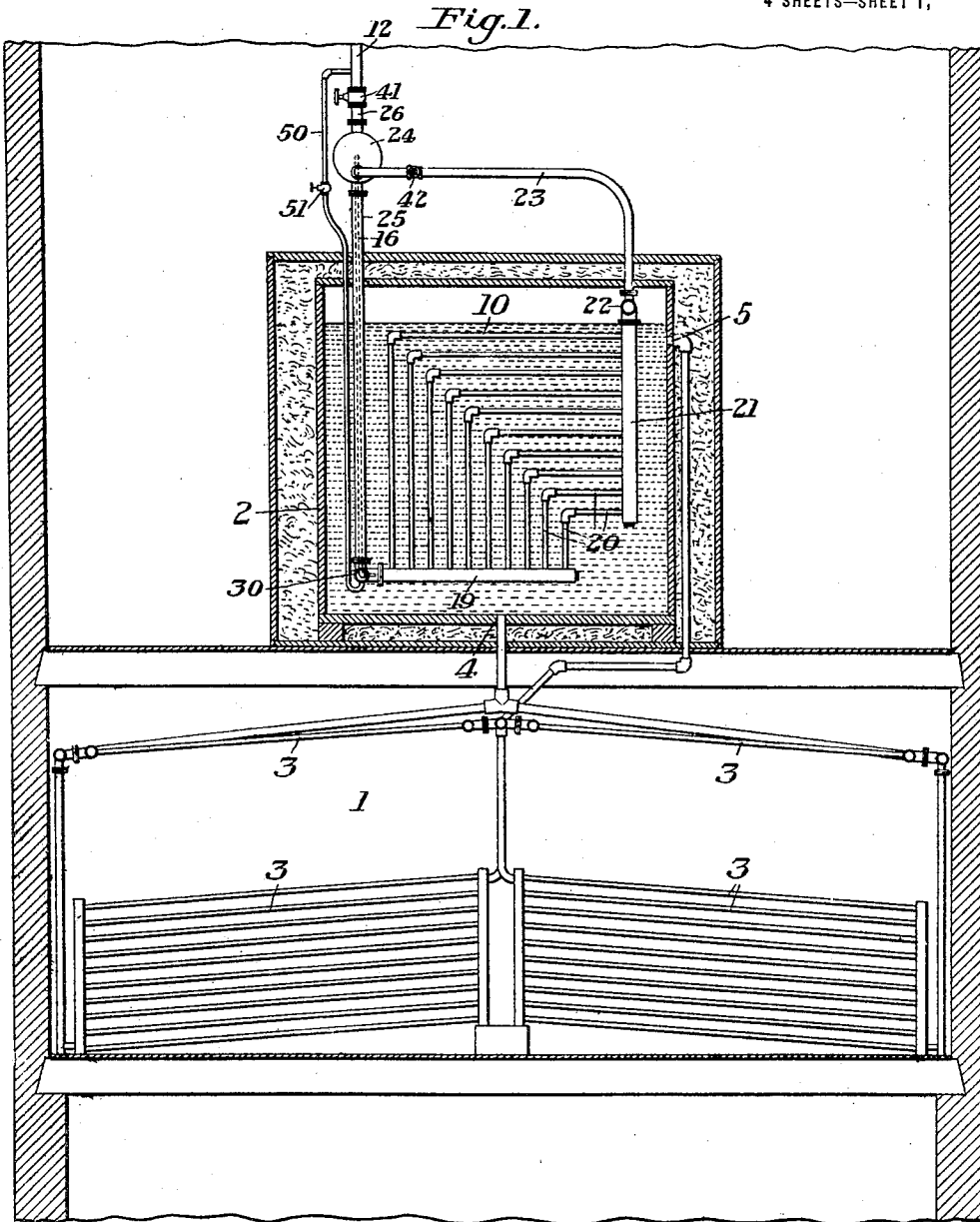


C. H. WORTHEN.
REFRIGERATING APPARATUS.
APPLICATION FILED FEB. 19, 1917.

1,332,703.

Patented Mar. 2, 1920.

4 SHEETS—SHEET 1,



WITNESSES

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INVENTOR

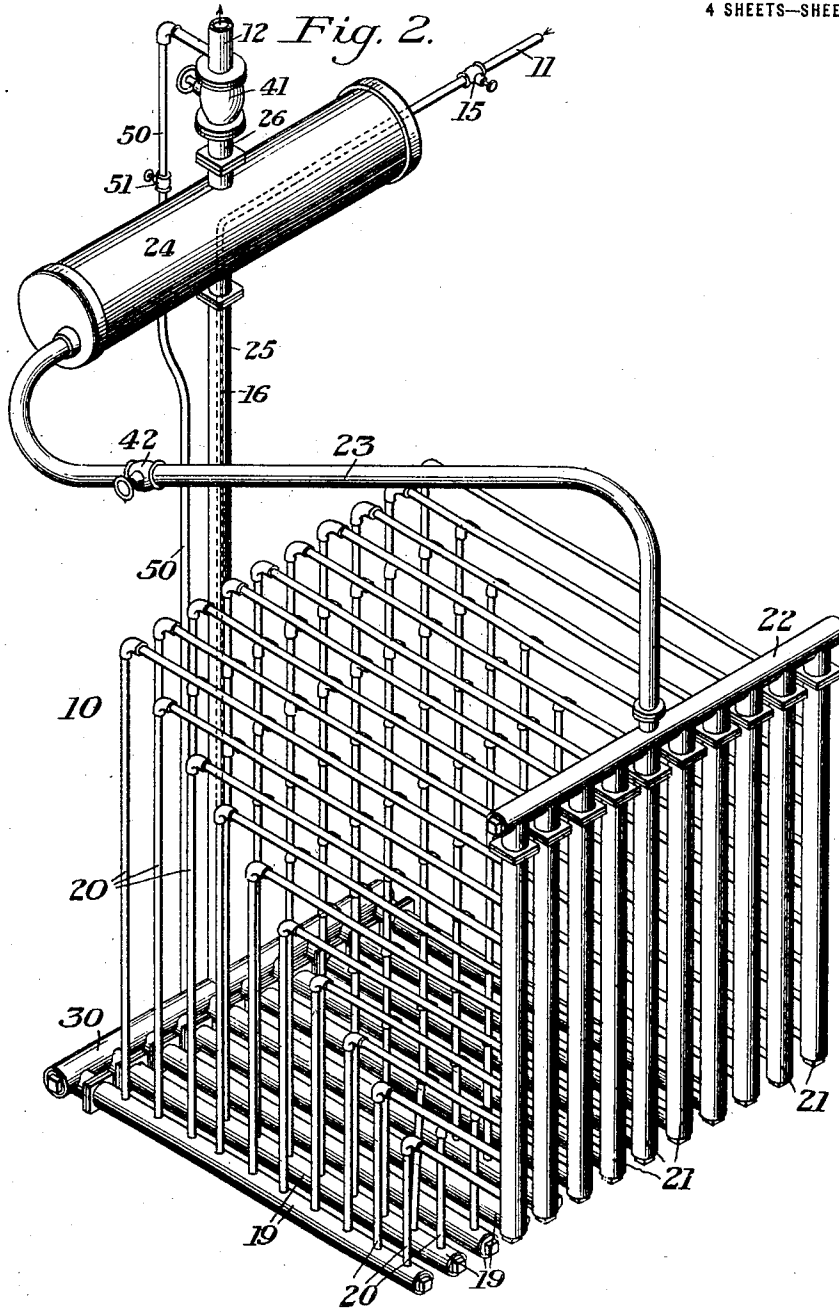
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4 SHEETS—SHEET 2,



WITNESSES

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4 SHEETS—SHEET ,3

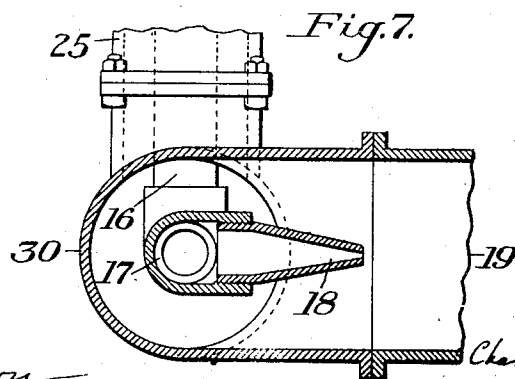
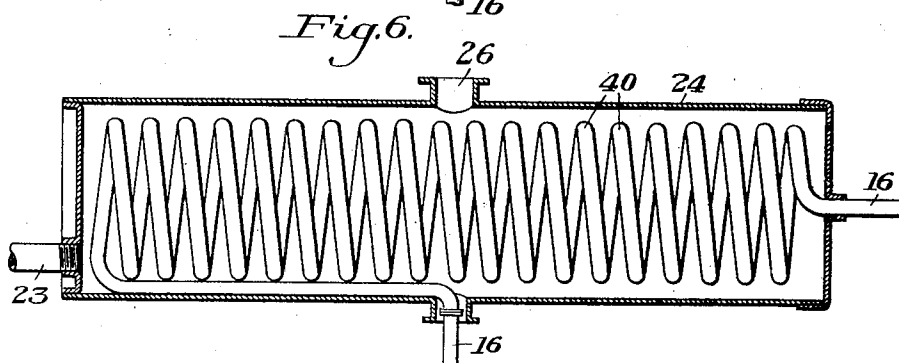
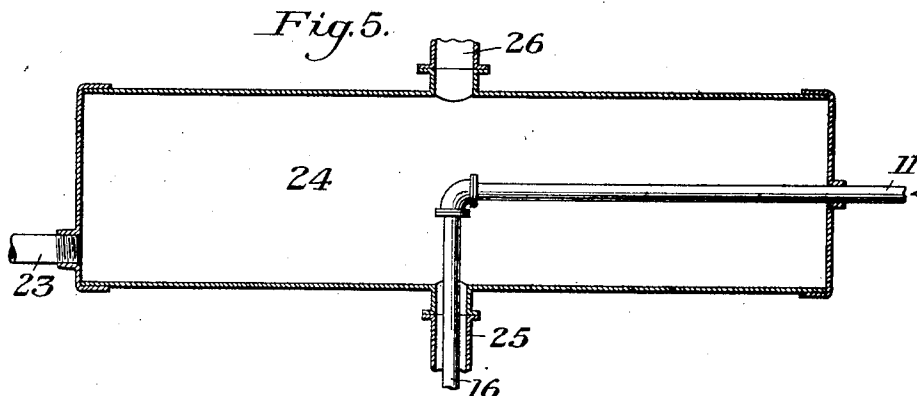
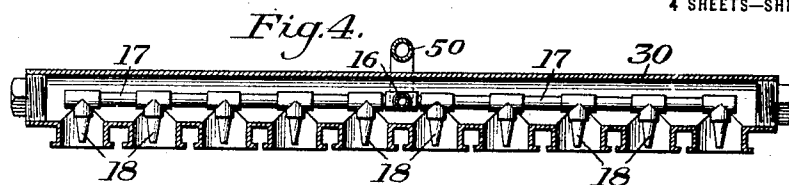


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4 SHEETS—SHEET 4,



WITNESSES

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UNITED STATES PATENT OFFICE.

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REFRIGERATING APPARATUS.

1,332,703.

Specification of Letters Patent.

Patented Mar. 2, 1920.

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To all whom it may concern:

Be it known that I, CHARLES H. WORTHEN, a citizen of the United States, residing at Beaver, in the county of Beaver and State of Pennsylvania, have invented a new and useful Improvement in Refrigerating Apparatus, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1 is a view taken partly in vertical section through a refrigerating system embodying the invention.

Fig. 2 is a perspective view of the ammonia coils and separation drum.

Fig. 3 is a side elevation, partly in section, showing the ammonia coils and separation drum.

Fig. 4 is a horizontal section through the supply header for the coils.

Fig. 5 is a vertical section through the separation drum.

Fig. 6 is a view similar to Fig. 5 showing a modification, and

Fig. 7 is a fragmentary view, partly in vertical section, through one of the delivery nozzles.

The present invention relates to refrigeration, and more particularly to refrigeration effected by the use of a liquefiable gas, such, for example, as anhydrous ammonia gas. One of the features of the invention is the re-use of the denser part of the refrigerant which has passed through the cooling coils, so as to extract the greatest amount of available cold from the refrigerant, and thus effect economy in operation. The invention relates also to certain other features hereinafter described and particularly pointed out in the claims, the advantages of which will be apparent to those skilled in the art.

Referring to the drawings, which illustrate the preferred embodiment of the invention, the space or room 1 to be refrigerated is located beneath a brine tank 2. A system of brine circulating coils 3 is provided in the space to be cooled. These coils are connected at 4 and 5, respectively, to the top and bottom of the brine tank so as to automatically maintain, by thermo-siphon action, a continuous circulation of brine through the system.

The brine is cooled by a liquefiable gaseous refrigerant, preferably anhydrous am-

monia gas. The brine tank is provided with a system of cooling or circulating coils, indicated generally by reference numeral 10. The liquid ammonia under pressure is furnished through a supply pipe 11 and the used ammonia gas is led away through return pipe 12. The ammonia gas may be supplied by any suitable ammonia plant, operating either on the "dry" or "wet" system. The ammonia from the supply pipe 11 passes through a shut-off valve 15 and is led downward through a pipe 16 to a header 17, provided with a plurality of nozzles 18 which deliver the ammonia to the cooling coils. The ammonia is delivered into a series of large or main pipes 19 extending horizontally along the bottom of the tank. The ammonia is delivered into the pipes 19 in the form of spray from the nozzles 18. The pipes 19 serve as headers for a large number of cooling pipes or coils 20 which are taken off from the tops of the pipes 19. These smaller pipes 20 are L-shaped, as shown in the drawings, and discharge into a plurality of main receiving pipes 21, which are vertically disposed at one side of the tank, and which serve as headers for the smaller pipes 20. The vertical pipes 21 in turn discharge into a main receiving header 22 near the top of the tank. The ammonia passes from the main receiving header 22 through a pipe 23 to a separation drum 24. It is found in practice that the used ammonia does not on its single passage through the cooling coils absorb all of the heat which it is capable of absorbing, or, as it is ordinarily expressed, the ammonia has not given up all of its cold. As the ammonia is discharged into the separation drum 24, it is found that a part of the ammonia is more dense than the remainder. The denser part of the ammonia is apparently in the form of a fog or mist consisting of unevaporated particles of liquid carried in suspension by the gas. This denser part separates by gravity in the drum 24 and drops down through the return pipe 25 at the bottom of the drum. The lighter part of the gas from which the available cold has been extracted, rises through the pipe 26 and is delivered to the return pipe 12 through which it passes to the condensation or compression apparatus (not shown). The lighter part is apparently completely evaporated ammonia

gas with little if any unevaporated spray or mist entrained. The return pipe 25 surrounds the vertical portion of the pipe 16 which, as shown in Fig. 5, enters one end of the drum 24 and is bent downwardly, being inclosed by the pipe 25. The return pipe 25 empties into a header 30 which is connected to the ends of the horizontal pipes 19 and serves to deliver the heavier portion of the used ammonia from which the available cold has not been extracted to such horizontal pipes. As shown in Figs. 4 and 7, the header 30 surrounds the header 17 and delivers the used ammonia in an annular stream around the nozzles 18 which serve as injectors, the used ammonia being entrained with the fresh ammonia from the nozzles 18, and thus being carried through the cooling coils.

By the provision of the separation drum and chamber and the re-circulation of the denser part of the used ammonia, the ammonia is caused to absorb substantially all of the heat which it is capable of absorbing under conditions of practical operation. So long as the ammonia remains cold, dense, or "heavy," it is re-circulated through the system until it becomes "light", whereupon it is returned to be again liquefied. The "heavy" ammonia which is re-circulated, apparently holds in suspension unevaporated liquid ammonia in the form of fog, the complete evaporation of which absorbs a considerable amount of heat, which would be unavailable except for such re-circulation. The saving in cost of operation in using as completely as possible the refrigerating capacity of the ammonia before returning it for re-liquefaction, is too apparent for further discussion.

In Fig. 6 is shown a modification in which the pipe 16 is provided with a coil inclosed in the separation drum 24. The liquid ammonia entering through the pipe 11 is usually at approximately room temperature. During its passage through the coil 40, the liquid ammonia is, however, chilled and is delivered at a low temperature to the spray nozzles 18. This conduces to economy in operation, in that the available cold in the used refrigerant is made available for chilling the liquid refrigerant entering the expansion coils.

The pipe 26 is provided with a valve 41, and the pipe 23 is provided with a valve 42 for closing these pipes when desired.

A scavenging pipe 50 extends from the return pipe 12 above the valve 41 to the bottom of the header 30. This scavenging pipe is normally maintained closed by means of valve 51. If it is desired to remove any liquid which may have collected in the cooling coils, or if it is desired to empty the coils of all the ammonia for the purposes of repair, the valves 15, 41 and 42 are closed, the valve 51 is opened and suction is applied

to the pipe 12. This completely clears the cooling coils of any liquid or gas which may be contained in them.

The liquid anhydrous ammonia may be supplied from a refrigerating plant operating on either the continuous or the intermittent system, or operating on either the wet or dry system. When the present apparatus is used with the "dry" system it possesses one important coöperating advantage, namely, that by the re-circulation of the gas, no gas which is not completely vaporized gets to the return pipe 12. In plants operating on the dry system, a number of explosions have occurred, due to the fact that liquid ammonia has been returned to the compressor. If any quantity of liquid ammonia gets into the cylinder of a compressor, it, being incompressible, causes the cylinder head to blow out. Such accidents are impossible with the present system, which insures the re-circulation of any heavy or only partially evaporated ammonia until complete evaporation takes place.

The brine tank is preferably filled with calcium chlorid brine having a very low freezing point. The capacity of the tank is such that it will act as a store of cold for a considerable period, so that the supply of ammonia may be intermittent or cut off over night or over Sundays, and the space maintained at the requisite temperature. By means of the system of cooling coils above described, it is possible to refrigerate the brine to so low a temperature that the collection of hard ice on the brine circulating pipes 3 is prevented. In the system as installed, it is found that instead of the usual hard ice collected on the brine pipes 3, the moisture condenses on these pipes in the form of a light, flaky snow or frost, which may be readily brushed off.

It is found, as a practical matter, that the arrangement of the cooling pipes 20 in the L-shaped form shown in the drawings is of considerable advantage over the tortuous coils usually employed. The ammonia rises from the secondary header pipes 19 directly up into the vertical parts of the pipes 20 and then flows over to the secondary vertical headers 21. It will thus be seen that the pipes 20 form a large number of parallel coils, affording a direct and easy path for the ammonia.

While the preferred embodiment of the invention has been specifically illustrated and described, it is to be understood that the invention is not limited to its illustrated embodiment, but may be otherwise embodied, within the scope of the following claims.

I claim:

1. In a refrigerating apparatus, the combination of an expansion coil, an expansion nozzle at the lower part of the coil for

delivering a spray of previously liquefied anhydrous ammonia into the coil, a separation chamber into which the expansion coil discharges for separating the unevaporated particles of liquid entrained in the gaseous ammonia, and means for chilling the liquid ammonia before it is sprayed into the expansion coil including a supply pipe for the expansion nozzle, and a pipe surrounding the supply pipe and extending from the separation chamber to the lower part of the expansion coil for returning the separated unevaporated ammonia to the expansion coil, substantially as described.

2. In a refrigerating apparatus, the combination of an expansion coil, means including an expansion nozzle at the lower part of the coil for delivering a spray of previously liquefied anhydrous ammonia into the coil, a separation chamber above the coil into which the coil discharges for separating the unevaporated particles of liquid entrained in the gaseous ammonia, and a pipe extending from the separation chamber to the lower part of the expansion coil for delivering the unevaporated ammonia together with the spray into the lower part of the coil, substantially as described.

3. In a refrigerating apparatus, the combination of a horizontal header, a vertical header above the horizontal header, a plurality of L-shaped coils extending upwardly

from the horizontal header and then laterally to the vertical header, an expansion nozzle for delivering the previously liquefied anhydrous ammonia into the lower header, a separation chamber connected to the upper header and into which the upper header discharges for separating the unevaporated liquid particles entrained in the ammonia gas, and a pipe for delivering said unevaporated liquid to the lower header for recirculation, substantially as described.

4. In a refrigerating apparatus, the combination of an expansion coil, means including an expansion nozzle at the lower part of the coil for delivering a spray of previously liquefied anhydrous ammonia into the coil, a separation chamber into which the expansion coil discharges for separating the unevaporated particles of liquid entrained in the gaseous ammonia, and a pipe extending from the separation chamber and having an outlet surrounding the spray nozzle, for delivering such unevaporated particles to the lower part of the coil in a stream surrounding the spray from the nozzle, substantially as described.

In testimony whereof I have hereunto set my hand.

CHARLES H. WORTHEN.

Witnesses:

GEORGE R. BOVARD,
W. J. STEWART.