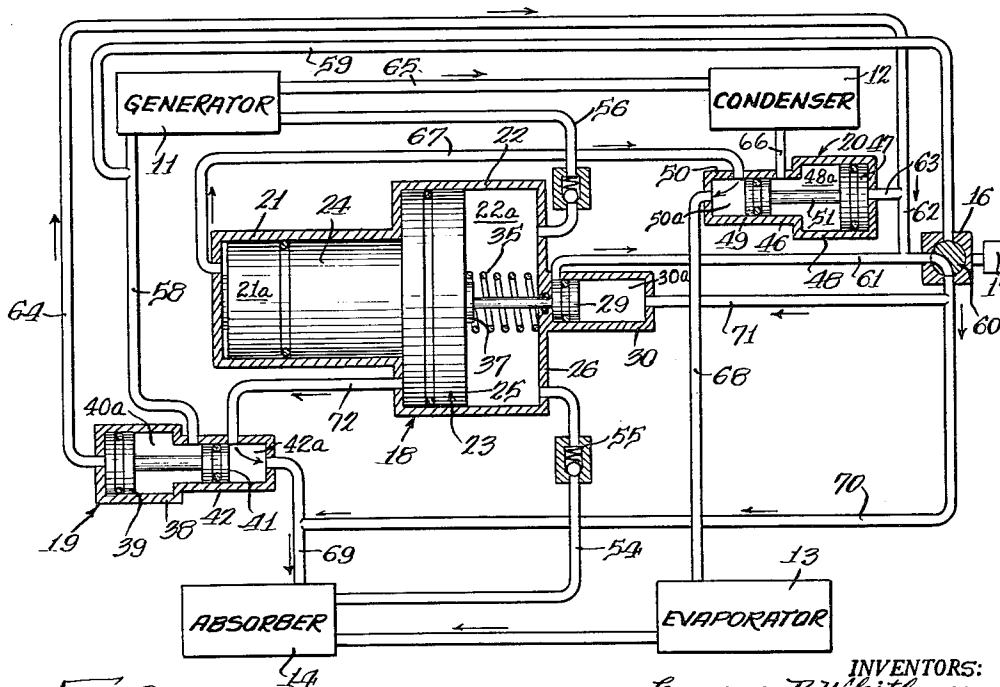
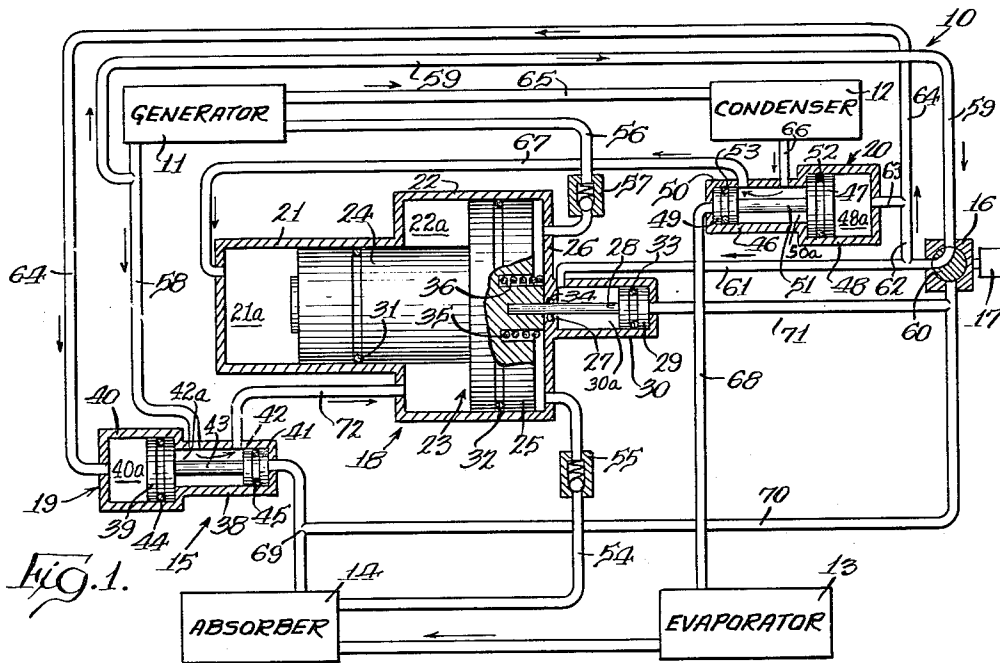


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MEANS FOR TRANSFERRING FLUIDS IN AN ABSORPTION
REFRIGERATION SYSTEM
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MEANS FOR TRANSFERRING FLUIDS IN AN ABSORPTION REFRIGERATION SYSTEM

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This invention relates to absorption refrigeration systems and in particular to means for transferring fluids from the low pressure portion to the high pressure portion of a two pressure absorption refrigeration system.

In the conventional two pressure absorption refrigeration system, circulation of the refrigerant fluid throughout the system is caused by the pressure differentials between different portions thereof. At one point in such a system, conventionally at the generator, energy is introduced to the system in the form of heat providing a high pressure refrigerant vapor conventionally delivered to a condenser wherein the vapor is condensed to a liquid at this high pressure. The liquified refrigerant is then delivered to an evaporator wherein it evaporates, drawing the heat of vaporization from the associated refrigerator elements and thereby effecting the desired refrigeration. The low pressure vaporized refrigerant is delivered from the evaporator to an absorber wherein it is reliquified, as by absorption in a liquid, and is delivered from the absorber to the generator, completing the cycle.

The present invention is concerned with a new and improved means for use in such a refrigeration system for pumping the low pressure liquified refrigerant and absorbent from the absorber to the generator against the high pressure of the vaporized refrigerant therein.

A principal feature of the invention is, therefore, the provision of a new and improved means for pumping refrigerant in a refrigeration apparatus.

Another feature is the provision of such a pumping means in an absorption refrigeration system having a first portion containing high pressure fluid and a second portion containing low pressure fluid, the pumping means including a pump connected between the first and second portions of the system for pumping fluid from the low pressure portion to the high pressure portion, and means using a portion of the energy of the high pressure fluid for operating the pump.

A further feature of the invention is the provision of such a pump means which is of simple and economical construction providing extended maintenance-free service.

Still another feature is the provision of such a pump means which may be readily controlled for adjustment of the rate of pumping.

A still further feature is the provision of such a pump means arranged for continuous functioning notwithstanding changes in the fluid pressure conditions within the system.

Another feature is the provision of a pumping mechanism which also serves as the expansion valve and pressure reducing valve in the system.

A yet further feature of the invention is the provision of such pump means which utilizes effectively minimum power, and which is substantially silent in operation.

Other features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing wherein:

FIGURE 1 is a schematic view of a refrigeration system including a pump means embodying the invention, the pump means being shown as near the end of the portion of the cycle of operation thereof wherein refrigerant fluid is delivered to the generator.

FIGURE 2 is a view similar to that of FIGURE 1

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but with the pump means shown as near the end of the retraction portion of the cycle of operation thereof.

In the exemplary embodiment of the invention as disclosed in the drawing, an absorption refrigeration system generally designated 10 includes a generator 11, a condenser 12, an evaporator 13, and an absorber 14 all of conventional construction. Illustratively, the refrigerant may comprise ammonia and the liquid absorbent for liquifying the refrigerant in the absorber may comprise water. The present invention is concerned with a new and improved pump means generally designated 15 for pumping the water which is rich in ammonia refrigerant, hereinafter referred to as rich liquid, from absorber 14 to generator 11 wherein the rich liquid is heated to vaporize the ammonia refrigerant for delivery to condenser 12. The water which is weak in ammonia refrigerant as a result of the boiling of the ammonia vapor therefrom, and which is hereinafter referred to as weak liquid, is returned from the generator through the pump means 15 wherein a portion of the pressure energy of the water is utilized for operating the pump means. Similarly, refrigerant condensed in condenser 12 is delivered to evaporator 13 through a portion of the pump means 15 wherein a portion of the pressure energy of the condensed refrigerant is used for operating the pump means. Control of the cycling of the pump means is obtained by means of a three-way valve 16 which may be operated by a suitable conventional timer 17 for continued cycling of the pump means 15 at preselected rates of delivery thereof.

More specifically, pump means 15 includes a pump 18, a first pilot valve 19, and a second pilot valve 20. The outer housing of pump 18 is defined by a first cylindrical portion 21 defining a first space 21a and a second, diametrically larger cylindrical portion 22 defining a second space 22a. A stepped piston 23 includes a first portion 24 slidable in housing portion 21 and an increased diameter portion 25 slidable in housing portion 21. The large diameter housing portion 22 is closed by an end wall 26 having an axial opening 27 through which extends a rod 28 secured at its inner end to piston portion 25 and its outer end to a power piston 29 slidably reciprocable in a small diameter cylindrical extension 30 of housing portion 22 defining a space 30a. As shown, piston portion 24 is slidably sealed to housing portion 21 by a piston ring 31, piston portion 25 is slidably sealed to housing portion 22 by a piston ring 32, power piston 29 is slidably sealed to housing extension 30 by a piston ring 33, and rod 28 is slidably sealed to housing end wall 26 by a shaft seal 34.

Piston 23 is biased away from end wall 26 (to the left as seen in FIGURE 1) by a coil spring 35 bottomed in an annular groove 36 arranged coaxially in piston portion 25 and opening toward end wall 26, the outer end of the spring bearing against the end wall concentrically of rod 28. Radially inwardly of groove 36, piston portion 25 is extended longitudinally outwardly to define a cylindrical boss 37 which engages housing end wall 26 to preclude complete surface contact of the piston with the end wall.

Pilot valve 19 includes a stepped cylindrical housing 38 slidably receiving a relatively large diameter piston 39 in a large diameter portion 40 defining a first space 40a thereof and a relatively small diameter piston 41 in a small diameter portion 42 defining a space 42a thereof, the pistons being connected by a rod 43 for conjoint coaxial reciprocable movement in housing 38. As shown, piston 39 is slidably sealed to housing portion 40 by a piston ring 44, and piston 41 is slidably sealed to housing portion 42 of a piston ring 45. Pilot valve 20 is identical in construction to pilot valve 19, including a housing 46, a relatively large diameter piston 47 slidably received in a large diameter portion 48 of the housing defining a first

space 48a therein, a relatively small diameter piston 49 slidably received in a small diameter portion 50 of the housing defining a second space 50a therein, a rod 51 connecting the pistons, a piston ring 52 slidably sealing the piston 47 to the housing portion 48 and a piston ring 53 slidably sealing the piston 49 to the housing portion 50.

Rich liquid is delivered from absorber 14 into space 22a of pump 18 between piston 25 and end wall 26 by means of a conduit 54 provided with a check valve 55 precluding reverse flow therethrough. The rich liquid is delivered from pump 18 to generator 11 by means of a conduit 56 leading from the space between piston portion 25 and end wall 26 and provided with a check valve 57 precluding reverse flow therethrough. Weak liquid is delivered from generator 11 through a conduit 58 to space 42a of pilot valve 19, and by means of a conduit 59 to three-way valve 16. In one position of the movable valve member 60 of valve 16, the weak liquid is delivered therefrom through a conduit 61 to housing extension space 30a adjacent end wall 26. Connected to conduit 61 adjacent valve 16 is another conduit 62 having one branch 63 connected to one end of the housing portion 48 of pilot valve 20, and a second branch 64 connected to the corresponding end of housing portion 40 of pilot valve 19.

High pressure refrigerant vapor is delivered from generator 11 to condenser 12 through a conduit 65. The condensed refrigerant is delivered from condenser 12 to space 50a of pilot valve 20 between pistons 47 and 49 thereof by a conduit 66. A conduit 67 connects space 50a at a point to the right of piston 49 when it is positioned at the leftward extreme of its movement, as shown in FIGURE 1, to the end of housing portion 20 of valve 18 for delivery of the high pressure refrigerant liquid to space 20a. Evaporator 13 is connected to the space 50a of pilot valve 20 by a conduit 68 and space 42a of pilot valve 19 is similarly connected to absorber 14 by a conduit 69. Conduit 69 is connected to three-way valve 16 by a conduit 70 and a conduit 71 connects conduit 70 to the outer end of housing extension 30. A conduit 72 connects the end of housing portion 21 opposite end wall 26 of pump 18 to space 42a of pilot valve 19 at a point spaced from the right-hand end of the housing portion 42 to be slightly to the left of the piston 41 when the piston is at the extreme right position as shown in FIGURE 1.

The pumping of the low pressure rich liquid from absorber 14 to generator 11 is effected by a movement of piston 23 to the right from the position of FIGURE 2 to the position of FIGURE 1. This cycle of the operation of the refrigeration system 10 is initiated by rotating movable valve member 60 of three-way valve 16 from the position of FIGURE 2 to the position of FIGURE 1, which movement may be automatically effected by timer 17. This rearrangement of valve 16 causes pilot valves 19 and 20 to move substantially immediately from the position of FIGURE 2 to the position of FIGURE 1, and the piston 23 to move slowly from the position of FIGURE 2 to the position of FIGURE 1. More specifically, high pressure weak liquid is directed by valve 16 from conduit 59 through conduit 61 into housing extension space 30a to urge piston 29 to the right as seen in FIGURE 1, from conduit 61 through conduits 62 and 63 into space 48a of pilot valve 20 to urge pistons 47 and 49 to the left, and through conduit 64 to space 40a of pilot valve 19 to urge pistons 39 and 41 thereof to the right. When the pistons of the pilot valves 19 and 20 reach the positions of FIGURE 1, high pressure weak fluid passes from conduit 58 through space 42a of pilot valve 19, and through conduit 72 into space 21a of pump 18 from the left side of piston portion 25 therein, and concurrently high pressure condensed refrigerant passes from the condenser through conduit 66, the space 50a of pilot valve 20, and through conduit 67 into the left end of space 20a of pump 18 from the left of piston portion 24. The right-hand end of housing extension space 30a is connected to the low pressure absorber 14 by conduits 71, 70 and 69. Thus, while

the piston 23 is effectively balanced by the fluid pressures on opposite sides thereof, the piston 29 is forced to the right by the pressure differential between the high pressure weak liquid in housing extension space 30a to the left of piston 29 and the low pressure liquid to the right thereof. Thus, piston 23 is moved to the right against the bias of spring 35 forcing the rich liquid from the right-hand end of chamber 22, through conduit 56 and into generator 11, check valve 55 precluding back flow of the rich liquid to absorber 14. This rightward movement of piston 23 continues until the piston portion 37 abuts end wall 26 whereby a predetermined volume of rich liquid is delivered from pump 18 to generator 11.

Refrigeration system 10 remains in the arrangement of FIGURE 1 until timer 17 effects a movement of valve member 60 of valve 16 to the position of FIGURE 2. When valve member 60 is thus positioned, pilot valves 19 and 20 are substantially immediately transferred from the position of FIGURE 1 to the position of FIGURE 2 and piston 23 is slowly forced to the leftmost position of FIGURE 2. More specifically, high pressure condensed refrigerant delivered from condenser 12 through conduit 66 to within housing 46 of pilot valve 20 between pistons 49 and 47 thereof moves the pistons to the right against the low pressure acting on the right side of piston 47 as a result of connecting the right-hand end of space 48a through conduits 63, 62 and 61, valve 16, and conduits 70 and 69 to absorber 14. Similarly, high pressure liquid delivered from generator 11 through conduit 58 to housing 38 of pilot valve 15 between pistons 41 and 39 thereof urges the pistons to the left against the low pressure in space 40a resulting from the connection thereof through conduits 64 and 62 to conduit 61. As both sides of piston 29 are subjected to the same low pressure as a result of the connection of conduits 71 and 61 jointly through conduits 70 and 69 to absorber 14, piston 29 is ineffectual in positioning the main piston 23, permitting coil spring 35 to urge the piston 23 slowly to the left whereupon rich liquid flows from absorber 14 through conduit 54 and into space 22a between piston 23 and housing end wall 26. Concurrently, the leftward movement of piston 23 causes piston portion 25 to force the weak liquid in space 21a to the left of piston portion 25 outwardly therefrom through conduit 72, through space 42a of pilot valve 15, and through conduit 69 to absorber 14, and causes piston portion 24 to force condensed refrigerant in space 21a of pump 15 therefrom through conduit 67, space 50a of pilot valve 20, and conduit 68 to evaporator 13.

It should be noted that in moving to the left, piston 23 forces a predetermined volume of condensed refrigerant, previously delivered from condenser 12 to pump 18, from the pump to evaporator 13, and concurrently forces a predetermined volume of weak liquid, previously delivered to pump 18 from generator 11, to absorber 14, the volume of weak liquid delivered to the absorber plus the volume of refrigerant delivered to the evaporator at this time being slightly greater than the volume of rich liquid previously delivered from the absorber to the generator as a result of the rightward movement of the pump piston. Thus, a simple and accurate adjustment of the pumping rate may be effected by controlling the rate at which the valve 16 is cycled. Illustratively, in a refrigeration system providing one ton of refrigeration, the pump may be arranged to deliver approximately one-quarter gallon per minute with a pressure differential between the high pressure and low pressure portions of the system of approximately 250 pounds per square inch and with the pump being cycled approximately ten times per minute.

The refrigeration apparatus 10 has extended maintenance-free life as a result of the effectively minimized wear of the sealing piston rings. More specifically, piston rings 31 and 32 have substantially equal pressures on each side thereof at all times. Piston ring 33 has equal pressures on opposite sides thereof during the entire half cycle when valve member 60 is arranged in the position

of FIGURE 2 and shaft seal ring 34 has equal pressures on opposite sides thereof at all times other than when the pilot valves 19 and 20 are being repositioned.

Because of the positive pumping operation of refrigeration system 10, operation of the system is continued notwithstanding a reduction in the amount of liquid in the system resulting from a reduction in the amount of heat delivered to the generator, a change in the ambient conditions relative to any or all of the generator, condenser, evaporator, and absorber, or gradual changes within the system. Under these conditions, the operation of pump 18 is effected by the high pressure vapor in lieu of the high pressure condensed refrigerant.

Having described our invention as related to the embodiment shown in the accompanying drawing, it is our intention that the invention be not limited by any of the details of description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the accompanying claims.

The embodiment of the invention in which an exclusive property or privilege is claimed is defined as follows:

1. In an absorption refrigeration system having a first portion containing high pressure fluid and a second portion containing low pressure fluid, apparatus comprising: a pump for pumping fluid from the second portion to the first portion including a housing having an inlet and an outlet at one end, a port at the other end, and a piston in the housing reciprocable toward and from said one end; first passage means for delivering fluid from said second portion of the system to said inlet upon spacing of said piston from said one end; a second passage means for delivering fluid from said outlet to said first portion of the system upon juxtaposing of said piston to said one end; a third passage means including a control valve responsive to pressure differentials thereacross for selectively connecting said port with either of said first and second portions of the system; means for selectively applying pressure differentials to said control valve for cyclically operating the control valve at preselected time intervals; and piston means at one end of said pump and arranged to use a portion of the energy of the high pressure fluid directed thereto by the control valve for reciprocating the piston.

2. In an absorption refrigeration system having a first portion including a generator containing high pressure weak liquid and a condenser containing high pressure condensed refrigerant, and a second portion including an absorber containing low pressure strong liquid and an evaporator, apparatus comprising: a pump having means defining a chamber and a first displacement member reciprocable in said chamber; first flow passage means communicating with said chamber at one side of the displacement member and with said absorber and said generator for delivering a predetermined volume of rich liquid from said absorber to said chamber during one movement of the displacement member and delivering said volume of rich liquid from said chamber to said generator during an opposite movement of the displacement member; a second flow passage means between said generator and said absorber and including a first pilot valve selectively delivering a predetermined volume of high pressure weak liquid to a first portion of said chamber at the opposite side of the displacement member during said one movement thereof and delivering said volume of weak liquid to said absorber during said opposite movement of the displacement member; a third flow passage means between said condenser and said evaporator and including a second pilot valve selectively delivering a predetermined volume

of condensed refrigerant from said condenser to a second portion of said chamber at said opposite side of the displacement member during said one movement thereof and delivering said volume of condensed refrigerant to said evaporator during said opposite movement of the displacement member; reciprocative power means for reciprocating the first displacement member including a second displacement member coupled to said first displacement member; means biasing the displacement members in one direction; and valve means cyclically connecting said power means alternately to said high pressure and low pressure portions of the refrigeration system at preselected intervals.

3. In an absorption refrigeration system having a first portion including a generator containing high pressure weak liquid and a condenser containing high pressure condensed refrigerant, and a second portion including an absorber containing low pressure strong liquid and an evaporator, apparatus comprising: a pump having means defining a chamber and a first displacement member reciprocable in said chamber; first flow passage means communicating with said chamber at one side of the displacement member and with said absorber and said generator for delivering a predetermined volume of rich liquid from said absorber to said chamber during one movement of the displacement member and delivering said volume of rich liquid from said chamber to said generator during an opposite movement of the displacement member; a second flow passage means between said generator and said absorber and including a first pilot valve selectively delivering a predetermined volume of high pressure weak liquid to a first portion of said chamber at the opposite side of the displacement member during said one movement thereof and delivering said volume of weak liquid to said absorber during said opposite movement of the displacement member; a third flow passage means between said condenser and said evaporator and including a second pilot valve selectively delivering a predetermined volume of condensed refrigerant from said condenser to a second portion of said chamber at said opposite side of the displacement member during said one movement thereof and delivering said volume of condensed refrigerant to said evaporator during said opposite movement of the displacement member; power reciprocative means for reciprocating the first displacement member including means defining a second chamber and a second displacement member coupled to said first displacement member and reciprocable in said second chamber; fourth flow passage means between the generator and absorber and connecting said second chamber at one side of said second displacement member to said absorber, and including a cycling control valve connecting said second chamber at the opposite side of said second displacement member at preselected intervals to said absorber and said generator; means biasing the second displacement member in a direction opposite to that in which it is urged when said second chamber at said opposite side of the second displacement member is connected to said generator.

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