Aug. 10, 1954 C. F. CONRAD 2,685,778

MULTIPLE STAGE REFRIGERATION SYSTEM

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Fig. 1.

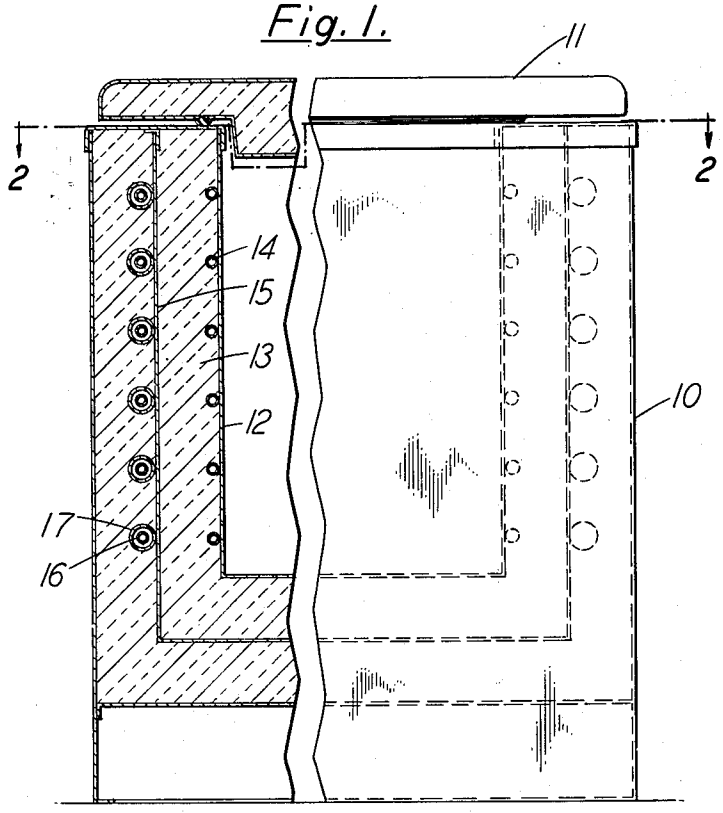


Fig. 3.

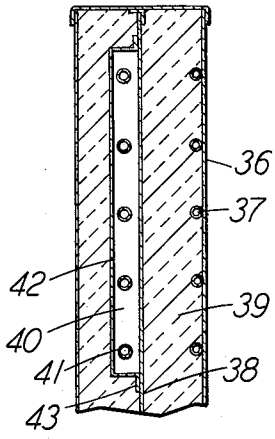


Fig. 4.

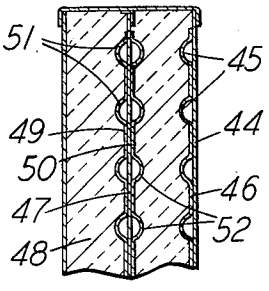
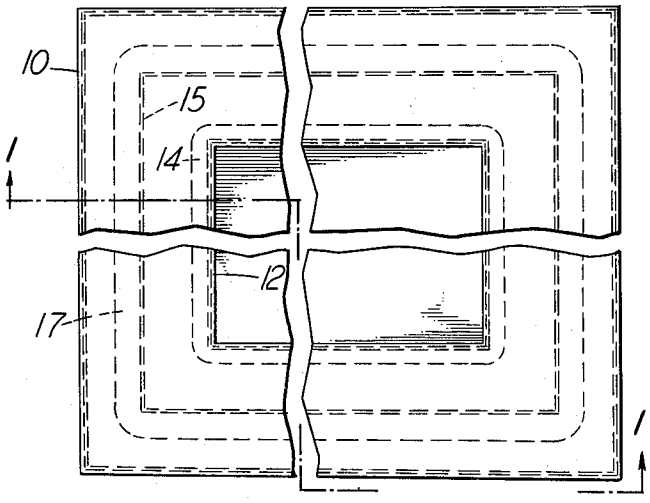


Fig. 2.



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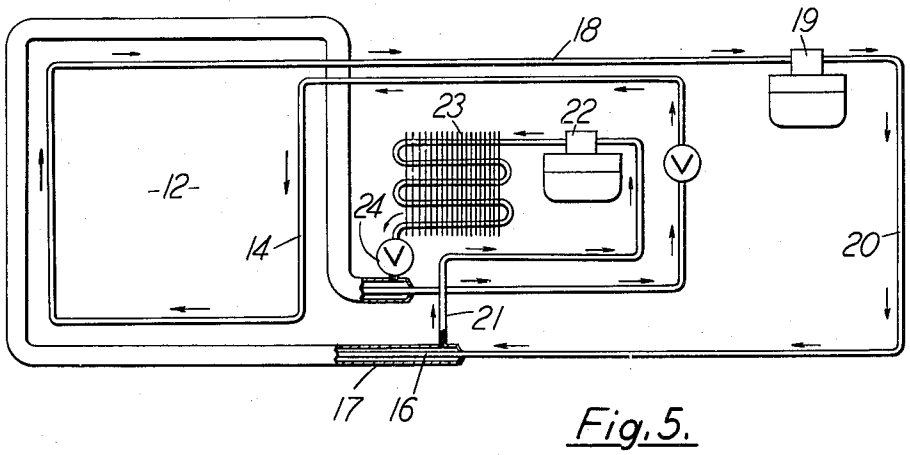


Fig. 5.

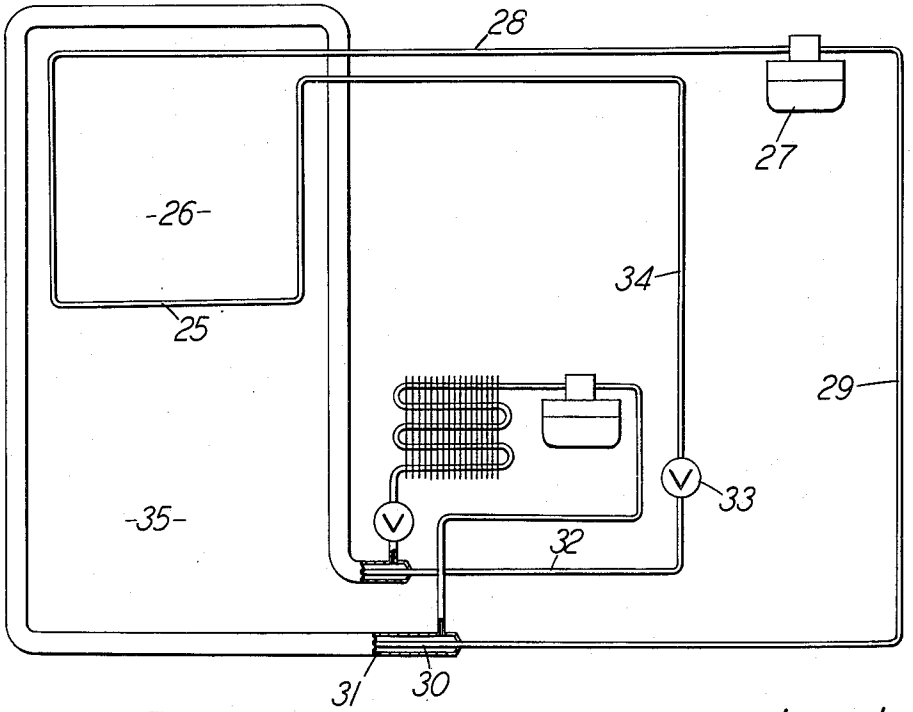


Fig. 6.

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MULTIPLE STAGE REFRIGERATION SYSTEM

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3 Claims. (Cl. 62—99)

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The present invention provides an improvement in cascade-type refrigeration systems. In these systems, a primary refrigerating circuit cools a low-temperature space or container by having its expansion coils in heat-exchanging association therewith, and a secondary circuit operates as a condenser for the primary circuit by having the expansion coils of the secondary in heat-exchanging relationship with the condensing portion of the primary. The condensers, in both cases, are positioned to receive the output of suitable compressors.

The present invention is also related to the type of refrigerating system having a broken temperature gradient between the inner cooled space and the exterior through the use of cooling means disposed at an intermediate point in the insulation. Illustrations of such systems are to be found in United States Patents Serial Numbers 2,479,732 and 2,585,908.

The present invention utilizes the advantages of both of the general systems outlined above, and provides a construction having excellent structural characteristics, as well as unusual operating efficiency. Particularly good heat transfer characteristics from primary to secondary circuit are achieved, as well as simplicity of design. The present invention utilizes the heat-exchanger associating the primary with the secondary system also as a means of establishing a cooled envelope around the inner container located at an intermediate point in the insulation. Several structural features cooperate to provide this arrangement. A modified form of the present invention utilizes the secondary system not only as outlined above, but also uses an extended section of it to refrigerate an intermediate-temperature cooled space.

The several features of the present invention will be discussed in detail through an analysis of the particular embodiments illustrated in the accompanying drawings. In these drawings,

Figure 1 is a view in elevation of a cabinet embodying the present invention, with portions of the unit broken away to conserve space, and a portion shown in section.

Figure 2 is a plan view of the unit illustrated in Figure 1. Portions of the unit are shown broken away to conserve space.

Figure 3 presents a modified form of the present invention with regard to the construction of the heat-exchanger associating the primary and secondary circuits.

Figure 4 shows another modification of the

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present invention and illustrates a different system for constructing the components of the system.

Figure 5 is a schematic diagram illustrating the relationship between the primary and secondary circuits utilized in the unit illustrated in Figures 1 and 2.

Figure 6 shows a modified form of the refrigeration circuit in which the secondary cooling system is used to refrigerate an intermediate-temperature cooled space, as well as act as a condenser cooler for the primary circuit.

Referring to Figure 1, a cabinet is shown having an outer shell or housing 10 and a cover 11. An inner container 12 is separated from the outer shell 10 by the insulation indicated at 13. The inner container 12 is cooled by the expansion coil 14 of a primary refrigerating circuit which will be discussed in detail through reference to Figure 5. At an intermediate point in the insulation 13, a panel 15 is positioned to act as a support for the heat-exchanger coils establishing the relationship between the primary and secondary cooling circuits to be discussed in detail hereinafter. This heat-exchanger comprises the double concentric tube system in which the inner tube 16 acts as the condenser for the primary cooling circuit and the outer tube 17 operates as the expansion coil for the secondary circuit.

The relationship between the primary and secondary circuits is illustrated in the schematic diagram shown in Figure 5. The inner cooled area is designated generally at 12 surrounded by the expansion coil 14 of the primary cooling circuit. Refrigerant leaves the coil 14 and passes through a section indicated at 18 outside the insulation and connecting to the compressor unit 19. From the compressor, the compressed refrigerant traverses the conduit 20 and enters the tube 16 forming the inner portion of the double tube heat-exchanger associating the primary and secondary circuits. Refrigerant passing through the tube 16 is cooled through being subjected to the cooled environment established by the expansion of refrigerant within the outer tube 17. Condensed refrigerant in the tube 16 is passed through a conventional expansion valve and conducted to the expansion coil 14.

It is preferred that the flow of refrigerant in the inner and outer tubes 16 and 17 be in the opposite direction for the most effective transfer of heat, and refrigerant leaves the outer tube 17 through the conduit 21. Refrigerant flows through the conduit 21 to the compressor 22 of

the secondary system, and from there passes to the exterior condenser 23. This unit may be either of the air or water cooled variety, and is disposed outside the refrigerated area (unless a succeeding series of cascade-type relationships is used in which this condenser would be refrigerated by another system). From the condenser 23, refrigerant passes through a suitable expansion valve 24 and enters the tube 17.

In the modification shown in Figure 6, an inner cooling coil 25 is shown in heat-exchanging relationship with an inner cooled space 26. A compressor 27 is connected with the expansion tube 25 by the conduit 28. Compressed refrigerant passes from the compressor 27 through the conduit 29, and through the inner tube 30 of the heat-exchanger. After having been cooled by association with the cooled refrigerant in the outer tube 31, the refrigerant in the inner tube 30 passes through the conduit 32, and through the expansion valve 33 to the expansion coil 25 via the conduit 34.

In the Figure 6 modification of the present invention, the heat-exchanger formed by the inner tube 30 and the outer tube 31 not only serves to condense the compressed refrigerant from the circuit including the expansion coil 25, but also operates to cool an intermediate-temperature area generally indicated at 35. With this arrangement and with conventional refrigerants, the inner container may be conveniently held to a temperature on the order of —100 degrees F., and the space 35 may be conveniently maintained at about —25 degrees F.

Referring to Figure 3, a modified form of the present invention is illustrated, particularly with regard to the construction of the heat-exchanger associating the primary and secondary circuits. In Figure 3, an inner container wall is designated at 36 with which an expansion coil system 37 is associated. A panel 38 is positioned at an intermediate point in the insulation 39, and supports a container 40 which acts as an expansion area for the refrigerant of the secondary circuit. The coil 41 forms the condenser for the primary circuit, in the same fashion as is indicated in the previously-discussed modifications. The container 40 forms an effective cooled envelope about the inner container 36, in the same fashion as does the double-tube system previously discussed. The container 40 is formed by the attachment of a pan-shaped member 42 to the panel 38 at the flange 43 by welding.

Referring to Figure 4, a modification is shown which illustrates another manner of constructing the cooling conduits involved in the present invention. An inner wall is indicated at 44, and an expansion tube is associated therewith comprising the formed areas 45 in a sheet 46 secured to the inner wall 44 by welding or by some other equivalent system. A panel 47 is positioned at an intermediate point in the insulation 48, and

sheets 49 and 50 are provided with formed sections and are secured to the panel 47. The formed portions 51 operate as the expansion coils of the secondary circuit, and the formed portions 52 as the condensing coil of the primary refrigeration circuit.

The particular embodiments of the present invention which have been illustrated in the accompanying drawings and are discussed herein, are for illustrative purposes only and are not to be considered as a limitation upon the scope of the appended claims. In these claims, it is my intention to claim the entire invention disclosed herein except as I am limited by the prior art.

I claim:

1. A refrigeration cabinet, comprising: an inner container; a layer of insulation at least partially surrounding said inner container; a first cooling system, said first cooling system including compressing means, expansion means associated with said inner container in heat-exchanging relationship, and condensing means disposed within said insulation; and a second cooling system, said second cooling system including compressing means, expansion means disposed in heat-exchanging relationship with the condensing means of said first cooling system, and condensing means.

2. A refrigeration cabinet, comprising: an inner container; a layer of insulation at least partially surrounding said inner container; a first cooling system, said first cooling system including compressing means, expansion means associated with said inner container in heat-exchanging relationship, and condensing means including a conduit disposed within said insulation; and a second cooling system, said second cooling system including compressing means, expansion means including a conduit parallel to and surrounding the condensing conduit of said first cooling system, and condensing means.

3. A refrigeration cabinet, comprising: an inner container; a layer of insulation at least partially surrounding said inner container; a first cooling system, said first cooling system including compressing means, expansion means associated with said inner container in heat-exchanging relationship, and condensing means disposed within said insulation; and a second cooling system, said second cooling system including compressing means, expansion means including a container surrounding the condensing means of said first cooling system, and condensing means.

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