May 25, 1937. J. R. ZWICKL 2,081,845

REVERSIBLE REFRIGERANT EXPANSION MEANS

Filed July 3, 1934 2 Sheets-Sheet 1

Fig. 1

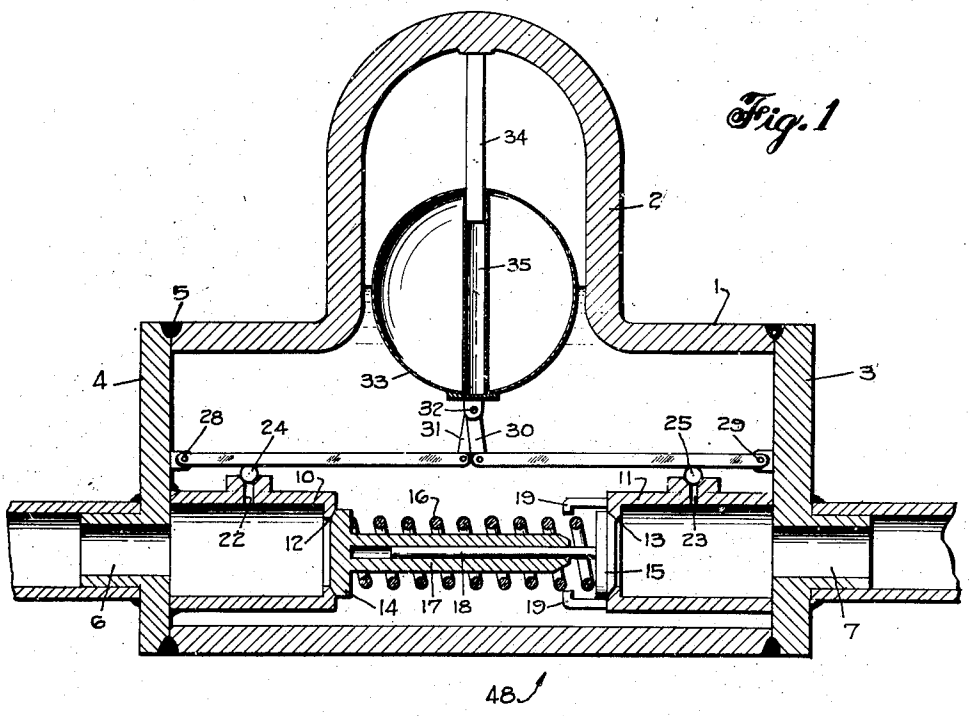
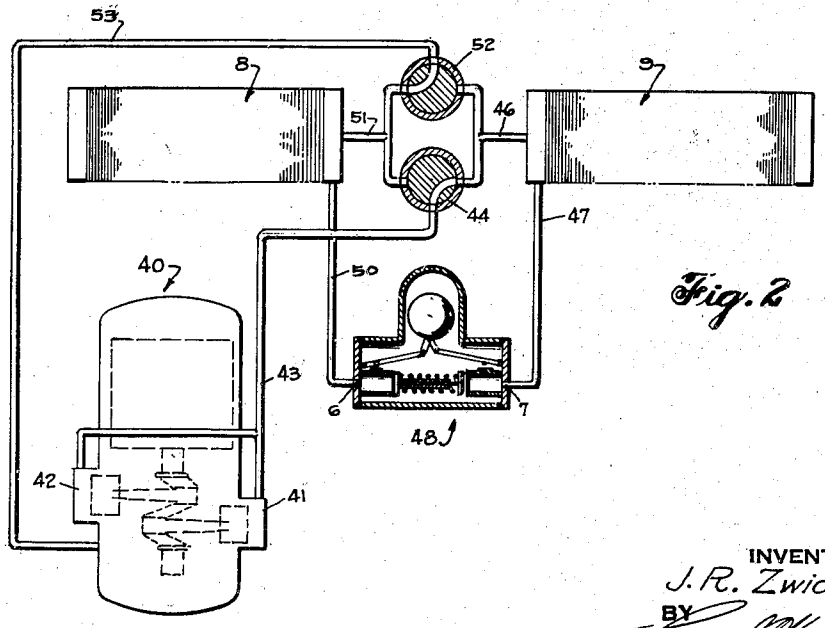


Fig. 2



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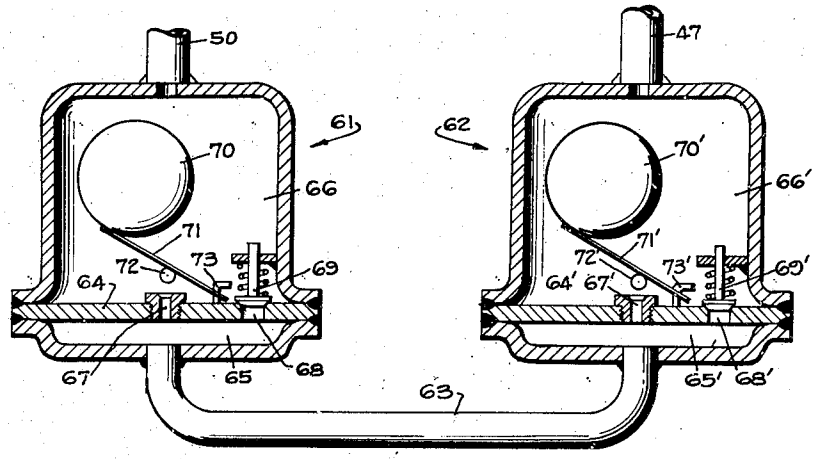
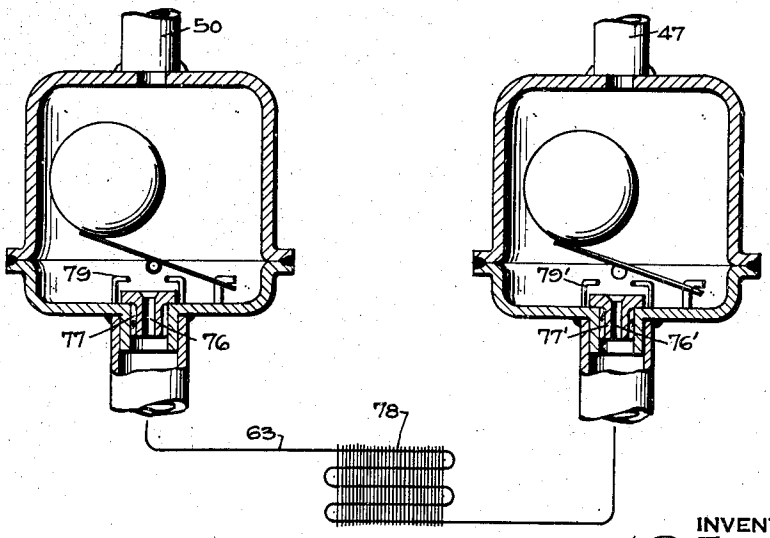


Fig. 3

Fig. 4



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REVERSIBLE REFRIGERANT EXPANSION MEANS

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14 Claims. (Cl. 62—127)

This invention relates generally to float controlled refrigerant expansion means and more particularly to an improved expansion means for reversible refrigerating systems employed for heating or cooling.

In a refrigerating system having a compressor-condenser-evaporator circuit, it is well-known that the condenser can be used for heating and that the evaporator may be used for cooling. Such a system is, therefore, well adapted for summer and winter use when employed in air conditioning apparatus especially where the condenser is of the air-cooled type arranged to have the outside air circulated thereover, the room air being cooled by circulation over the evaporator. However, to interchange the condenser and evaporator functions of the heat exchange elements so that the room air will be heated in passing over the heat exchange element now serving as a condenser, it is necessary to reverse the direction of refrigerant flow through the heat exchange elements. Irrespective of the direction in which the refrigerant may flow, it is necessary to control the expansion means so as to insure that substantially only refrigerant liquid passes therethrough.

It is desirable in effecting reversal of the refrigerant flow through the expansion means, especially of the type employing a pair of expansion orifices, that the refrigerant is not subjected to the possibility of a double expansion action, and it is one object of my invention to provide an improved but relatively simple expansion mechanism that is freely operative in either direction of refrigerant flow.

In one specific aspect of the invention I accomplish the foregoing by providing an improved reversible expansion means controlled by a single float. Another object in this respect is to provide a plurality of expansion orifices commonly controlled by a single float and it is another object of my invention to provide in combination therewith improved means for rendering one or the other of said orifices inoperative as an expansion orifice automatically in accordance with the direction of refrigerant flow through the heat exchange elements.

In a more specific aspect of the invention I have provided a reversible expansion means controlled by a liquid actuated float in combination with a valve controlled expansion orifice and check valve means for bypassing refrigerant around said orifice automatically when the refrigerant flow is in one direction but will cause said orifice to be operative for expansion purposes when the refrigerant flow is in the opposite direction.

Other objects and advantages will be more apparent to those skilled in the art from the following description of the accompanying drawings in which:

Fig. 1 is a longitudinal sectional view through one form of my improved valve mechanism;

Fig. 2 is a diagrammatic view of a refrigerating system in which my improved valve is disposed;

Fig. 3 is a modified form of a reversible expansion mechanism employing liquid float means for controlling a plurality of expansion orifices;

Fig. 4 is a further modification similar to Fig. 3 but employing a somewhat different form of bypass check valves.

In the illustrated embodiments of the invention which are shown herein merely for the purpose of disclosing certain specific forms among possible others that the invention might take, I have provided in Fig. 1 a reversible expansion mechanism having an outer casing 1, preferably circular in transverse section, a float dome 2 also preferably circular in cross-section terminating in a curved top. As a result of this circular construction, the casing may easily withstand high internal pressures to which it may be subjected while at the same time a relatively simple and compact device is provided. The ends of the casing 1 are closed by end pieces 3 and 4 which are suitably secured, preferably as by welding 5, to the ends of casing 1. Passages 6 and 7 extend through the end plates 3 and 4 for communication with complementary heat exchange elements generally indicated at 8 and 9, Fig. 2. The passages 6 and 7 communicate preferably with bypass chambers 10 and 11 disposed preferably, but not necessarily, in axial alignment with each other as is also the case with check valve controlled passages or ports 12 and 13. These ports are adapted to be closed by valves 14 and 15 normally yieldingly urged apart by a spring 16 interposed therebetween. The valves have inner and outer mutually supporting telescoping stems 17 and 18 although if desired auxiliary guide pins 19, bent at their ends to limit outward movement of the valves, may be secured to the ends of members 10 and 11 to suitably guide said valves at their periphery. This arrangement has the advantage that the valves 14 and 15 can readily have some degree of alignment with their seats around ports 12 and 13, although if desired the outer stem 17 may be suitably guided in a bearing supported directly from casing 1.

Communicating with chambers 10 and 11 is

a pair of expansion orifices 22 and 23 controlled respectively by any suitable valves preferably balls 24 and 25. The balls 24 and 25 are preferably slightly loosely connected to said levers for the purpose of insuring proper seating alignment and closure of orifices 22 and 23. The outer ends of these levers are suitably pivotally connected at 28 and 29 to plates 4 and 5 while the inner ends of said levers are pivotally connected to links 30 and 31. These links are commonly pivotally secured at 32 to a liquid float 33 which is preferably entirely hermetically sealed to avoid admission thereto of liquid or gas. The float may be guided in any suitable manner either by the walls of the dome 2 or if desired by a guide stem 34 secured to the dome and projecting downwardly therefrom into a suitable tubular passage 35 in float 33.

Operation of Fig. 1 form.—The expansion mechanism is normally employed, as shown in Fig. 2, in a refrigerating system having a compressor generally indicated at 40 and complementary heat exchange elements 8 and 9. The compressor cylinders 41 and 42 are commonly connected to a discharge pipe 43 and thence through a reversing valve 44 to pipe 46 and heat exchange element 9 which in the arrangement shown in Fig. 2 is functioning as a condenser. The condensed refrigerant flows from element 9 through pipe 47 to passage 7 of the expansion mechanism generally indicated at 48. The condensed refrigerant which is under high pressure enters chamber 11 and forces valve 15 open to discharge into the interior of casing 1 and dome 2 and thereby raise float 33 and in turn lift ball valves 24 and 25 through the links and levers 30, 31 and 26, 27. The lifting of valve 25 does not have any effect upon the inflowing condensed refrigerant because the check valve 15 is entirely open to permit free flow of refrigerant therethrough. However, check valve 14 remains closed and therefore the opening of orifice 22 by raising valve 24 permits the liquid refrigerant to expand through orifice 22 into passage 6 and thereupon flow through pipe 50 to heat exchange element 8 now functioning as an evaporator. The evaporated refrigerant from element 8 passes through pipes 51 to a second reversing valve 52 and thence through suction pipe 53 to the inlet side of the compressor cylinders 41 and 42.

When it is desired to interchange the functions of elements 8 and 9, valves 44 and 52 are each rotated 90° in a clockwise direction, thereby causing discharge pipe 43 to connect with pipe 51 while suction pipe 53 connects with pipe 46. Thereupon element 8 will serve as a condenser and element 9 as an evaporator, and condensed refrigerant from element 8 will now flow into passage 6 under high pressure and thereby open check valve 14 and close valve 15. The liquid refrigerant will thus flow into the float chamber freely until sufficiently full to raise float 33, whereupon valves 24 and 25 will be lifted from their orifices 22 and 23. However, the opening of orifice 22 will have no appreciable effect on the flow of refrigerant to the float chamber as the check valve 14 is already open to bypass refrigerant around orifice 22. However, the lifting of valve 25 permits liquid refrigerant to expand through orifice 23 into pipe 7 leading to what is now the evaporator 9.

From the foregoing disclosure it is seen that I have provided a positive liquid actuated float controlled reversible expansion means whereby the refrigerant expands through only one or the other of a plurality of expansion orifices automatically in accordance with the direction of refrigerant flow through the valve mechanism.

Fig. 3 modification.—In Fig. 3 I have shown two separate expansion means generally indicated at 61 and 62 commonly connected by a pipe 63 and respectively connected at their upper ends to pipes 47 and 50 of the refrigerating system shown in Fig. 2. These expansion means take the place of the preferred form of mechanism 48, Fig. 1. Inasmuch as two devices 61 and 62 are identical in construction, it will suffice to describe only one. The casing 61 has a partition 64 to provide two chambers 65 and 66. An expansion orifice 67 is disposed in this partition, while an orifice 68 is controlled on the top side by a suitable spring-held check valve 69. Expansion orifice 67 is controlled by a liquid actuated float 70 secured to the free end of a lever 71. This lever carries a ball valve 72 preferably slightly movable relative to lever 71 to insure proper seating of the ball during closure of orifice 67. The other end of lever 71 is suitably pivotally attached at 73 to partition 64.

Operation.—When liquid refrigerant flows into valve mechanism 61 through pipe 50, float 70 will gradually rise to unseat orifice 67 whereupon the liquid under high pressure expands through orifice 67 and into the pipe 63 thereby to raise check valve 69' of valve mechanism 62. The raising of this check valve allows free flow of the low pressure liquid into the float chamber independently of its expansion orifice 67', the refrigerant thus communicating under low pressure with the evaporator through pipe 47. If the reversing cocks 44 and 52 are rotated as previously described so as to interchange the condenser and evaporator functions, then condensed refrigerant under high pressure flows through pipe 47 into valve casing 62 to close check valve 69' and gradually raise float 70', whereupon the high pressure liquid refrigerant expands through orifice 67' into passage 63 and then raises check valve 69 so as to bypass the refrigerant around orifice 67. The refrigerant under reduced pressure then flows through pipe 50 to the evaporator. From the foregoing disclosure, it is seen that I have provided a liquid actuated float controlled expansion means provided with a plurality of expansion orifices adapted to be alternatively rendered operative or inoperative automatically in accordance with direction of refrigerant flow through the expansion mechanism.

Fig. 4 modification.—This combination embodies the same general arrangement as shown in Fig. 3 except that the expansion orifices 76 and 76' are formed in the check valves 77 and 77'. These check valves are suitably guided in suitable bypass passages communicating with a common connection 63 which if desired may include an intercooler 78. This intercooler may also be employed in the other modifications. Suitable limit stops or pins 79 overhang the tops of the check valves to limit their upward movement.

The operation of this modification is the same as that of Fig. 3 and the structure is likewise the same except that the check valves and expansion orifice are incorporated in the bottom of the valve mechanism rather than in the partition 64 of Fig. 3.

From the foregoing disclosure of the several modifications, it is seen that I have provided an extremely effective reversible expansion means

employing a plurality of expansion orifices adapted to be rendered alternatively operative or inoperative automatically in accordance with the direction of refrigerant flow therethrough, the control of the expansion means being effected in a positive manner by fluid actuated floats which definitely open the expansion orifices only in accordance with the liquid content in the float chamber. The combination of the structural elements as set forth is such that a relatively inexpensive and yet very strong construction is provided while at the same time permitting all functions to be readily and effectively performed.

It will of course be understood that various changes in details of construction and arrangement of parts may be made by those skilled in the art without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. Refrigerant expansion means for complementary heat exchange elements through which refrigerant successively flows in one direction or the other whereby in one direction of flow one of said elements functions as a condenser and the other element as an evaporator, and vice versa for opposite direction of flow, comprising, in combination, means forming inlet and outlet passages, a plurality of orifices for expanding refrigerant in either direction of flow through said passages, a plurality of check valve controlled passages one of which is for bypassing refrigerant around one of said orifices and the other of which bypasses refrigerant around the other orifice depending upon the direction of fluid flow, and means whereby liquid refrigerant is bypassed through one of said check valve passages and then expanded through the orifice associated with the other bypass.

2. Refrigerant expansion means for complementary heat exchange elements through which refrigerant successively flows in one direction or the other whereby in one direction of flow one of said elements functions as a condenser and the other element as an evaporator, and vice versa for opposite direction of flow, comprising, in combination, means forming a plurality of expansion orifices, means for controlling refrigerant flow through said orifices including liquid actuated float means, and means for bypassing one or the other of said orifices automatically in accordance with the direction of refrigerant flow through said heat exchange elements.

3. The combination set forth in claim 2 further characterized in that said bypassing means includes a check valve controlled passage through which refrigerant flow is prevented in one direction but free flow of refrigerant is allowed in the other direction of flow to bypass one of said expansion orifices.

4. The combination set forth in claim 2 further characterized in that said bypassing means includes a plurality of check valve controlled bypasses one around each of said orifices whereby in one direction of refrigerant flow one of said bypasses is automatically closed and the other is automatically opened or vice versa upon reverse refrigerant flow.

5. Refrigerant expansion means for complementary heat exchange elements through which refrigerant successively flows in one direction or the other whereby in one direction of flow one of said elements functions as a condenser and the other element as an evaporator, and vice versa for opposite direction of flow, comprising, in combination, means forming a plurality of expansion orifices between said heat exchange elements, means for controlling refrigerant flow through said orifices including a common float, and means for bypassing one or the other of said orifices automatically in accordance with the direction of refrigerant flow through said heat exchange elements.

6. The combination set forth in claim 5 further characterized in that said bypassing means includes check valve controlled bypasses one around each of said orifices, and means for controlling said bypasses automatically in accordance with the direction of refrigerant flow through said heat exchange elements thereby to render one or the other of said expansion orifices operative.

7. Refrigerant expansion means for complementary heat exchange elements through which refrigerant successively flows in one direction or the other whereby in one direction of flow one of said elements functions as a condenser and the other element as an evaporator, and vice versa for opposite direction of flow, comprising, in combination, a plurality of expansion orifices, and means for bypassing one or the other thereof automatically in accordance with the direction of refrigerant flow through said heat exchange elements including a pair of opposed check valve controlled openings connected in series with a common passage and arranged to discharge toward each other.

8. The combination set forth in claim 7 further characterized by the provision of means for yieldingly urging said check valves in opposite directions to close their respective valve openings.

9. Refrigerant expansion means for complementary heat exchange elements through which refrigerant successively flows in one direction or the other whereby in one direction of flow one of said elements functions as a condenser and the other element as an evaporator, and vice versa for opposite direction of flow, comprising, in combination, a pair of pipes connected to said heat exchange elements, a plurality of orifices one of which is connected in series with one pipe and the other of which is connected in series with the other pipe, means forming a common passage connected in series with each of said orifices, liquid actuated float means for controlling said orifices, and means for bypassing fluid around one or the other of said orifices automatically in accordance with the direction of fluid flow through said heat exchange elements.

10. Refrigerant expansion means for complementary heat exchange elements through which refrigerant successively flows in one direction or the other whereby in one direction of flow one of said elements functions as a condenser and the other element as an evaporator, and vice versa for opposite direction of flow, comprising, in combination, a pair of pipes connected to said heat exchange elements, a plurality of orifices one of which is connected in series with one pipe and the other of which is connected in series with the other pipe, means forming a common passage connected in series with each of said orifices, liquid actuated float means for controlling said orifices, a bypass around one of said orifices connecting one of said pipes with said common space, and a bypass for the other orifice connecting the other pipe with said space.

11. The combination set forth in claim 10 fur-

ther characterized by the provision of check valve means for said bypasses whereby liquid refrigerant flows freely through one of said bypasses and is then expanded through the orifice associated with the other bypass.

12. The combination set forth in claim 10 further characterized by the provision of check valve means for said bypasses whereby liquid refrigerant flows freely through one of said bypasses and is then expanded through the orifice associated with the other bypass, and vice versa automatically in accordance with reversal of flow through the heat exchange elements.

13. The combination set forth in claim 10 further characterized in that a plurality of check valves is provided, one of which is for one bypass and the other of which is for the other bypass, said valves being arranged to permit free flow into said common space from each of said pipes.

14. The combination set forth in claim 10 further characterized in that a plurality of check valves is provided, one of which is for one bypass and the other of which is for the other bypass, said valves being arranged to permit free flow from said common space into said pipes.

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