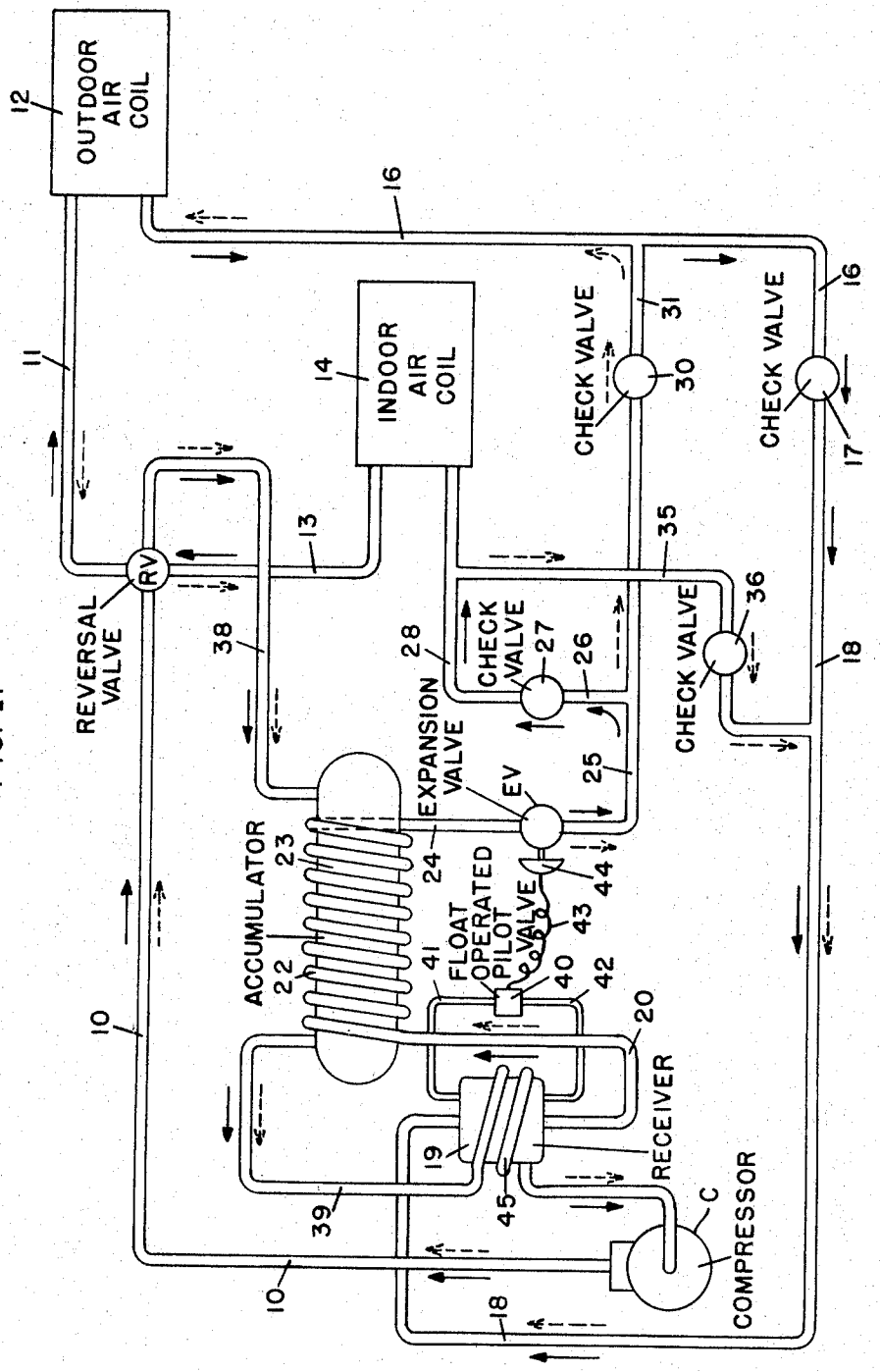
Nov. 7, 1967 J. R. HARNISH 3,350,898

REFRIGERATION SYSTEMS USING HIGH PRESSURE RECEIVERS

Filed May 23, 1966 2 Sheets-Sheet 1

FIG. 1.



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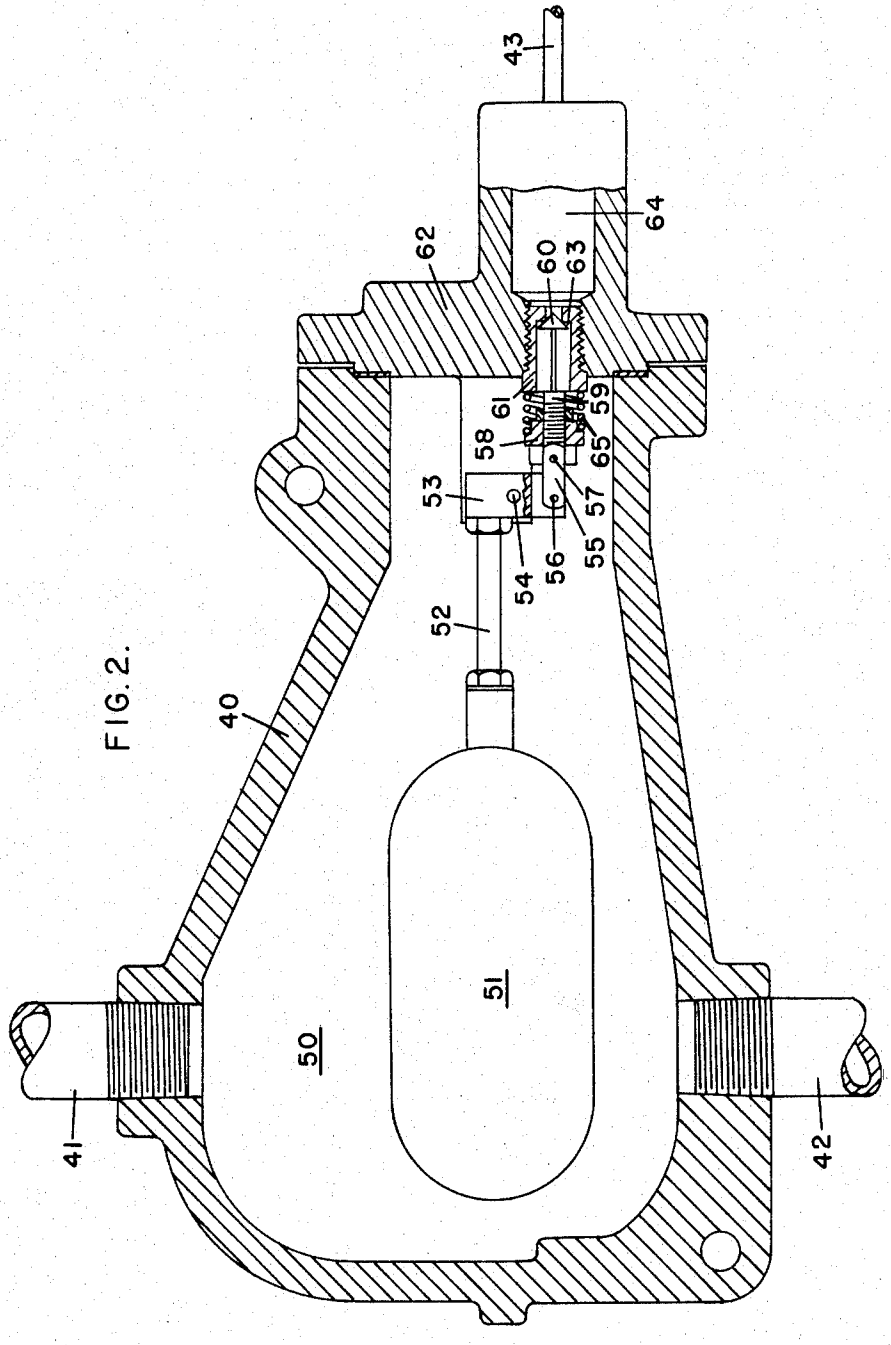


FIG. 2.

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REFRIGERATION SYSTEMS USING HIGH PRESSURE RECEIVERS

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6 Claims. (Cl. 62—218)

This invention relates to refrigeration systems using high pressure receivers, and has as an object to adjust an expansion valve in accordance with changes in the level of refrigerant liquid within such a receiver.

My copending application, Ser. No. 447,008, filed Apr. 9, 1965, issued as Patent No. 3,264,837, discloses the advantages of using an expansion valve which supplies refrigerant to an associated evaporator at the rate at which the refrigerant is condensed within an associated condenser, thus keeping the condenser adequately drained, and overfeeding the evaporator so that all of its internal surface is thoroughly wetted. The unevaporated refrigerant flowing from the evaporator is prevented from flowing into the associated compressor, by flowing it into an accumulator where it is evaporated by heat from the high pressure liquid, the latter being subcooled by this action. In that application, the excess refrigerant liquid flowing into the accumulator is evaporated by heat from a coil immersed in liquid within the accumulator, with the high pressure liquid flowing through that coil.

This invention uses a high pressure receiver to store liquid drained from a condenser, and adjusts the associated expansion valve in accordance with changes in the level of the liquid within the receiver. When the level of such liquid increases, the expansion valve is adjusted towards open position, and when the level of the liquid decreases, the expansion valve is adjusted towards closed position, with the expansion valve effectively supplying refrigerant to the evaporator at the rate at which the refrigerant is condensed within the condenser. Another feature of this invention is that the heat exchange coil arranged to heat the liquid within an accumulator, is wrapped around the accumulator in heat exchange contact with its outer surface.

This invention will now be described with reference to the annexed drawings, of which FIG. 1 is a diagrammatic view of a heat pump embodying this invention, and FIG. 2 is an enlarged view, in section, of the float-operated pilot valve of FIG. 1.

A refrigerant compressor C is connected by discharge gas tube **10** to a conventional refrigerant reversal valve RV which is connected by tube **11** to one end of outdoor air coil **12**, and by tube **13** to one end of indoor air coil **14**. The other end of the outdoor coil **12** is connected by tube **16** to check-valve **17** which is connected by tube **18** to high pressure receiver **19**. The receiver **19** is connected by tube **20** to heat exchange coil **22** wrapped around a suction line accumulator **23** in heat exchange contact with the outer surface of the latter. The coil **22** is connected by tube **24** to expansion valve EV which is connected by tube **25**, and by tube **26** to a check-valve **27** which is connected by tube **28** to the other end of the indoor coil **14**. The expansion valve EV is also connected by the tube **25** to check-valve **30** which is connected by tube **31** to the tube **16**. The tube **28** is connected by tube **35** containing a check-valve **36** to the tube **18** between the check-valve **17** and the receiver **19**. The reversal valve RV is connected by tube **38** to the upper portion of the

accumulator **23** at one end of the latter. A suction gas tube **39** connects the upper portion of the accumulator **23** at the other end of the latter to the suction side of the compressor C, and has an intermediate portion **45** wrapped around the receiver **19** in heat exchange with the outer surface of the latter.

A conventional, float-operated, pilot valve **40** is connected by tube **41** to the top of the receiver **19**, and a tube **42** connects the pilot valve **40** to the bottom of the receiver **19**. The pilot valve **40** is connected by a tube **43** to piston chamber **44** of the expansion valve EV. The valve **40** may be a conventional Phillips pilot valve No. 270A, and the expansion valve EV may be a conventional Phillips expansion valve No. 801. The latter, and its operation are disclosed on pages 327–329 of the textbook "Principles of Refrigeration" by R. J. Dossat, published in 1961 by John Wiley & Sons.

Referring now to FIG. 2, the pilot valve **40** has a float chamber **50** connecting with the tubes **41** and **42**, and within which is a float **51** connected to a rod **52** which is attached to the top of a float block **53**. The latter is pivoted between its top and bottom about a lever pin **54**, and its bottom is attached by a pivot pin **56** to a link **55**. The latter is attached by a pin **57** to a nut **58** threaded on one end of rod **59**. A needle valve **60** is formed on the other end of the rod **59**. The valve **60** is slidable within a nut **61** threaded in wall **62** of the valve **40**, and its outer end converges towards an orifice **63** in the outer end of the nut **61**, the edge of the orifice forming a seat for the valve **60**. The orifice **63** connects with a passage **64** which connects with the tube **43**. A coiled spring **65** extends between the nuts **58** and **61**, and biases the valve **60** towards unseated position.

The needle valve **60**, when unseated, supplies high pressure refrigerant liquid from the float chamber **50**, through the tube **43** into the piston chamber **44** of the expansion valve EV. A rise in the level of the liquid within the chamber **50** causes the float **51** to move the valve **60** towards unseated position, and vice versa.

Cooling operation

The solid-line arrows alongside the tubes show the direction of refrigerant flow during cooling operation. Discharge gas from the compressor C flows through the tube **10**, the reversal valve RV and the tube **11** into the outdoor coil **12** operating as a condenser coil. Liquid flows from the coil **12** through the tube **16**, the check-valve **17** and the tube **18** into the receiver **19**. Liquid flows from the receiver **19** through the tube **20**, the heat exchange coil **22**, the tube **24**, the expansion valve EV, the tubes **25** and **26**, the check-valve **27** and the tube **28** into the indoor coil **14** operating as an evaporator coil. Gas and unevaporated liquid flow from the coil **14** through the tube **13**, the reversal valve RV and the tube **38** into the accumulator **23**. Gas separated from the liquid within the accumulator **23** flows through the suction gas tube **39** to the suction side of the compressor C.

The heat pump preferably would be overcharged with refrigerant so that there would always be a quantity of refrigerant within the accumulator. Heat from the high pressure liquid flowing through the coil **22** heats the liquid within the accumulator, and evaporates an amount of such liquid equal to the amount of unevaporated liquid flowing from the coil **14**, the high pressure liquid being subcooled by this action. Heat from the high pressure liquid within the receiver **19** through the contact of the latter with the coil portion **45** of the suction gas tube **39**,

evaporates any refrigerant liquid entering the suction gas tube **39**, the high pressure liquid being further subcooled by this action.

The level of the refrigerant liquid within the receiver **19** varies in accordance with the quantity of liquid condensed within the outdoor coil **12**. The pilot valve **40** responds to changes in the level of the liquid within the receiver **19**, and adjusts the expansion valve EV towards open position on an increase in liquid level, and adjusts the expansion valve EV towards closed position on a decrease in the level of the liquid, thus maintaining the liquid level substantially constant, and causing the expansion valve EV to feed the indoor coil **14** at the rate at which the refrigerant is condensed within the coil **12**. The coil **12** is adequately drained, and the coil **14** is overfed since the quantity of condensed liquid is that evaporated within the coil **14**, and within the accumulator by the coil **22**.

This invention could be embodied in a non-reversible cooling system which would operate as described in the foregoing except that the reversal and check-valves would be omitted.

Heating operation

The dashed-line arrows alongside the tubes show the direction of refrigerant flow during heating operation. Discharge gas from the compressor C flows through the tube **10**, the reversal valve RV and the tube **13** into the indoor coil **14** operating as a condenser coil. Liquid flows from the coil **14** through the tube **35**, the check-valve **36**, and the tube **18** into the receiver **19**. Liquid flows from the receiver **19** through the tube **20**, the heat exchange coil **22**, the tube **24**, the expansion valve EV, the tube **25**, the check-valve **30** and the tubes **31** and **16** into the outdoor coil **12** operating as an evaporator coil. Gas and unevaporated liquid flow from the coil **12** through the tube **11**, the reversal valve RV and the tube **38** into the accumulator **23**. Gas separated from the liquid within the accumulator **23** flows through the suction gas tube **39** to the suction side of the compressor C.

Heat from the high pressure liquid flowing through the coil **22** evaporates the unevaporated refrigerant liquid flowing from the coil **12** into the accumulator **23**, the high pressure liquid being subcooled by this action. Heat from the high pressure liquid within the receiver **19** superheats through the heat exchange contact of its outer surface with the coil portion **45** of the suction gas tube **39**, the suction gas flowing through the coil portion **45**, the high pressure liquid being further subcooled by this action.

The level of the refrigerant liquid within the receiver **19** varies in accordance with the quantity of liquid condensed within the indoor coil **14**. The pilot valve **40** responds to changes in the level of the liquid within the receiver **19**, and adjusts the expansion valve EV towards open position on an increase in the liquid level, and adjusts the expansion valve EV towards closed position on a decrease in the liquid level, thus maintaining the liquid level substantially constant, and causing the expansion valve EV to feed the outdoor coil **12** at the rate at which refrigerant is condensed within the indoor coil **14**. The coil **14** is adequately drained, and the outdoor coil **12** is overfed.

What is claimed is:

1. A refrigeration system comprising a refrigerant compressor, a condenser, a receiver, a heat exchange coil, an expansion valve, an evaporator, and a suction line accumulator connected in the order named in a refrigeration circuit, said heat exchange coil being arranged to heat liquid within said accumulator, and means including means responsive to changes in the level of refrigerant liquid within said receiver connected to said expansion valve for adjusting said expansion valve towards open position on an increase in liquid level, and towards closed position on a decrease in liquid level, said system being overcharged with refrigerant so that there is always a quantity of refrigerant liquid within said accumulator, said expansion valve overfeeding said evaporator so that unevaporated liquid flows from the latter into said accumulator, said heat exchange coil being arranged to evaporate refrigerant liquid within said accumulator at substantially the same rate at which unevaporated refrigerant liquid flows from said evaporator into said accumulator.

2. A refrigeration system as claimed in claim **1** in which said heat exchange coil is wrapped around said accumulator in heat exchange contact with the outer surface of said accumulator.

3. A refrigeration system comprising a refrigerant compressor, a condenser, a heat exchange coil, an expansion valve, an evaporator, and a suction line accumulator connected in the order named in a refrigeration circuit, said heat exchange coil being wrapped around said accumulator in heat exchange contact with the outer surface of said accumulator, and means including means connected to said expansion valve for adjusting said expansion valve to supply refrigerant from said heat exchange coil to said evaporator at the rate at which the refrigerant is condensed within said condenser.

4. A heat pump comprising a refrigerant compressor, reversal valve means, a discharge gas tube connecting the discharge side of said compressor to said reversal means, an outdoor coil, a second tube connecting said reversal means to said outdoor coil, an indoor coil, a third tube connecting said reversal means to said indoor coil, a receiver, a fourth tube containing a first check-valve connecting said outdoor coil to said receiver, means including a fifth tube containing a second check-valve connecting said indoor coil to said receiver, a heat exchange coil, a sixth tube connecting said receiver to said heat exchange coil, an expansion valve, a seventh tube connecting said heat exchange coil to said expansion valve, means including an eighth tube containing a third check-valve connecting said expansion valve to said indoor coil, means including a ninth tube containing a fourth check-valve connecting said expansion valve to said outdoor coil, a suction line accumulator, a tenth tube connecting said reversal means to said accumulator, a suction gas tube connecting said accumulator to the suction side of said compressor, said heat exchange coil being arranged to heat liquid within said accumulator, and means including means responsive to changes in the level of liquid within said receiver connected to said expansion valve for adjusting said expansion valve towards open position on an increase in liquid level, and towards closed position on a decrease in liquid level.

5. A heat pump as claimed in claim **4** in which said heat exchange coil is wrapped around said accumulator in heat exchange contact with the outer surface of said accumulator.

6. A heat pump comprising a refrigerant compressor, reversal valve means, a discharge gas tube connecting said reversal means to the discharge side of said compressor, an outdoor coil, a second tube connecting said reversal means to said outdoor coil, an indoor coil, a third tube connecting said reversal means to said indoor coil, a heat exchange coil, means including a fourth tube containing a first check-valve connecting said outdoor coil to said heat exchange coil, means including a fifth tube containing a second check-valve connecting said indoor coil to said heat exchange coil, an expansion valve, a sixth tube connecting said heat exchange coil to said expansion valve, means including a seventh tube containing a third check-valve connecting said expansion valve to said indoor coil, means including an eighth tube containing a fourth check-valve connecting said expansion valve to said outdoor coil, a suction line accumulator, a ninth tube connecting said reversal means to said accumulator, a suction gas tube connecting said accumulator to the suction side of said compressor, said heat exchange coil being wrapped around said accumulator in heat exchange contact with

the outer surface of said accumulator, and means including means connected to said expansion valve for adjusting said expansion valve to supply refrigerant from said heat exchange coil to the one of said indoor or outdoor coils which is operating as an evaporator coil at the rate at which the refrigerant is condensed within the one of said outdoor or indoor coils which is operating as a condenser coil.

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