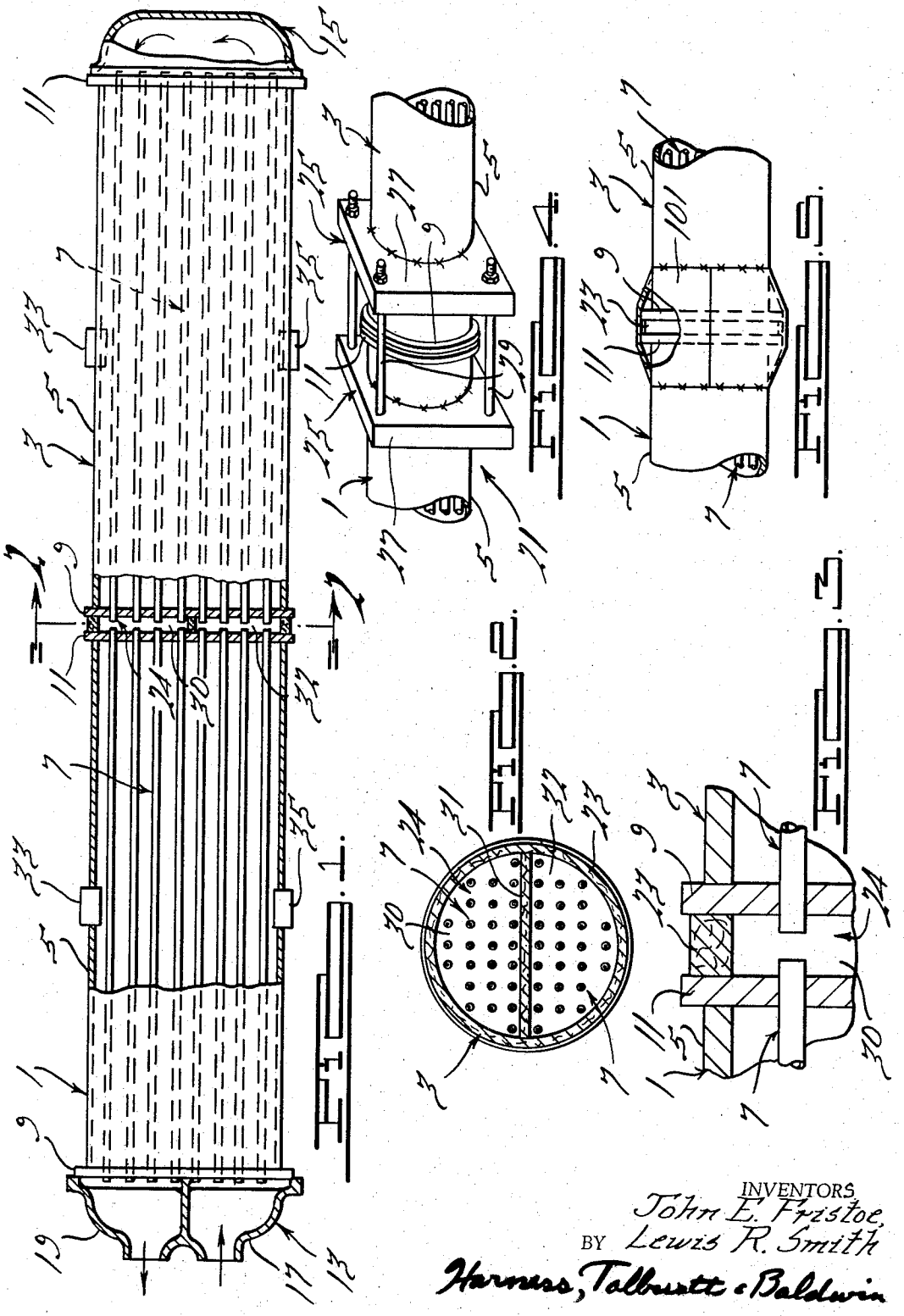
April 9, 1968 J. E. FRISTOE ET AL 3,376,917

CONDENSER FOR TWO REFRIGERATION SYSTEMS

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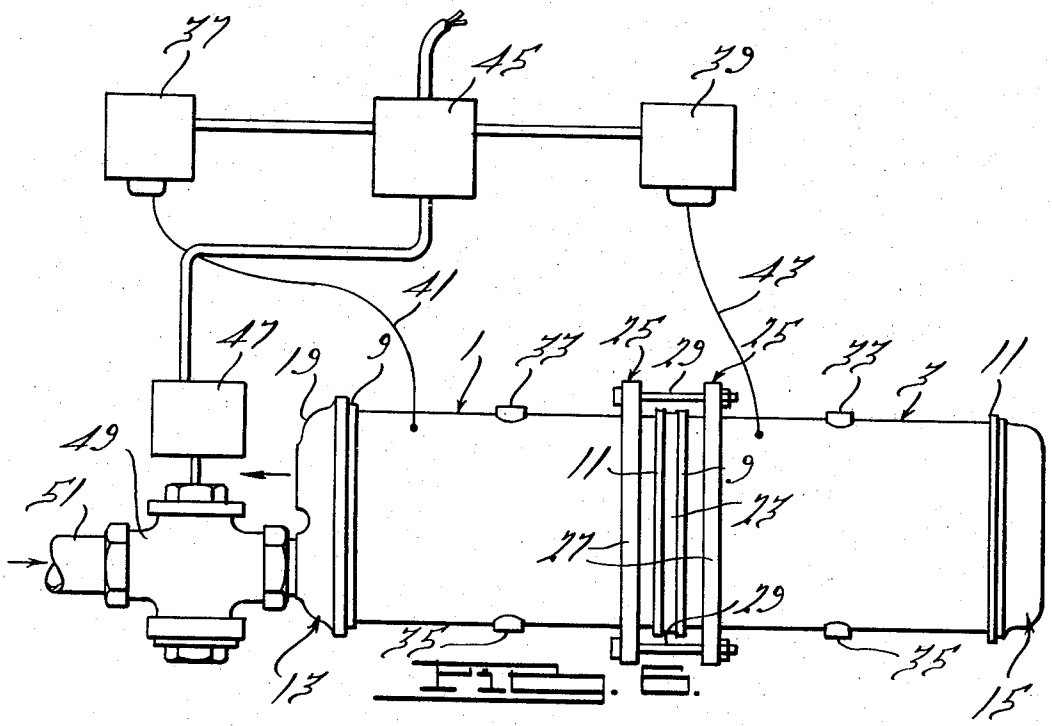


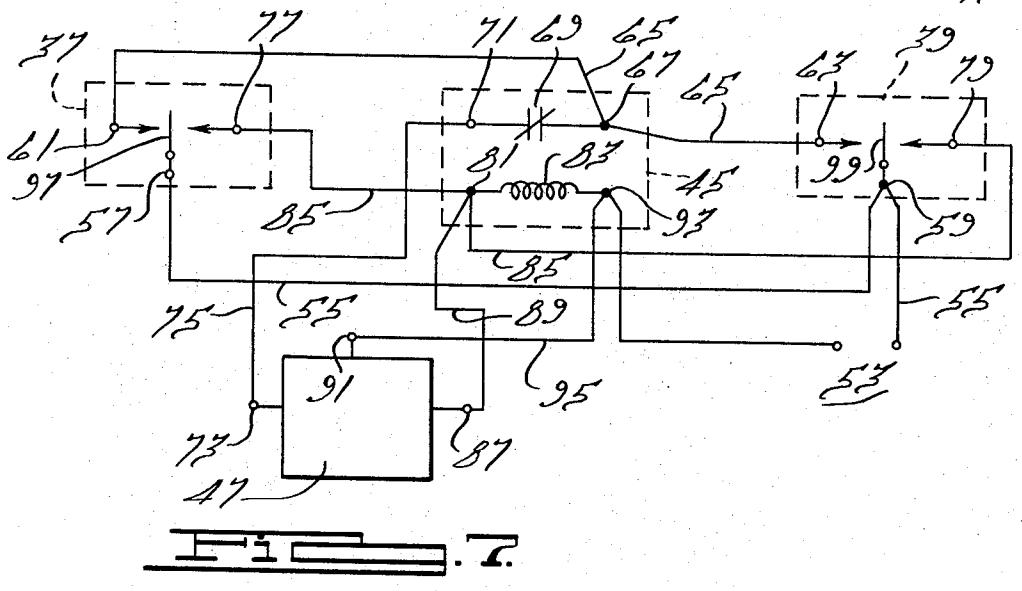
INVENTORS
John E. Fristoe,
BY Lewis R. Smith
Harness, Talbutt & Baldwin
ATTORNEYS

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INVENTORS
John E. Fristoe,
Lewis R. Smith

BY Harness, Talburtt & Baldwin

ATTORNEYS

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CONDENSER FOR TWO REFRIGERATION SYSTEMS

John E. Fristoe, Xenia, and Lewis R. Smith, Dayton, Ohio, assignors to Chrysler Corporation, Highland Park, Mich., a corporation of Delaware

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ABSTRACT OF THE DISCLOSURE

Condenser apparatus including two condenser units connected together in an end-to-end manner which allows refrigerant in two different refrigerant circuits to be condensed by circulating a common liquid supply through tubes in both of the condensers. Seals are provided between the condensers to maintain the refrigerants in the two circuits isolated from one another as they pass through the condensers.

This invention relates to heat exchangers, and more particularly to condenser apparatus adapted to condense refrigerant circulating in multiple and separate refrigeration circuits.

In systems requiring two or more water-cooled refrigerant condensers wherein the refrigerant of each circuit must be completely isolated from the other, it is conventional to use a separate condenser for each circuit. Each of these condensers requires two separate water headers for each condenser, one for the inlet end and one for the outlet end of the cooling passages. Thus, in a system employing two separate condensers, four water headers must be provided. The construction and utilization of apparatus necessary to provide four water headers is expensive. Moreover, the water piping for both condensers takes up a considerable amount of space. Since space is usually at a premium in installations of this type, any method of reducing the space required for condensing apparatus would be beneficial.

Accordingly, it is a primary object of this invention to provide condensing apparatus for condensing refrigerant circulating in two or more isolated circuits which reduces the number of water headers necessary for efficient operation of the refrigerant circuits.

Another object of this invention is to provide condensing apparatus of the type described which occupies less space than separate condenser arrangements.

A further object of this invention is to provide condenser apparatus such as described which reduces the space requirements for water piping connections compared with the space required for pipe connections using two or more separate condensers.

Still another object of this invention is to provide condensing apparatus such as described which is simple to mount, thus eliminating costly and complicated mounting structure usually accompanying apparatus of the multiple condenser type.

A further object of this invention is to provide condensing apparatus of the class described which is simple and economical in construction and reliable in operation.

Other objects and advantages of this invention will be made apparent as the description progresses.

In the accompanying drawings, in which two of various possible embodiments are illustrated,

FIG. 1 is a side elevation of apparatus constructed in accordance with this invention, certain parts being broken away and shown in section for clarity;

FIG. 2 is a section taken along line 2—2 of FIG. 1;

FIG. 3 is an enlarged fragmentary view of FIG. 1;

FIG. 4 is a perspective view illustrating one type of connection used to join two sections of the invention together;

FIG. 5 is a side elevation of another type of connection used to join two sections together;

FIG. 6 is a side elevation of the apparatus illustrating the water delivery controls for the apparatus; and

FIG. 7 is an electrical circuit diagram for the water delivery controls.

Like parts are referred to by corresponding reference characters throughout the several views of the drawings.

Referring now to the drawings, the condensing apparatus of this invention is generally shown in FIG. 1 to comprise two or more condensers **1** and **3** connected together end-to-end in a manner which allows refrigerant in two different refrigerating circuits to be condensed by circulating a common water supply through both of the condensers, the refrigerants in the two circuits remaining isolated from one another as they pass through the condensers.

Each condenser **1** and **3** includes a conventional shell **5** and tube or conduit assembly **7**. The tubes **7** are connected by brazing, for example, to tube sheets **9** and **11** located at opposite ends of each condenser. An inlet and outlet water manifold or header member **13** is secured to condenser **1** adjacent its tube sheet **9** and a return manifold or header member **15** is connected to condenser **3** adjacent its tube sheet **11**. The inlet portion of manifold **13** is indicated at **17** and the outlet portion is indicated at **19**.

The adjacent ends of condensers **1** and **3** are joined together by a sealing and clamping device, one embodiment of which is indicated at **21** in FIG. 4. It includes a gasket **23** compressed between the adjacent tube sheets **9** and **11** to provide a space **24**. Gasket **23** prevents leakage of water from the space **24**. The tube patterns in each condenser are aligned with one another. The device **21** shown in FIG. 4 also includes plates **25**, secured by welding, for example, to each condenser shell **5**, and providing shoulders or flanges **27** through which bolts **29** extend for tightening the joint between the condensers. The bolts **29**, in addition to compressing gasket **23**, also provide a means for drawing the condensers together. Another gasket **31** extends diametrically across the condensers **1** and **3** between tube sheets **9** and **11** to divide the space **24** into two compartments **30** and **32**. Gasket **31** prevents the transfer of any water from the upper tubes in compartment **30** to the lower tubes in compartment **32** and vice versa.

Refrigerant inlets **33** are provided in the upper side of each shell **5** for receiving refrigerant gas from the compressors of each of the refrigerant systems. Refrigerant outlets **35** are also provided in the bottom of each shell **5** for discharging liquid refrigerant from the condensers to the respective evaporators of the refrigerant systems.

Condenser refrigerant pressure in each condenser **1** and **3** can be controlled by metering the common water supply to the condensers with the control apparatus shown in FIG. 6. This apparatus includes pressure control switches **37** and **39** connected by pressure lines **41** and **43**, respectively, to sense the pressure of refrigerant in condensers **1** and **3**, respectively. Pressure control switches **37** and **39** are electrically connected to a normally closed relay **45** which controls the operation of a reversible motor **47**. The motor **47** operates a valve **49** located in a water line **51** connected to the inlet portion **17** of manifold **13**.

An electrical circuit diagram for the control apparatus is shown in FIG. 7 and includes a power source **53**. A line **55** interconnects terminals **57** and **59** of switches **37**

and 39, respectively, to power source 53. Terminals 61 and 63 of switches 37 and 39 are interconnected by a line 65 with a terminal 67 of the normally closed switch 69 of relay 45. The other terminal 71 of switch 69 is connected to one reversing terminal 73 of reversible motor 47 by a line 75. Terminals 77 and 79 of switches 37 and 39 are interconnected with a terminal 81 of the coil 83 of relay 45 by a line 85. Terminal 81 is also connected to a reversing terminal 87 of motor 47 by a line 89. The common terminal 91 of motor 47, a terminal 93 of coil 83 and the power source are joined together by a line 95. The arms 97 and 99 of switches 37 and 39 are controlled by the refrigerant pressure in the condensers 1 and 3, respectively. When the pressure of the refrigerant in either of the condensers 1 and 3 increases beyond a predetermined point the respective switch arm 97 or 99 is swung clockwise as viewed in FIG. 7 to connect line 55 with line 85. When the pressure of refrigerant in either of the condensers 1 and 3 drops below a predetermined value, the respective switch arm 97 or 99 swings counterclockwise to interconnect line 55 with line 65.

Operation of the apparatus of this invention is as follows:

It is to be assumed that the shells 5 of condensers 1 and 3 are connected into separate refrigeration circuits and that the end-to-end connection of the condensers is sealed by gaskets 23 and 31 to prevent leakage. It may also be assumed that the tubes 7 and manifolds 13 and 15 are substantially full of water, i.e., the condenser apparatus is flooded.

If the pressure of the refrigerant entering on of the condenser units rises, such as the refrigerant pressure in condenser 1 for example, switch arm 97 swings clockwise as viewed in FIG. 7 and interconnects lines 55 and 85. This connects terminals 87 and 91 to the power source and the motor 47 is energized to open the valve 49, thereby increasing the flow of water to the condenser tubes 7. Coil 83 is also energized, thereby opening switch 69. This prevents the closing of an electrical circuit to terminal 73 of motor 47 even if the switch arm 99, which is under the control of refrigerant pressure in condenser 3, should swing counterclockwise to connect line 55 to line 65, thereby indicating low pressure in condenser 3. Since the condenser 1, which has a higher refrigerant pressure, causes the control system to override the signal from the condenser 3, which has a lower refrigerant pressure, the pressure of the refrigerant in condenser 3 therein will drop lower due to the increased water flow through the tubes 7 in response to the signal from condenser 1. While this may slightly affect the operation of the refrigeration system in which the condenser 3 is located, such a change does not significantly affect the operation of such system. The water flows through the inlet 17 and the lower group of tubes 7 in condenser 1 to the compartment 32 between the adjacent tube sheets 9 and 11. The water then flows through the lower group of tubes 7 in condenser 3 into the return manifold 15. From the manifold 15 the water flows back through the upper group of tubes 7 in condenser 3 to the compartment 30 between tube sheets 9 and 11 above gasket 31. From this compartment, the water flows through tubes 7 in condenser 1 to the outlet portion 19 of manifold 13 from which it passes back to the water system.

If the refrigerant pressure in condenser 1 decreases beyond a predetermined value, the switch arm 97 is swung counterclockwise as viewed in FIG. 7 until line 55 is connected with line 65. Assuming switch 39 is in an open position, terminal 73 of motor 47 is connected to the power source through lines 75, 65 and 55. This energizes motor 47 in a reverse direction and closes valve 49, thereby decreasing the flow of water to the condensers. However, if the refrigerant pressure in condenser 3 is above the predetermined value and the switch arm 99 has connected lines 55 and 85, relay switch 69 is opened, thereby opening the circuit to terminal 73 of the motor 47, and terminal 87 is connected to power source 53 through lines 89, 85 and 55. The motor then reverses and valve 49 is opened in accordance with the water demands of condenser 3. The water demands of condenser 1 are thus overridden.

A second form of connection between condenser 1 and 3 is shown in FIG. 5. It includes a gasket 23 between tube sheets 9 and 11 in the same manner as the connection shown in FIG. 4. A steel band 101, formed of two semicircular pieces, is placed around the condenser shells 5 over the gasket and tube sheets and the edges of the band are welded to the shells. The rigidity of the band must be high enough to maintain the gasket 23 in a sealed condition. The band should have a width great enough to prevent the welding heat from adversely affecting the physical properties of gasket 23.

It will be seen that the condenser apparatus of this invention eliminates the need for inlet and outlet headers at opposite ends of each condenser, as well as eliminating several water piping connections normally required when separate condenser units are employed in multiple refrigeration systems.

Rather than providing two water passes through the condenser apparatus, i.e., from inlet 17 to header 15 and back to outlet 19, it will be understood that the headers and the gasket 31 between tube sheets 9 and 11 could be designed to provide additional passes through the condensers before being discharged therefrom. Furthermore, the water control system could utilize two separate valves each controlled by a different condenser, or even a single valve controlled directly by refrigerant pressures in the condensers. Thus, the water control system of this apparatus could be in several different forms.

In view of the foregoing, it will be seen that the various objects and other advantages are obtained.

It will be understood that the invention is not to be limited to the exact constructions shown and described, but that various changes and modifications may be made without departing from the spirit and scope of the invention, as defined in the appended claims.

We claim:

1. Condenser apparatus comprising first and second condenser units, each unit including a plurality of liquid carrying tubes, each unit also having af refrigerant inlet and a refrigerant outlet, the inlet and outlet of said first unit being adapted to be connected to one refrigerant circuit and the inlet and outlet of the said second unit being adapted to be connected to another refrigerant circuit, means connecting said units end-to-end to permit the transfer of liqiud from tubes in said first unit to tubes in said second unit and to prevent the transfer of refrigerant from one unit to the other, means for delivering liquid into certain tubes in said first unit, means for directing liquid flowing through said certain tubes in said first unit into certain tubes in said second unit and then back through other tubes into said second unit into other tubes in said first unit, and control means for controlling the rate of flow of liquid into said certain tubes in said first unit in response to refrigerant pressure in each of said condenser units.

2. Condenser apparatus as set forth in claim 1 wherein said control means includes a valve for controlling the rate of flow of liquid into said means for delivering liquid into said certain tubes in said first condenser unit, a motor for operating said valve, and pressure responsive means connected to each condenser unit and adapted to actuate said motor to open said valve when the refrigerant pressure in either of said condenser units exceeds a first predetermined value.

3. Condenser apparatus as set forth in claim 2 wherein said pressure responsive means includes means for actuating said motor to close said valve when the refrigerant pressure in either one of said condenser units falls below a second predetermined value if the refrigerant pressure in the other condenser unit is below said first predetermined value.

4. Condenser apparatus as set forth in claim 3 wherein said control means further includes means operable when the refrigerant pressure in one of said condenser units is above said first predetermined value for preventing actuation of said motor in a manner which would close said valve.

5. Condenser apparatus as set forth in claim 1 wherein said means connecting said units end-to-end includes a gasket forming an enclosed space between said ends, said means for directing liquid flowing into certain tubes in said second unit and then back through other tubes in said second unit into tubes in said first unit comprising a gasket extending across said units between the adjacent ends thereof dividing said space into two compartments, said certain tubes in said first unit and second units opening into one of said compartments, said other tubes in said first and second units opening into the other compartment, and a return header attached to said second unit for directing liquid from said certain tubes in said second unit into said other tubes in said second unit.

6. Condenser apparatus as set forth in claim 5 wherein said control means includes a valve for controlling the rate of flow of liquid into said means for delivering liquid into said certain tubes in said first condenser unit, a motor for operating said valve, and pressure responsive means connected to each condenser unit and adapted to actuate said motor to open said valve when the refrigerant pressure in either of said condenser units exceeds a first predetermined value.

7. Condenser apparatus as set forth in claim 6 wherein said pressure responsive means includes means for actuating said motor to close said valve when the refrigerant pressure in either one of said condenser units falls below a second predetermined value if the refrigerant pressure in the other condenser unit is below said first predetermined value.

8. Condenser apparatus as set forth in claim 7 wherein said control means further includes means operable when the refrigerant pressure in one of said condenser units is above said first predetermined value for preventing actuation of said motor in a manner which would close said valve.

9. Condenser apparatus comprising first and second condenser units, each unit also having a refrigerant inlet and a refrigerant outlet, the inlet and outlet of said first unit being adapted to be connected to one refrigerant circuit and the inlet and outlet of the said second unit being adapted to be connected to another refrigerant circuit, water conduit means extending through both condensers to permit the flow of water first through said first unit and then through said second unit, and control means for controlling the rate of flow of water through said conduit means in response to refrigerant pressure in each of said units.

10. Condenser apparatus as set forth in claim 9 wherein said water conduit means includes means for returning water flowing from said second unit back through said second unit and then through said first unit.

11. Condenser apparatus as set forth in claim 10 wherein said control means includes a valve for controlling

the rate of flow of water into said conduit means, a motor for operating said valve, and pressure responsive means connected to each condenser unit and adapted to actuate said motor to open said valve when the refrigerant pressure in either of said condenser units exceeds a first predetermined value.

12. Condenser apparatus as set forth in claim 11 wherein said pressure responsive means includes means for actuating said motor to close said valve when the refrigerant pressure in either one of said condenser units falls below a second predetermined value if the refrigerant pressure in the other condenser unit is below said first predetermined value.

13. Condenser apparatus as set forth in claim 12 wherein said control means further includes means operable when the refrigerant pressure in one of said condenser units is above said first predetermined value for preventing actuation of said motor in a manner which would close said valve.

14. Condenser apparatus as set forth in claim 9 wherein each of said units includes an elongate shell and tube sheets therein, said water conduit means comprising tubes supported by said tube sheets, said shells being positioned in an end-to-end relationship, one of the tube sheets in each shell being located adjacent the adjacent ends of the shells, sealing means between the tube sheets adjacent the adjacent ends of the shells, means for maintaining compression on said sealing means comprising flanges extending outwardly from the adjacent ends of said shells, and means extending between said flanges for shortening the distance therebetween to compress said sealing means.

15. Condenser apparatus as set forth in claim 9 wherein each of said units includes an elongate shell and tube sheets therein, said water conduit means comprising tubes supported by said tube sheets, said shells being positioned in an end-to-end relationship, one of the tube sheets in each shell being located adjacent the adjacent ends of the shells, sealing means between the tube sheets adjacent the adjacent ends of the shells, means for maintaining compression on said sealing means comprising a band surrounding said sealing means and said shells adjacent said adjacent ends of said shells, the edges of said band being welded to the adjacent shells to hold said sealing means in compression.

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MEYER PERLIN, *Primary Examiner.*

A. W. DAVIS, *Assistant Examiner.*