

Oct. 19, 1965

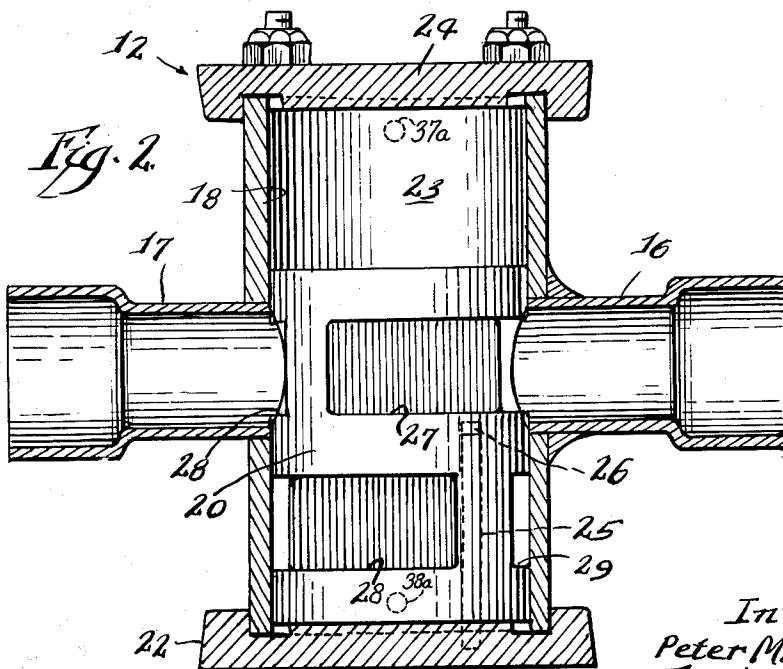
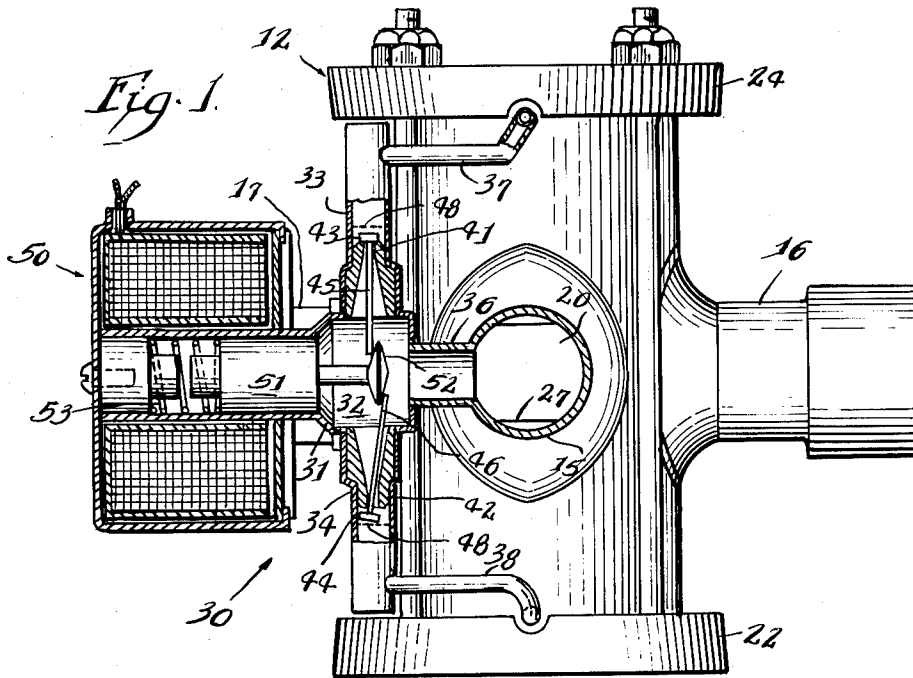
P. M. HALL ETAL

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CONTROL SYSTEM FOR FOUR-WAY REVERSING VALVE

Filed May 14, 1962

2 Sheets-Sheet 1



Inventors.  
Peter M. Hall.  
Edwin E. Townsend.

By: Zabel Baker York Jones & Dittmar  
Attorneys.

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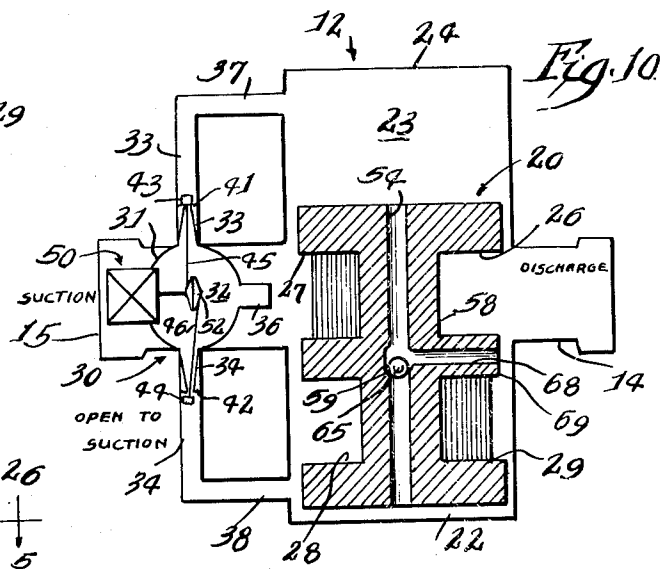
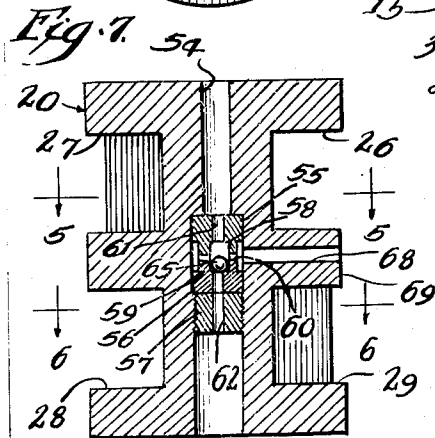
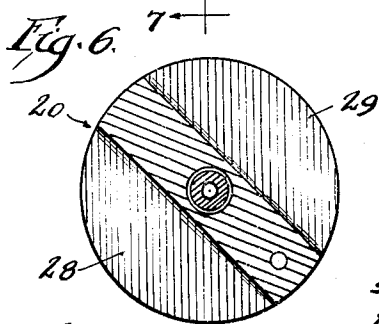
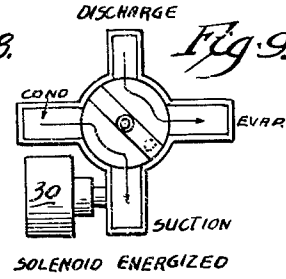
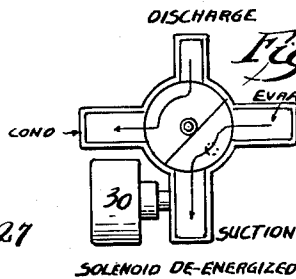
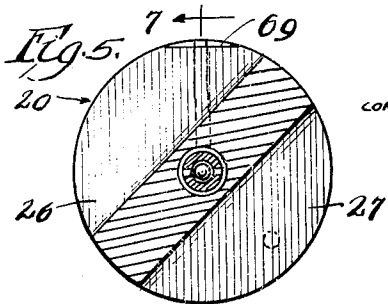
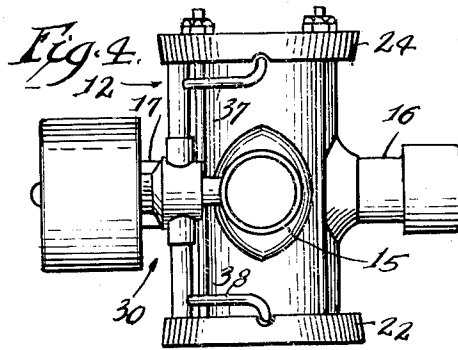
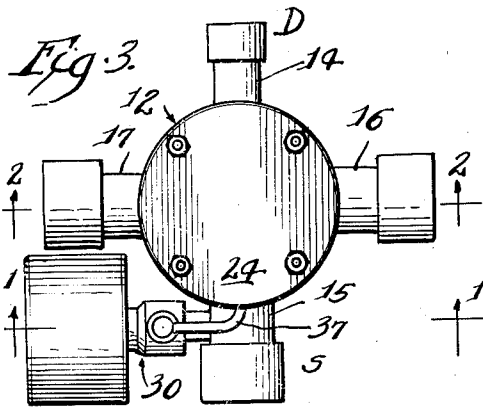
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CONTROL SYSTEM FOR FOUR-WAY REVERSING VALVE

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2 Sheets-Sheet 2



Inventors.  
 Peter M. Hall.  
 Edwin F. Townsend.  
 By: Jabel Baker York Jones &  
 Dithmar Attorneys.

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3,212,527

## CONTROL SYSTEM FOR FOUR-WAY REVERSING VALVE

Peter M. Hall, Tinley Park, Ill. (7455 S. 76th Ave., Bridgeview, Ill), and Edwin F. Townsend, Palos Hills, Ill. (9733 Southwest Highway, Oak Lawn, Ill.)  
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This invention relates to a four-way reversing valve, and more particularly to a control system for such a valve.

By way of example and brief introduction, four-way reversing valves customarily are used in air conditioning equipment, particularly equipment designed to provide air heating and air cooling at different times. Such valves also are used in air cooling systems to enable rapid defrosting.

Reversing valves used in air conditioning equipment normally have four ports, two of which are connected to the compressor. These two ports may be referred to as the compressor discharge or high pressure port and the compressor suction or low pressure port. The other two valve ports are connected respectively to the evaporator and the condenser of the system. A separate connection between the condenser and evaporator, including an expansion valve, serves to complete a basic air conditioning system.

When such an air conditioning system is operating in air cooling phase, the four-way reversing valve connects the evaporator to the compressor suction or low pressure valve port and the condenser to the compressor discharge or high pressure valve port. When the system is operating to provide air heating or defrosting, the valve is reversed to connect the evaporator to the compressor discharge or high pressure valve port and the condenser to the compressor suction or low pressure valve port.

Four-way reversing valves per se and air conditioning systems utilizing same are well known, and thus not within the scope of the present invention. The invention, as mentioned, concerns itself with a control system for actuating a four-way reversing valve which otherwise is of known type.

One object of the invention, therefore, is to provide an improved control system for a four-way reversing valve.

Another object is to provide an improved control system for a four-way reversing valve wherein pressurized fluid, usually a gas, serves to move the main valve element back and forth between two alternative positions.

Another object is to provide such a control system wherein a pilot valve, preferably solenoid-actuated, is used to condition the four-way reversing valve for valve action in response to the pressurized fluid.

Another and more detailed object is to provide such a control system wherein the pilot valve includes a pair of valves, each having a valve element which is unseated by tilting the valve element. In such a pilot valve, a solenoid, or equivalent, at any given time functions to tilt one of said valve elements and to permit the other valve element to be seated.

Another object is to provide a control system which utilizes a control valve, or equivalent, located within the movable part, or piston, of the main valve. This control valve, in a preferred form of the invention, has a movable element which alternately assumes two positions, one of which permits pressurized fluid to enter one end of the main valve and thereby push the movable part, or piston, toward the opposite end of the main valve. The other position of the movable element establishes a path which directs pressurized fluid to the other end of the main valve, thereby causing the piston to move in reverse direction.

The control system of the invention is reliable, effective, sensitive and virtually unaffected in operation by below-normal or low pressure conditions, despite the fact that the system relies on pressurized fluid to actuate the reversing valve. In detailed aspects of the invention, the tiltable valve elements in the pilot valve of the system are of particular importance, as is the two-position control valve mounted within the movable piston of the main reversing valve.

Other objects, advantages and details of the control system will be apparent as the description proceeds, reference being had to the accompanying drawings wherein one form of the invention is shown. The four-way reversing valve is illustrated and described to the extent necessary for an understanding of the control system. It is to be understood that the description and drawings are illustrative only, and that the scope of the invention is to be measured by the appended claims.

In the drawings:

FIG. 1 is an elevational view, partly in section on line 1—1 of FIG. 3, of a four-way reversing valve embodying the control system of the invention.

FIG. 2 is a sectional view on line 2—2 of FIG. 3.

FIG. 3 is a top plan view to reduced scale, of the valve shown in FIG. 1.

FIG. 4 is an elevational view of the valve on the same scale as FIG. 3.

FIG. 5 is a sectional view on line 5—5 of FIG. 7 of the movable part, or piston, used in the valve.

FIG. 6 is a sectional view on line 6—6 of FIG. 7.

FIG. 7 is a sectional view on line 7—7 of FIG. 5 showing details of the movable piston including the associated internal control valve.

FIGS. 8 and 9 are reduced diagrammatic views of the four-way reversing valve illustrating the connections made by the valve at the two alternative positions of the movable part, or piston.

FIG. 10 is an enlarged diagrammatic view illustrating in simplified form the control system of the invention.

Referring to the drawings, and first to FIG. 3, a four-way reversing valve embodying the control system of the invention includes a main valve body, generally designated 12, having four ports extending in quadrature relation with the axes lying in a common plane. For purposes of description, the four ports are designated discharge or high pressure port 14, suction or low pressure port 15, evaporator port 16 and condenser port 17.

Referring to FIG. 2, main valve body 12 has a hollow interior 18, the shape of this interior in the valve shown being cylindrical.

A movable valve part or piston 20 (FIGS. 2, 5—7 and 10) is mounted in interior 18 of main valve body 12. Piston 20 has a close fit with valve body 12 and is adapted to move lengthwise in the valve body between positions adjacent the opposite body ends. In FIG. 2, piston 20 is shown adjacent body end 22, at which time an end chamber 23 exists between piston 20 and opposite body end 24. In alternative valve condition, piston 20 is adjacent opposite body end 24 and a chamber (not shown) exists between piston 20 and body end 22. As will be seen later, piston 20 in operation does not actually engage body ends 22 and 24 due to the presence of a cushion of fluid therebetween.

A pin 25 extending upwardly from body end 22 is received within a longitudinal opening 26 in piston 20 to maintain proper orientation of the piston.

Referring to FIGS. 5—7 and 10, piston 20 has upper recesses, designated 26 and 27 in FIG. 5, and lower recesses designated 28 and 29 in FIG. 6. These recesses establish connections within the valve between the respective valve ports during the alternative positions of

piston 20. The portions of the four-way reversing valve so far described are more or less conventional.

Coming now to the control system of the invention, there is provided an auxiliary or pilot valve generally designated 30 (FIGS. 1, 3, 4 and 8-10). Referring to FIGS. 1 and 10, pilot valve 30 includes pilot valve body 31 having a central region 32 and end regions 33 and 34. Central region 32 communicates through duct 36 with low pressure port 15, while end regions 33 and 34 respectively communicate through ducts 37 and 38 with the opposite end chambers of main valve body 12. As best shown in FIG. 10, duct 37 connects with end chamber 23 in spaced relation with body end 24, and duct 38 connects with the opposite end chamber in spaced relation with body end 22. The ports in the end chambers at the ends of ducts 37 and 38 are designated 37a and 38a in FIG. 2 where they are shown in phantom to illustrate the spaced relationship with the body ends.

End region 33 of pilot valve 30 has a valve seat 41, while end region 34 has an oppositely directed valve seat 42. The effective openings surrounded by seats 41 and 42 are large compared to openings used in prior pilot valves of this general character. Valve seats 41 and 42 respectively have cooperating valve elements 43 and 44, the two valve elements having stems 45 and 46 which extend into the central region of the auxiliary valve. Valve elements 43 and 44 are designed so that they are unseated by tilting, and may be seated by the action of the pressurized fluid. Alternatively, the valve elements may be seated by springs or the like.

Suitable means such as retainers 48 (FIG. 1) may be located adjacent valve elements 43 and 44 to maintain the elements in effective relation with the associated valve seats.

A solenoid 50 or the like is mounted adjacent pilot valve body 31, the solenoid having a plunger 51 which carries an actuator 52. Valve stems 45 and 46 are alternately engaged and tilted by actuator 52.

Solenoid 50 is shown deenergized in FIG. 1. In this condition, plunger 51 is in extended position due to the action of solenoid spring 53. Actuator 52 is in engagement with valve stem 46 and has tilted valve element 44 to open condition. Conversely, actuator 52 has permitted valve element 43 to become and remain seated.

When solenoid 50 is energized, plunger 51 retracts, and actuator 52 tilts valve element 43 to open condition and permits valve element 43 to become seated, as will be understood.

Referring now to FIGS. 7 and 10, piston 20 has a longitudinal opening 54 extending from end to end. In the illustrated form of the invention, as shown in FIG. 7, opening 54 is provided with inserts 55 and 56 which are held in position by nut 57. Inserts 55 and 56 include oppositely directed valve seats 58 and 59 which are spaced apart longitudinally. The abutting ends of inserts 55 and 56 have one or more recesses which cooperate to provide at least one transverse opening 60 to the interior of the inserts which, as shown in FIG. 7, have longitudinal openings 61 in alignment with piston opening 54. Nut 57 also has an aligned longitudinal opening 62.

In the form of the invention shown, a pressure-responsive movable valve element 65 is located within inserts 55 and 56 between valve seats 58 and 59. As illustrated, movable valve element 65 comprises a ball valve element, and it will be noted that valve seats 58 and 59 are spaced apart by a distance greater than the diameter of valve element 65. This spacing permits valve element 65 to move back and forth and seat itself on one of the valve seats 58 or 59 while leaving the other seat open.

Piston 20 has a transverse opening 68 which extends from opening 60 of the inserts to high pressure port 14. The periphery of piston 20 is relieved slightly at the end of transverse opening 68, as shown at 69 in FIGS. 5, 7 and 10, so that opening 68 will communicate at all times

with high pressure port 14, regardless of the longitudinal position of piston 20 within main valve body 12.

The operation of the control system of the invention may be described with reference to FIG. 10 where piston 20 is shown in lower position. Incidentally, piston 20 was moved to this position by pressurized fluid from high pressure port 14 which traveled through transverse opening 68, insert openings 60 and 61 (FIG. 7) and the upper portion of longitudinal opening 54 into valve chamber 23. Because tiltable valve element 43 at that time (solenoid deenergized) was in closed condition, thereby blocking the path through auxiliary valve 30 to low pressure port 15, the pressurized fluid was effective to move piston 20 to lower position.

As piston 20 approaches lower body end 22, the end of the piston closes the port in the valve body leading to duct 38 and pilot valve 30. When this port is closed a quantity of fluid is trapped in the end chamber of the body, thereby providing a cushion which precludes possibly damaging impact or engagement between piston 20 and body end 22. Also, the closed port prevents fluid which might leak around the piston from entering pilot valve 30 through then-open valve element 44 and passing into low pressure port 15.

When solenoid 50 is energized to reverse the connections provided by the main valve, actuator 52 on solenoid plunger 51 is withdrawn. Actuator 52 engages valve stem 45 to thereby tilt valve element 43 and open the previously closed connection between the pressurized fluid in chamber 23 and low pressure port 15.

This changes the pressure conditions previously existing within main body 12, and ball valve element 65 immediately changes position (because of the abrupt pressure drop in chamber 23 and the momentary flow of fluid from opening 68 to chamber 23) and seats itself on its upper seat 58. The pressurized fluid is thereby diverted to the opposite or lower end of main valve body 12, the passage comprising transverse opening 68, insert openings 60 and 61, opening 62 in nut 57 and the lower part of longitudinal opening 54. The pressurized fluid thus forces piston 20 toward the opposite or upper end of the valve body. Again there is no impact due to closure by the piston of the port leading to duct 37.

Meanwhile, in the form of the invention shown, the pressurized fluid in the lower end of valve body has extended to end region 34 of auxiliary valve 30 (because the port leading to duct 38 has been uncovered by piston 20), and has caused tiltable valve element 44 to seat itself on seat 42, thereby blocking the flow of pressurized fluid to low pressure port 15. Piston 20 stays in this alternative upper position as long as solenoid 50 remains energized. When the solenoid is deenergized, the control system is effective to reverse the position of piston 20, as will be understood.

From the above description it is thought that the construction and advantages of the invention will be readily apparent to those skilled in the art. Various changes in detail may be made without departing from the spirit or losing the advantages of the invention.

Having thus described the invention, what we claim as new and desire to secure by Letters Patent is:

1. A control system for a four-way reversing valve of the type including a main valve body having high and low pressure ports and a piston movable between opposite ends of said main valve body, said control system comprising:

a pilot valve body having a central region and a pair of end regions, said central region communicating with said low pressure port and said end regions communicating respectively with ports in the opposite end chambers of said main valve body, the ports in said end chambers leading from the end regions of said pilot valve body spaced from the ends of said main valve body;

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a valve seat in each end region of said pilot valve body and a tiltable valve element of the pressure-seating type associated with each valve seat, each valve element having a valve stem extending into said central region;

solenoid means alternately engaging one of said valve stems and tilting the associated valve element to valve-open condition while permitting the other valve element to remain pressure-seated in valve-closed condition;

a pressure-responsive movable ball valve element in the interior of said piston, said piston having a longitudinal opening extending from end to end with said ball valve element located centrally in said opening; and

opposed valve seats in said longitudinal opening, one on each side of said ball valve element and spaced apart by a distance greater than the diameter of said ball valve element;

said piston having a transverse opening extending from the central region between said opposed valve seats to said high pressure port, whereby reversal of condition of said tiltable valve elements causes a pressure change within said main valve body and consequent movement of said ball valve element to alternative position, thereby permitting pressurized fluid from said high pressure port to pass through the previously closed portion of said longitudinal piston opening and move said piston to alternative position, said piston closing the port in the end chamber into which the piston moves, thereby providing a cushion of fluid to prevent impact, and sealing said end chamber to prevent the escape of pressurized fluid through said pilot valve body.

2. A control system for a reversing valve of the type including a main valve body having high and low pressure ports and a piston movable between opposite ends of said main valve body, said control system comprising:

a pilot valve including a pair of tiltable valve elements respectively disposed in ducts extending between ports in the end chambers of said main valve body and said low pressure port, the ports in said end chambers spaced from the ends of said main valve body;

means alternately tilting one of said valve elements to valve-open condition while permitting the other valve element to remain in valve-closed condition;

a pressure-responsive movable ball valve element in the interior of said piston, said piston having a longitudinal opening extending from end to end with said ball valve element located centrally in said opening; and

opposed valve seats in said longitudinal opening, one on each side of said ball valve element and alternately engageable by same;

said piston having a transverse opening extending from the central region between said opposed valve seats to said high pressure port, whereby reversal of condition of said tiltable valve elements causes a pres-

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sure change within said main valve body and consequent movement of said ball valve element to alternative position, thereby permitting pressurized fluid from said high pressure port to pass through the previously closed portion of said longitudinal piston opening and move said piston to alternative position, said piston closing the port in the end chamber into which the piston moves, thereby providing a cushion of fluid to prevent impact, and sealing said end chamber to prevent the escape of pressurized fluid through said pilot valve.

3. A control system for a reversing valve of the type including a main valve body having high and low pressure ports and a piston movable between opposite ends of said main valve body, said control system comprising:

a pilot valve including a pair of tiltable valve elements respectively disposed in ducts extending between ports in the end chambers of said main valve body and said low pressure port, the ports in said end chambers spaced from the ends of said main valve body;

means alternately tilting one of said valve elements to valve-open condition while permitting the other valve element to remain in valve-closed condition;

valve means in the interior of said piston, said piston having a longitudinal opening extending from end to end with said valve means in said opening;

said piston having a transverse opening extending from said high pressure port to said valve means, whereby reversal of condition of said tiltable valve elements causes a pressure change within said main valve body which permits pressurized fluid from said high pressure port to pass through a portion of said longitudinal piston opening and move said piston to alternative position, said piston closing the port in the end chamber into which the piston moves, thereby providing a cushion of fluid to prevent impact, and sealing said end chamber to prevent the escape of pressurized fluid through said pilot valve.

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M. CARY NELSON, *Primary Examiner.*

MILTON KAUFMAN, *Examiner.*