May 9, 1933. J. J. SHIVELY 1,907,885

REFRIGERATION SYSTEM AND METHOD

Filed June 7, 1927 3 Sheets-Sheet 1

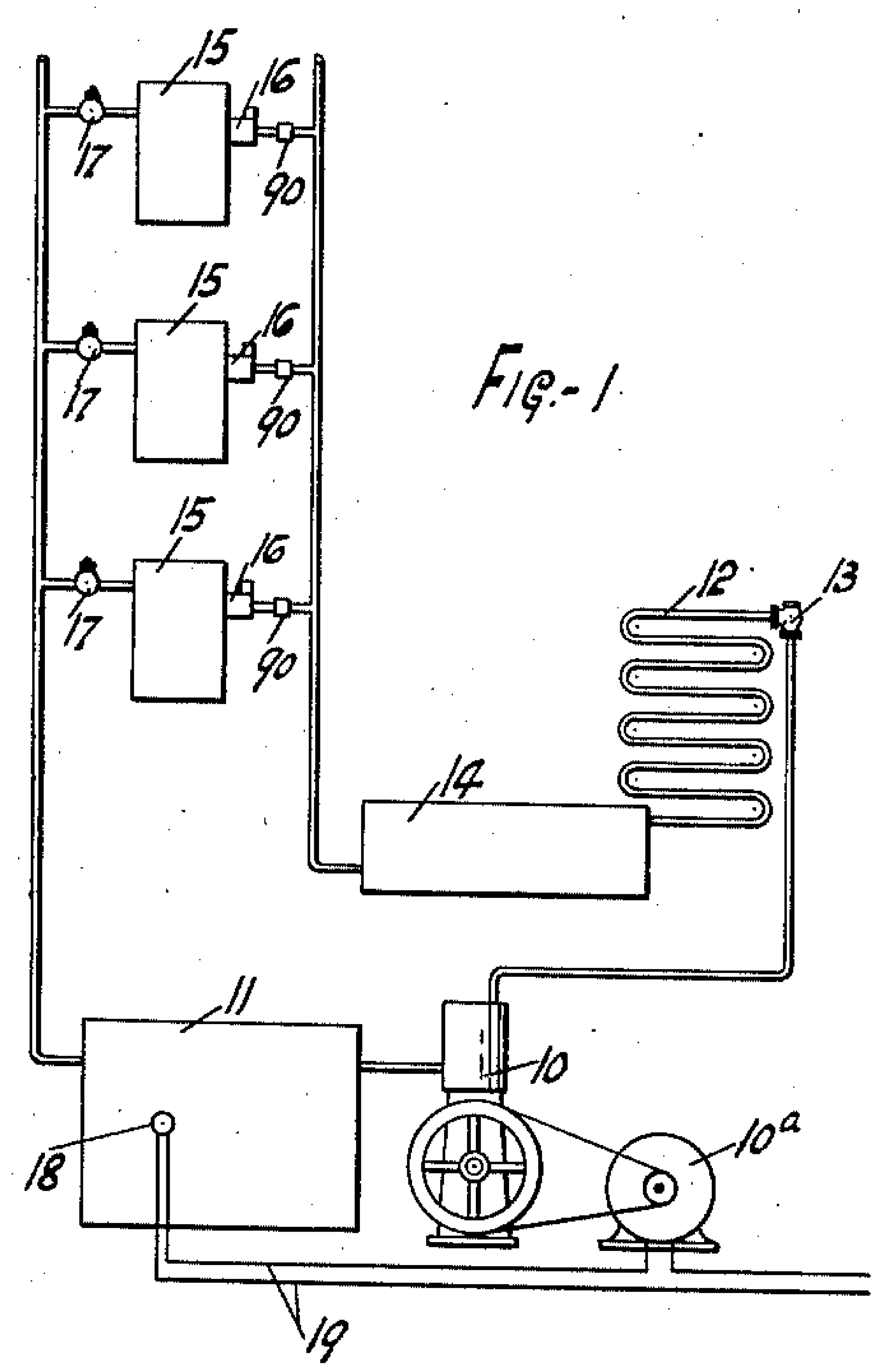

FIG.-1

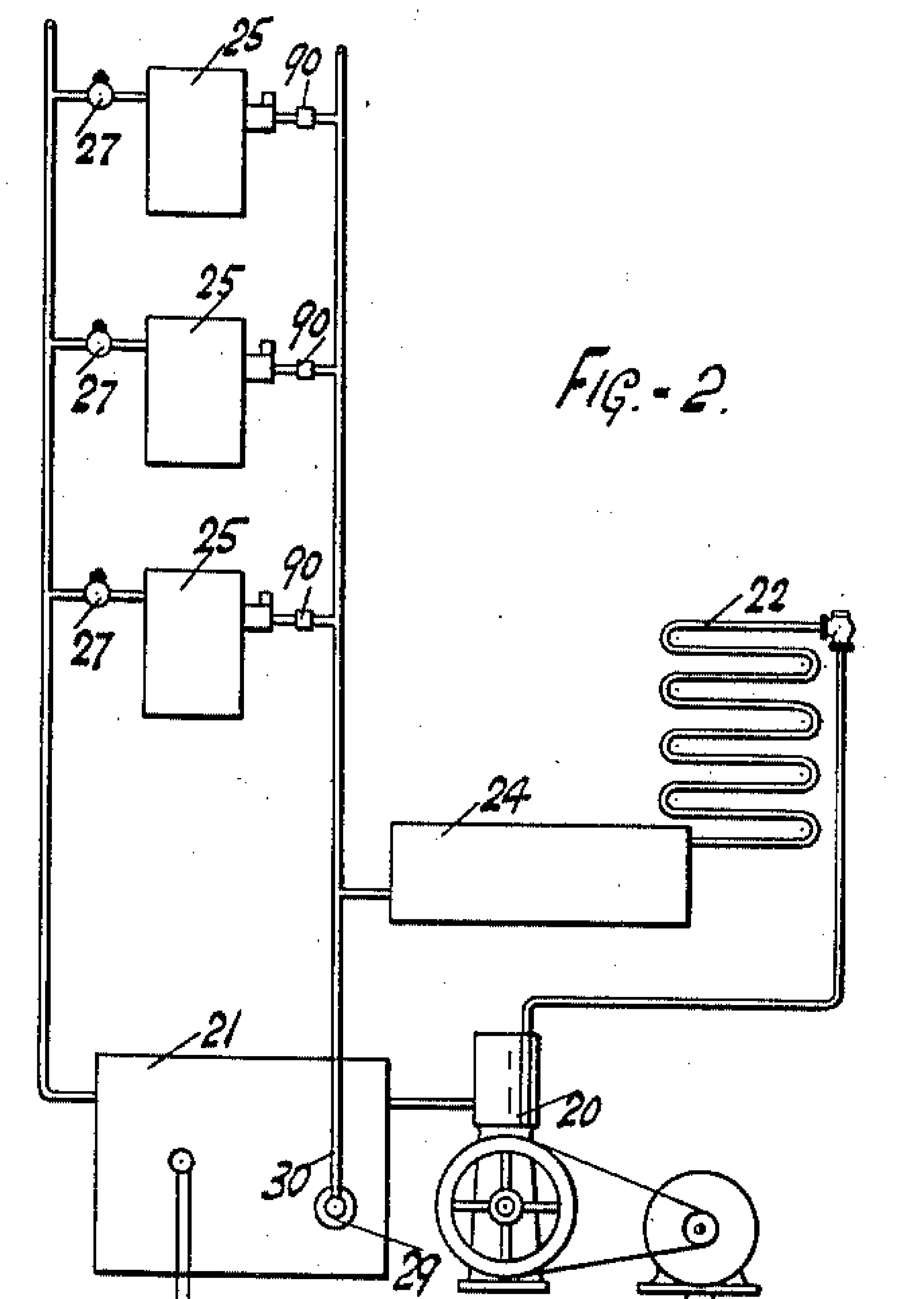

FIG.-2.

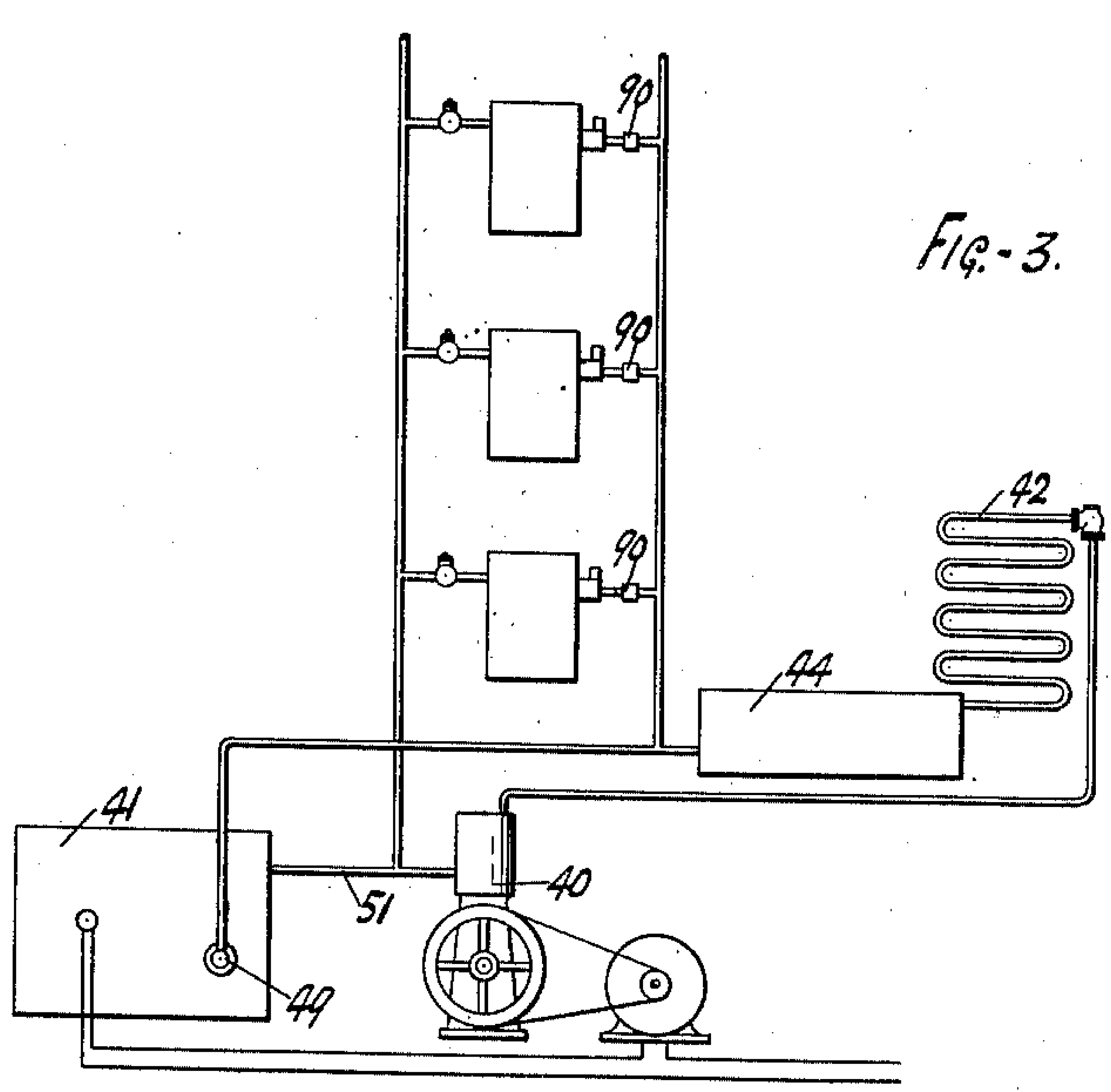

FIG.-3.

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REFRIGERATION SYSTEM AND METHOD

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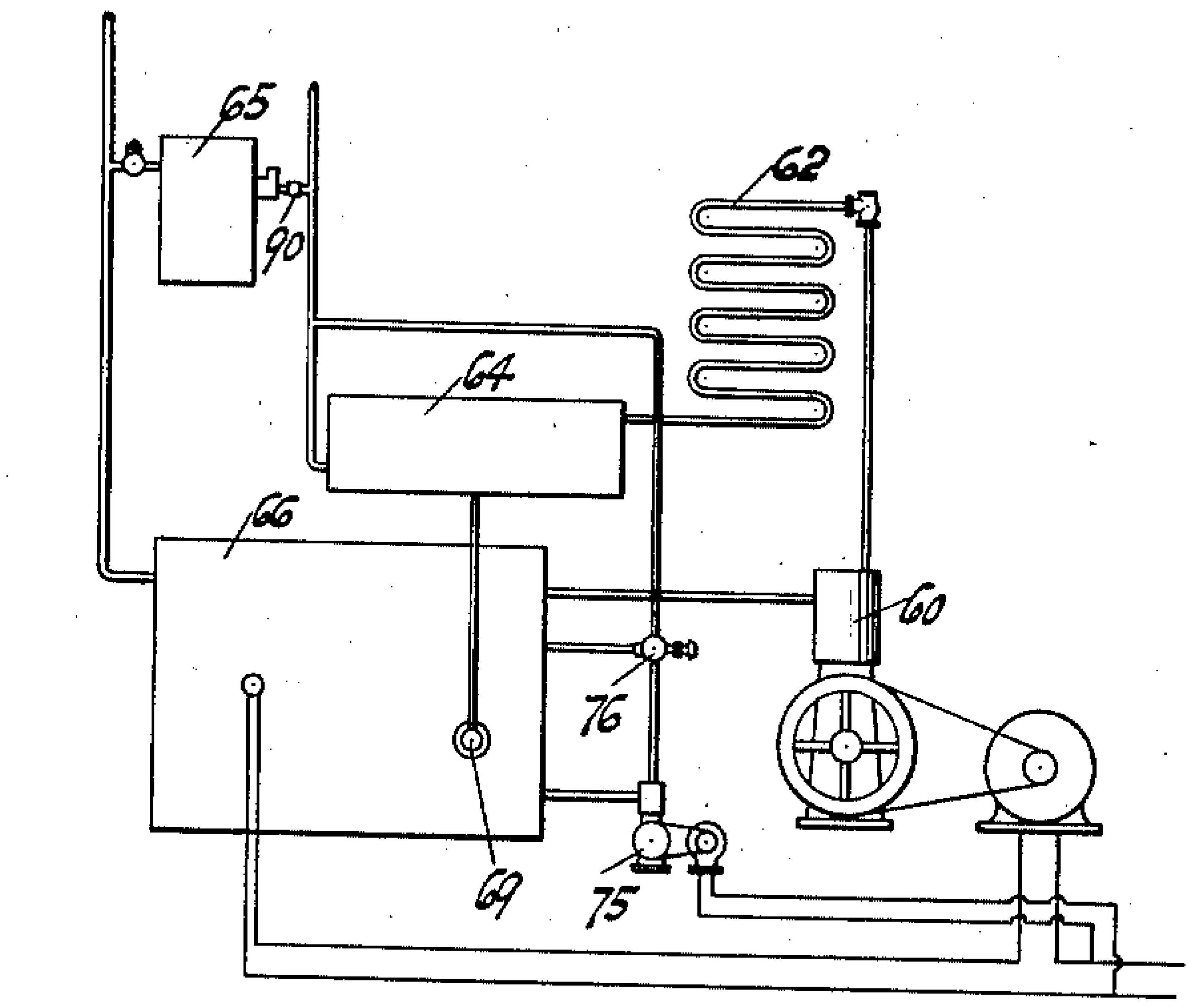

FIG. - 4

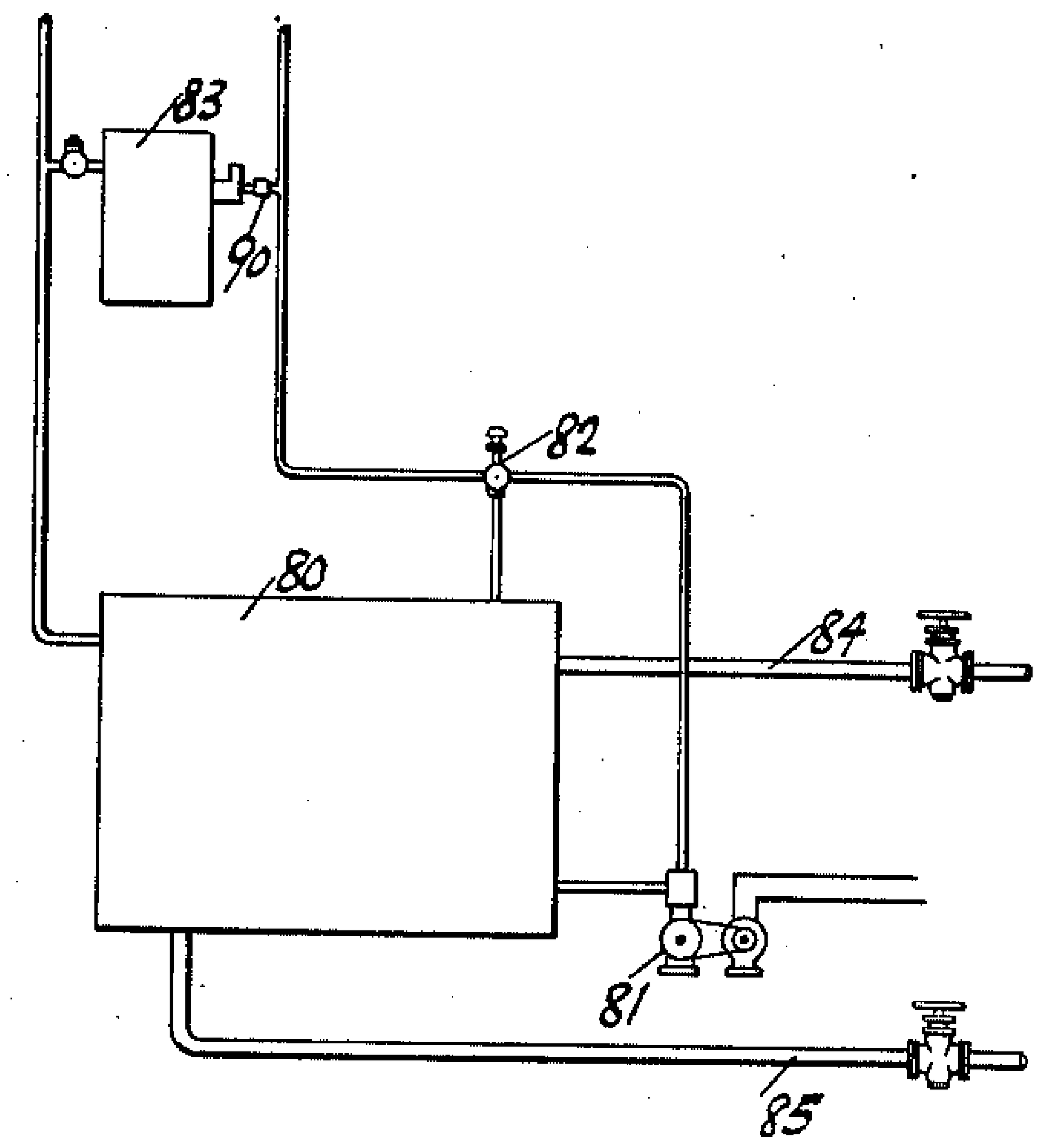

FIG. - 5.

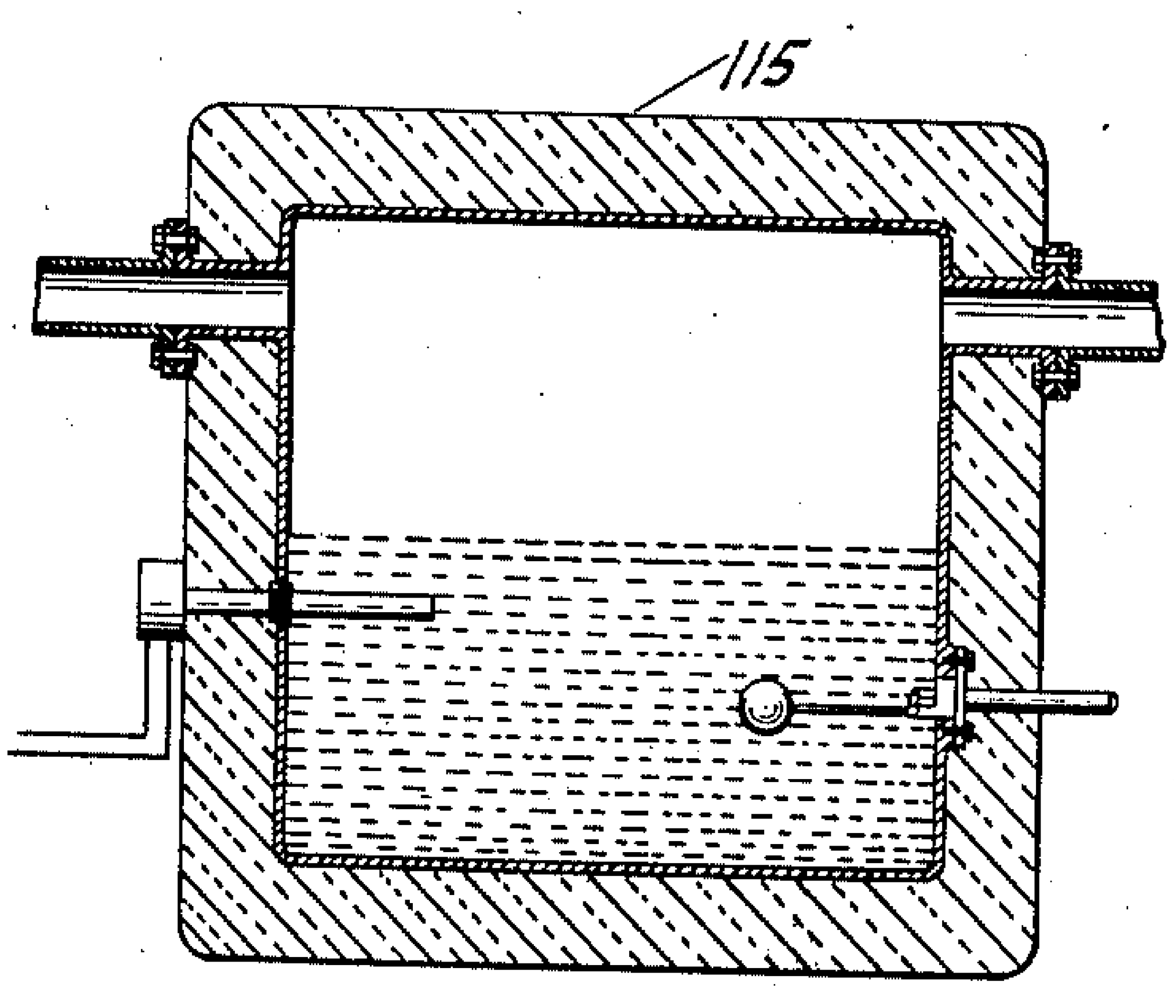

FIG. - 8.

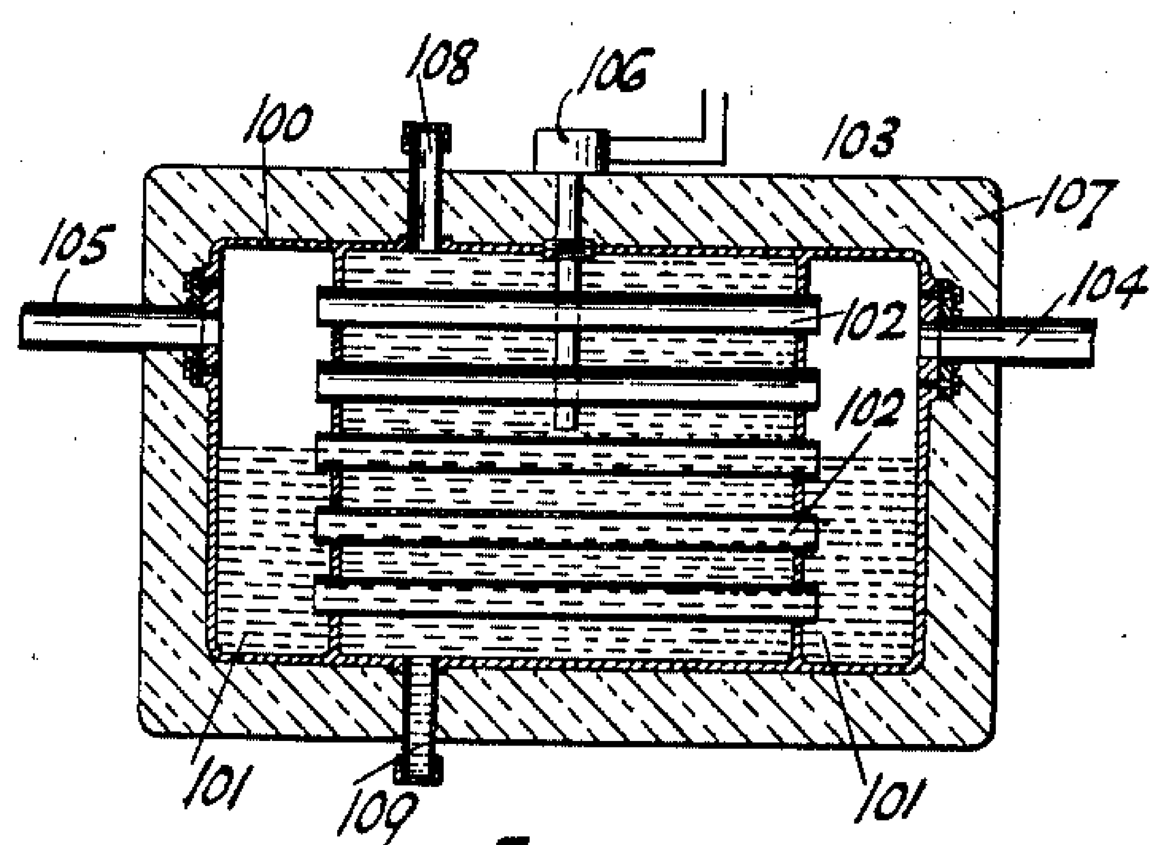

FIG. - 6.

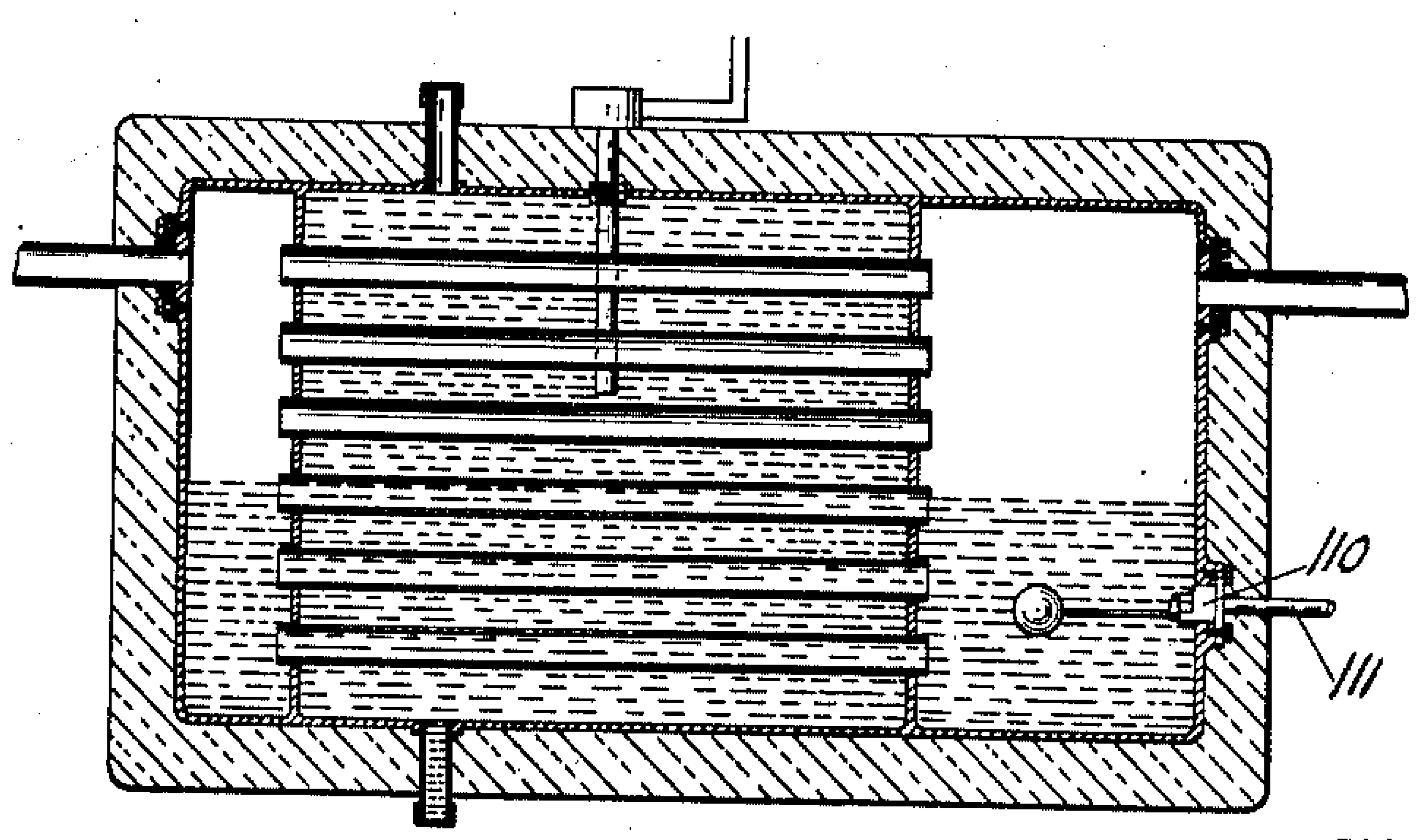

FIG. - 7

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REFRIGERATION SYSTEM AND METHOD

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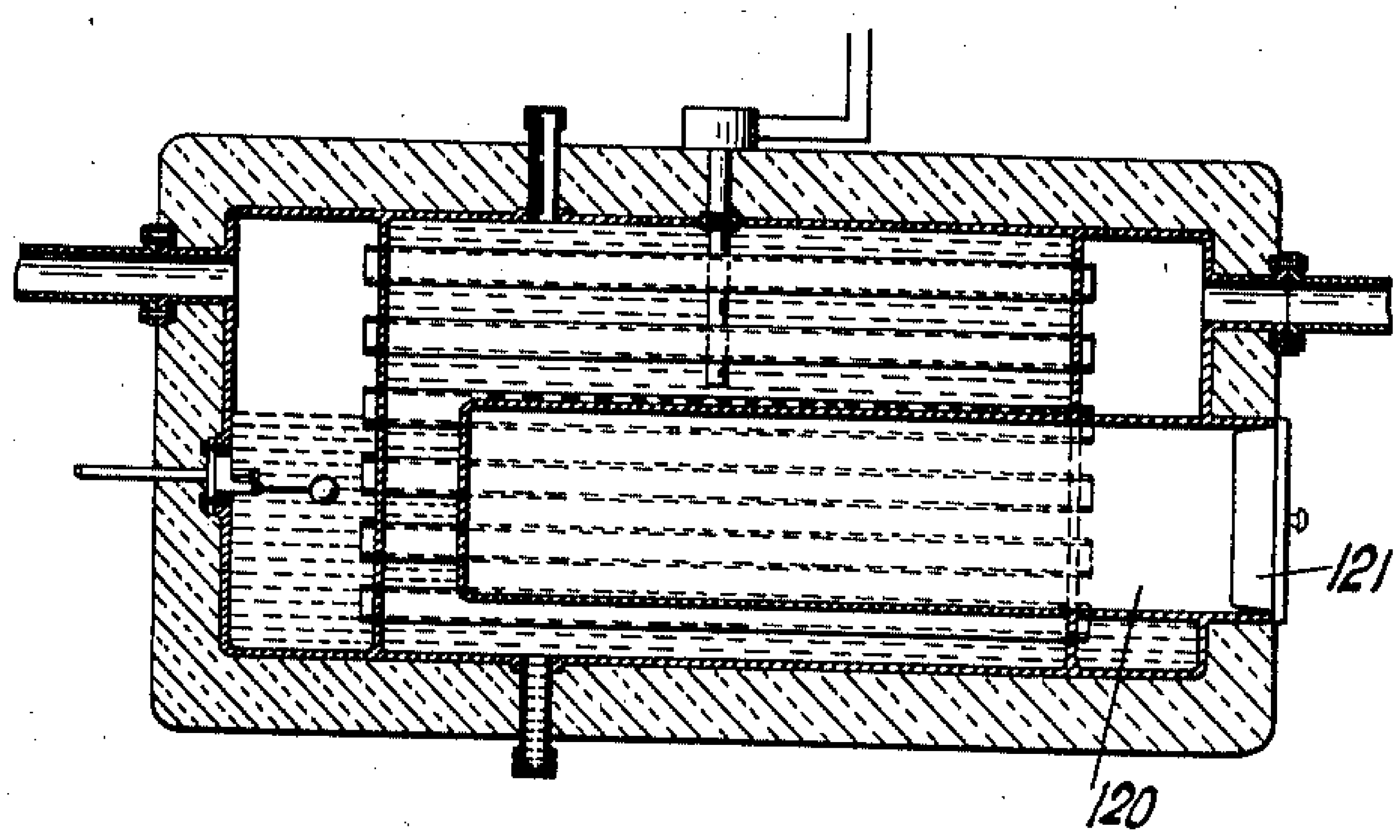

Fig.-9.

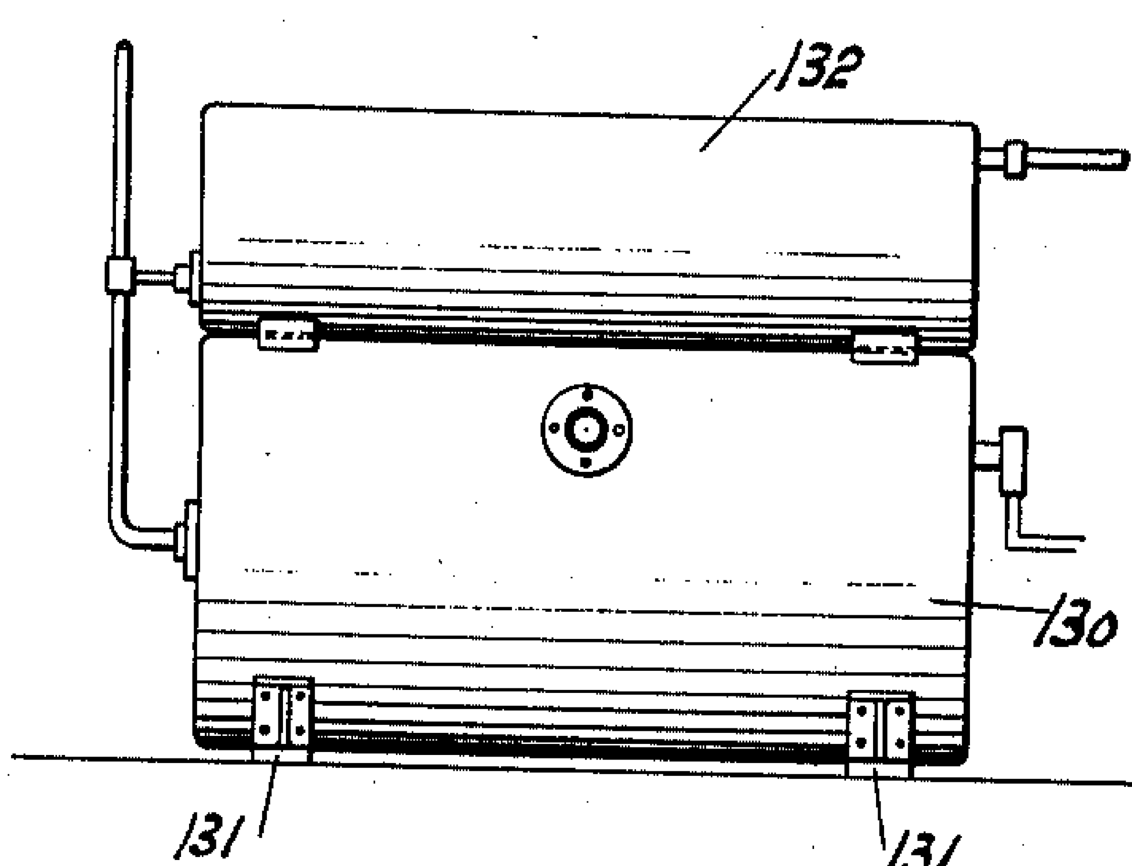

Fig.-10.

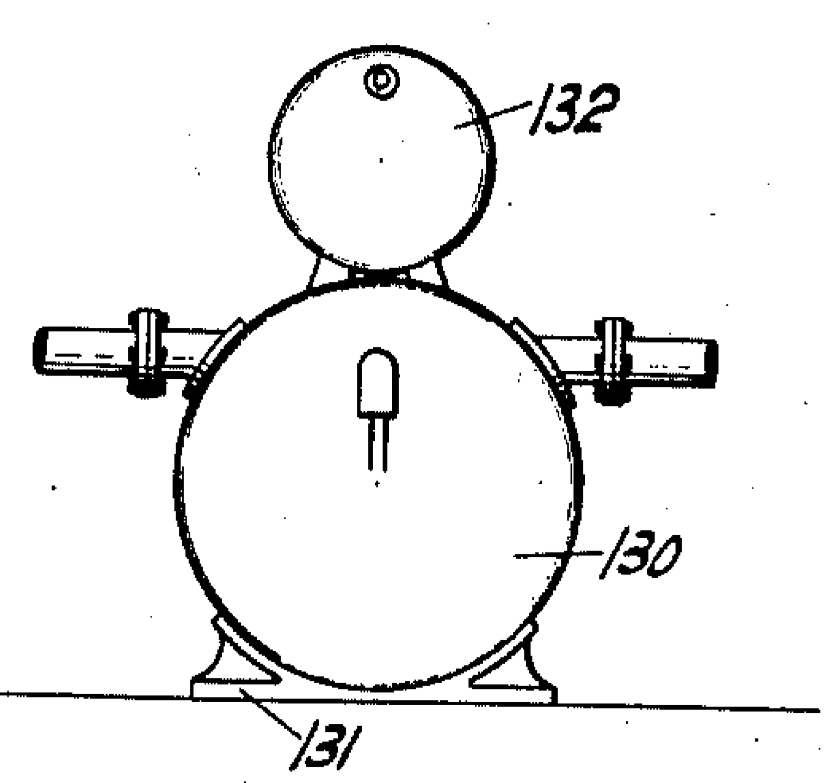

Fig.-11.

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UNITED STATES PATENT OFFICE

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REFRIGERATION SYSTEM AND METHOD

Application filed June 7, 1927. Serial No. 197,147.

This invention relates to methods and apparatus for use in mechanical refrigeration.

The general purpose of the invention is to provide an improved method for furnishing refrigeration to one or more coolers, such as, for example, in a system for use in apartment houses, etc., and also to provide an improved apparatus for carrying out the method.

Heretofore in such systems it was required that the compressors either shall run continuously or shall start up when any one unit requires cooling, both types being inefficient in that more refrigeration is usually furnished to all or the majority of the units than is required, and the latter type is objectionable because of the frequent startings and stoppings of the compressor. Brine circulation systems are also objectionable because of corrosion, large amount of insulated pipe, etc.

Particularly the present invention is directed to a method and apparatus whereby the various coolers may be kept at determinate temperatures at all times, or may even be cut out altogether independently of the compressor and the latter will run only sufficiently to keep the refrigerant sufficiently cold to maintain the temperatures in the cooler units. The aggregate running of the compressor, of course, will be enough to cool all units as desired, but continuous running or frequent starts and short runs will be eliminated and each unit will regulate itself and maintain its set temperature whether the machine is running or not. By proper proportioning of the volume of refrigerant and cooling surfaces, the running periods can be made whatever desired, as, for example, by using a large volume of storage medium, the running periods can be made long and the stopping periods correspondingly long.

More particularly, the invention has for its object the provision in a refrigeration system of what might be termed a refrigeration accumulator, and any desired number of cooling units independently regulatable to dispense with operation of the compressor in response to demands of individual cooling units, without the use of brine circulation to coolers.

The foregoing and other purposes or objects are attained by the practice of the method and the use of apparatus such as described herein and illustrated in the accompanying drawings. It is to be understood, however, that the invention is not limited to the particular forms described or illustrated.

Of the accompanying drawings,

Figure 1 is a diagrammatic view of a simple form of a system embodying and adapted to carry out the invention;

Figure 2 is a similar view of a second form of such system;

Figure 3 is a similar view of a third form of such system;

Figure 4 is a similar view of a fourth form of such system;

Figure 5 is a similar view of a fifth form of such system;

Figure 6 is a section through an accumulator embodying the invention;

Figure 7 is a similar view through a second form of accumulator;

Figure 8 is a similar view of a third form of accumulator;

Figure 9 is a similar view of a fourth form of accumulator; and

Figures 10 and 11 are respectively side and end elevations of an accumulator and receiver unit adapted especially for installation in existing systems.

Referring to Figure 1 of the drawings, the numeral 10 indicates a compressor, the suction side of which is connected to an accumulator 11 for storing a large volume of any suitable refrigerant. The compressor 10 is connected to a condenser 12 through a check valve 13, the condensed refrigerant being delivered to a receiver 14 which is designed to supply refrigerant to all coolers during the time the compressor is stopped, the coolers indicated at 15, 15 being connected to receiver 14 through float or expansion valves 16, 16. The cooler units 15 are, in turn, connected to accumulator 11 through suitable, independently regulatable valves 17, 17 of a known type which can be set to open to the suction when the cooler unit pressure rises to a predetermined point. A thermostat or pressure switch at 18 is connected by leads 19 in the circuit of a compressor driving motor 10[a] to start and stop the motor in accordance with a set pressure and corresponding temperature in the accumulator 11.

Upon starting this system, a body of refrigerant being in accumulator 11 and receiver 14, the compressor 10 will be driven, drawing vapor from the suction side, forcing it through the condenser 12 through the check valve 13 into the receiver 14 and from the latter into the units 15, 15. The vapor is drawn from coolers 15 and also accumulator 11, until the coolers reach the pressure and corresponding temperature for which valves 17 are set, the valves then shutting them off from the line. After all the coolers shut off, the compressor continues to run until it reaches a set pressure and temperature, preferably at a point considerably below the temperature of the coolest unit 15 when, by the action of a thermostat or pressure switch at 18, the compressor is shut off.

The accumulator 11 is highly insulated to remain at a low temperature, but the coolers being required to cool foods, etc., warm up. As soon as any cooler warms up sufficiently so that its pressure opens a valve 17, vapor is exhausted from that cooler into the accumulator and gives up its heat to the storage medium therein and is condensed. The accumulator being always at a lower temperature than any cooler, the vapor continues to flow into it with evaporation and consequent cooling in the unit until its regulating valve 17 shuts off.

All coolers 15 will feed to the accumulator 11 under control of their valves 17 until sufficient heat has been absorbed by the accumulator to trip the thermostat or pressure switch at 18 and start the motor and compressor. The setting of the switch is such that it is tripped before the accumulator can rise in temperature to that of the coolest box.

The check valve 13 is employed to maintain liquid pressure in the delivery line to the coolers while the compressor is stopped, the receiver 14 providing a supply of liquid to all coolers 15 as it is evaporated therefrom into the accumulator 11.

Figure 2 illustrates a similar system including compressor 20, condenser 22, receiver 24, cooler units 25, regulating valves 27 and accumulator 21. A float valve 29 is provided in a connection 30 between the receiver 24 and the accumulator and is operable by a drop in the level of the refrigerant in accumulator 21 below a determinate point to render the system fully automatic.

The operation of the system shown in Figure 2 is similar to that of Figure 1, with the additional control float valve between the receiver and accumulator arranged to keep the system balanced. A small amount of heat will leak into the accumulator so that it is necessary to evaporate a slightly larger amount of liquid therein than that supplied by the coolers. This will cause a gradual drop in level in the accumulator, and in extreme cases, as when many coolers are shut down, the amount of liquid will be insufficient to cool the accumulator, so that the compressor would not stop. By utilizing the float valve or other suitable control valve, such as an expansion valve, liquid enters the accumulator directly from the receiver as required and preserves the balance of the system.

The system illustrated in Figure 3 is similar to that shown in Figure 2 and includes a compressor 40, condenser 42, receiver 44 and an accumulator 41 having a float control valve 49, the accumulator, however, being arranged in a branch line 51 instead of between the coolers and compressor. In the operation of this system, during the time while the compressor is running, vapor feeds from the accumulator to the compressor as before, but when the compressor stops, the vapor flow in line 51 reverses, the vapor flowing from the coolers to the accumulator. Otherwise the system operates the same as that previously described.

For very large installations, a system such as disclosed in Figure 4 may be provided. This is similar to that shown in Figure 2 and includes compressor 60, condenser 62, receiver 64, coolers 65, accumulator 66, float control valves 69, etc. In such systems, to provide sufficient receiver capacity to supply all coolers would be expensive and call for a very large volume of refrigerant. To obviate this objection, a small liquid pump 75 is arranged to deliver liquid from the accumulator 66 to the liquid line when the compressor is stopped, an automatic or pressure controlled by-pass valve 76 maintaining the desired pressure in the line by feeding the excess refrigerant back into the accumulator.

Figure 5 shows a system embodying the invention in which the accumulator 80 provides a volume of refrigerant which a liquid pump 81 is arranged to deliver from the accumulator into the line, an automatic by-pass valve 82 being arranged to maintain the desired line pressure for coolers 83 which exhaust into the accumulator as in the previously described forms. The accumulator 80, instead of being connected in a compressor-condenser system, is arranged to be cooled by an outside source, such as a brine system, connection of the accumulator to the brine system being indicated at 84 and 85. In this case, the accumulator is, in effect, a condenser for the system.

In any of the systems described above, the amount of refrigeration furnished each cooler may be determined by arranging meters 90, 90 in the cooler branch lines.

A suitable accumulator of simple form is disclosed in Figure 6. This comprises a casing 100 containing liquid compartments 101, 101 at each end connected by tubes 102, 102 extending through a central chamber which may contain a volume of brine 103. Inlet and outlet pipes 104 and 105 are arranged near the top of the end compartments or headers 101 for the systems shown in Figures 1 and 2, only one such pipe being employed in a system such as shown in Figure 3. The numeral 106 represents a thermostat which may be inserted in any desired manner and of which a pressure operated switch is the equivalent. The accumulator is, of course, heavily insulated as indicated at 107. Plugs 108 and 109 are provided to permit filling and emptying of the brine chamber 103.

A similar accumulator is shown in Figure 7 with a float valve 110 added thereto and having a pipe connection 111 with a receiver as illustrated in the systems of Figures 2, 3 and 4.

Figure 8 discloses an accumulator 115 similar to the previously described forms with the exception that the brine chamber is omitted, a large volume of refrigerant being used. This accumulator is best adapted for small systems.

Since the accumulator temperature is always lower than the cooler units, freezing of liquids, such as water for ice, and also freezing of desserts, etc., may be arranged for by providing an accumulator such as shown in Figure 9 with a freezing compartment 120 having a closure 121 and in which the usual trays (not shown) may be mounted.

A compact unit to facilitate installation of the systems disclosed herein and especially to adapt old systems for practicing the invention is illustrated in Figures 10 and 11, an accumulator 130 being provided with supports 131, 131 and, in turn, supporting thereon a receiver 132, the two elements of the unit being connected by piping as shown for installation as a unit in a refrigerating system.

There are many other forms of systems and constructions of accumulators not disclosed herein which may be adapted for special application of the invention, and there are many other applications thereof than heretofore mentioned. For example, the operation of mechanically refrigerated soda fountains can be greatly improved by use of a system embodying this invention.

Single cooler units are operable with any desired regulation characteristics. A simple unit with practically no storage capacity in itself and which requires frequent starts and stops or continuous running of the compressor to prevent melting off, can be kept freezing steadily with long stops of the compressor simply by inserting somewhere in the suction line, an accumulator of the proper size.

It will be understood that the various units of the system including the coolers, accumulator, prime mover, etc., may be manually controlled instead of automatically, a manual control valve being used, for example, to exhaust a cooler into the accumulator when the cooler rises above any desired temperature, and a manual control for the prime mover or other devices being operated whenever the accumulator temperature rises above any desired temperature.

It will appear from the foregoing that numerous modifications of the invention may be resorted to without departing from the spirit thereof or the scope of the appended claims.

What is claimed is:

1. A refrigerating system including a compressor, a condenser, a receiver for a volume of refrigerant delivered by the compressor, a check valve between the compressor and the receiver, one or more cooler units arranged to receive refrigerant from the receiver, an accumulator into which the cooler units exhaust, a valve between each cooler unit and the accumulator adapted to be set to open at any determinate pressure and corresponding temperature in its cooler unit, a connection between the accumulator and the suction inlet of the compressor, a liquid pump for delivering liquid refrigerant from the accumulator into the cooler line, and an automatic by-pass valve responsive to pressure in the cooler line for delivering excess refrigerant back to the accumulator.

2. A refrigerating system including one or more cooler units arranged to receive refrigerant, an accumulator into which the cooler units exhaust, means for cooling the refrigerant in the system, a valve between each cooler unit and the accumulator adapted to be set to open at any determinate pressure and corresponding temperature in its cooler unit, a liquid pump for delivering liquid refrigerant from the accumulator into the cooler line, and an automatic by-pass valve responsive to pressure in the cooler line for delivering excess refrigerant back to the accumulator.

3. A refrigerating system including a compressor, a condenser, a receiver for a volume of refrigerant delivered by the compressor, a check valve between the compressor and the receiver, one or more cooler units arranged to receive refrigerant from the receiver, an accumulator into which the cooler units exhaust, a valve between each cooler unit and the accumulator adapted to be set to open at any determinate pressure and corresponding temperature in its cooler unit, a connection between the accumulator and the suction inlet of the compressor, and a liquid pump for delivering liquid refriger-

ant from the accumulator into the cooler line.

4. A refrigerating system including one or more cooler units arranged to receive refrigerant, an accumulator into which the cooler units exhaust, means for cooling the refrigerant in the system, a valve between each cooler unit and the accumulator adapted to be set to open at any determinate pressure and corresponding temperature in its cooler unit, and a liquid pump for delivering liquid refrigerant from the accumulator into the cooler line.

5. A refrigerating system including a compressor, a condenser, a receiver for a volume of refrigerant delivered by the compressor, one or more cooler units arranged to receive refrigerant from the receiver, an accumulator into which the cooler units exhaust, a valve between each cooler unit and the accumulator adapted to be set to open at any determinate pressure and corresponding temperature in its cooler unit, a connection between the accumulator and the suction inlet of the compressor, a liquid pump for delivering liquid refrigerant from the accumulator into the cooler line, and an automatic by-pass valve responsive to pressure in the cooler line for delivering excess refrigerant back to the accumulator.

6. A refrigerating system including a compressor, a condenser, a receiver for a volume of refrigerant delivered by the compressor, one or more cooler units arranged to receive refrigerant from the receiver, an accumulator into which the cooler units exhaust, a valve between each cooler unit and the accumulator adapted to be set to open at any determinate pressure and corresponding temperature in its cooler unit, a connection between the accumulator and the suction inlet of the compressor, and a liquid pump for delivering liquid refrigerant from the accumulator into the cooler line.

7. A refrigerating system including a compressor, a condenser, a receiver for a volume of refrigerant delivered by the compressor, one or more cooler units arranged to receive refrigerant from the receiver, an accumulator into which the cooler units exhaust, a valve between each cooler unit and the accumulator for controlling the temperature of the cooler, and a float valve in the accumulator operable to connect the accumulator to the receiver upon drop of the liquid refrigerant in the accumulator below a predetermined level.

8. A refrigerating system including a compressor, a condenser, a prime mover for running the compressor, a receiver for a volume of refrigerant delivered by the compressor, one or more cooler units arranged to receive refrigerant from the receiver, an accumulator into which the cooler units exhaust, means responsive to temperature of the accumulator for controlling the operation of the prime mover, and a valve between each cooler unit and the accumulator for controlling the temperature of the cooler.

9. A refrigerating system including a compressor, a condenser, a prime mover for running the compressor, a receiver for a volume of refrigerant delivered by the compressor, one or more cooler units arranged to receive refrigerant from the receiver, an accumulator into which the cooler units exhaust, means responsive to temperature of the accumulator for controlling the operation of the prime mover, a valve between each cooler unit and the accumulator for controlling the temperature of the cooler and a float valve in the accumulator operable to connect the accumulator to the receiver upon drop of the liquid refrigerant in the accumulator below a predetermined level.

10. The combination in a mechanical refrigerating system of one or more coolers, means for delivering a volume of refrigerant thereto, an accumulator into which the coolers exhaust and comprising a casing providing a chamber for a volume of refrigerant, and a valve operable to connect the chamber to a supply of liquid refrigerant in the system when the level of refrigerant in the chamber falls below a determinate point to preserve the balance of the system.

11. The combination in a mechanical refrigerating system of one or more coolers, means for delivering a volume of refrigerant thereto, an accumulator into which the coolers exhaust and comprising a casing providing a chamber for a volume of refrigerant, and a valve operable to connect the chamber to a supply of liquid refrigerant in the system when the quantity of refrigerant in the chamber falls below a determinate point to preserve the balance of the system.

12. The combination in a mechanical refrigerating system including one or more coolers and means for supplying a volume of refrigerant thereto, of an accumulator into which the coolers exhaust and comprising an insulating casing for containing a volume of refrigerant, a chamber in the casing for providing a medium for storing cold, means providing passageways for the refrigerant through said medium, and a compartment in the accumulator for use in freezing materials.

13. The combination in a mechanical refrigerating system including one or more coolers and means for supplying a volume of refrigerant thereto, of an accumulator into which the coolers exhaust and comprising an insulating casing for containing a volume of refrigerant, a chamber in the casing for providing a medium for storing cold, and means providing passageways for the refrigerant through said medium.

14. The combination in a mechanical refrigerating system of one or more coolers, an accumulator for the refrigerant into which the coolers are adapted to exhaust automati-

cally upon reaching determinate temperatures, means providing a supply of refrigerant for the coolers, and means for maintaining the accumulator normally at a lower temperature than the coolers.

15. The combination in a mechanical refrigerating system of one or more coolers, an accumulator for the refrigerant into which the coolers are adapted to exhaust automatically upon reaching determinate temperatures, and means for maintaining the accumulator normally at a lower temperature than the coolers.

16. That method of mechanically refrigerating a cooler which comprises delivering the refrigerant to the cooler, periodically exhausting the refrigerant from the cooler into an accumulator for a substantial volume of refrigerant when the cooler temperature rises above a desired point, maintaining the accumulator at a lower temperature than the cooler, and periodically cooling the supply of refrigerant when the temperature in the accumulator rises above a certain point.

17. That method of mechanically refrigerating a cooler which comprises delivering the refrigerant to the cooler, periodically exhausting the refrigerant from the cooler into an accumulator for a substantial volume of refrigerant when the cooler temperature rises above a desired point, and maintaining the accumulator at a lower temperature than the cooler.

18. That method of mechanically refrigerating a series of coolers which comprises providing a supply of refrigerant for the coolers, delivering the refrigerant to the coolers, independently exhausting each cooler into an accumulator arranged to receive the refrigerant from the accumulator when the temperature in such cooler rises above a desired point, and maintaining the temperature of the accumulator below that of any cooler by periodically cooling the supply of refrigerant when the temperature of the accumulator rises above a certain point.

19. That method of mechanically refrigerating a series of coolers which comprises providing a supply of refrigerant for the coolers, delivering the refrigerant to the coolers, independently exhausting each cooler into an accumulator arranged to receive the refrigerant from the cooler when the temperature in such cooler rises above a desired point, and maintaining the temperature of the accumulator below that of any cooler.

20. In a mechanical refrigerating system, a cooling unit, means for cooling the refrigerant in the system, means for delivering the refrigerant to the cooling unit, an accumulator separate from the cooling unit for storing the refrigerant in liquefied condition and into which the cooling unit is arranged to exhaust, and means controlled by the quantity of liquid refrigerant in the accumulator for intermittently operating said delivering means.

21. In a mechanical refrigeration system, a compressor, a condenser, a cooler, a receiver for refrigerant between the compressor and cooler, an accumulator for liquid refrigerant in the suction line of the system separate from the cooler into which the cooler exhausts, and means controlled by the quantity of liquid in the accumulator for operating the compressor intermittently.

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