Sept. 17, 1940. O. A. F. KRAMHØFT 2,215,046

COMPRESSION REFRIGERATING PLANT

Filed Jan. 20, 1938 2 Sheets-Sheet 1

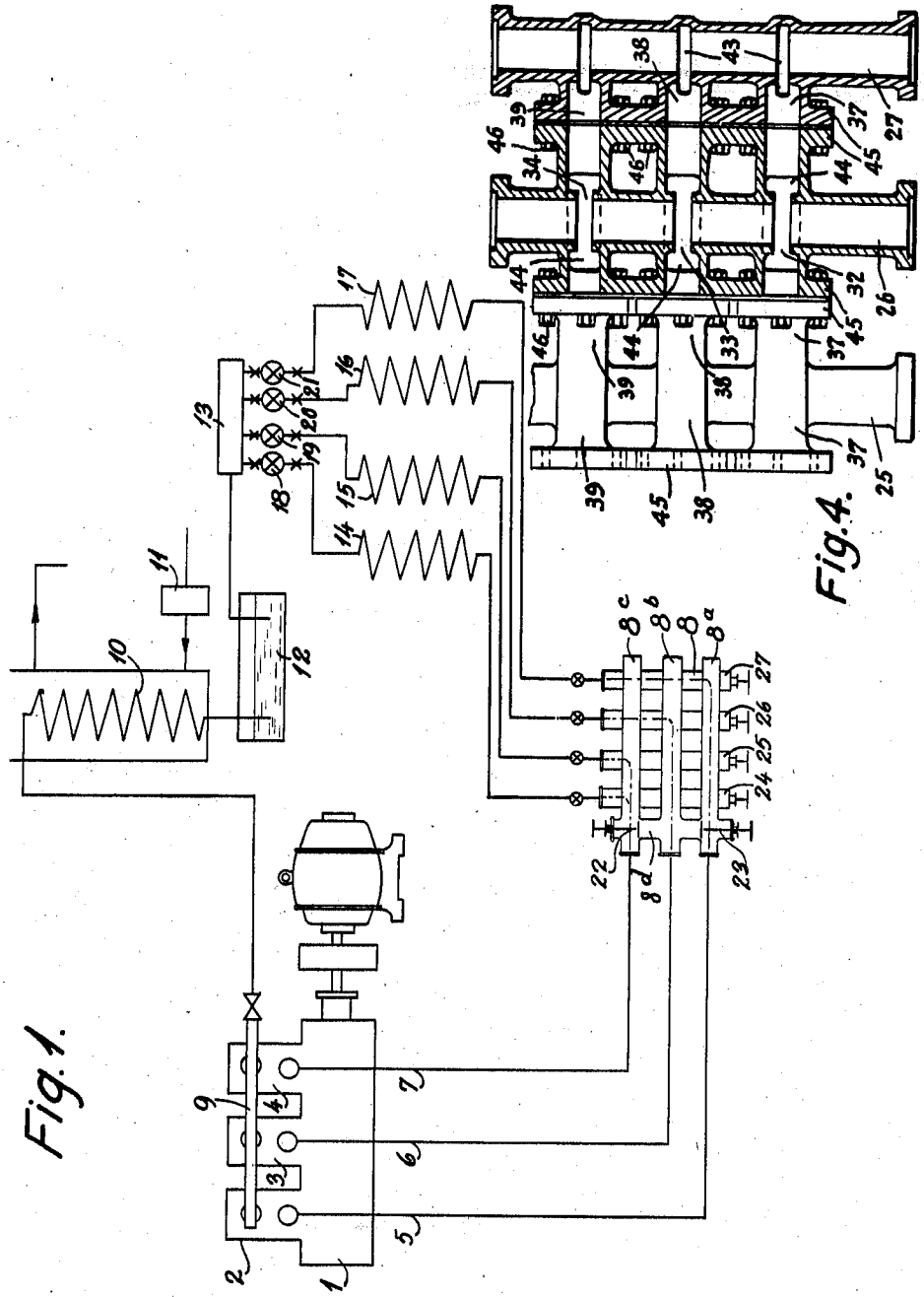

Fig. 1.

Fig. 4.

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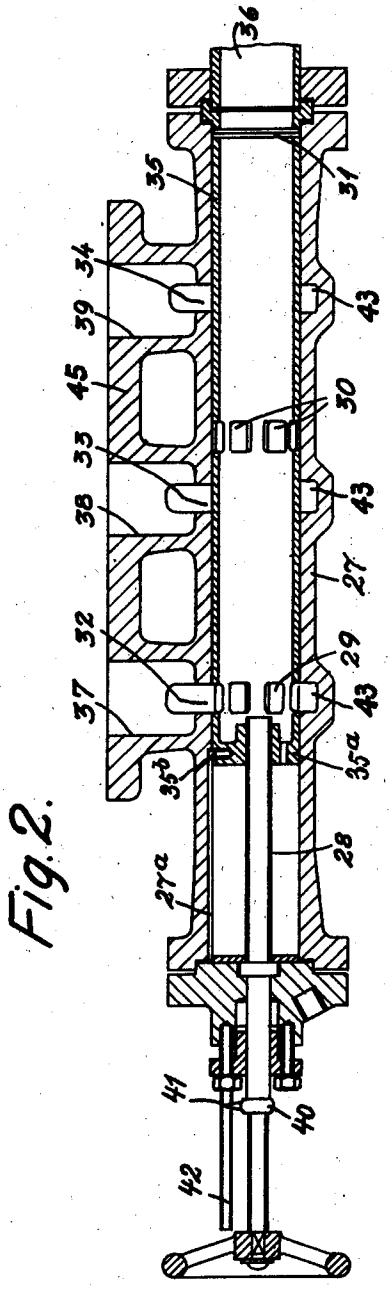

Fig. 2.

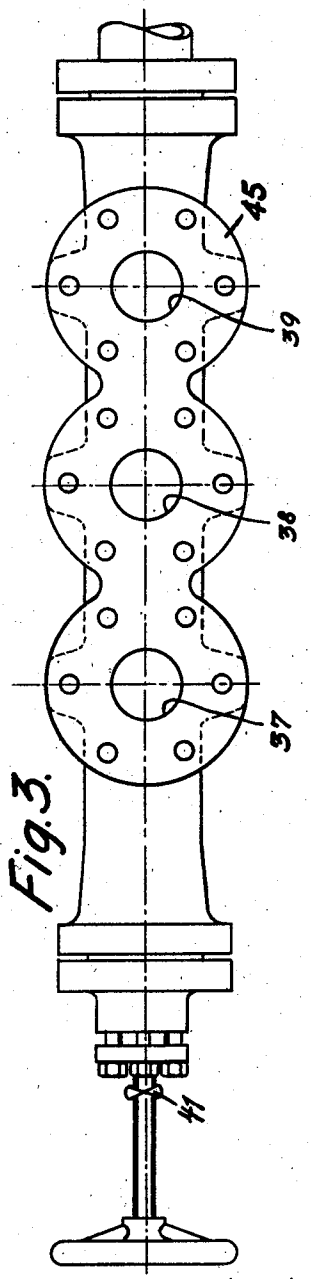

Fig. 3.

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Patented Sept. 17, 1940 2,215,046

UNITED STATES PATENT OFFICE

2,215,046

COMPRESSION REFRIGERATING PLANT

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Application January 20, 1938, Serial No. 185,982
In Denmark January 23, 1937

4 Claims. (Cl. 62—115)

In refrigerating plants having two or more refrigerators the problem often occurs that the temperature must be different at the various refrigerators. This in many cases has been attained by using cooled brine as cooling medium, brine having just the temperature suitable for cooling the rooms being circulated through the refrigerating elements arranged in the rooms by means of mixing valves and one or more brine pumps.

In refrigerating plants working with direct evaporation of the refrigerating medium in pipe coils arranged in the rooms and without using brine as an intermediate agent, it has been necessary as a rule to produce the different temperatures by increasing or decreasing the refrigerating surfaces or by employing more compressors, each associated with a room to be cooled. The first named of these methods will often be detrimental to the goods stored in the room, since the air in some rooms will be too moist and in other rooms it will be too dry depending upon whether the refrigerating surface is large or small (the cooling coil being long or short), and both systems suffer from the drawback that they can only be regulated to an insufficient degree. When multicylinder compressors or double acting compressors with separated suction sides are used it has, therefore, in some cases been preferred to operate with different suction pressures, but in known arrangements of this kind complicated pipe systems with ordinary valves and numerous flange joints are used which require a large space, create possibilities for leakage and involve an unreliable and difficult inspection.

The invention has for its purpose to obviate these drawbacks in a compression refrigerating system having a compressor plant with more compression spaces and a plurality of refrigerators operating by direct evaporation, which are adapted to work at two or more different suction pressures and temperatures. The invention is mainly characterized by the provision of a suction manifold comprising a plurality of passage or channel members and a plurality of double-adjustable or multiple-adjustable valves, which passages and the housings of said valves are connected each with a separate compression space and with an evaporator respectively, each valve being adjustable to connect either of a plurality of compression spaces with the evaporator in question. Alternatively the valve housings are in communication each with a compression space whereas the said passages are connected each with an evaporator. The said valves may consist of two-way valves in a simple case or of multiple way cocks, but they are preferably formed as slide valves or as rotary slide valves. In such a plant two or more different suction temperatures can be obtained by as few manipulations as possible by means comprising for instance a multicylinder compressor or a double acting compressor, and in addition a greater or smaller fraction of the entire compressor capacity may be concentrated on the evaporator or evaporators where it is required. In this way the present refrigerating system for direct evaporation is as readily controllable as a brine refrigerating plant, and moreover the number of necessary flange joints and stuffing-boxes and thereby the risk for leakage is materially reduced, so that much space is saved, which is particularly important on board ships, where the available space is always very restricted and parts of the technical installations are often accessible with difficulty only, and where the possibility of accidents and destroying of goods and machinery by leaking refrigerating medium is substantially greater than in plants ashore.

The suction manifold, whose passages or channels and slide valves or other valves preferably, but not necessarily have their axes arranged transversely to each other can advantageously be constructed as a mechanically coherent unit or structure which can be handled as such and connected with the various conduits of the refrigerating system. However, in such manifold the passages and the slide valves may be arranged in inclined relationship or they may be parallel to each other, suitable pipe branches and flange joints being provided for this purpose.

The manifold in addition to the said passages may contain an extra passage or casing connected therewith and provided with suitable valves so disposed that each compression space can be connected with either of the other passages.

If the suction manifold comprises slide valves the slide valve housings are preferably provided with a plurality of lateral connecting branches with ports adapted to be opened or closed by a displaceable or rotatable hollow, cylindrical slide valve body also provided with ports. The number of the latter does not necessarily need be equal to the number of ports in the wall of the slide valve housing, since one end of the slide valve body may for instance serve as a control edge.

The invention may be utilized for all kinds of refrigerating systems for direct evaporation, such as stationary plants and ship installations, and

in either case the number of compressor cylinders or compressor cylinder sides may be equal to or different from the number of refrigerators.

As an example of a stationary plant, wherein various temperatures are required ice-cream factories may be named, in which the goods are frozen at −10° C. to −15° C. are hardened at −20° C. to 25° C. and are quick-frozen at −45° C. to −50° C., or fish freezing plants wherein ice is produced at −10° C. to −12° C., fish is frozen at −30° C. to −40° C. and frozen fish is stored at −15° C. to −20° C.

With regard to ship cooling installations the invention is applicable for instance to fruit boats which must simultaneously transport for instance bananas at 12° C., oranges at 6° C. and applies at 0° C.

The invention will be further described with reference to the accompanying drawings, in which

Figure 1 diagrammatically shows an embodiment of a compression refrigerating plant according to the invention and

Figures 2 and 3 on a larger scale show longitudinal section and top view respectively of a preferable embodiment of a distributing slide valve, four such slide valves being included in the suction battery forming part of the refrigerating plant illustrated in Figure 1, and

Figure 4 shows on a scale smaller than that of Figures 2 and 3 a front view, partly in section, of part of the suction manifold.

In Figure 1 the numeral 1 designats a three-cylinder-compressor whose three cylinders 2, 3 and 4 have each a separate suction conduit 5, 6 and 7 respectively through which the evaporated refrigerating medium is admitted from a suction manifold designated as a whole by the numeral 8. The delivery conduit 9 common to all of the three compressor cylinders is connected with a condenser 10, in which the compressed refrigerating medium is condensed by cooling water maintained in circulation by means of a cooling water pump 11. The liquid refrigerating medium is collected in a receiver 12, from which it flows to a manifold 13, and then to the refrigerating coils 14, 15, 16 and 17 controlled by hand operated regulating or expansion valves 18, 19, 20 and 21 respectively. For these hand-operated valves could be substituted automatic regulating valves. The number of regulating valves varies with the number of refrigerators. In Figure 1 four refrigerating coils are shown, but the invention can also be used in such cases where there is found a greater or smaller number of refrigerating coils, and the compressor likewise may have more cylinders or less cylinders than those shown. As a rule in ships more than one compressor is installed in order to establish a reserve, but the reserve compressor with accessories is omitted on the drawings to make the same more perspicuous.

The suction manifold 8 as shown comprises three passages or channels 8^a 8^b and 8^c connected each to a separate suction conduit 5, 6 and 7 respectively, and four distributing slide valves 24, 25, 26 and 27 arranged transversely to said passages and connected each to one of the refrigerating coils 14, 15, 16 and 17 respectively. These distributing slide valves may for instance be constructed in the manner shown in Figures 2 and 3 to be more clearly described in the following, but at any rate each slide valve is so formed as to control communication of the refrigerating coil with which it is associated with either of the suction conduits 5, 6 and 7. The suction manifold 8 moreover is provided at one end with an additional passage 8^d arranged transversely to the other passages, connected to the left hand end of all of them as shown in Figure 1 and furnished with two valves 22 and 23. The manifold 8 forms a unitary structure, whose parts are for instance interconnected by means of flanges and bolts.

The desired different temperatures in the refrigerating coils are obtained in the following way:

It is assumed that the valves 22 and 23 are closed. The distributing slide valves 24, 25, 26 and 27 are thought to be so adjusted, that the cylinder 4 draws refrigerating medium from the refrigerating coils 14 and 15 as indicated by dotted lines, that the cylinder 3 draws from the refrigerating coil 16, and that the cylinder 2 draws from the refrigerating coil 17 as likewise shown in dotted lines. It is hereby made possible to work in the refrigerating coils 14 and 15 with a temperature different from that in the refrigerating coils 16 and 17. It will be easily understood, however, that by suitably adjusting the valves 22 and 23 and the distributing slide valves many other combinations can be obtained, and especially that by operating the valves 22 and 23 two or more cylinders may be caused to simultaneously draw refrigerating medium from a single refrigerating coil.

The embodiment of a distributing slide valve shown in Figures 2 and 3 has a hollow cylindrical valve body 35 open at one end, which valve body by means of a rotatable, but non-displaceable screw-spindle 28 (or in any other suitable way, for instance by means of a lever mechanism not shown) can be so adjusted that the ports 29 in the cylindrical wall of the valve body are put in communication with the port 32 in the valve housing 27 or that the port 30 in the valve are connected with the port 33 of the valve housing or finally that the interior of the valve housing at the right hand end 31 of the valve body comes into communication with the port 34 in the valve housing. Thus either of the three connecting branches 37, 38 and 39 can be connected at will with the supply conduit 36 for the evaporated low-pressure refrigerating medium. In the position of the slide valve shown in Figure 2 the branch 37 is connected with the conduit 36, whereas the two other branches 38 and 39 are cut off from the latter.

In the embodiment of the slide valve shown in Figures 2 and 3 the end wall 35^a of the valve body forms a nut threaded on the screw-spindle 28, and said end wall has a pin 35^b engaging a longitudinal groove 27^a in the inner wall of the valve housing, whereby rotation of the valve body is prevented. A small non-rotatable nut 40 threaded on the external portion of the screw-spindle 28 is provided with a pointer 41 indicating the momentary axial position of the slide valve along a scale 42.

As will be readily understood by those skilled in the art the slide valve construction shown in Figures 2 and 3 can easily be modified to form a rotary valve operating almost in the same way.

While Figures 2 and 3 show an embodiment of the slide valve 27 at the right end of the suction manifold 8 Figure 4 shows a greater part of a practical form of this manifold, namely the three valves 25, 26 and 27.

However, only the valve housings are shown

to make the arrangement of the various passages more clear. It will be seen that the valves **25** and **26** are similar to the valve **27** except that they have each a double set of connecting branches **37**, **38** and **39**. Furthermore the annular cavities **44** in connection with the ports **32**, **33** and **34** have a greater cross-section than have the corresponding annular cavities **43** of the valve **27**. In the manifold of Figure 4, quite irrespective of the positions of the slide valve bodies not shown, uninterrupted transverse passages corresponding to the passages 8^a, 8^b and 8^c of Figure 1 are formed each by a horizontal series of connecting branches and annular cavities **44** and **43**. Thus the slide valve housings also constitute the necessary elements of the transverse passages. The three branches on one side of the valves have a common flange **45**, see Figures 2–4, and these flanges are clamped together by bolts **46**.

I claim:

1. In a compression refrigerating system the combination of a compressor plant having a plurality of compression spaces, a condenser, a plurality of evaporators, a regulating valve interposed between each of said evaporators and said condenser, a manifold including two coöperating interconnected sets of passages, each of the passages of one set communicating with one of said compression spaces, each of the passages of the other set communicating with one of said evaporators, the walls of one set of said passages forming valve housings, and an adjustable valve in each of said valve housings for selectively communicating the passage therein with any one of the passages of the other set whereby various connections may be established between said compression spaces and said evaporators.

2. In a compression refrigerating system the combination of a compressor plant having a plurality of compression spaces, a condenser, a plurality of evaporators, a regulating valve interposed between each of said evaporators and said condenser, a set of parallel channel members, each of said channel members communicating with one of said compression spaces, a second set of parallel channel members arranged transversely to said first set and connected with each channel member thereof, each of the channels of the second set communicating with one of the evaporators, the walls of one set of said channel members constituting valve housings, and an adjustable valve in each of said valve housings for selectively communicating its associated channel with the channels of the other set whereby various connections may be selectively established between said compression spaces and said evaporators.

3. In a compression refrigerating system the combination of a compressor plant having a plurality of compression spaces, a condenser, a plurality of evaporators, a regulating valve interposed between each of said evaporators and said condenser, a manifold including two cooperating interconnected sets of passages, each of the passages of one set communicating with one of said compression spaces, each of the passages of the other set communicating with one of said evaporators, the walls of one set of said passages forming valve housings, an adjustable valve in each of said valve housings for selectively communicating its associated passage with the passages in the other set whereby various connections may be established between said compression spaces and said evaporators, and auxiliary valve means operatively associated with the passages communicating with said compression spaces whereby each compression space may be put into communication with any of the passages communicating with the evaporators.

4. In a compression refrigerating system, the combination of a compressor plant having a plurality of compression spaces, a condenser, a plurality of evaporators, a regulating valve interposed between each of said evaporators and said condenser, a manifold including two cooperating interconnected sets of passages, each of the passages of one set communicating with one of said compression spaces, each of the passages of the other set communicating with one of said evaporators, the walls of one set of said passages being formed as slide valve housings each having a plurality of laterally disposed openings leading to the other set of said passages, and a hollow cylindrical slide valve body in each of said slide valve housings, said slide valve body having openings in its cylindrical wall arranged relative to said valve housing openings whereby when the slide valve is moved, the valve body openings may be brought selectively into registration with the valve housing openings to establish communication of the interior of the valve body with any one of the passages of the other set.

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