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A. TRASK

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REVERSING VALVE FOR HEAT PUMPS

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FIG. 1

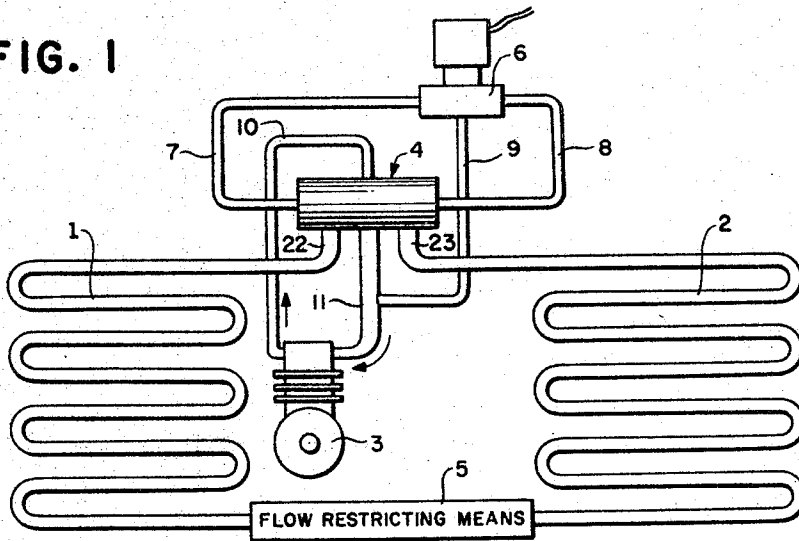


FIG. 2

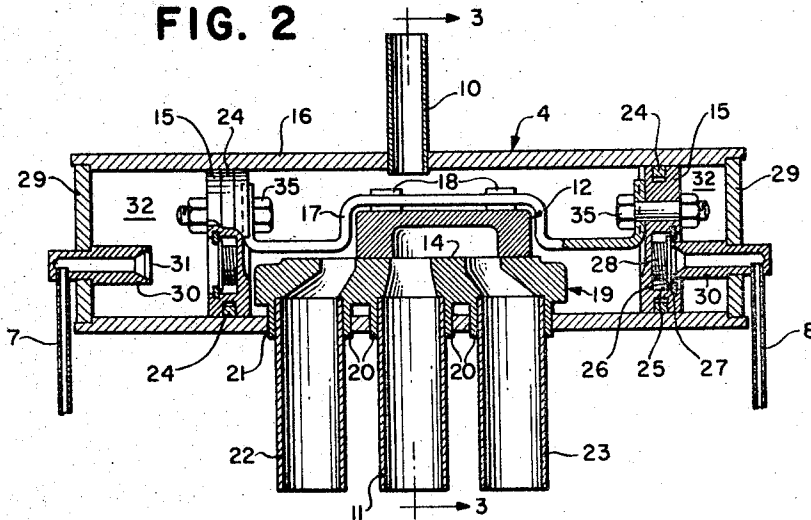
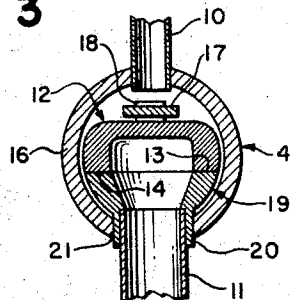


FIG. 3



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REVERSING VALVE FOR HEAT PUMPS

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4 Claims. (Cl. 137-625.33)

This invention relates to heat pumps comprising a reversible compression type refrigeration system and more particularly to the valve means for reversing the system.

A compression type heat pump used for cooling a residence or other structure in the summer and heating it during the colder months of the year essentially comprises a reversible refrigeration circuit including an indoor heat exchanger, an outdoor heat exchanger, compressor means for effecting the flow of refrigerant through the circuit, means for effecting and maintaining a pressure differential between the two heat exchangers, and a reversing valve means for reversing the direction of refrigerant flow through the heat exchangers.

A common type of refrigerant reversing valve is of the sliding type known as a D slide valve. This type of valve has been in wide use in steam engines. The D slide is positioned on its seat in the position of an inverted cup covering two of three ports. In a heat pump circuit the D slide is held to its seat with a pressure equal to the pressure difference between the two heat exchangers. When refrigerant "Freon 22" is used in the system, the pressure holding the D valve to its seat is in the order of 200 pounds per square inch.

In damp weather of high humidity when outdoor temperatures range from 25° F. to 40° F. the outdoor heat exchanger is operating at temperatures below freezing most of the time. This causes frost and ice to accumulate on the outdoor heat exchanger to reduce its effectiveness. When the outdoor heat exchanger is the usual fin tube type, the fins accumulate ice and frost between them blocking the flow of air through them thus reducing their capacity for heat exchange. Means for frequent reversal of the system long enough to melt the accumulations of frost and ice during frost forming weather is usually provided in a heat pump. Such defrosting means is essential in heat pumps operating in outdoor temperatures around 40° F. and lower.

Frequent reversing of a D slide type reversing valve operating under high pressure presents a problem of lubricating the valve seat. In compression type systems an amount of lubricating oil sufficient to lubricate the compressor pistons escapes from the compressor discharge valves and circulates around the refrigerant circuit with the refrigerant. This lubricant is adequate in quantity to lubricate the D slide valve but when the slide face and valve seat are both smooth and flat, as required to prevent refrigerant leaks, the valve pressure wipes the lubricant from the valve seat in its normal sliding action. The pressure on the D slide maintains such a tight contact between it and its seat that lubricant cannot wet the valve face or its seat by capillary action to provide for smooth lubricated movement of the D slide.

A valve forced to slide on a dry, unlubricated seat is subject to sticking and abrasion which will cause tearing or galling of the valve face and/or the valve seat and thereby cause the valve to leak.

A primary object of this invention is to provide posi-

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tive lubrication in a sliding type reversing valve for use in heat pumps.

Another object of this invention is to provide a combination of materials for a sliding type reversing valve wherein the valve slide and/or its seat will entrain and retain lubricant under all circumstances of heat pump functioning.

Another object of this invention is to provide a structure wherein the parts are subject to liberal tolerances in quantity production without permitting internal leaks.

A further object of this invention is to provide a valve structure wherein the only requirement for accuracy beyond normal quantity production tolerances is the finish and flatness of the valve slide face and its seat.

The above and further objects and advantages of this invention will become apparent from the following description of the preferred embodiment thereof.

Referring to the drawings:

Fig. 1 is a diagram of a conventional type of reversible refrigeration system used for heat pumps;

Fig. 2 is a cross-sectional view of the reversing valve embodying the features of the present invention; and

Fig. 3 is a sectional view taken substantially on line 3-3 of Fig. 2.

Referring to Fig. 1, the heat pump system shown diagrammatically comprises an indoor heat exchanger or coil 1, and an outdoor heat exchanger or coil 2, which is usually larger than the indoor coil.

Means for conducting refrigerant between the two heat exchanger coils, and reversing the direction of refrigerant flow, includes a compressor 3 and a reversing valve 4. A pressure differential between the two coils is maintained by a conventional type of refrigerant flow restricting means 5. A three-way solenoid pilot valve 6 is connected by refrigerant conduits 7 and 8 to opposite ends of the reversing valve 4, and by conduit 9 to the suction side of compressor 3. Conduit 10 connects the discharge side of the compressor 3 to the reversing valve 4. Conduit 11 connects the suction side of compressor 3 to the reversing valve 4.

Referring to Figs. 2 and 3, a D valve slide 12 has its lower surface or face 13 in contact with the flat seat 14 of the valve seat unit 19. Two pistons 15 in the cylindrical housing 16 are bolted by bolts 35 to the ends of a yoke stamping 17 which also engages adjacent its center the valve slide 12 by means of two upwardly extending cylindrical projections 18 on the valve slide 12. Thus pistons 15, yoke 17, and valve slide 12 become a piston assembly.

The valve seat unit 19 may be a casting or it may be moulded from an alloy mixture of powdered metals, such as a mixture of powdered iron and powdered copper, pressure moulded and sintered in a high temperature furnace having a reducing atmosphere. It is constructed with three depending annular collars 20 spaced to fit three similarly spaced holes 21 in the housing 16, and is assembled into the housing with collars 20 protruding a small amount below the outside of housing 16, as shown in Figs. 2 and 3. Collars 20 have their inside diameters sized to fit three connecting tubes 11, 22 and 23.

The valve seat unit 19 may be assembled and joined to the housing 16 and the connecting tubes 11, 22 and 23 by silver soldering in one operation by applying the solder to the portion of annular collars 20 extending through to the outside of housing 16 and flowing the solder to cover the extended portion of collars 20, and making sweat solder joints between the outside of the collars and housing holes 21, and between the inside of the housing collars 20 and the ends of connecting tubes 11, 22 and 23. A special feature of this invention is the

construction which provides for the joining of these five parts in one silver soldering operation.

Either one of two procedures may be used for the sequence of finishing the flat valve seat 14 of valve seat unit 19 and assembling the unit into the housing 16:

(1) The valve seat unit 19 may, in a first operation, be assembled by silver soldering to housing 16 and tubes 11, 22 and 23; and in a second operation have its seat surface 14 finished flat by a broaching operation.

(2) The valve seat unit 19 may, in a first operation, have its seat surface 14 ground flat in a surface grinding machine; and in a second operation it may be assembled by silver soldering to housing 16 and tubes 11, 22 and 23.

Either valve seat unit 19 or valve slide 12 may be made of a moulded powdered metal mixture compressed and sintered. The powder grain sizes should be selected to result in the part having a microscopic sponge-like porosity providing capillary attraction and absorption of lubricating oil customarily used for lubricating refrigeration compressors. The porosity should be open enough to insure oil migration to its seat surface, surface 13 for the valve slide and surface 14 for the valve seat, and tight enough to prevent blow-through of refrigerant gas under the pressure differential range produced by the flow restricting means 5.

Pistons 15 are fit to cylindrical housing 16 with a comparatively loose fit to insure free piston movement within the manufacturing tolerances of housing 16 which may be seamless drawn steel tubing, and the piston as produced on an automatic screw machine. Piston rings 24 are provided to assist in sealing the clearance between the pistons and housing 16. However, as pointed out hereinafter, this sealing is not complete and some leakage around the piston is desirable.

A cylindrical recess 25 in the outer faces of the pistons 15 is provided with a valve disc 26 held against a retaining ring 27 by a coil spring 28. Cylinder heads 29 enclose the ends of cylindrical housing 16 to which they may be silver soldered in assembly. A tubular part 30 having valve seat 31 at its inside end extends through each cylinder head 29 to which it may be assembled by silver soldering, and is located so that each valve seat 31 engages its respective valve disc 26 at each end of the piston assembly stroke. Pistons 15 are spaced apart by yoke 17 so that at the end of each stroke one piston approaches valve seat unit 19 as a stop, while the opposite piston brings its valve disc 26 to engage its valve seat 31, and move the valve disc from its retainer ring 27 by compressing its valve spring 28 so that the valve disc rests freely on its seat.

Tubular parts 30 are closed at their outer ends while their bores are in communication with conduits 7 and 8 respectively.

In the process of reversing the refrigerant flow, the solenoid pilot valve 6 controls the operation of reversing valve 4 in the following manner, well known to the art. When the piston assembly including the D slide valve 12 is in its righthand position as shown in Fig. 2, the solenoid pilot valve 6 provides communication between conduits 8, 9 and 11 to the suction side of compressor 3, and closes communication between conduits 7 and 9. When the righthand piston 15 is in its extreme righthand position, its valve disc 26 closes communication to conduit 8 by its seating on valve seat 31. Conduit 10 in communication with the high pressure side of compressor 3 conducts high pressure refrigerant vapor into housing 16 between pistons 15. This vapor pressure leaks past piston rings 24 into cylinder head chambers 32 to equalize the pressure on both sides of both pistons 15. This restrained pressure equalization is essential to the functioning of the reversing valve. Therefore the seamless steel tubing as it comes from the tube mill is suitable for housings 16 without internal machining. The normal out-of-round mill tolerance will provide the required pressure leak past piston rings 24.

When the piston assembly and valve slide 12 is in the position shown in Fig. 2, communication is established between outdoor heat exchanger 2 and the suction side of compressor 3; indoor heat exchanger 1 is in communication with the high pressure side of compressor 3; and the system is in the heating cycle.

When the system is to be reversed, solenoid pilot valve 6 is energized to establish communication between conduits 7, 9 and 11 to the suction side of compressor 3. The pressure in lefthand cylinder head chamber 32 is quickly reduced to the compressor suction pressure, and the high pressure in righthand cylinder head chamber 32 expands to move the piston assembly and valve slide 12 to the lefthand end of its stroke where the valve disc 26 of lefthand piston 15 meets its seat 31 to close it. During the movement of the piston assembly from right to left, the pressure leakage past piston ring 24 of the righthand piston assists and accelerates the movement. Thus leakage past the piston rings is desirable.

When the piston assembly and slide valve 12 are in the lefthand position opposite the position shown in Fig. 2, then communication is established between indoor heat exchanger 1 and the suction side of compressor 3; outdoor heat exchanger 2 is in communication with the high pressure side of compressor 3; and the system is in the cooling cycle.

The closing of the conduits 7 and 8 by the valve discs 26 at the end of the left and righthand strokes respectively of the piston assembly prevents the compressed refrigerant that might otherwise leak past one or the other of the pistons, depending upon the left or righthand position of the piston assembly, from passing through the then open passageway of the pilot valve 6 to the suction side of the compressor which would thereby by-pass the heat exchangers.

In small sizes it may be desirable to produce valve seat unit 19 of moulded sintered metal powders, while in larger sizes it may be more practical to make the valve seat of heat treated cast iron, and the valve slide 12 of moulded sintered metal powders. In any size the structure of this invention may be assembled of parts with a minimum of machining having customary dimensional tolerances of high quantity production in all operations. The only accuracy required is the flatness and finish of the seating face 13 of slide valve 12, and the valve seat 14 of valve seat unit 19. Both of these parts may be surface ground and lapped to the required flatness and finish in high production machines. It is not required that a dimensional tolerance be kept in these finishing operations.

If it is desired to finish the flat valve seat 14 of the valve seat unit 19 in a broaching operation, then this should be done after the silver soldering operation wherein the housing 16, valve seat unit 19, and the three connecting tubes 11, 22 and 23 are assembled.

The piston and valve slide assembly will accept normal tube mill tolerances for cold rolled mechanical seamless steel tubing. The distortions in cylindrical housing 16 which may be caused by the heat of the silver soldering operation can be tolerated because they will not restrict the free movement of the piston assembly. If the housing is slightly bent, the bend will not cause the piston assembly to bind or stick. All the components of the structure of this invention may be made in high production and assembled quickly with assurance of proper functioning after a minimum of inspection.

While the invention has been shown and described in but a single preferred embodiment, it will be apparent that numerous modifications can be made therein without departing from the spirit or essential attributes thereof, and it is desired therefore that only such limitations be placed thereon as are imposed by the appended claims.

What is claimed is:

1. A refrigerant flow reversing valve for use in a

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refrigeration system comprising a cylindrical housing, a valve seat unit inside said housing having three ports and three individually associated annular collars in communication with respective ones of said ports, a reversing valve connecting tube ending inside each of said collars, said annular collars extending through the wall of said housing and being attached thereto and to said connecting tubes with solder, a D valve slide seating on said valve seat unit and arranged to selectively connect each outside port with the center port, and piston means operable by the pressures within said cylindrical housing for selectively positioning said D valve slide.

2. A refrigerant flow reversing valve for use in a refrigeration system comprising a cylindrical housing, a valve seat unit made of sintered powdered metal inside said housing having three ports and three individually associated annular collars in communication with respective ones of said ports, said sintered powdered metal having a porosity suitable to permit oil migration therethrough to the seat surface and to prevent blow-through of the refrigerant gas used in the system, a reversing valve connecting tube ending inside each of said collars, said annular collars extending through the wall of said housing and being attached thereto and to said connecting tubes with solder, a D valve slide seating on said valve seat unit and arranged to selectively connect each outside port with the center port, and piston means operable by the pressures within said cylindrical housing for selectively positioning said D valve slide.

3. A refrigerant flow reversing valve for use in a refrigeration system comprising a cylindrical housing, a valve seat unit inside said housing having three ports and three individually associated annular collars in communication with respective ones of said ports, a reversing valve connecting tube ending inside each of said collars, said annular collars extending through the wall of said hous-

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ing and being attached thereto and to said connecting tubes with solder, a D valve slide made of sintered powdered metal seating on said valve seat unit and arranged to selectively connect each outside port with the center port, said sintered powdered metal having a porosity suitable to permit oil migration therethrough to the seat surface and to prevent blow-through of the refrigerant gas used in the system, and piston means operable by the pressures within said cylindrical housing for selectively positioning said D valve slide.

4. A refrigerant flow reversing valve for use in a refrigeration system comprising a cylindrical housing, a valve seat unit inside said housing having three ports and three individually associated annular collars in communication with respective ones of said ports, a reversing valve connecting tube ending inside each of said collars, said annular collars extending through the wall of said housing and being attached thereto and to said connecting tubes with solder, a D valve slide seating on said valve seat unit and arranged to selectively connect each outside port with the center port, and piston means operable by the pressures within said cylindrical housing for selectively positioning said D valve slide, said piston means including two pistons fitting said cylindrical housing with one of each side of said D valve slide connected together with a yoke engaging the valve slide.

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