Sept. 8, 1970 A. COLOMBO 3,527,256

NINE-WAY VALVE FOR INVERTING CYCLE PROVIDING BOTH A PERFECT HEAT PUMP AND A REFRIGERATOR PUMP CIRCUIT, AND CIRCUIT OBTAINED BY SAID VALVE

Filed Sept. 16, 1968 2 Sheets-Sheet 1

FIG. 1

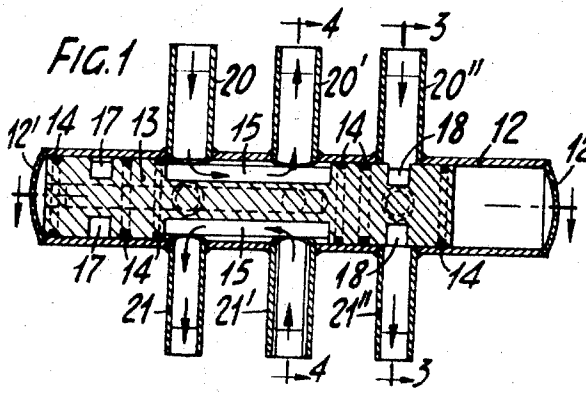



FIG. 3

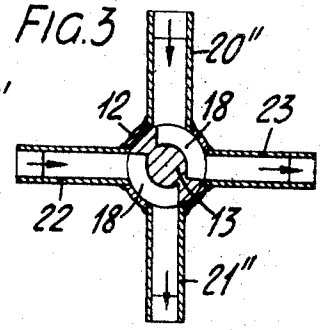



FIG. 2

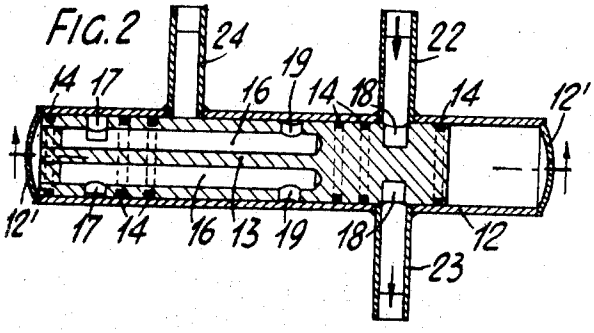



FIG. 4

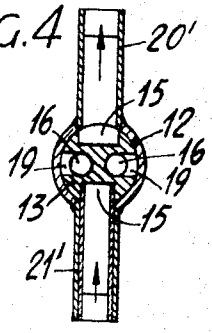



FIG. 5

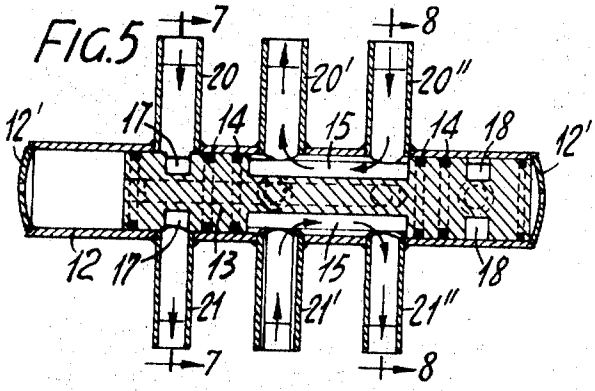



FIG. 7

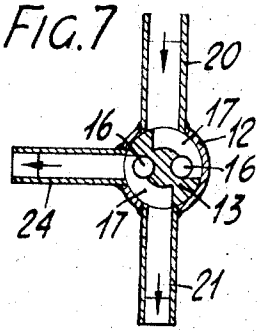



FIG. 6

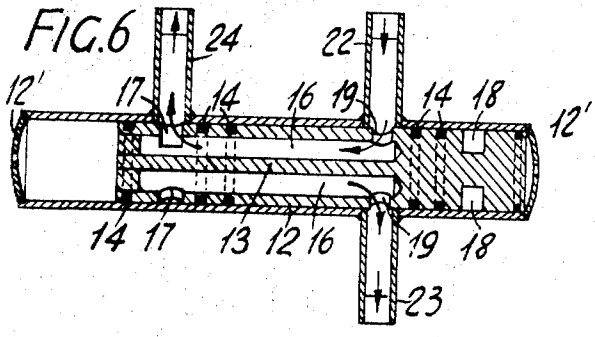
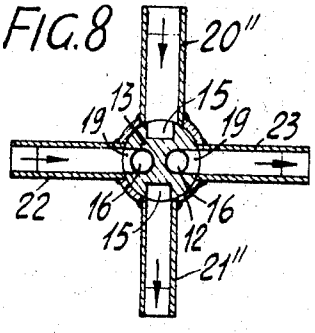



FIG. 8

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Filed Sept. 16, 1968 2 Sheets-Sheet 2

FIG. 9

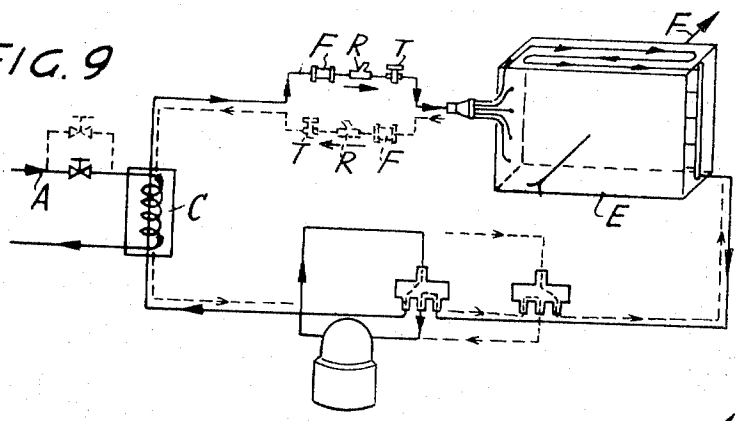



FIG. 10

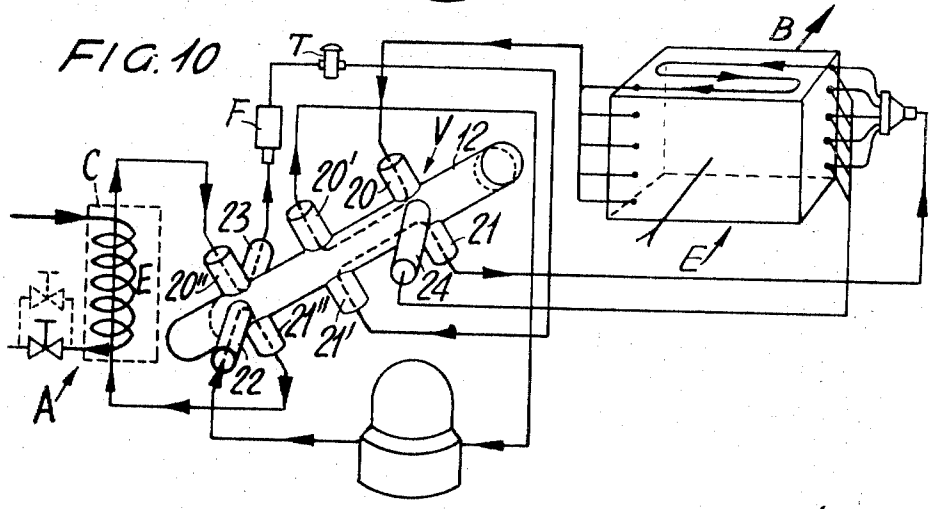
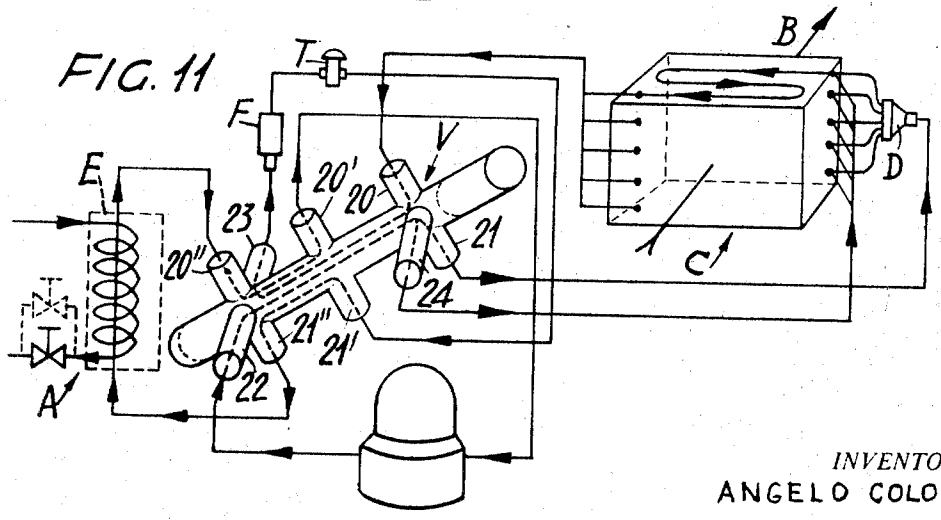



FIG. 11

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United States Patent Office 3,527,256
Patented Sept. 8, 1970



3,527,256

# NINE-WAY VALVE FOR INVERTING CYCLE PROVIDING BOTH A PERFECT HEAT PUMP AND A REFRIGERATOR PUMP CIRCUIT, AND CIRCUIT OBTAINED BY SAID VALVE

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Filed Sept. 16, 1968, Ser. No. 769,468
Claims priority, application Italy, Sept. 15, 1967, 20,498/67
Int. Cl. F16k 11/07
U.S. Cl. 137—625.48 8 Claims

## ABSTRACT OF THE DISCLOSURE

A cycle inverting nine-way valve providing a heat and refrigerator pump circuit, characterized in that said circuit is unidirectional for both cases. The valve comprises a cylinder in which a core can be moved to two extreme positions. In said core there are four longitudinal channels, two of which are peripheral and the other two internal, and four independent radial connecting passages, two of which communicate with the two inner channels. Nine radial unions connect the valve interior to the outer conduits.

This invention relates to a nine-way valve for inverting the cycle of a pump circuit. By the valve according to the invention, a perfect circuit is provided both as to cooling and heating the fluids being counterflowing in both cases.

As to structure and operation, the basic feature of the present valve is that the movable member, i.e. the distribution piston, is subjected to radially balanced internal pressures, whereby, whatever the means for controlling it may be substantial forces are not required for displacements thereof, because it is highly slidable within the seating cylinder even on operation. Indeed, the present valve-owing to its internal balance—can be controlled by a suitable electrovalve (core movement) through the difference in pressure provided by the compressor forming part of the unit.

The particular counterflow circuit can be carried out indeed, owing to the provision of the present valve according to the invention. The valve, of course, is connected to several conduits, by which highly significant advantages are obtained as to efficiency and operation, in addition to the practical advantage of removing a filter, two check valves and a thermostatic valve.

The valve comprises a cylinder, internally of which a core is adapted for a sealing movement, four longitudinal channels being formed in said core, two of these channels being peripheral at opposite locations and the other two internal are on a plane perpendicular to the plane of the former; four independent radial connecting members, two of which communicating with two inner channels; nine radial unions connecting the outer conduits communicating with the cylinder interior, six of said nine unions being coaxial by pairs and coplanar on a plane perpendicular to the plane on which the other three unions are located, two of the latter in a coaxial pair on the same plane of the extreme right-hand pair in the other three pairs, the third union being located on the plane perpendicular to the extreme left-hand pair thereof.

The valve according to the present invention substantially provides a circuit attainable by a similar eleven-way valve, or four three-way valves and a two-way valve suitably controlled and connected.

A further significant feature of the circuit as provided by the present valve is in the constantly unidirectional flow of the fluid, while cycle change is provided by varying the pressure areas and the physical state of the gas.

For a better understanding, the invention will now be more particularly described with reference to the accompanying drawings showing a preferred, but not restrictive embodiment thereof, changes or modifications being possible as to arrangement or details, particularly where the present valve should be used for functions other than those of the present disclosure and drawings since, as obvious, said changes will fall within the scope of this invention. In the accompanying drawings:



FIGS. 1 and 2 are mutually perpendicular longitudinal sectional views of the valve, in which the core is moved to the left;

FIGS. 3 and 4 are two cross-sections of the same valve taken along lines 3—3 and 4—4 of FIG. 1, respectively;

FIGS. 5 and 6 are views similar to FIGS. 1 and 2, in which the core is moved to the right;

FIGS. 7 and 8 are two cross-sections of the same valve taken along lines 7—7 and 8—8 of FIG. 5, respectively;

FIG. 9 shows a common direction inverting circuit; and FIGS. 10 and 11 show the single direction circuit according to the present invention.

Particularly referring to FIGS. 1–6, the nine-way valve comprises a cylinder **12**, in which a core **13** is controllably moved, the sealing for said core being ensured by annular gaskets **14**; provisions are made along the periphery of said core **13** for two diametrically opposite channels **15** and two inner channels **16**, the latter being coplanar and symmetrical to the axis and perpendicular to the former, and adapted for communicating with the outside through sector connecting members **17** at the left end; said core **13** additionally has sector connecting members **18** at the right end and intermediate holes **19**; all of these connections are coplanar in the sectional view of FIG. 1.

Through heads **12'**, core **13** is adapted to be controlled from the outside by mechanical or pneumo-hydraulic means. Cylinder **12** is made fast with a first set of six unions arranged in three coaxial and coplanar pairs **20–21**, **20'–21'** and **20''–21''**; said pairs are located at the middle portion of the cylinder and the mutual position thereof (FIG. 1) is such that as the first and second pairs are connected by channels **15**, the third pair communicates through sector connecting members **18** with the perpendicular and coplanar pair **22–23**. On rightward movement of core **13** the connections will be as follows: the second and third pair (FIG. 5) are connected by channels **15**, whilst the first pair is connected by means of sectors **17** through channels **16** and intermediate holes **19** to said perpendicular pair **22–23**, in addition to cause connecting member **21** to communicate with connecting members **20–21** (FIGS. 7 and 8). Only at this "piston to the right" position (FIG. 6) the connecting member **24** is connected with connecting member **22**, whilst at the "piston to the left" position (FIG. 2) said connecting member **24** is blind. When said connecting member **24** is open it communicates with connecting member **21** as well as connecting member **22** and, as seen from FIGS. 10 and 11, the circuit external to the valve from unions **24** is in parallel with the circuit from connecting member **21** to liquid dispenser D; this applies only when circuit E (evaporator) operates as a refrigerator (core to the right in FIG. 10 and core to the left in FIG. 1). When the core is at left position of FIG. 11 (the core at right position in FIG. 5), circuit E of FIG. 10 becomes condenser C, and conversely condenser C of FIG. 10 becomes E, and therefore the gas in place of liquid will flow through liquid dispenser D. In this case a high resistance will occur in the dispenser to gas passage therethrough, due to the volume increase, i.e. before the refrigerant quantity ($q$) was liquid, and now the same quantity ($q$) is gaseous due to the cycle inversion. With its additional circuit in parallel to the dispenser and totally cancelling said resistance, the connecting member **24** here finds its extremely remarkable significance.

In the common circuit of FIG. 9 the two cases are achieved by the inversion of flow direction, as shown by dashed lines in the figure, whereby a case will occur in which flow direction is not counterflowing; this case further requires a pair of thermostatic valves T, a pair of check valves R and a pair of filters F to be installed.

In both cases. with its nine-way valve V the circuit according to the invention (FIGS. 10 and 11) always provides a unique flow direction, as shown by the arrows in both figures, and a counterflow passage: in condenser C relative to water flow A and in evaporator E relative to air flow B. As a result, only one thermostatic valve T and one filter F are required in said circuit, check valves R being removed (FIG. 9).

I claim:

**1.** A cycle inverting nine-way valve providing a heat and refrigerator pump circuit, characterised in that said circuit is unidirectional for both cases, the valve comprises a cylinder in which a core can be moved to two extreme positions, in said core there are four longitudinal channels, two of which are peripheral and the other two internal; four independent radial connecting passages two of which communicate with the two inner channels; nine radial unions connecting the outer conduits communicating with the valve interior, six of which being coaxial by pairs and coplanar on a plane perpendicular to the plane containing the other three unions, two of the latter being coaxial and on the same plane of the rightmost pair of the other three pairs, whilst the third union is on a plane perpendicular to the leftmost pair thereof.

**2.** A nine-way valve according to claim **1**, characterized in that said two diametrically opposite and symmetrical peripheral channels extend so as to connect only two pairs of unions in both core positions.



**3.** A nine way valve according to claim **1**, characterized in that said two inner channels, which are more extended than the former and moved to the left, have at the ends thereof substantially 90° sector connecting members for a right angle interconnection of two adjacent unions.

**4.** A nine way valve according to claim **1**, characterized in that the intermediate connecting members radially and coaxially extend by pair from the inner channels.

**5.** A valve according to claim **1**, characterized in that in all cases the pressure distribution on said core by the fluid from the unions is so balanced that said core will move within said cylinder free of localized frictions.

**6.** A valve according to claim **1**, characterized in that the sealing for said core is ensured by annular gaskets.

**7.** A valve according to claim **1**, characterized in that the control for said core is carried out by any preferred means through the cylinder heads.

**8.** A heat and cold pump circuit provided by the valve according to claim **1**, characterized in that by the provision of only one thermostatic valve and one filter, the circuit provides for a unidirectional flow in both cases, and on cycle inversion said circuit has an additional parallel circuit for cancelling the resistance generated by the change of the pressure area.

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