

Feb. 2, 1937.

C. STEENSTRUP

2,069,630

FLOW CONTROLLING DEVICE FOR REFRIGERATING SYSTEMS

Filed Oct. 24, 1935

Fig. 1.

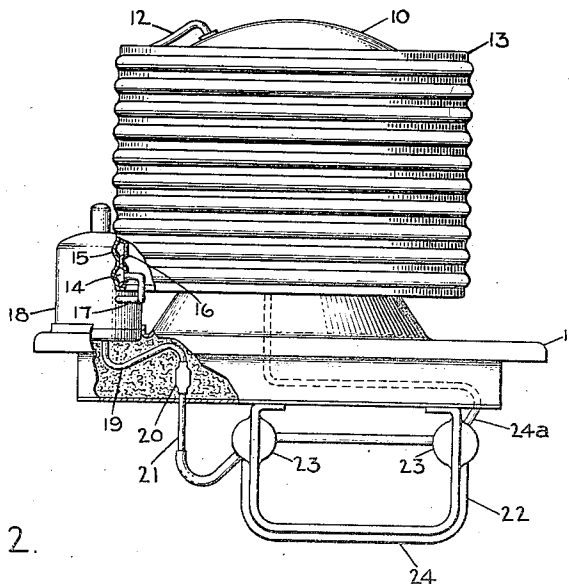


Fig. 2.

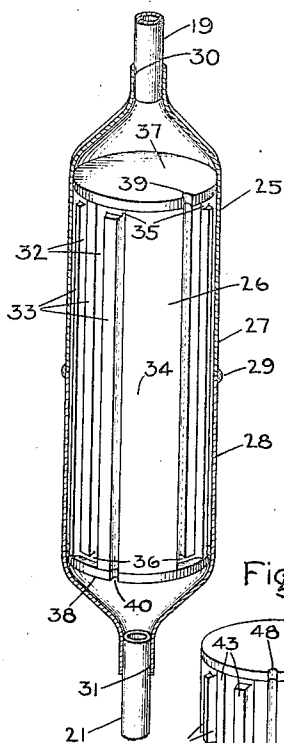


Fig. 4.

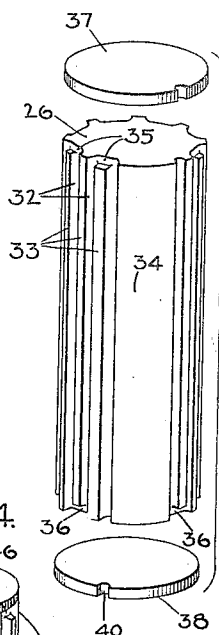
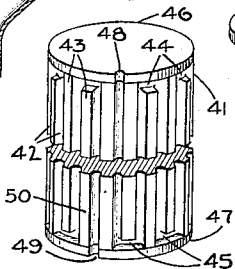


Fig. 3.

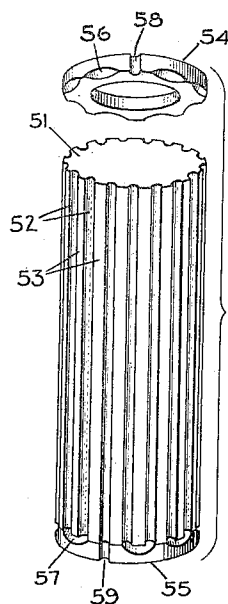


Fig. 5.

Inventor:
Christian Steenstrup,
by *Harry E. Dunham*
His Attorney.

UNITED STATES PATENT OFFICE

2,069,630

FLOW CONTROLLING DEVICE FOR
REFRIGERATING SYSTEMSChristian Steenstrup, Schenectady, N. Y., as-
signor to General Electric Company, a corpo-
ration of New York

Application October 24, 1935, Serial No. 46,499

8 Claims. (Cl. 138-42)

My invention relates to flow controlling devices for controlling the flow of refrigerant between the high and low pressure sides of a refrigerating system.

5 In refrigerating systems, it is necessary to provide a pressure reducing device between the condenser, which is on the high pressure side of the system, and the evaporator or cooling unit, which is on the low pressure side of the system, for
10 regulating the flow of liquid refrigerant from the condenser to the evaporator. This pressure reducing device in most systems comprises an automatic valve and in systems using a flooded evaporator a float valve is usually employed. In com-
15 pression refrigerating systems having a compressor which is driven at constant speed, the compressor has a constant capacity and, in a system of this type, it is desirable that the flow controlling device provide for the flow of refrigerant therethrough at about the same rate that
20 the liquid refrigerant is condensed in the condenser.

An essential requirement of a satisfactory flow controlling device is that it should prevent the
25 flow of gaseous refrigerant after the liquid refrigerant has passed therethrough or should limit such flow to a very small amount. This is due to the fact that such a flow of gaseous refrigerant from the high pressure side to the low
30 pressure side of the system results in a loss in capacity and efficiency of the refrigerating system. At the same time, the flow controlling device must permit a sufficient quantity of liquid
35 refrigerant to flow therethrough to meet the capacity requirements of the system at the lowest pressure difference prevailing between the high and low pressure sides of the system during the normal operation thereof.

A float valve fully meets all of these require-
40 ments of control of the flow of refrigerant, but is relatively expensive due to the fact that it requires a number of quite accurately manufactured moving parts. It has been sought to avoid the use of float valves by the substitution there-
45 for of long capillary tubes having a comparatively small inside diameter and constructed to obtain sufficient pressure drop to maintain the required difference in pressure between the condenser and evaporator and also to afford adequate flow of liquid refrigerant from the condenser to the evaporator during the operation of the refrigerating system. Such capillary tubes are, however, very bulky and susceptible to damage since such a tube may be easily crushed thus cutting off the

flow of refrigerant therethrough and rendering the refrigerating machine inoperative.

It is an object of my invention to provide a flow controlling device for controlling the flow of refrigerant between the high and low pressure
5 sides of a refrigerating system, which includes an extended sinuous refrigerant passage of relatively small cross sectional area, which is compact, rugged, and economical to manufacture, and
10 which efficiently restricts or substantially prevents the flow of vaporized refrigerant therethrough, while at the same time maintaining the required pressure difference between the high pressure and the low pressure sides of the re-
15 frigerating system and permitting a sufficient quantity of liquid refrigerant to flow therethrough to meet the capacity requirements of the system at the lowest pressure difference prevailing between the high and low pressure sides
20 of the system.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my invention will be pointed
25 out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention, reference may be had to the accompanying drawing, in which Fig. 1 is a side elevation partly in section of a refrigerating machine provided with
30 a flow controlling device embodying my invention; Fig. 2 is a perspective view partly in section of the flow controlling device of the refrigerating machine shown in Fig. 1; Fig. 3 is an exploded perspective view of the plug and caps of the flow
35 controlling device shown in Figs. 1 and 2; Fig. 4 is a perspective view, with the central portion thereof cut away, of a modified form of plug and caps which may be used in a flow controlling device such as that shown in Figs. 1 and 2; and
40 Fig. 5 is an exploded perspective view of a further modified form of plug and caps which may be used in a flow controlling device such as that shown in Figs. 1 and 2.

Referring to the drawing, I have shown in
45 Fig. 1 a refrigerating machine designed for household use, which includes a motor-driven compressor unit contained in a cylindrical hermetically sealed casing 10 mounted on the upper side of the removable heat insulated top wall 11 of a
50 refrigerator cabinet with which the refrigerating machine is used. Compressed vaporized refrigerant, such as sulphur dioxide, is supplied from the compressor contained in the casing 10
55

through a conduit 12 to a cylindrical sheet metal condenser 13, which surrounds the casing 10 and is mounted thereon. The compressed gaseous refrigerant thus supplied to the condenser 13 circulates through a helical refrigerant circulatory passage 14 formed by complementary indentations in the inner and outer sheets 15 and 16, respectively, of the condenser 13 and is liquefied by the transfer of heat therefrom to the cooling air which circulates over the surfaces of the condenser 13. The cooling air circulates upwardly over the surfaces of the condenser and between the condenser and the casing 10 by natural draft. The refrigerant thus liquefied in the condenser 13 flows through a conduit 17 to a cylindrical receiver 18 which is mounted on the wall 11. Liquefied refrigerant accumulated in the receiver 18 flows therefrom through a conduit 19 to a flow controlling device 20 embodying my invention and is supplied therefrom through a liquid line 21 to a flooded type sheet metal evaporator 22. The evaporator 22 is supported on the lower side of the wall 11 in a refrigerator cabinet food storage compartment, the contents of which is to be cooled. The evaporator is provided with a pair of longitudinal cylindrical headers 23 and a plurality of U-shaped refrigerant circulator passages 24 which communicate with the headers 23 below the normal liquid level therein. The headers 23 are maintained about half full of liquid refrigerant and the refrigerant circulatory passages 24 are thus flooded with liquid refrigerant. The liquid refrigerant contained in the evaporator 22 is vaporized by the absorption of heat from the compartment in which the evaporator is located and the refrigerant thus vaporized is collected in the headers 23 above the level of the liquid refrigerant therein. The vaporized refrigerant thus collected in the headers 23 is returned to the compressor in the casing 10 through a suction conduit 24a which communicates with one of the headers 23 above the normal liquid level therein. This cycle is repeated and continued until the temperature of the compartment in which the evaporator 22 is located is reduced to the desired value.

The flow controlling device 20 includes a tubular casing 25 and a plug 26 tightly fitted in the casing. The plug is provided with an extended relatively narrow groove formed in the surface thereof having a plurality of sharp reentrant bends. The groove cooperates with the adjacent portions of the tubular casing 25 to form an extended sinuous flow controlling refrigerant passage of sufficient length and sinuosity as compared to its cross sectional area substantially to prevent the flow of vaporized refrigerant therethrough, while permitting the quantity of liquid refrigerant to flow therethrough required by the capacity of the system at the lowest pressure difference existing between the high and low pressure sides of the system during the normal operation thereof. The tubular casing 25 includes upper and lower cup-shaped sheet metal portions 27 and 28, respectively, having complementary edges arranged in abutting relation and secured together by welding as indicated at 29. The upper portion 27 of the casing is provided with an inlet opening 30 in the reduced upper end portion thereof to which the conduit 19 is silver soldered, brazed, or otherwise hermetically sealed. The lower portion 28 of the casing is provided with an outlet opening 31 in the reduced lower end portion thereof to which the end of the conduit 21 is silver soldered, brazed, or otherwise hermetically

sealed. The plug 26 is preferably cylindrical in shape and may be made from a rod of steel or the like. As shown in Figs. 2 and 3, a series of longitudinal grooves 32 separated by longitudinal lands 33 are broached or otherwise formed in the surface of the plug 26. The grooves 32 are preferably distributed over only a portion of the surface of the plug 26, an ungrooved portion 34 being left in the surface thereof which separates the inlet and outlet of the groove. The longitudinal grooves 32 are connected in series relation at the alternate ends thereof. As shown in Figs. 2 and 3, the ends of the lands 33 are alternately spaced from the ends of the plug 26. This may conveniently be done by milling away the alternate ends of the lands 33 for a short distance. Thus, a series of cross channels or passages 35 and 36 are formed at the opposite ends of the plug 26, which connect the alternate ends of the longitudinal grooves 32 in series relation. The ends of the grooves 32 and the cross passages 35 and 36 are closed by disk-shaped metal caps 37 and 38 which are arranged at the upper and lower ends, respectively, of the plug 26. The caps 37 and 38 are of substantially the same diameter as the maximum diameter of the plug 26 and may be welded, or otherwise rigidly secured, in position thereon. A notch 39 is formed in the periphery of the plug 37 and registers with one end of one of the grooves 32. Refrigerant entering the casing 25 through the inlet opening 30 thereof thus passes through the notch 39 into the grooves 32 and flows in series through the grooves 32 and cross passages 35 and 36. A notch 40 is provided in the periphery of the lower end cap 38 and registers with the lower end of one of the grooves 32 at the terminus of the sinuous passage formed by the grooves 32 and cross passages 35 and 36. The refrigerant which has passed through the passage thus formed escapes therefrom through the notch 40 from which it passes to the outlet opening 31 of the casing 25.

It will be seen that in the arrangement described above, I have provided a flow controlling device having a refrigerant passage therein formed by the grooves 32 and cross passages 35 and 36 which has a plurality of sharp reentrant bends therein at the opposite ends of the grooves 32. Such an arrangement of sharp reentrant bends is especially efficient in retarding or preventing the flow of vaporized refrigerant through the passage, while at the same time it permits a sufficient quantity of liquid refrigerant to flow therethrough to meet the requirements of the system at the lowest pressure difference prevailing between the high and low pressure thereof. The ungrooved portion 34 of the surface of the plug 26 is preferably arranged to separate the inlet and outlet ends of the passage formed by the grooves 32 in order to minimize the heat exchange therebetween which would otherwise cause a loss of efficiency in the system.

The size of the grooves has been somewhat exaggerated in the drawing in order to better illustrate the shape and construction thereof. I have found, however, that in a refrigerating machine using sulphur dioxide as a refrigerant and a compressor having a displacement of approximately 1,800 cubic inches per minute that a proper sinuosity and relation between the length and cross sectional area of the grooves 32 and plug 26 is had if the plug is made about 4 inches in length and the grooves are made about .020 inch deep and .030 inch wide, the total length of

the passage being approximately one hundred and sixty inches.

In Fig. 4, I have illustrated a modified form of plug and cap arrangement which may be substituted in the flow controlling device 20, illustrated in Figs. 2 and 3, for the plug and cap device shown therein. In the form of my invention illustrated in Fig. 4, a cylindrical plug 41 is utilized which is similar to the plug 26 illustrated above and which is provided with a series of longitudinal grooves 42, broached or otherwise formed in the surface thereof, and separated by longitudinal lands 43. The opposite adjacent ends of the lands 43 are cut away to provide cross passages 44 and 45 at the opposite ends thereof, thus connecting the grooves 42 in series relation. Disk-shaped caps 46 and 47 are positioned on the opposite ends of the plug 41 and notches 48 and 49 are formed in the peripheries thereof, respectively, registering with the opposite ends of the grooves 42 located on opposite sides of a land 50 which extends the entire length of the plug 41. The plug and end cap construction shown in Fig. 4 is thus identical with that shown in Figs. 2 and 3, except that the grooves 42 are distributed over the entire surface of the plug rather than over only a portion thereof.

In Fig. 5, I have illustrated another modified form of plug and end cap construction which may be used in the flow controlling device 20 illustrated in Figs. 1 and 2, and described above. In the form of my invention illustrated in Fig. 5, a metal plug 51, made of steel or the like, and preferably cylindrical in shape is provided with a series of longitudinal grooves 52, broached or otherwise formed in the surface thereof, and separated by longitudinal lands 53. The lands and grooves 52 extend throughout the entire length of the plug 51 and, consequently, the machining operations in forming the same are somewhat simplified as compared to the construction shown in Figs. 2, 3, and 4 since the alternate ends of the adjacent lands need not be cut away. Instead, the grooves 52 are connected in series relation at the adjacent ends thereof by recesses formed in disk-shaped end caps 54 and 55 which are positioned at the upper and lower ends, respectively, of the plug 51. In the form of my invention illustrated in Fig. 5, the recesses in the end caps 54 and 55 are notches 56 and 57, respectively, which may be conveniently milled or otherwise formed in the peripheral edges of the end caps. Notches 58 and 59 are formed in the peripheries of the end caps 54 and 55, respectively, and register with the opposite ends of an adjacent pair of grooves 52. Refrigerant thus enters the passage formed by the grooves 52 and notches 56 and 57 through the notch 58 and after passing there-through is discharged through the notch 59.

In assembling the various flow controlling devices, described above, the end caps are positioned on the opposite ends of the plugs and preferably welded, or otherwise rigidly secured, thereto. The upper and lower portions 27 and 28 of the tubular casing 25 are then tightly fitted on the plugs and the adjacent edges of the portions of the casing are welded together. The flow controlling device is then ready for attachment to the conduits 19 and 21 of the refrigerating system.

It will thus be seen that I have provided a flow controlling device which may be simply and economically manufactured from metal parts by a series of simple and well known manufacturing operations. The flow controlling device which I have provided forms a restricted and extended

refrigerant passage of extreme sinuosity which is especially adapted to restrict or substantially prevent the flow of vaporized refrigerant therethrough, while at the same time permitting a sufficient quantity of liquid refrigerant to flow therethrough to meet the capacity requirements of the system.

While I have shown a particular embodiment of my invention in connection with a compression type refrigerating machine especially designed for household use, I do not desire my invention to be limited to the particular construction shown and described and I intend, in the appended claims, to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A flow controlling device for controlling the flow of refrigerant between the high and low pressure sides of a refrigerating system, comprising a tubular casing having an inlet and an outlet, and means including a plug provided with a plurality of narrow grooves in the surface thereof and co-operating with said tubular casing for providing a sinuous flow controlling refrigerant passage between said inlet and said outlet and through said grooves in said series of sufficient length and sinuosity as compared with its cross-section area substantially to prevent the flow of vaporized refrigerant therethrough while permitting a quantity of liquid refrigerant to flow therethrough required by the capacity of the system at the lowest pressure difference between the high and low pressure sides of the system.

2. A flow controlling device for controlling the flow of refrigerant between the high and low pressure sides of a refrigerating system comprising a tubular casing having an inlet and an outlet, a plug tightly fitted in said casing, said plug being provided with a plurality of longitudinal grooves formed in the surface thereof, and means for connecting alternate adjacent ends of said grooves in series relation, said grooves and the adjacent portions of said casing cooperating to form an extended sinuous flow controlling refrigerant passage between said inlet and said outlet of sufficient length and sinuosity as compared to its cross sectional area substantially to prevent the flow of vaporized refrigerant therethrough while permitting the quantity of liquid refrigerant to flow therethrough required by the capacity of the system at the lowest pressure difference between the high and low pressure sides of the system.

3. A flow controlling device for controlling the flow of refrigerant between the high and low pressure sides of a refrigerating system comprising a tubular casing having an inlet and an outlet, a plug tightly fitted in said casing, said plug being provided with a plurality of longitudinal grooves formed in the surface thereof and distributed over only a portion of the surface thereof, and means for connecting alternate adjacent ends of said grooves in series relation, said grooves and the adjacent portions of said casing cooperating to form an extended sinuous flow controlling refrigerant passage between said inlet and said outlet of sufficient length and sinuosity as compared to its cross sectional area substantially to prevent the flow of vaporized refrigerant therethrough while permitting the quantity of liquid refrigerant to flow therethrough required by the capacity of the system at the lowest pressure difference between the high and low pressure sides of the system.

4. A flow controlling device for controlling the flow of refrigerant between the high and low pressure sides of a refrigerating system comprising a tubular casing having an inlet and an outlet, a plug tightly fitted in said casing, said plug being provided with a plurality of longitudinal grooves formed in the surface thereof and separated by a series of longitudinal lands, the alternating ends of said lands being cut away to form cross channels between said longitudinal grooves for connecting the same in series relation, and means for closing the ends of said grooves and the exterior sides of said cross channels, said grooves and said cross channels cooperating with the adjacent portions of said casing to form an extended sinuous flow controlling refrigerant passage between said inlet and said outlet of sufficient length and sinuosity as compared to its cross sectional area substantially to prevent the flow of vaporized refrigerant therethrough while permitting the quantity of liquid refrigerant to flow therethrough required by the capacity of the system at the lowest pressure difference between the high and low pressure sides of the system.

5. A flow controlling device for controlling the flow of refrigerant between the high and low pressure sides of a refrigerating system comprising a tubular casing having an inlet and an outlet, a plug tightly fitted in said casing, said plug being provided with a plurality of longitudinal grooves formed in the surface thereof and separated by a series of longitudinal lands, the alternating ends of said lands being cut away to form cross channels between said longitudinal grooves for connecting the same in series relation, and means including disk-shaped caps located at the opposite ends of said plug for closing the ends of said grooves and the exterior sides of said cross channels, said grooves and said cross channels cooperating with the adjacent portion of said casing to form an extended sinuous flow controlling refrigerant passage between said inlet and said outlet of sufficient length and sinuosity as compared to its cross sectional area substantially to prevent the flow of vaporized refrigerant therethrough while permitting the quantity of liquid refrigerant to flow therethrough required by the capacity of the system at the lowest pressure difference between the high and low pressure sides of the system.

6. A flow controlling device for controlling the flow of refrigerant between the high and low pressure sides of a refrigerating system comprising a tubular casing including complementary cup-shaped portions arranged with the edges of the open ends thereof in abutting relation and having inlet and outlet connections formed at the opposite ends thereof, means for securing said abutting edges together, a plug tightly fitted in said casing, said plug being provided with a plurality of longitudinal grooves formed in the surface thereof and separated by a series of longitudinal lands, the alternating ends of said lands being cut away to form cross channels between said longitudinal grooves for connecting the same

in series relation, and means including disk-shaped caps located at the opposite ends of said plug for closing the ends of said grooves and the exterior sides of said cross channels, said grooves and said cross channels cooperating with the adjacent portions of said casing to form an extended sinuous flow controlling refrigerant passage between said inlet and said outlet of sufficient length and sinuosity as compared to its cross sectional area substantially to prevent the flow of vaporized refrigerant therethrough while permitting the quantity of liquid refrigerant to flow therethrough required by the capacity of the system at the lowest pressure difference between the high and low pressure sides of the system.

7. A flow controlling device for controlling the flow of refrigerant between the high and low pressure sides of a refrigerating system comprising a tubular casing having an inlet and an outlet, a plug tightly fitted in said casing, said plug being provided with a plurality of longitudinal grooves formed in the surface thereof, and means including caps located at the opposite ends of said plug and having recesses formed in the inner surfaces thereof extending between the adjacent ends of said grooves for connecting alternate adjacent ends of said grooves in series relation, said grooves and said recesses in said caps cooperating with said casing to form an extended sinuous flow controlling refrigerant passage between said inlet and said outlet of sufficient length and sinuosity as compared to its cross sectional area substantially to prevent the flow of vaporized refrigerant therethrough while permitting the quantity of liquid refrigerant to flow therethrough required by the capacity of the system at the lowest pressure difference between the high and low pressure sides of the system.

8. A flow controlling device for controlling the flow of refrigerant between the high and low pressure sides of a refrigerating system comprising a tubular casing including complementary cup-shaped portions arranged with the edges of the open ends thereof in abutting relation and having inlet and outlet connections formed at the opposite ends thereof, means for securing said abutting edges together, a plug tightly fitted in said casing, said plug being provided with a plurality of longitudinal grooves formed in the surface thereof, and means including caps located at the opposite ends of said plug and having recesses formed in the inner surfaces thereof extending between the adjacent ends of said grooves for connecting alternate adjacent ends of said grooves in series relation, said grooves and said recesses in said caps cooperating with said casing to form an extended sinuous flow controlling refrigerant passage between said inlet and said outlet of sufficient length and sinuosity as compared to its cross sectional area substantially to prevent the flow of vaporized refrigerant therethrough while permitting the quantity of liquid refrigerant to flow therethrough required by the capacity of the system at the lowest pressure difference between the high and low pressure sides of the system.

CHRISTIAN STEENSTRUP.