Feb. 26, 1957 F. J. MARTIN 2,782,610

VALVE CONSTRUCTION FOR REVERSE CYCLE SYSTEM

Filed Jan. 24, 1955

Fig. 1.

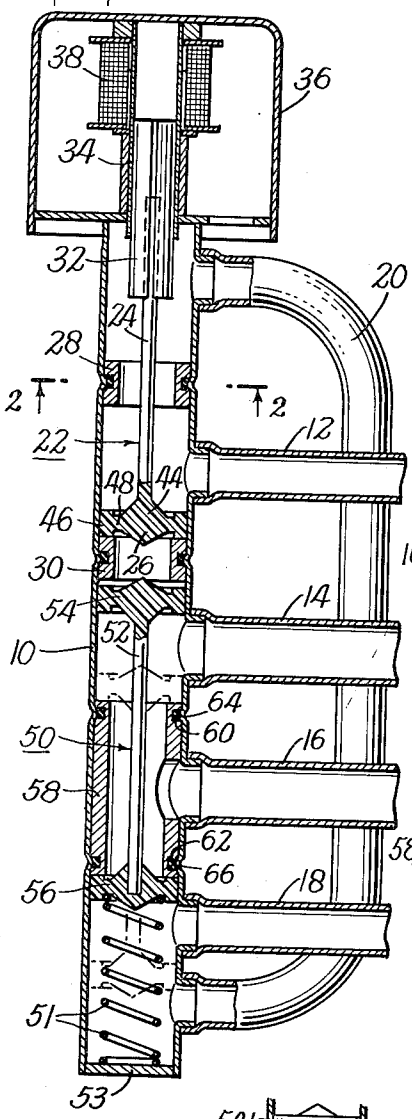


Fig. 2.

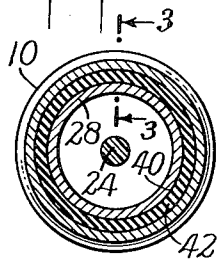


Fig. 3.

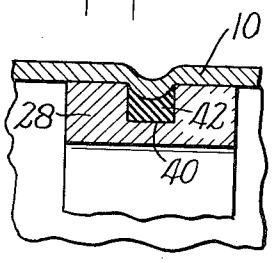


Fig. 4.

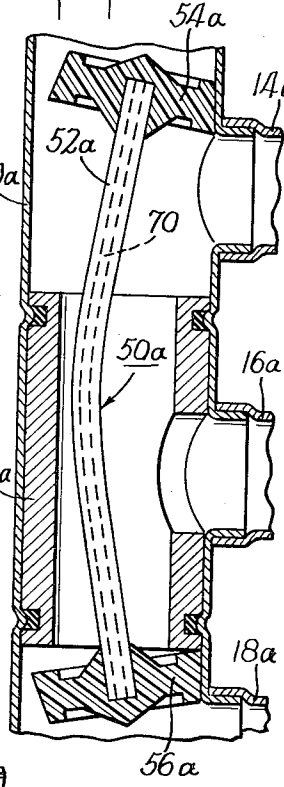


Fig. 5.

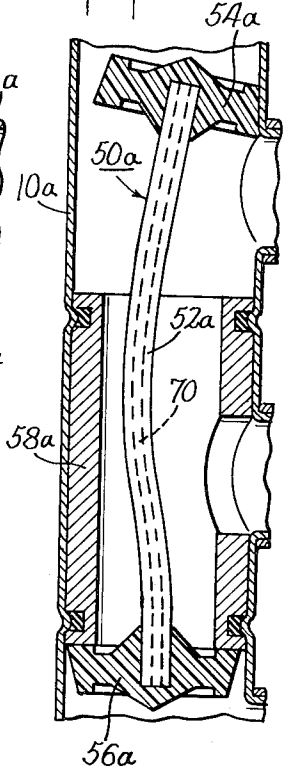
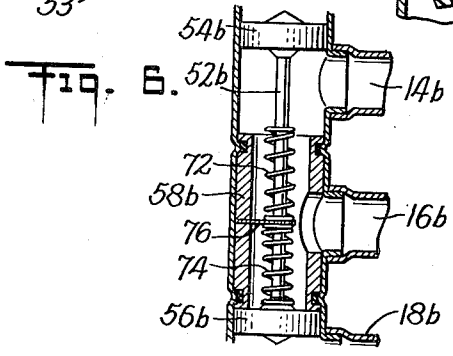


Fig. 6.



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VALVE CONSTRUCTION FOR REVERSE CYCLE SYSTEM

Frank J. Martin, Miami, Fla., assignor to Seal-O-Matic, Inc., Coral Gables, Fla., a corporation of Florida

Application January 24, 1955, Serial No. 483,537

17 Claims. (Cl. 62—115)

This invention relates to valves for controlling the flow of fluid, and more particularly to a valve construction that is especially adapted for use in reversing the flow of refrigerant in a combined heating and cooling system. With respect to certain features, the invention described herein is an improvement over the valve construction disclosed and claimed in the copending application of Frank J. Martin, Serial Number 382,615 and filed on September 28, 1953.

For many years now there has been a continual growth in the use of air-conditioning apparatus for cooling the air spaces of homes, office-buildings, etc., particularly in those regions having a hot climate. Such apparatus has been both of the individual room type, which is commonly mounted adjacent a window opening, and of the central-system type including ducts for carrying the cooled air from a central refrigerating plant to a number of rooms. With either type, however, the refrigeration system typically comprises a closed circuit including a compressor and two series-connected coils. The high pressure fluid delivered by the compressor first enters a condenser coil, where it is condensed into liquid form to give off heat, then passes through a line restrictor to an evaporator coil, where the liquid is evaporated to absorb heat and cool the surrounding spaces, and finally returns from the evaporator coil back to the low pressure side of the compressor to repeat the cycle.

It has been known for some time that such air-conditioning systems may be operated interchangeably as cooling units or heating units, depending upon the direction of refrigerant fluid flow through the two series-connected coils. For example, many room air-conditioners, particularly those sold for use in regions where houses are often not equipped with central heating equipment, have been provided with externally-controllable valve arrangements for reversing the direction of refrigerant flow, so that during the cooler seasons the air-conditioner may be operated as an auxiliary heating unit.

The valve arrangements previously used for this purpose, however, have been unsatisfactory in many respects. For example, whether manually-operated or power-driven, they typically have been complex and cumbersome, and have been costly to produce particularly because of the need for precision manufacturing techniques. Consequently, the overall cost of air-conditioning apparatus utilizing such reversing valve constructions has been so high as to unduly restrict commercial acceptance of the combined heating and cooling units.

Also, for those reversing valves which use the pressure of the refrigerant to aid in holding a movable valve body against a corresponding valve seat, the relatively large pressure differentials existing in the typical air-conditioning system (e. g. 200 to 250 p. s. i.) during operation has made it impractical to reverse the valve without first de-energizing the compressor and waiting an excessively long time until the system pressures have become equalized. That is, the pressure holding the valve against its seat when the compressor is operating is too great to be overcome by the usual valve-operating arrangements, whether manually controlled or power-driven. Thus, it has been necessary to first turn off the compressor to permit the system pressures to equalize before shifting the valve. However, the system pressures typically do not equalize sufficiently to permit operation of the valve until at least three or four minutes after the compressor has been turned off, and this long waiting period between turning off the compressor and reversing the valve has in the past represented a serious commercial problem.

Additionally, with valves having an elongated casing and a valve body movable therein, there has been a long standing problem of securing and sealing the required valve seats in their proper position within the casing, i. e. in a "blind" location. Various attempts have been made in the past to solve this problem, but none of these has provided a valve construction of the requisite simplicity and low cost.

Accordingly, it is an object of the present invention to provide valve arrangements that are superior to those used heretofore. It is a further object of this invention to provide a reversing valve that is reliable in operation, rugged, and inexpensive to manufacture.

In a preferred embodiment of the invention, to be described hereinbelow in more detail, a reversing valve assembly is provided in which all of the movable valve elements are contained within an integral elongated casing, formed of readily available copper tube stock, and the side wall of which is arranged with a series of openings for connection to the fluid-carrying conduits leading to the compressor and to the evaporator and condenser coils. Internally, the valve includes a master valve body which is controlled by a magnetic solenoid for movement into either of two alternate positions to engage one or the other of a first pair of valve seats, and a slave valve body which is movable into either one of two alternate positions by the system pressure, in accordance with the selected positioning of the master valve body, to engage one or the other of a second pair of valve seats. When the master valve body has been moved to one of its two positions, the system pressure forces the slave valve body to a corresponding position, and the passages within the valve are thereby arranged to deliver fluid from the compressor through the series-connected coils in a given direction. However, when the master valve body is moved to its other position, the system pressure correspondingly moves the slave valve body to its other position, and the internal valve passages are thereby rearranged to deliver fluid from the compressor through the coils in a reverse direction.

The valve seats engaged by the two movable valve bodies are held securely in position and sealed to prevent the passage of gases or fluids by a novel crimping arrangement to be described. In addition, the slave valve body is arranged so as to produce a small spring-back torque tending to tip the valve head away from its seat, to "break" the system pressure shortly after the compressor has been turned off and thus permit a rapid equalization of the pressures within the valve.

Other objects, aspects and advantages of the present invention will be pointed out in, or apparent from, the following description considered together with the accompanying drawings, in which:

Figure 1 is a vertical section of a reversing valve adapted for use with a reverse-cycle heating and cooling system;

Figure 2 is a sectional view along line 2—2 of Figure 1, particularly showing the manner in which the blind valve seats are sealed in place;

Figure 3 is an enlarged detail view taken along line 3—3 of Figure 2;

Figure 4 shows a slave valve body having a slightly bent shaft;

Figure 5 shows the valve body of Figure 4 with one valve head pressed against a corresponding seat; and

Figure 6 shows one head of a slave valve provided with a separate spring-back arrangement.

Referring now to Figure 1, the movable valve elements are all enclosed within an elongated cylindrical casing **10** formed, in the preferred embodiment, of hard drawn copper tube. This casing is provided with six spaced-apart openings arranged in a line along one side. The middle four openings communicate, respectively, with four parallel conduits **12**, **14**, **16** and **18** leading to other portions of the system (not shown) to be controlled by the valve operation. The two openings at extreme opposite ends of the casing are connected together by a curved tube **20** which passes beneath the four conduits. When the valve is used as part of a reverse-cycle, heating and cooling system (such as described in the above-mentioned copending application), the upper conduit **12** is connected to the high-pressure outlet of the fluid compressor, the next lower conduit **14** is connected to the evaporator coil, the next lower conduit **16** is connected to the low-pressure compressor inlet, and the lowest conduit **18** is connected to the condenser coil.

The openings in the casing **10** may readily be formed by first placing tube stock in a suitable die having, for example, properly dimensioned depressions opposite the places where the openings are to be made, and then forcing fluid under pressure into the interior of the casing to bulge the tube wall outwards into the die depressions. The tips of the bulges may then be removed to leave circular rims around which the conduits and the tube may be positioned and brazed or soldered securely into place. In the embodiment shown herein, the casing **10** has an outer diameter of ¾". The upper and lower conduits **12** and **18** have an outer diameter of ⅜", while the inner conduits **14** and **16** have an outer diameter of ½".

Positioned within an upper portion of the casing **10** is a valve body, generally indicated at **22**, and including a valve shaft **24** and a valve head **26** at the lower end thereof. The valve shaft and head are formed of nylon, and preferably are cast as an integral unit. The valve body **22** is arranged for sliding movement within the casing **10**, and the valve head **26** is alternately engageable with either one of a pair of opposing valve seats **28** and **30**.

The upper end of the valve shaft **24** is frictionally secured within the longitudinal bore of a cylindrical core **32** formed of magnetic material. This core **32** is slidable within a non-magnetic sleeve **34** centrally mounted within a solenoid casing **36**. Surrounding the sleeve **34** and within the housing **36** is a coil **38** which is adapted to be connected to the usual 110 volt, 60 C. P. S. power line through an on-off control switch (not shown). When the coil is energized, the resulting magnetic flux in the interior of the coil pulls the core **32** up in the usual manner, and forces the valve head **26** against the sealing surfaces of the upper valve seat **28**. When the valve is mounted vertically (as shown), deenergization of the coil **38** permits the core **32** to drop down under the force of gravity to bring the valve head **26** into engagement with the lower valve seat **30**. If the valve is to be mounted in other than a vertical position, other known means may be used to positively force the valve head against the lower seat; for example, an additional solenoid coil may be employed for this purpose.

Experience has shown that the core in the typical commercially available solenoids tend to vibrate excessively, under the influence of the rapidly alternating flux, and to produce undesirable noise as it vibrates. It has been found that this difficulty may be eliminated by sheathing the core with a nylon tube (not shown) of sufficient thickness that the natural resilience of the nylon absorbs the impact shock of the core as it vibrates within the solenoid. To firmly secure such a tube in place, it may

for example first be soaked in water, then slipped over the core and allowed to dry; as the moisture evaporates, the nylon will shrink down onto the core in a tight gripping engagement.

The valve seats **28** and **30** are annular-shaped and formed of brass. As shown more clearly in Figures 2 and 3, these seats are provided with a groove **40**, extending around the outer periphery of each seat, and in which is positioned a flat ring **42** formed of a resilient material such as rubber. The side wall of the casing **10** is displaced inwardly adjacent the groove **40**, so that the wall penetrates the flat ring **42** circumferentially around the valve seat. This serves to seal the valve seat against the casing wall, and also to hold the valve seat firmly in its proper position.

Such valve seats can, in general, be formed of any metal, plastic or composition material by turning, molding, forging or die casting as desired. In the preferred embodiment, these seats have an outside diameter of 0.66", an inside diameter of 1$\frac{3}{32}$", a groove depth of 0.085" and a groove with of 0.082".

One special advantage of such a valve seat construction is economy in production costs. Thus, the seats may very simply be placed in their blind locations by pushing them into the valve casing with a tool of predetermined length, and, after the seats are so positioned, the casing wall may be crimped inwardly for example by a pair of rolling wheels or by a forming die operated by an air vise. The resilient material in the groove may, to meet certain specific valve requirements, be formed of a relatively soft metal or plastic composition adapted to provide, in combination with the inwardly displaced casing wall, a positive seal against the passage of gases or fluids between the valve seat and the inner wall of the casing.

It has been found especially advantageous to form the valve bodies of nylon. For example, such valve bodies are highly resistant to the chemical action of corrosive fluids, thus giving a long, trouble-free operational life, and provide a particularly tight seal when pressed against the valve seat. In addition, such valve bodies produce essentially no noise when they are shifted from one position to the other, and are inexpensive to manufacture since they may readily be formed in a simple die-casting operation.

The configuration of the valve head **26**, as shown in Figure 1, has also been found to be especially desirable for efficient valve operation. The relatively thick conical portion **44** in the central region and the raised portion **46** in the peripheral region, provide structural strength where such strength is particularly needed. The remaining portion **48** of the head is relatively thin to provide flexibility and a desirable cushioning effect when the head strikes the valve seat.

A second or slave valve body, generally indicated at **50**, comprising a nylon shaft **52** having at each end a nylon valve head **54** and **56**, is positioned in the lower region of the casing **10** and is arranged for sliding movement therein. An elongated valve seat **58** having outwardly facing seating surfaces at opposite ends thereof is secured within the casing, between the valve heads **54** and **56**, by a crimping arrangement similar to that described above. For this purpose, the valve seat **58** is provided with a pair of annular grooves **60** and **62**, one at each end of the seat, and in each of which is positioned a rubber flat ring **64** and **66**. The casing wall is displaced inwardly adjacent each of these grooves **60** and **62** to penetrate the corresponding flat ring, and to firmly grip and seal the valve seat **58** in place.

In this embodiment, the nylon valve shaft **52** and upper valve head **54** are cast as an integral unit. The lower valve head **56** is formed with a central bore, perpendicular to its seating surfaces, having a diameter to form a tight press fit with the valve shaft **52**. Preferably, the end of the valve shaft **52** is coated with a substance ad-

hesive to nylon before being pressed into the bore of the valve head **56**, so that when the adhesive hardens the head will tightly grip the shaft.

A small coil spring **51** (e. g. having a force of about 6 ounces) is positioned between the valve head **56** and the lower end plug **53** of the casing **10**, to apply an upward force against the valve body **50**. This spring serves to prevent any oscillations of the valve bodies, for example such as might be due to small leakage past one of the valve bodies that has not been fully closed at the time high pressure fluid is initially introduced into the valve assembly.

When the valve assembly is connected as part of a reverse-cycle heating and cooling system, such as described in the above-mentioned copending application, the operation is generally as follows: Considering first the cooling cycle, the solenoid coil **38** will be deenergized, and the valve body **22** will be in its lower position with its valve head **26** engaging the lower valve seat **30** (as shown in Figure 1). Fluid at a relatively high pressure from the refrigerant compressor enters the casing **10** through the upper conduit **12**, turns upwardly in the casing, and passes into the curved connecting tube **20** through which it travels to the lower end of the casing. The pressure of this fluid forces the lower valve body **50** upwards against the valve seat **58**, thus closing off the passage into the lower valve chamber. With that passage blocked, the fluid is forced to pass out of the casing **10** through the lower conduit **18** to the condenser and the evaporator coil, from which the fluid (now at a lower pressure) reenters the casing **10** through the conduit **14**.

Since the valve head **26** prevents this low pressure fluid from flowing upwards in the casing **10** into the upper valve chamber, the fluid turns downwardly and enters the lower valve chamber, from which it again leaves the casing **10** through the conduit **16** to return to the inlet side of the compressor. It may be noted that both the upper valve body **22** and the lower valve body **50** are forced against their corresponding seats by the relatively high pressure fluid delivered by the compressor. The fluid pressure tending to unseat these valve bodies is at a lower pressure, since it has passed through the condenser and evaporator coils.

When the valve assembly is to be shifted to its "heat" position, the solenoid coil **38** is energized, and the upper valve body **22** is moved up to seating engagement with its upper valve seat **28**. Thus, the high pressure fluid from the compressor entering the casing **10** through the conduit **12** turns downwardly, and passes through the lower valve seat **30** to force the lower valve body **50** to its lowermost position in sealing engagement with the valve seat **58**. The high pressure fluid consequently flows out of the casing **10** through the conduit **14**, from which it passes through the evaporator and the condenser coil, and reenters the casing through the lower conduit **18**. Since flow through the connecting tube **20** and into the upper valve chamber is blocked off by the upper valve body **22**, the low pressure fluid from the condenser coil turns upwardly in the casing and passes into the lower valve chamber, from which it flows through the conduit **16** back to the inlet side of the compressor. Again, it may be noted that both valve bodies are seated against their corresponding valve seats by the high pressure fluid from the compressor.

In a typical refrigeration system, the fluid delivered by the compressor might be under a pressure of about 300 p. s. i., while the fluid at the return side of the compressor might have a pressure of approximately 75 p. s. i. Thus, if it is desired to switch the reversing valve from its cooling to its heating position while the system is in operation, it would be necessary to move the upper valve body **22** against a pressure differential of some 225 p. s. i. holding it against its lower valve seat **30**. Since this pressure differential is too great to be overcome by ordinary mechanical or electrical means, the practice has been to turn off the compressor when it is desired to switch from cooling to heating and wait until the system pressures have become effectively equalized (typically at approximately 130–160 p. s. i.) before shifting the valve. However, the disadvantage with such an arrangement is that it commonly is necessary to wait three or four minutes before the system pressures have become sufficiently equalized to shift the valve.

It has been found that this difficulty may be alleviated by special construction of the slave valve designed to "break" the system pressure before it has become fully equalized. Referring now to Figure 4, a slave valve body **50*a*** is provided similar in most respects to the slave valve body **50** described above. However, the valve shaft **52*a*** comprises a hollow tube of nylon in which is inserted a metal rod **70** extending the full length of the shaft. This metal rod, which may for example be formed of spring steel, is given a slight permanent bend (e. g. 6 degrees, but shown exaggerated in the drawing) approximately midway between its ends. Thus, the valve heads **54*a*** and **56*a*** are tipped at a slight angle with respect to the sealing surfaces of the valve seat **58*a*** when the valve body is allowed to assume its free space position within the valve casing **10*a***. The side walls of the two valve heads **54*a*** and **56*a*** are tapered, at approximately 12½ degrees, to permit the heads to tip without interference from the inner wall of the valve casing.

Figure 5 shows the valve body **50*a*** with one of its heads **56*a*** forced against the valve seat **58*a*** by the system pressure, as when the reversing valve is set for operating an air-conditioning system in its cooling cycle. It can be seen that, by forcing the head **56*a*** into alignment with the end surfaces of the valve seat **58*a***, a torque is applied to the bent rod **70** tending to swing it laterally within the casing **10*a***. However, since the valve head **54*a*** at the other end of the shaft is constrained by the inner wall of the valve casing, this torque effects essentially only a partial straightening of the rod **70**, and the rod, because of its natural springiness, resists this straightening and consequently applies a countertorque to the valve head **56*a***.

When it is desired to switch the air-conditioning system to its "heating" cycle, the compressor is turned off and the pressure differential between opposite sides of the valve head **56*a*** rapidly decreases to a value such that the countertorque produced by the bent rod **70** is sufficient to crack the valve head slightly away from the seating surfaces. When the head has been tipped sufficiently to create a small opening, the higher pressure fluid quickly flows through to the low pressure side and the pressures within all spaces of the valve are almost instantaneously equalized. When equalization has thus been obtained, the upper valve body **22** (referring now to Figure 1) is free to be moved by the solenoid to its other position to start the heating cycle.

It has been found that the arrangement described immediately above is capable of "breaking" the system pressure when the pressure differential across the valve head has been reduced to approximately 10 to 15 p. s. i., a condition which, in the typical air-conditioning system, occurs relatively soon after the compressor has been turned off.

Somewhat the same effect can be achieved by canting one of the slave valve heads at a slight angle, e. g. 12½ degrees, with respect to the valve shaft, and omitting the metal rod.

A different arrangement for achieving a spring-back force, and having certain practical advantages, is shown in Figure 6. In this construction, two loosely fitting coil springs **72** and **74** are positioned around the valve shaft **52*b***. Also surrounding this valve shaft, and between the coil springs, is a thin metal stop plate **76**, the left hand edge of which extends into a transverse slot in the wall of the valve seat **58*b***, midway between the ends of the seat, where it is firmly held in place. The

stop plate **76** is apertured to permit the valve shaft **52***b* to pass freely therethrough; this aperture, however, is smaller than the diameter of the coil springs **72** and **74** so that these springs, when compressed, bear against the stop plate. The length of each of the coil springs is slightly greater than the distance between the stop plate **76** and the corresponding end of the valve seat. Consequently, each of the valve heads **54***b* and **56***b* will compress the corresponding spring **72** and **74** a moderate amount when the head is pressed against the sealing surface of the valve seat **58***b* by the system pressure, and the compressed spring accordingly will apply a counterforce to such valve head (e. g. head **56***b* as shown in Figure 6) tending to unseat it. When, after the fluid compressor has been turned off, the pressure differential across the seated valve head has dropped to a sufficiently low value, the valve cracks open slightly due to the counterforce of the compressed spring, and the system pressures rapidly equalize as described before.

It has been found especially desirable to use such a spring-back arrangement on the lower valve body (i. e. the "slave" valve) rather than on the upper valve body (i. e. the "master" valve). The valve operation is thereby made highly reliable, and malfunctioning is virtually eliminated.

Although specific preferred embodiments of the invention have been set forth in detail, it is desired to emphasize that these are not intended to be exhaustive or necessarily limitative; on the contrary, the showing herein is for the purpose of illustrating one form of the invention and thus to enable others skilled in the art to adapt the invention in such ways as to meet the requirements of particular applications, it being understood that various modifications may be made without departing from the scope of the invention as limited by the prior art.

I claim:

1. A reversing valve assembly comprising, in combination, an integral tubular member having a plurality of openings in the side wall thereof through which fluid may enter or leave said member, two of said openings being adapted for connection to the outlet and inlet respectively, of a source of fluid pressure, two other of said openings being adapted for connection to a load element, a first valve body including a valve head slidable within said member, a first pair of valve seats secured within said member and associated with said first valve body, control means for moving said first valve body to either of two positions to engage one or the other of said pair of valve seats, a second valve body slidable within said member, a second pair of valve seats secured within said member, said second valve body being movable to either one of two positions by fluid pressures within said member in accordance with the selected positioning of said first valve body, to engage one or the other of said second pair of valve seats, said openings being arranged with respect to said valve bodies and seats so that when said valve bodies are moved from one of their corresponding positions to the other of their corresponding positions, the direction of fluid flow through said load element is reversed.

2. Reversing valve structure comprising, in combination, an elongated tubular casing having a plurality of openings formed in the side wall thereof, two of said openings being adapted for connection to the outlet and inlet, respectively, of a source of fluid pressure, two other of said openings being adapted for connection to a load element through which it is desired to pass fluid under pressure alternately in opposite directions, a first valve body slidable longitudinally within said casing, a first pair of valve seats secured within said casing and associated with said first valve body, control means operable externally of said casing to position said first valve body selectively in seating engagement with one or the other of said first pair of valve seats to control the direction of fluid flow through a portion of said casing, a second valve body slidable longitudinally within said casing, a second pair of valve seats secured within said casing and associated with said second valve body, said second valve body being movable to either of two positions by fluid pressures within said casing in accordance with the selected positioning of said first valve body to engage one or the other of said second pair of valve seats, said valve bodies and associated seats being arranged with respect to said openings such that a reversal in positioning of said valve bodies produces a corresponding reversal in direction of flow from said source of fluid pressure through said load element.

3. A reversing valve structure comprising, in combination, an integral tubular member having a plurality of spaced-apart openings arranged in a straight line along the side wall thereof and through which fluid may enter or leave said member, a first pair of said openings being adapted for connection to the outlet and inlet respectively, of a source of fluid pressure, a second pair of said openings being adapted for connection to a load element, a first valve body including a valve head slidable within said member, a first pair of valve seats secured within said member and associated with said first valve body, a solenoid having a core connected to said first valve body for moving said first valve body to either of two positions to engage one or the other of said pair of valve seats, a second valve body slidable within said member, a second pair of valve seats secured within said member and associated with said second valve body, said second valve body being movable to either of two positions by fluid pressures within said member in accordance with the selected positioning of said first valve body to engage one or the other of said second pair of valve seats, said openings being arranged with respect to said valve bodies and seats such that when said valve bodies are moved from one of their corresponding positions to the other of their corresponding positions, the direction of fluid flow through said load element is reversed.

4. A reversing valve assembly comprising, in combination, an integral tubular member having a plurality of openings in the side wall thereof through which fluid may enter or leave said member, two of said openings being adapted for connection to the outlet and inlet respectively, of a source of fluid pressure, two other of said openings being adapted for connection to the input and output, respectively, of a load element, a first valve body including a valve head slidable longitudinally within said member, a first pair of valve seats within said member and associated with said first valve body, control means for moving said first valve body to either of two positions to engage one or the other of said pair of valve seats, a second valve body slidable longitudinally within said member, the axis of motion of said second valve body being in line with the axis of motion of said first valve body, a second pair of valve seats within said member, said second valve body being movable to either of two positions by fluid pressures within said member in accordance with the selected positioning of said first valve body to engage one or the other of said second pair of valve seats, said openings being arranged with respect to said valve bodies and seats such that when said valve bodies are moved from one of their corresponding positions to the other of their corresponding positions, the direction of fluid flow through said load element is reversed.

5. A reversing valve assembly comprising, in combination, an elongated casing having a plurality of openings formed in the side wall thereof, two of said openings being adapted for connection to the outlet and inlet, respectively, of a source of fluid pressure, two other of said openings being adapted for connection to a load element through which it is desired to pass fluid under pressure alternately in opposite directions, a first valve body slidable longitudinally within said casing, a first pair of valve seats secured within said casing and associated with said

first valve body, control means operable externally of said casing to position said first valve body selectively in seating engagement with one or the other of said first pair of valve seats to control the direction of fluid flow through a portion of said casing, a second valve body slidable longitudinally within said casing, said first and second valve bodies having valve heads formed of nylon and being movable on a common axis, a second pair of valve seats secured within said casing and associated with said second valve body, and means to apply fluid pressure within said casing to said second valve body in such a way that said second valve body is moved in accordance with the selected positioning of said first valve body into seating engagement with one or the other of said second pair of valve seats, said valve bodies and associated seats being arranged with respect to said openings such that a reversal in positioning of said valve bodies produces a corresponding reversal in direction of flow from said source of fluid pressure through said load element.

6. A reversing valve assembly comprising, in combination, an elongated tubular casing having a plurality of openings formed in the side wall thereof, two of said openings being adapted for connection to the outlet and inlet, respectively, of a source of fluid pressure, two other of said openings being adapted for connection to a load element through which it is desired to pass fluid under pressure alternately in opposite directions, a first valve body slidable longitudinally within said casing, a first pair of valve seats secured within said casing and associated with said first valve body, control means operable externally of said casing to position said first valve body selectively in seating engagement with one or the other of said first pair of valve seats to control the direction of fluid flow through a portion of said casing, a second valve body slidable longitudinally within said casing, a second pair of valve seats secured within said casing and associated with said second valve body, at least one of said pairs of valve seats being formed with a depression around the periphery thereof, a mass of resilient material positioned in said depression, the side wall of said casing being displaced inwardly adjacent said depression to engage said resilient material and seal said one valve seat firmly in position, said second valve body being movable to either of two positions by fluid pressures within said casing in accordance with the selected positioning of said first valve body to engage one or the other of said second pair of valve seats, said valve bodies and associated seats being arranged with respect to said openings such that a reversal in positioning of said valve bodies produces a corresponding reversal in direction of flow from said source of fluid pressure through said load element.

7. A reversing valve assembly comprising, in combination, an integral tubular member having a plurality of openings in the side wall thereof through which fluid may enter or leave said member, two of said openings being adapted for connection to the outlet and inlet respectively, of a source of fluid pressure, two other of said openings being adapted for connection to the input and output, respectively, of a load element, a first valve body including a valve head slidable within said member, a first pair of valve seats secured within said member and associated with said first valve body, control means for moving said first valve body to either of two positions to engage one or the other of said pair of valve seats, a second valve body slidable within said member, a second pair of valve seats secured within said member, said second valve body being movable to either of two positions by fluid pressures within said member to engage one or the other of said second pair of valve seats in accordance with the selected positioning of said first valve body, and spring means urging said second valve body into engagement with one of said second pair of valve seats to minimize the possibility of oscillation of said valve bodies, said openings being arranged with respect to said valve bodies and seats such that, when said valve bodies are moved from one of their corresponding positions to the other of their corresponding positions, the direction of fluid flow through said load element is reversed.

8. A reversing valve assembly comprising, in combination, an elongated tubular casing having a plurality of openings formed in the side wall thereof, two of said openings being adapted for connection to the outlet and inlet, respectively, of a source of fluid pressure, two other of said openings being adapted for connection to a load element through which it is desired to pass fluid under pressure alternately in opposite directions, a first valve body having a valve head at one end thereof and slidable longitudinally within said casing, first and second opposing valve seats secured within said casing and positioned on opposite sides of the valve head on said first valve body, control means operable externally of said casing to position said first valve body selectively in seating engagement with one or the other of said first pair of valve seats to control the direction of fluid flow through a portion of said casing, a second valve body slidable longitudinally within said casing and including a valve shaft having a valve head on each end thereof, a third valve seat secured within said casing and positioned between the two heads of said second valve body, said third valve seat having sealing surfaces at each end thereof engageable, respectively, with said two valve heads, and means to apply fluid pressure within said casing to said second valve body in such a way that said one or the other of said two valve heads is moved into seating engagement with one or the other of said two sealing surfaces in accordance with the selected positioning of said first valve body, said valve bodies and associated seats being arranged with respect to said openings such that a reversal in positioning of said valve bodies produces a corresponding reversal in direction of flow from said source of fluid pressure through said load element.

9. A valve structure comprising, in combination, an elongated tubular member for carrying fluid, the side wall of said member being sufficiently thin to permit pressure deformation thereof, a valve seat positioned within the interior of said tubular member in a blind location remote from the ends of said member, said valve seat being formed with a groove extending around the outer periphery thereof adjacent the inner wall of said tubular member, and a mass of resilient material positioned in said groove, the wall of said tubular member being displaced inwardly adjacent said groove so that a portion of the wall extends into and makes intimate contact with said resilient material, whereby said valve seat is tightly sealed and firmly held in position within said tubular member.

10. A valve structure comprising, in combination, an elongated tubular portion for carrying fluid, said portion having a side wall that is sufficiently thin to permit pressure deformation thereof, at least one valve seat positioned within the interior of said tubular portion in a blind location remote from the ends of said portion, said valve seat being formed with a groove extending around the outer periphery of said seat adjacent the inner wall of said tubular portion, and a resilient ring positioned in said groove, the wall of said tubular portion being displaced inwardly adjacent said groove to form an annular depression extending into and making intimate contact with said resilient ring, whereby said valve seat is tightly sealed and firmly held in position within said tubular portion.

11. A valve structure comprising, in combination, an elongated tubular fluid-carrying casing, the wall of said casing being adapted to accommodate pressure deformation thereof, a valve seat positioned within the interior of said casing in a blind location remote from the ends of said casing, said valve seat being formed with a groove extending around the outer periphery thereof in a plane parallel to a sealing surface of said seat and adjacent the inner wall of said casing, and a mass of resilient material positioned in said groove, the wall of said casing being displaced inwardly adjacent said groove so that a portion

of the wall extends into and makes intimate contact with said resilient material, whereby said valve seat is tightly sealed and firmly held in position within said casing.

12. A valve structure comprising, in combination, an elongated cylindrical casing for carrying fluid, the wall of said casing being adapted to accommodate pressure deformation thereof, at least one valve seat positioned within the interior of said casing in a blind location remote from the ends of said casing, said valve seat being formed with a groove extending around the outer periphery thereof in a plane parallel to a sealing surface of said valve seat adjacent the inner wall of said casing, said groove having a rectangular cross-section, and a tight-fitting flat ring formed of rubber positioned in said groove, the wall of said casing being displaced inwardly adjacent said groove so that a portion of the wall extends into and makes intimate contact with said flat ring, whereby said valve seat is tightly sealed and firmly held in position within said casing.

13. Reversing valve structure for use with combined cooling and heating systems comprising, in combination, a first valve body movable within a corresponding valve chamber, a first pair of valve seats selectively engageable by said first valve body, control means for moving said first valve body, a second valve body mechanically independent of said first valve body and movable within a corresponding valve chamber, a second pair of valve seats selectively engageable by said second valve body, a first pair of conduits adapted to be connected respectively to the outlet and inlet of a compressor unit, a second pair of conduits adapted to be connected to a load element, said valve chambers and said conduits being interconnected in such a manner that the system pressure moves said second valve body from engagement with one to the other of said second pair of valve seats when said first valve body is moved by said control means from engagement with one to the other of said first pair of valve seats, said conduits also being arranged with respect to said valve chambers such that the corresponding movement of said valve bodies from one position to the other reverses the direction of fluid flow through said load element, spring means associated with one of said valve bodies and arranged to apply a force to said one valve body to urge said body away from engagement with a corresponding valve seat, said force being sufficient to move the valve body slightly away from its seat shortly after the compressor unit has been cut off so as to permit the system pressures rapidly to equalize, whereby the first valve body may readily be moved by said control means from one position to its other position.

14. Valve structure for use with a reverse-cycle heating-cooling system wherein a compressor delivers fluid under pressure in either direction through an arrangement of coils, comprising, in combination, a master valve body movable within a first valve chamber, control means for moving said master valve body, a first pair of valve seats alternately engageable by said master valve body in accordance with the setting of said control means, a slave valve body movable within a second valve chamber, a second pair of valve seats alternately engageable by said slave valve body, a first pair of conduits each connected to one of said valve chambers and adapted to be connected at their remote ends to the inlet and outlet, respectively, of said compressor, a second pair of conduits associated with said valve chambers and adapted to be connected at their remote ends to respective opposite ends of said arrangement of coils, said conduits being so arranged with respect to said valve chambers that said slave valve body is moved from one to the other of said second pair of valve seats by fluid pressure when said master valve body is moved from one to the other of said first pair of valve seats and the direction of fluid flow through said arrangement of coils correspondingly is reversed, means associated with one of said valve bodies to apply a torque to at least one of its valve heads when said one head is seated against the corresponding valve seat, said torque being applied in a plane perpendicular to the plane of said corresponding valve seat and in such a direction as to tip said one head away from engagement with said corresponding valve seat, whereby when the system pressures within the valve structure have become nearly equalized after cutting off said compressor prior to reversing the cycle, said one head breaks away from its corresponding valve seat to permit the flow of fluid therethrough to rapidly equalize the system pressures so that the master valve body may readily be shifted from one position to the other by said control means.

15. A reversing valve assembly for use with combined cooling and heating systems comprising, in combination, a valve casing, a first valve body movable within said casing, a first pair of valve seats selectively engageable by said first valve body, control means for changing the positioning of said first valve body, a second valve body movable within said casing, a second pair of valve seats selectively engageable by said second valve body, a first pair of openings in said casing adapted to be connected, respectively, to the outlet and inlet of a compressor unit, a second pair of openings in said casing adapted to be connected to a load element, said openings being located with respect to said valve bodies such that the system pressure moves said second valve body to engage one or the other of said second pair of valve seats when said first valve body is moved by said control means from engagement with one to the other of said first pair of valve seats, said openings also being arranged such that the movement of said valve bodies from one position to the other reverses the direction of fluid flow through said load element, spring means associated with one of said valve bodies and arranged to apply a torque to a valve head secured to said one valve body in a plane transverse to the plane of the seating surface of said head, said torque being sufficient to move the valve head slightly away from its corresponding seat shortly after said compressor unit has been de-energized to permit the system pressures rapidly to equalize on opposite sides of the seated valve head, whereby the first valve body may readily be moved by said control means from one position to its other position.

16. A reversing valve assembly for use with combined cooling and heating systems comprising, in combination, a first valve body movable within a corresponding valve chamber, a first pair of valve seats selectively engageable by said first valve body, control means for moving said first valve body, a second valve body mechanically independent of said first valve body and movable within a corresponding valve chamber, a second pair of valve seats selectively engageable by said second valve body, a first pair of conduits adapted to be connected respectively to the outlet and inlet of a compressor unit, a second pair of conduits adapted to be connected to a load element, said valve chambers and said conduits being interconnected in such a manner that the system pressure moves said second valve body from engagement with one to the other of said second pair of valve seats when said first valve body is moved by said control means from engagement with one to the other of said first pair of valve seats, said conduits also being arranged with respect to said valve chambers such that the corresponding movement of said valve bodies from one position to the other reverses the direction of fluid flow through said load element, spring means associated with said second valve body and arranged to apply a force to urge said body away from engagement with a corresponding valve seat, said force being sufficient to move the valve body slightly away from its seat shortly after the compressor unit has been cut off to permit the system pressures rapidly to equalize, whereby the first valve body may readily be moved by said control means from one position to its other position.

17. Reversing valve structure for use with combined cooling and heating systems comprising, in combina-

tion, a first valve body movable within a corresponding valve chamber, a first pair of valve seats selectively engageable by said first valve body, control means for moving said first valve body, a second valve body movable within a corresponding valve chamber, and comprising a valve shaft having a valve head at each end thereof, said valve shaft including a slightly bent metal rod integral therewith, a second pair of valve seats selectively engageable by the heads of said second valve body, a first pair of conduits adapted to be connected respectively to the outlet and inlet of a compressor unit, a second pair of conduits adapted to be connected to a load element, said valve chambers and said conduits being interconnected in such a manner that the system pressure moves said second valve body from engagement with one to the other of said second pair of valve seats when said first valve body is moved by said control means from engagement with one to the other of said first pair of valve seats, said conduits also being arranged with respect to said valve chambers such that the corresponding movement of said valve bodies from one position to the other reverses the direction of fluid flow through said load element, said bent rod being arranged to apply a

torque to one of said valve heads when said one head is pressed against a corresponding valve seat to urge said head away from engagement with said seat, said torque being sufficient to tip the head slightly away from its seat shortly after the compressor unit has been cut off so as to permit the system pressures rapidly to equalize, whereby the first valve body may readily be moved by said control means from one position to its other position.

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