

Oct. 27, 1942.

H. C. OSBORN, JR., ET AL

2,300,058

APPARATUS FOR EXCHANGING HEAT

Filed July 21, 1941

2 Sheets-Sheet 1

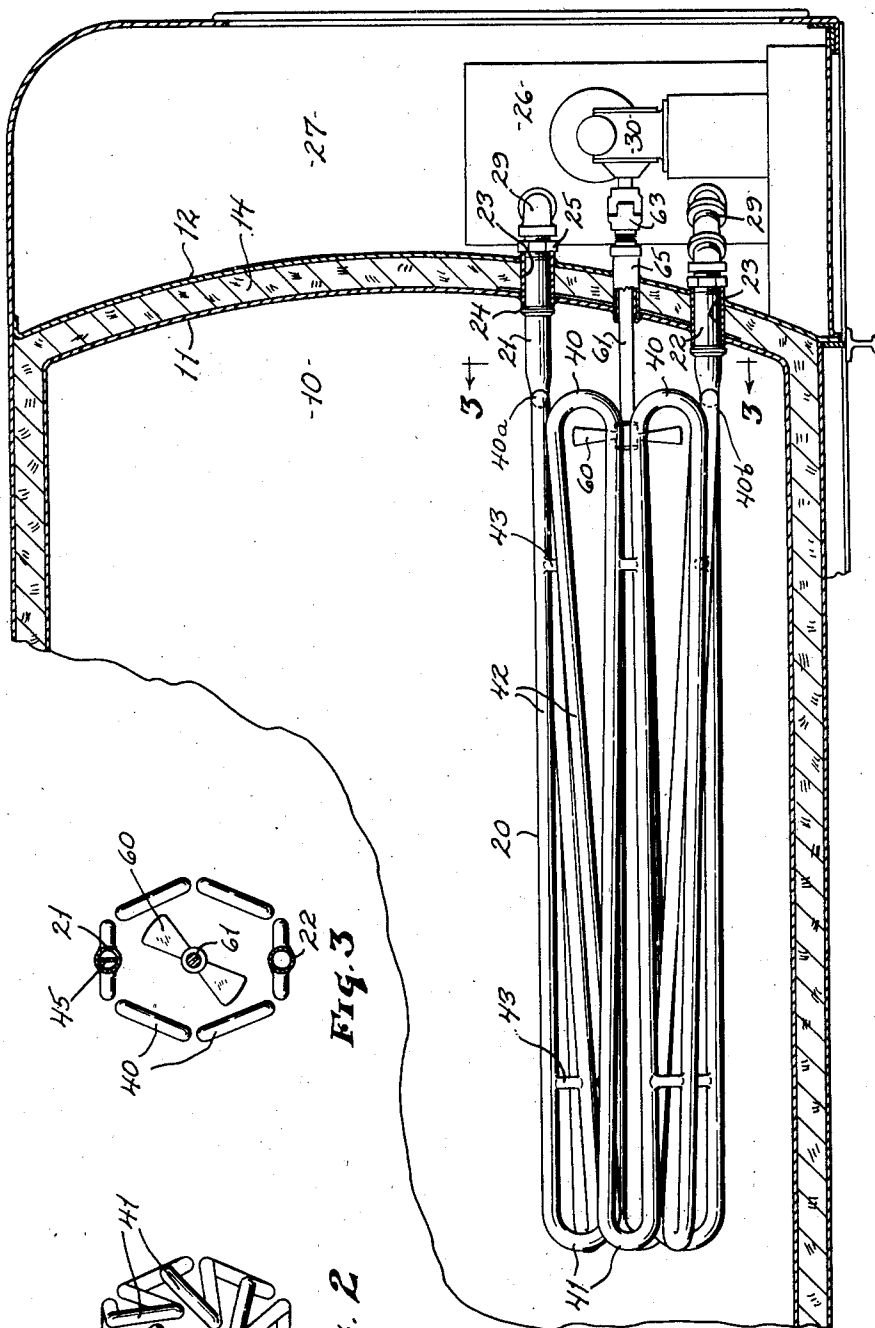


Fig. 1

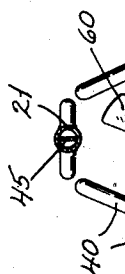


Fig. 3

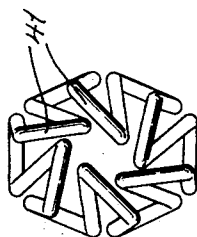


Fig. 2

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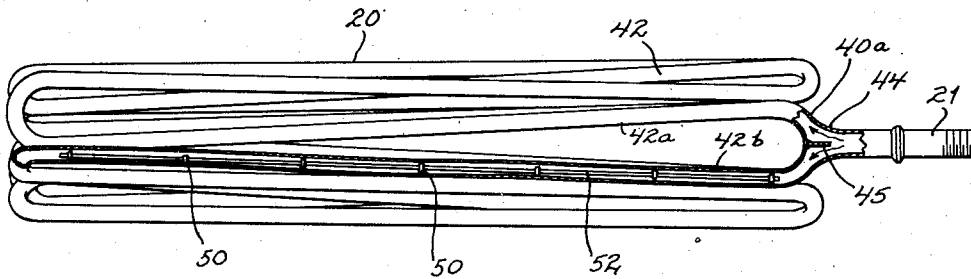


Fig. 4

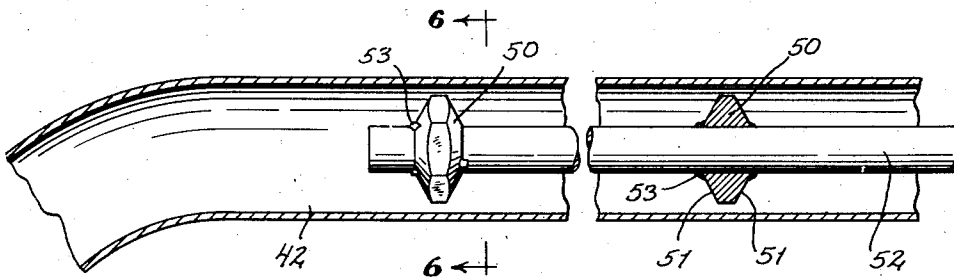


Fig. 5

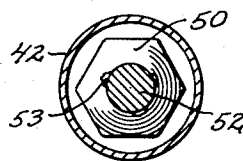


Fig. 6

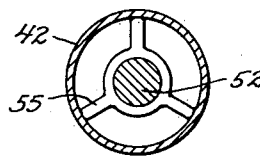


Fig. 7

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2,300,058

APPARATUS FOR EXCHANGING HEAT

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Application July 21, 1941, Serial No. 403,334

11 Claims. (Cl. 62-126)

This invention relates to a heat exchange system and more particularly to a heat exchange system for cooling the fluid contents of a tank or other receptacle. In the past, cooling systems utilizing units through which a refrigerant is forced have been used to chill or cool the fluid contents of tanks and other receptacles. In such systems it is important to so arrange the cooling unit as to displace as small an amount of fluid as possible, and thereby refrain from materially decreasing the fluid capacity of the tank or container. It, therefore, is important that the cooling unit be efficient and so arranged that the fluid will not solidify around the cooling unit as well as to provide circulation of the tank contents to maintain a substantially uniform temperature throughout the entire tank or receptacle. Accordingly, the general object of the present invention is to provide an improved system for cooling the contents of a tank or other container, including an arrangement of a cooling unit, whereby a high degree of heat transfer may be constantly maintained.

A further object of this invention is to provide an improved cooling unit for cooling the contents of tanks and other liquid receptacles.

A more specific object is to provide a cooling system for cooling the contents of tanks and the like, which system will include an improved cooling unit and a mechanism to agitate the fluid through the cooling unit to thereby avoid solidification of the fluid around the cooling unit and maintain a substantially even temperature throughout the entire area of the tank.

Another object of the present invention is to provide a simple cooling system which may be economically manufactured, and easily installed in existing tanks and receptacles, and in which the cooling mechanism will be accessible and readily cleansed when so installed, and at the same time have a highly efficient refrigeration transfer.

Other objects and advantages of this invention will become more apparent from the following description, reference being had to the drawings in which there is illustrated a preferred embodiment of the invention. The essential features of the invention will be summarized in the claims.

In the drawings, Fig. 1 is a sectional view of an insulated tank or receptacle having our improved cooling system installed therein; Fig. 2 is an end elevation of the cooling unit, looking at the left hand end of the unit as shown in Fig. 1; Fig. 3 is a sectional view as indicated by the lines 3-3 on Fig. 1, and illustrates a right-hand end view of the cooling unit; Fig. 4 is a view of a cooling unit

removed from the receptacle, certain portions of the unit being broken away to more clearly illustrate the internal structure; Fig. 5 is an enlarged sectional view through a portion of the cooling unit; Fig. 6 is a transverse sectional detail as indicated by the line 6-6 on Fig. 1, and Fig. 7 is a sectional detail view similar to Fig. 6, but illustrating one manner of supporting a restricting member which is positioned within the tubes of the cooling unit.

Referring now to the drawings in detail, and particularly to Fig. 1, a tank or container is generally indicated at 10 as having inner and outer walls 11 and 12, separated by suitable insulating material 14. The tank is of a general nature and its particular construction is not essential to the present invention. Suffice it to say that the tank may be either open or closed, but if closed, should be provided with a suitable man-hole (not shown), through which a cooling unit may be inserted, and which will provide entrance for a workman to facilitate the positioning, installation and maintenance of the cooling unit in the tank.

The cooling unit comprises a coil 20 of continuous tubular construction hereinafter to be more fully described. The coil 20 is provided at one end with an inlet conduit 21 and an outlet conduit 22, which pass through an end wall of the tank through suitable openings 23. Packing members, such as rings 24 and packing nut formations 25 carried by the conduits serve to maintain the coil 20 in position relative to the tank and at the same time provide a fluid tight joint.

The refrigeration unit itself may be of any type desired, such as will force a suitable refrigerating liquid, as for instance, ammonia, sulphur dioxide, Freon, through the cooling unit in the well-known manner. Such a unit is generally indicated at 26 in the drawings, as being mounted in an enclosure 27 carried by one end of the tank, piping, such as that indicated at 29, removably connects the inlet and outlet of the refrigeration coil 20 with the cooling unit. A motor, indicated at 30, is provided to operate the refrigeration unit 26 as well as an agitator mechanism hereinafter to be more fully described.

The heat exchange device or coil comprises a continuous convoluted tubular conduit made up of a series of successive U-shaped portions, alternately facing in opposite directions so that the final leg of the first U leads into the first leg of the second U, and so forth, to the final leg of the last U which joins the first leg of the first U. The U shaped bends 40 at one end of the coil

form chords of a bounding orbit, while the bends 41 at the opposite ends extend inward from a similar orbit toward a materially smaller orbit. Thus, the bends 40 provide substantially free flow of fluid into the envelope provided by the tubes 42 joining the bends, while the bends 41 at the opposite end of the coil materially restrict the flow of fluid out of such envelope, causing a considerable amount of such fluid to disperse radially through the envelope.

In other words the coil 20 comprises a convoluted tubular conduit made up of a series of elongated runs of pipe 42, each run being connected at its ends to the ends of adjacent runs 42 by return pipe bends 40 or 41. The arrangement is such that the alternate runs of pipe constitute a set of runs forming a cage, which as illustrated, has substantially the same cross section through the length of the runs. The other alternate runs 42 of pipe form an inner cage, which as illustrated, is located with the first cage. The cross section of the latter cage is such that it diminishes in area as the locus of the section approaches one end of the cage, thus restricting the flow of fluid to be acted on as it is forced through the cage, as by an impeller 60 (Fig. 1). The cages thus are of substantially the same cross sectional area at one end thereof (the right hand end in Figs. 1 and 4) and of a materially different area at the opposite end. The inlet and outlet end of the conduit is at the right hand end (Figs. 1 and 4). The fluid to be treated also enters the cages at this end thereof.

The various runs of the coil may be tied together by bridges, such as are indicated in Fig. 1 at 43. These bridges are preferably welded to the runs and serve to maintain the coil in a substantially rigid condition.

Two diametrically opposite loops 40 of the coil, at the open or large end of the internal cone, are joined to the inlet and outlet tubes 21 and 22, respectively. As shown in Fig. 4, it will be noted that the inlet tube 21 is connected, as at 44, with the loop 40a. A bridgelike formation 45 secured internally within the loop causes the inlet stream of refrigerant to divide two ways, part going through the leg 42a of the coil and part through the adjacent leg 42b. The opposite loop 40b is connected to the outlet 22 and is likewise provided with a partition, not illustrated but similar to the partition 45, so that the fluid passing out of the coil will be drawn from both adjacent legs of the loop 40b, thus insuring the passage of two streams of refrigerant through the coil.

Within the long legs 42 of the coil, there is positioned a series of spaced restricting members 50 to cause successive pressure drops throughout the entire cooling coil. This has been found to greatly increase the efficiency of the coil. The restricting members preferably comprise flat edged members having conically shaped front and rear surfaces 51, as generally indicated in Fig. 5, to deflect the refrigerant toward the internal wall of the tube.

The use of opposite conical surfaces on the members 50, as shown in Fig. 5 avoids possible misplacement of the frusto-conical elements or cones in the tube. The members 50 are preferably mounted at spaced intervals on a rod or bar 52, being secured to the bar, as for instance, by welds 53. The perimeter of the conical members may be rectangular, or, as shown, hexagonal, and are of such contour as to restrict the flow of the refrigerant fluid, but nevertheless permit its flow between the perimeter of the frusto-conical ele-

ments or cones, and the internal surface of the tube. The conical members 50 when secured to a rod or bar 52 may be merely laid in the longitudinal sections of the coil, the rod being of such a length that the end members 50 will contact the surface of the coil adjacent the bends and in effect wedge the rod in position and cause the intermediate cones to be spaced from the internal wall of the tube.

If desired, the bar 52 may be provided at its ends with spacer members. One type of spacer is generally indicated at 55 in Fig. 7. Such spacers may snugly fit the tube and thereby serve to maintain the rod 52 and, therefore, the cones 50 in a fixed position relative to the tube. The rod or bar 52, in addition to serving as a mount for the conical members 50, also serves to fill the central portion of the tubes and thus causes more intimate contact between the refrigerating fluid and the walls of the tube. This additionally increases the effectiveness of the coil as a transfer unit.

Reference herein has been made to the coil as being bounded by a substantially cylindrical theoretical envelope. It will be noted from Figs. 2 and 3 that said envelope would be elliptical in cross section rather than circular. Therefore, the term cylindrical envelope is used in a broad sense rather than with reference to the cross section of a circle. There is an advantage in arranging the coil so that the cross section of the coil is elliptical with the major axis vertical, as this adapts the coil better for use on tanks having elliptical man-holes at the end, but it is understood that the coils may be arranged so as to be bounded by a cylinder having a circular cross section, if desired.

The agitator heretofore mentioned comprises, as shown in Figs. 1 and 3, a fan 60 positioned within the large or inlet end of the coil in the region of the bends 40, as shown in Fig. 1. This agitator is mounted at the end of a shaft 61 which passes through the end wall of the tank and is connected by a universal coupling 63 with the motor 30 heretofore mentioned. A suitable packing arrangement 65 maintains the tank liquid tight in the region of the fan shaft. The fan is preferably operated to force the fluid contents of the tank into the envelope formed by the tubes 42 of the coil toward the bends 41 at the opposite ends of the coil, the restricting bends as well as the alternate legs 42 of the coil serve to restrict the flow axially through the envelope causing a considerable amount of the fluid to flow radially through the envelope, thus producing a highly efficient cooling system.

We claim:

1. A refrigerating apparatus comprising a conduit forming a passageway for the flow of a refrigerating agent having a tendency to pass from a liquid state to a gaseous state as the pressure drops, and a series of coaxial frusto-conical elements spaced along the axis of and positioned centrally within said passageway and having faces arranged to divert the flow of refrigerating agent toward the inner wall of said conduit and said elements being arranged and adapted to cooperate with said inner wall to cause a series of individual and successive pressure drops in said agent.

2. A refrigerating apparatus comprising a conduit forming a passageway for the flow of a refrigeration agent under pressure, said agent having a tendency to pass from a liquid state to a gaseous state as heat is absorbed, a filler posi-

tioned substantially centrally of said passageway to reduce the cross sectional area thereof, and a series of coaxial frusto-conical elements supported at spaced intervals on said filler and having faces arranged to cooperate with said inner wall of the conduit to cause a series of individual and successive pressure drops in the refrigerating agent as it passes through said passageway.

3. A refrigerating apparatus comprising a conduit forming a passageway for the flow of a refrigerating agent having a tendency to pass from a liquid state to a gaseous state as heat is absorbed, a series of members spaced along the axis of said passageway and having faces arranged to cooperate with the wall of the conduit to cause a series of individual and successive pressure drops in said agent, and wherein each of said members has a pair of conical surfaces facing respective ends of said conduit.

4. A refrigerating apparatus comprising a conduit forming a passageway for the flow of a refrigeration agent under pressure, and having a circular cross section, said agent having a tendency to pass from a liquid state to a gaseous state as the pressure drops, a filler positioned substantially along the axis of said passageway to reduce the cross sectional area thereof, a series of cones supported at spaced intervals on said filler and having faces arranged to cooperate with said inner wall of the conduit to cause a series of individual and successive pressure drops in the refrigerating agent as it passes through said passageway, the perimeter of the base of said cones being non-circular and spaced from the inner wall of said conduit, and means to position said filler and cones within said conduit.

5. In a heat exchange apparatus, a conduit having an inlet and an outlet, and comprising a series of tubular runs, each run being connected at its ends to the ends of the adjacent runs by return bends, alternate runs constituting a set of runs forming the boundary of an outer cage, and the other set of alternate runs forming the boundary of an inner cage, the cross section of which gradually diminishes in area as the locus of the sections approaches one end of the runs.

6. In a heat exchange apparatus, a conduit having an inlet and an outlet, and comprising a series of elongated runs of pipe, each run being connected at its ends to the ends of the adjacent runs by return bends, alternate runs constituting a set of runs forming the boundary of a cage of substantially the same cross section throughout the length of the runs, and the other set of alternate runs forming an inner cage, the cross section of which diminishes in area as the locus of the section approaches one end of the runs.

7. In a heat exchange apparatus, a conduit having an inlet and an outlet, and comprising a series of runs of pipe, each run being connected at its ends to the ends of adjacent runs by return bends, certain of said runs forming the boundary of an outer cage, and certain other runs forming the boundary of an inner cage, said cages being substantially identical in cross sectional area at one end of the heat exchange apparatus, and materially different in cross sectional areas at the other end of said apparatus, and means adjacent the first named end of said cages to force a fluid through said cages toward the opposite end of

said apparatus, and means to force a heat exchange medium through the conduit from inlet to outlet thereof.

8. In a heat exchange apparatus, a conduit having an inlet and an outlet, and comprising a series of runs of pipe, each run being connected at its ends to the ends of adjacent runs by return bends, alternate runs constituting a set of runs forming the boundary of a cage of substantially the same cross section throughout the length of the runs, the other set of alternate runs forming an inner cage, located within the first mentioned cage and the cross section of which diminishes in area as the locus of the section approaches one end of the cage, means to direct a heat exchange medium through said conduit from the inlet to the outlet thereof, and means to circulate a fluid to be subjected to a heat exchanging process through said cages toward the restricted end of said last mentioned cage.

9. A heat exchange device and means to cause flow of fluid to be treated axially through said device from one end to the opposite end, said device comprising a convoluted tubular conduit made up of a series of elongated runs of pipe interconnected at their ends by return bends to form a continuous conduit, said conduit being provided with an inlet and an outlet, certain of said runs comprising a set forming a cage substantially cylindrical in form, and certain other of said runs forming a coaxial cage substantially coaxial with the first named cage and substantially conical in form and arranged so that whereby the flow of fluid axially through said cages will be restricted thereby.

10. A heat exchange device comprising a conduit having an inlet and an outlet, and made up of two sets of substantially straight runs of pipe, the runs of one set being connected to the runs of the other set by return bends, the runs of one set being so arranged that all of the exterior surfaces thereof that lie in a plane perpendicular to the axis of the coil would be tangent to a symmetrical curved outline lying in said plane, the runs of the other set converging toward the axis of the coil and presenting surfaces in position to touch a smaller symmetrical closed curved figure lying in the same plane.

11. A heat exchange coil comprising a conduit having an inlet and an outlet, said conduit being made up of two sets of substantially straight runs of pipe, the runs of one set being connected to the runs of the other set by return bends, the runs of one of said sets being so arranged that all the exterior surfaces thereof that lie in a plane perpendicular to the axis of the coil would be tangent to a symmetrical closed outline lying in said plane, the runs of the other set converging towards the axis of the coil and presenting surfaces in position to touch a symmetrical closed curved figure lying in said plane, bridges interconnecting said runs intermediate their ends to maintain the runs in position, and impeller means positioned at one end of said coil to force a fluid through the coil toward the diverging ends of said last named runs.

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