Feb. 22, 1955 R. S. GAUGLER 2,702,460

REFRIGERANT EVAPORATING MEANS

Filed June 23, 1951 3 Sheets-Sheet 1

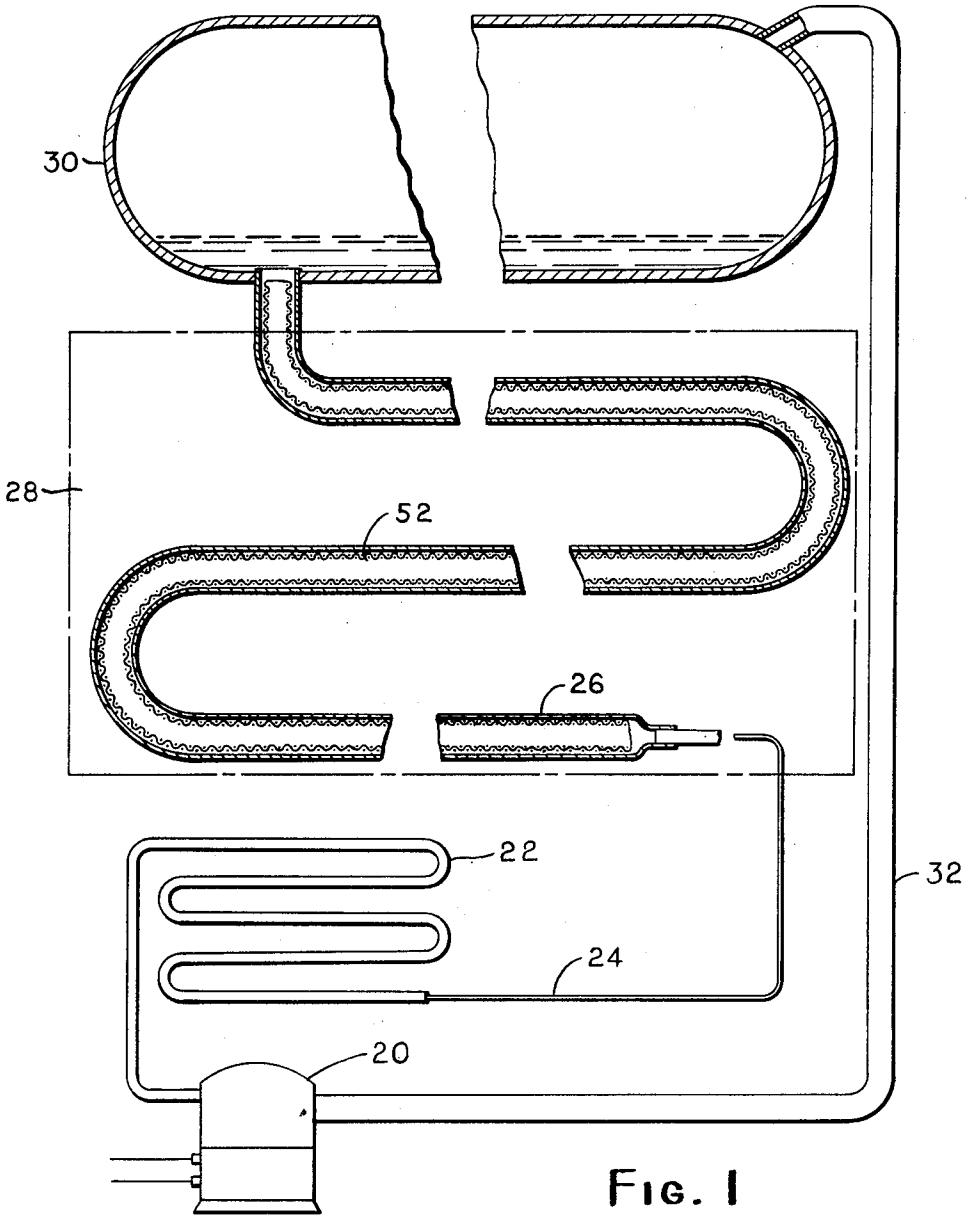


FIG. 1

INVENTOR.
Richard S Gaugler
BY
Willits Haidman and Fehr
attorneys

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Filed June 23, 1951 3 Sheets-Sheet 2

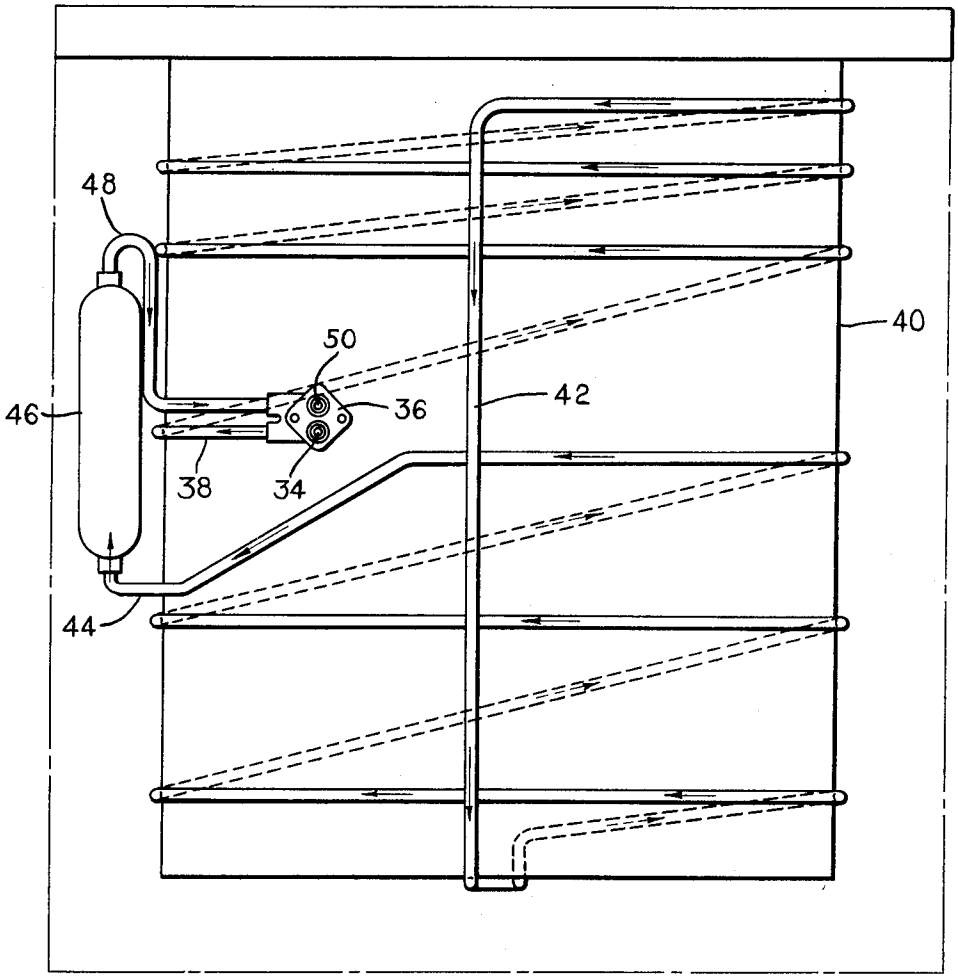


FIG. 2

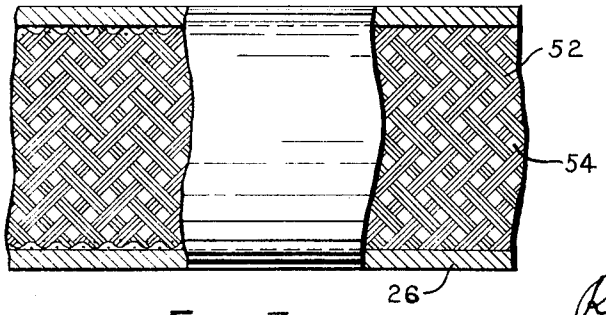


FIG. 3

INVENTOR.
Richard S. Gaugler
BY
Willits Hardman and Fehr
Attorneys

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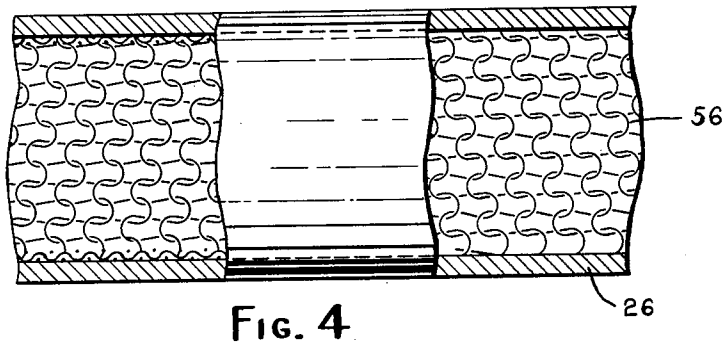


FIG. 4

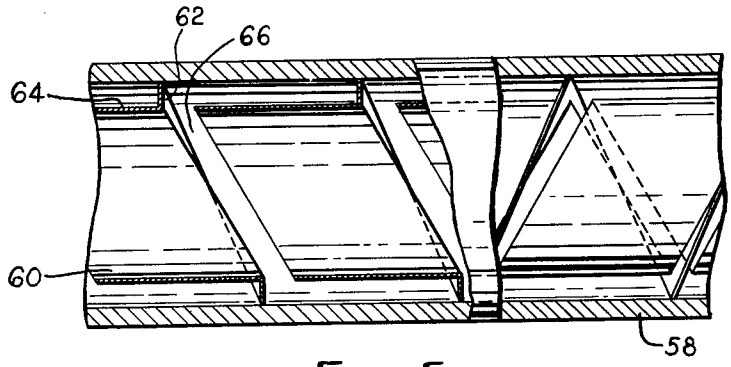


FIG. 5

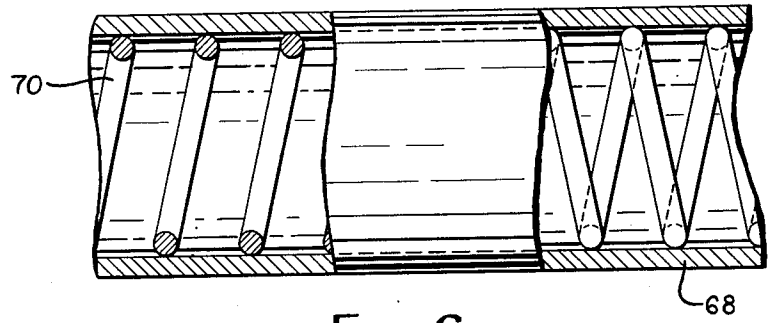


FIG. 6

INVENTOR.
Richard S. Gaugler
BY
Willits Hardman and Tehr
attorneys

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2,702,460

REFRIGERANT EVAPORATING MEANS

Richard S. Gaugler, Oakwood, Ohio, assignor to General Motors Corporation, Dayton, Ohio, a corporation of Delaware

Application June 23, 1951, Serial No. 233,193

2 Claims. (Cl. 62—126)

This invention relates to refrigeration apparatus and more particularly to refrigerant evaporating means of the series type.

In the series type of refrigerant evaporator, as the liquid passes through the refrigerant passages more and more of it turns from the liquid state into the gaseous state. Inasmuch as the gaseous volume is over 100 times the liquid volume of a unit weight of common refrigerants, the gaseous refrigerant takes more and more space as it passes through the refrigerant passages. In the latter half of the tube, the gas is divided by small liquid slugs which act like pistons and this separated gas and liquid slugs are carried through the tubing in the manner of a vapor lift pump. As these slugs proceed through the tubing, the liquid slugs grow smaller and disappear while the gas pockets enlarge enormously. This keeps the latter portion of the refrigerant passage within the tubing or container substantially free of liquid refrigerant so that the latter portion is unable to affect any substantial amount of heat transfer.

It is an object of my invention to shield the liquid refrigerant clinging to the walls of the evaporator tubing from being swept away by the evaporated refrigerant.

It is another object of my invention to keep liquid refrigerant in contact with the interior wall surface throughout the entire length of evaporator tubing or refrigerant passages.

It is another object of my invention to provide a pervious shielding means lining the inner walls of evaporator tubing and refrigerant passages for shielding the liquid refrigerant clinging to the inner walls of the tubing or passages from the wiping action of the evaporated refrigerant while the liquid refrigerant on the inner wall surface is permitted to evaporate and pass through the shielding means into the central portion of the tubing which conducts the evaporated refrigerant.

Briefly, according to my invention, in a series type of evaporator, there is provided a pervious sleeving or coiling which shields the liquid refrigerant clinging to the walls of the passage by keeping the flow of evaporated refrigerant confined to the axially central portions of the refrigerant passages or the refrigerant tubing.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a diagrammatic representation of a refrigerating system embodying one form of my invention;

Fig. 2 is a view partly diagrammatic of an ice cream cabinet or home freezer embodying my invention;

Fig. 3 is a fragmentary enlarged view of the tubing partly in section showing as one form of my invention braided wire sleeving within the tubing;

Fig. 4 is a fragmentary view of evaporator tubing partly in section containing as another form of my invention knitted wire sleeving;

Fig. 5 is a fragmentary view of evaporator tubing partly in section illustrating a third form of my invention incorporating a spiral metal strip; and

Fig. 6 is another fragmenary view of evaporator tubing partly in section showing a fourth form of my invention incorporating resilient helical wiring within the tubing.

Referring now to the drawings and more particularly to Fig. 1, there is shown a sealed motor compressor unit

20 for compressing evaporated refrigerant and forwarding the compressed refrigerant to a condenser 22 where the compressed refrigerant is liquefied and conducted through a capillary restrictor 24 which conducts the liquid refrigerant to a series tubular type of evaporator 26. This series tubular type of evaporator 26 is placed in direct heat exchange relation with some medium generally designated by the reference character 28 capable of transferring heat at a rapid rate to the tubing 26. The tubing 26 extends upwardly in any suitable fashion such as a serpentine arrangement as shown and its discharge end portion is connected to the bottom of an accumulator 30. To the top of the accumulator 30 is a suction conduit 32 connected with the suction inlet of the motor compressor unit 20.

A practical example of the evaporator and accumulator in such a system is shown in Fig. 2 wherein the liquid refrigerant enters through the inlet passage 34 in the dual fitting 36 and connects directly with the inlet end 38 of the series type refrigerant evaporator tubing. As illustrated, the inlet portion 38 connects to a section of tubing extending rearwardly along the left side and thence is wound somewhat in a helical fashion around the top of the insulated container 40 after which there is a downwardly extending tubular section 42 which extends rearwardly across the bottom of the container 40 and is wound about the lower half of the container 40 and terminates in an outlet portion 44 connecting with the bottom of the vertical accumulator 46. The top of the accumulator 46 is connected by a suction conduit 48 connecting with the outlet opening 50 in the fitting 36. The fitting 36 connects the inlet opening 34 with the capillary tubing and the condenser of a refrigerant liquefying apparatus while it also connects the outlet opening 50 with the suction inlet of the motor compressor unit of such apparatus.

My invention is especially advantageous where low suction pressures are required to attain the refrigerating temperature desired. For example, when it is desired to maintain a temperature of about 0° F., and difluorodichloromethane is used as a refrigerant, only 1 cubic inch of liquid, when evaporated, increases to about 149 cubic inches of evaporated refrigerant at 0° F. In other words if a small slug of this liquid refrigerant 1 inch long in a tube is changed to a vapor, this vapor will occupy approximately 149 inches of tubing. As the liquid refrigerant leaves the capillary tubing 24 and enters the evaporator tubing 26, a considerable portion vaporizes in order to provide sufficient cooling to reduce the temperature of the liquid refrigerant to the temperature of the evaporator tubing 26. As the remainder of the liquid refrigerant passes through the tubing 26 it will absorb more and more heat causing more and more to evaporate and displace liquid refrigerant. In the latter portion of the evaporator tubing, the evaporated refrigerant becomes separated by slugs of liquid refrigerant which act as liquid pistons and both the liquid slugs and the pockets of evaporated refrigerant pass through the tubing into the accumulator 30 in the manner of an evaporator lift pump. This starves the latter portions of the evaporator tubing of liquid refrigerant and causes this liquid refrigerant to accumulate in the accumulator 30 where it is a problem. The accumulator 30 is so full that the evaporated refrigerant has difficulty in passing through it and there is always a tendency for some liquid to be carried into the conduit 32.

According to my invention there is provided within the tubing 26 braided wire sleeving designated by the reference character 52. As shown in Fig. 1, this braided wire sleeving 52 extends entirely from one end of the tubing 26 to the other through the convolutions thereof. This braided wire sleeving 52, as is better shown in Fig. 3, is quite pervious. However, it screens or shields the inner surface of the walls of the tubing 26 from the rapid flow of evaporated refrigerant. It protects a relatively thin film of liquid refrigerant clinging to the inner wall surface of the tubing 26 from the wiping action of the evaporated refrigerant. The braided wire sleeving 52 also has a capillary action particularly in connection with its contact with the inner wall surface. This causes the liquid refrigerant to be tightly held and thus prevented

from being swept away by the evaporated refrigerant. Only a single layer of wire sleeving need be used but if desired a double thickness or two layers of wire sleeving in direct contact with each other and with the inner wall surface may be used. The double thickness provides greater capillary attraction and therefore always a greater amount of liquid refrigerant in contact with the inner wall surface.

The open spaces **54** in the braided wire sleeving readily permit the evaporation of liquid refrigerant from the inner wall surface of the tubing **26**. The capillary attraction of the braided wire sleeving **52** insures the immediate replacement of the evaporated refrigerant from the mixture of liquid refrigerant and evaporated refrigerant which flows through the interior of the sleeving **52**. While I prefer to make the sleeving **52** of metal wire, it may be made of suitable non-metallic filaments or fibers such as glass fiber or substantially insoluble synthetic plastics, such as nylon (polymericamides) or polyvinyl chloride-acetate resin fibers.

In the interests of reducing the cost, only the latter third or last half of the evaporator tubing may be provided with the braided sleeving. In these latter portions, a much greater amount of evaporated refrigerant flows and a higher velocity is attained. The entire portion of the evaporater tubing shown in Fig. 2 from the inlet portion **38** to the outlet portion **44** may be provided with braided wire sleeving **52** as shown in Fig. 3. Since ice cream cabinets and home freezers often reach 0° F., and consequently the gas volume is large in proportion to the liquid volume, the provision of braided sleeving on the interior of this tubing greatly improves the heat transfer efficiency of the tubing. Since the tubing is directly in contact with the metal walls **40** which surround the refrigerated compartment, ample heat flow is provided to the exterior of the tubing. Therefore, with this ample heat flow, the presence of liquid refrigerant directly in contact with the entire inner wall surface of the tubing on the walls **40** greatly increases the rate of heat transfer. This makes it unnecessary to reduce the suction pressure a considerable amount below that corresponding to the temperature desired within the container **40** and, in this way, the operating efficiency of the system is improved as well as the heat transfer efficiency. It is possible to reduce the length of tubing required to obtain the same amount of refrigeration capacity. The evaporated refrigerant flows freely through the interior of the sleeving **52**, and any liquid refrigerant which evaporates from the inner wall surface is replenished immediately by liquid refrigerant drawn from the stream by the capillary action of the braided sleeving.

In Fig. 4, the tubing **26** is provided with knitted wire sleeving **56** which is likewise in contact with the inner wall contact **26**. This knitted wire sleeving **56** also has capillary attraction which draws liquid refrigerant from the mixed stream of liquid refrigerant and gas in the interior of the sleeving to refrigerate a liquid refrigerant which evaporates from the inner wall surface. This knitted sleeving can be used in any place where the braided sleeving **52** may be used.

In Fig. 5, the tubing **58** contains a coaxial helically slotted tube **60** formed of a helically wound flat strip having one edge **62** turned outwardly so as to separate the axially extending portion **64** of this strip away from the inner wall surface of the tubing **58**. This slotted tube **60** shields the inner wall surface of the tubing **58** from the flow of evaporated refrigerant which is forced to flow substantially entirely through the interior of the tube **60**. The liquid refrigerant, therefore, is enabled to collect and remain between the slotted tubing **60** and the inner wall surface of the tubing **58**. The slot **66** provided by the helical construction of the tube **60** provides a space for the flow of evaporator refrigerant from the inner wall surface to the inner of slotted tubing **60**. Preferably, the space between the axially extending portion **64** of the strip and the interior wall surface of the tubing **58** is substantially of capillary dimension so that liquid refrigerant wil be drawn by capillary action into this space. This modification is especially useful for evaporating means formed of long lengths of straight tubing.

In Fig. 6, the interior of the tubing **68** is provided with spring wire **70** extending within the tubing **68** in the form of a helix in firm spring contact with the inner wall surface. The liquid refrigerant between the coils of the wire spring is protected and shielded from the flow of evaporated refrigerant which flows across axially through the center portion of the wire spring **70**. This form of shielding means **70** can be used with any type of evaporating means to which the wire spring **70** can conform. The spring **70** has a limited capillary attraction adjacent its portions in contact with the inner wall surface of the tubing.

In each of the forms, in addition to the shielding means serving as a capillary device to hold liquid refrigerant in contact with the inner wall surface and to protect it from the wiping action of the evaporator system, the shielding means also acts as an internal fin surface puncturing any vapor layer on the internal surface of the tubing if such a layer exists. The internal fin surface action of this shielding means also increases the surface for heat transfer between the tubing and the liquid refrigerant. The invention may be applied to other forms and phases of evaporating means and is useful wherever the surface of the refrigerant passages must be protected from the wiping action of the evaporated refrigerant. The vapor lift type of pumping action is effectively prevented, and slugs of liquid are broken up by the shielding means.

While the form of embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, as may come within the scope of the claims which follow.

What is claimed is as follows:

1. Refrigerant evaporating means including means forming an elongated refrigerant passage, refrigerant compressing and condensing means for feeding liquid refrigerant substantially into one end of said passage and withdrawing evaporated refrigerant substantially from the other end of said passage, said means forming said passage being arranged in convolutions with turns, and a flexible metal member extending within the passage continuously throughout a major portion of said convolutions including at least some of the turns closely adjacent the walls of said refrigerant passage for guiding the primary flow of evaporated refrigerant away from the walls of the refrigerant passage for protecting the film of liquid refrigerant clinging to the walls, said flexible metal member occupying only the outer region of said passage whereby the central portion of said passage provides for unobstructed flow of refrigerant therethrough.

2. Refrigerant evaporating means including means forming an elongated refrigerant passage, refrigerant compressing and condensing means for feeding liquid refrigerant substantially into one end of said passage and withdrawing evaporated refrigerant substantially from the other end of said passage, said means forming said passage being arranged in convolutions with turns, and a flexible metal member extending within the passage continuously throughout a major portion of said convolutions including at least some of the turns closely adjacent the walls of said refrigerant passage for guiding the primary flow of evaporated refrigerant away from the walls of the refrigerant passage for protecting the film of liquid refrigerant clinging to the walls, said flexible metal member occupying only the outer region of said passage whereby the central portion of said passage provides for unobstructed flow of refrigerant therethrough, said flexible member comprising a helically wound flat strip having one edge turned outwardly for engagement with the walls of said refrigerant passage and so as to space the main body of said strip from the walls of said refrigerant passage.

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