottom of the booster valve at 32. This inrush of gas or refrigerant vapor, which may be at a pressure of say sixty to eighty pounds per square inch, instantly raises the disc 19 and causes it to seat tightly upon the inner end of inlet tube 18, thereby closing the booster valve. This closing compels the refrigerant debouching from the outlet of evaporator 10, which has been largely condensed to liquid form while melting the frost on the evaporator, to flow through suction conduit 13 and branch conduit 26 to hold back valve 29 which

latter serves to lower the pressure and temperature of the refrigerant before it enters the reevaporator 27, wherein the reevaporation of the liquid portion of the refrigerant is accomplished largely due to the effect of the fan and motor unit 35 with which the reevaporator is equipped. The refrigerant thus vaporized passes through connection 28 at the outlet of the reevaporator, and thence to the compressor intake.

At the termination of the defrosting cycle, the electrical control recloses solenoid valves 33 and 34, thus permitting resumption of the refrigerating cycle heretofore described because the closing of the said valves 33 and 34 not only permits refrigerant flow from compressor to condenser, to receiver, to thermostatic expansion valve and evaporator inlet, but also permits flow from evaporator outlet through booster valve back to compressor intake due to the fact that the closing of pilot valve 34 interrupts the inflow of hot gas from compressor discharge to the lower part of the booster valve and thereby permits the disc 19 to move away from the inlet tube 18 and come to rest upon its lower stop 24. This movement of the disc 19 under the influence of gravity takes place because the escape of high pressure gas from the lower part of the booster valve between the perimeter of the disc and the body portion of the valve results in substantial equalization of pressure above and below the disc so that gravity may become effective. In this connection, it should be observed that, in contradistinction to its instantaneous closing movement, the disc 19 has a gradual opening movement which permits a continuation of at least partial flow of the condensed refrigerant resulting from the defrosting function through the hold back valve and reevaporator for a brief period following closing of solenoid valves 33 and 34 to terminate the defrosting cycle. This beneficially contributes to the reestablishment of refrigerating condition by the evaporator 10. The fact that the hot gas from the compressor discharge which serves to move the disc 19 to a closing position is at a high pressure permits the use of a disc which is of substantial thickness and weight to insure response to the influence of gravity, and also promotes durability. This further allows the use of a pilot valve 34 which is small in size and port area, thereby affording an appreciable lessening of manufacturing cost, while the actual size of the booster valve itself may be reduced, with concomitant saving in expense for the same reason. Economy in operation is promoted by the fact that, during the relatively long refrigerating cycles, pilot valve 34 is closed and does not consume electrical current which latter is active only during the relatively short defrosting cycles when it energizes the solenoid of the said valve. During refrigerating cycles the flow through the booster valve is very free due mainly to the large port area of the said valve, which is a matter of importance in reducing friction pressure drop of the refrigerant returning to the compressor intake and thereby enhancing the efficiency of compressor action.

The modified form of the invention illustrated in Fig. 2 is the same as that of Fig. 1, and corresponding parts are similarly numbered, with the exception that a single solenoid valve, marked 36 in Fig. 2, is substituted for the two valves 33 and 34, and is positioned in the defrosting conduit 30 at a point nearer the compressor 1 than the point at which the branch conduit 31 connects with conduit 30. Thus this single solenoid valve 36 performs the double duty of a defrosting cycle valve and a pilot valve for the booster, although the individual effect of the pilot valve 34 is lost in the sense that the modification of Fig. 2 provides no means for closing and opening the booster independently of the opening and closing of the defrosting conduit valve, which independent action may be desirable in certain circumstances, e.g. to extend the delay in the opening of the booster following defrosting, and can, of course, be accomplished by suitable arrangement of the electrical solenoid valve

control. Other than as just set forth, the mode of operation of the system shown in Fig. 2 is the same as that of the system shown in Fig. 1.

The showing of Fig. 3 relates merely to a modification of the form of the booster valve itself. In this modified booster valve, the body portion corresponding largely to the body portion 15 of the booster shown in Figs. 1 and 2, is marked 37; the inlet corresponding to inlet tube 18 is indicated by 38, and the outlet corresponding to outlet 20 is denoted by 39. The element corresponding to disc 19 is a piston 40; while the bottom of the valve corresponding to 17 is labeled 41, and the pilot valve is marked 42. The direction of flow through the valve is indicated by arrows, and it will be clear that, when piston 40 is in the position shown, the valve is open for refrigerant flow therethrough during refrigerating cycles as described in connection with Fig. 1, while the elevation of the piston under the influx of hot gas through pilot valve 42 at the outset of defrosting cycles will close the booster valve by contact of the shouldered surfaces indicated at 43. This booster valve of Fig. 3 performs in a manner largely similar to that of the valves shown in Figs. 1 and 2, and it has a certain advantage particularly with respect to the item of first cost although it lacks certain advantages inherent in the disc type booster of Figs. 1 and 2.

The optimum in relative size of the ports of the booster valves and their pilot valves is a variable figure, well within engineering knowledge and calculation but it may be pertinent to mention an approximate indication of this relationship by noting that the booster valves, having ports varying from one inch to four inches in diameter can, generally speaking, be satisfied by pilot valves having ports varying from one-quarter inch to one-half inch in diameter.

While the embodiments of the invention shown in the drawings and described herein depict the suction conduit branch 26 as leading to means for reevaporating refrigerant that has been liquefied in defrosting cycles of the system, and while such may prove to be the most frequent commercial and industrial expression of the invention, we wish to make clear that the true scope of the invention is not so circumscribed, as the suction conduit branch may channel the refrigerant to other than reevaporating means, e.g. to means for supplying it to an additional space cooling evaporator or evaporators. In other words, the important function of the booster valve is to close the suction conduit that leads directly to the compressor intake during defrosting cycles of the system thus diverting the refrigerant flow through a branch conduit the particular character of the terminus of the latter not being an item of inventive consequence.

It should also be observed that the valve construction, with its operational adaptability, itself constitutes a feature of the present invention which is neither limited to performance of the particular functions herein described nor necessarily combined with a refrigerating system. It is regarded as a novel flow controlling device and is intended to be covered in that scope by the claims which are directed to the valve itself.

Referring to all forms of the invention, we desire it to be understood that various changes may be resorted to in the form, construction and arrangement of the several parts without departing from the spirit and scope of the invention; and hence we do not intend to be limited to details herein shown or described except as the same may be included in the claims or be required by disclosure of the prior art.

What we claim is:

1. A refrigerating system of the compression type having a refrigerant flow circuit including operatively conduit interconnected compressor, condenser, evaporator, and hot gas defrosting means connecting compressor discharge with evaporator, together with a booster valve interposed in the suction conduit connecting evaporator

outlet with compressor intake, and a branch conduit leading off from the suction conduit, said booster valve being normally open for refrigerant flow therethrough from evaporator directly to compressor during refrigerating cycles of the system, and means communicating with the compressor discharge for subjecting the booster valve to pressure in the high side of the system for closing the valve during defrosting cycles and thereby diverting the refrigerant flow from the evaporator to said branch conduit, the said means for subjecting the booster valve to pressure in the high side of the system also constituting means for subjecting the said valve to the compressor discharge hot gas pressure of the defrosting means, and the said booster valve comprising an inlet connected with the evaporator outlet, an outlet connected with the compressor intake, an aperture connected with the compressor discharge, and a valve closing and opening element positioned between the inlet and the said aperture.

2. A refrigerating system as defined in claim 1, which also includes a pilot valve positioned between compressor discharge and the booster valve for permitting and inhibiting operative access of the compressor discharge hot gas defrosting pressure to the booster valve.

3. A refrigerating system of the compression type having a refrigerant flow circuit including operatively conduit interconnected compressor, condenser, evaporator, and hot gas defrosting means connecting compressor discharge with evaporator, together with a booster valve interposed in the suction conduit connecting evaporator outlet with compressor intake, and a branch conduit leading off from the suction conduit, said booster valve being normally open for refrigerant flow therethrough from evaporator directly to compressor during refrigerating cycles of the system, and means communicating with the compressor discharge for subjecting the booster valve to pressure in the high side of the system for closing the valve during defrosting cycles and thereby diverting the refrigerant flow from the evaporator to said branch conduit, said last named means also constituting means for subjecting the said valve to the compressor discharge hot gas pressure of the defrosting means.

4. A refrigerating system as defined in claim 3, which also includes a pilot valve positioned between the compressor discharge and the booster valve for permitting and inhibiting operative access of the compressor discharge hot gas defrosting pressure to the booster valve.

5. A refrigerating system as defined in claim 3, in which the hot gas defrosting means and the means for subjecting the booster valve to pressure in the high side of the system comprise, a hot gas conduit connecting the compressor discharge with the evaporator inlet, a branch conduit connecting the hot gas conduit with the booster valve, and means for opening and closing said hot gas and branch conduits to the flow of refrigerant therethrough.

6. A refrigerating system as defined in claim 5, in which the means for opening and closing said hot gas and branch conduits to the flow of refrigerant therethrough includes a device positioned in each of said conduits.

7. A refrigerating system as defined in claim 3, in which the booster valve comprises an inlet connected with the evaporator outlet, an outlet connected with the compressor intake, an aperture connected with the compressor discharge, and a valve closing and opening element positioned between the inlet and the said aperture.

8. A refrigerating system as defined in claim 7, in which the valve closing and opening element is loosely positioned in the valve to permit fluid pressure flow between the element and the adjacent portion of the valve.

9. A refrigerating system as defined in claim 8, in which the booster valve inlet includes an inwardly extending tube and the valve closing and opening element is a disc adapted to move into and out of contact with said inlet tube, the disc being smaller in size than the

portion of the valve in which it is positioned to permit fluid flow between the perimeter of the disc and said valve portion.

10. A refrigerating system as defined in claim 9, in which the disc moves to closing position under the influence of fluid pressure and moves to open position under the influence of gravity.

11. A refrigerating system as defined in claim 3, in which the booster valve comprises an inlet and an outlet which open into each other, and a piston-like element constituting means for closing the opening between inlet and outlet under the influence of pressure and to open the said opening under the influence of gravity.

12. A refrigerating system as defined in claim 11, in which the opening between inlet and outlet and the closing surface of the piston are mutually shouldered to prevent leakage when the piston is in closed position.

13. A refrigerating system of the compression type having a refrigerant flow circuit including operatively conduit interconnected compressor, condenser, evaporator, and hot gas defrosting means, together with a booster valve interposed in the suction conduit connecting evaporator outlet with compressor intake, and a branch conduit leading off from the suction conduit, said booster valve being normally open for refrigerant flow therethrough from evaporator directly to compressor during refrigerating cycles of the system, and a valved conduit by-passing the evaporator and communicating directly with the high side of the system for subjecting the booster valve to high side pressure for closing the valve during defrosting cycles and thereby diverting refrigerant flow from the evaporator to said branch conduit.

14. A refrigerating system as defined in claim 13, in which the hot gas defrosting means and the said conduit means for subjecting the booster valve to high side pressure comprise, a hot gas conduit connecting the compressor discharge with the evaporator inlet, a conduit con-

necting the high side of the system with the booster valve, and means for opening and closing said two last named conduits to the flow of refrigerant therethrough.

15. A refrigerating system as defined in claim 14, in which the means for opening and closing said two last named conduits to the flow of refrigerant therethrough includes a valve positioned in each of said conduits.

16. A refrigerating system as defined in claim 13, in which the booster valve comprises an inlet connected with the evaporator outlet, an outlet connected with the compressor intake, an aperture communicating with the high side of the system, and a valve inlet closing and opening element positioned between the inlet and the said aperture.

17. A refrigerating system as defined in claim 13, in which the booster valve comprises an inlet and an outlet which communicate with each other, and a piston-like element constituting means for closing communication between inlet and outlet under the influence of pressure and opening communication under the influence of gravity.

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