

Oct. 6, 1931.

H. H. MARSHALL

1,826,253

LIQUID COOLING APPARATUS

Filed June 25, 1930

2 Sheets-Sheet 1

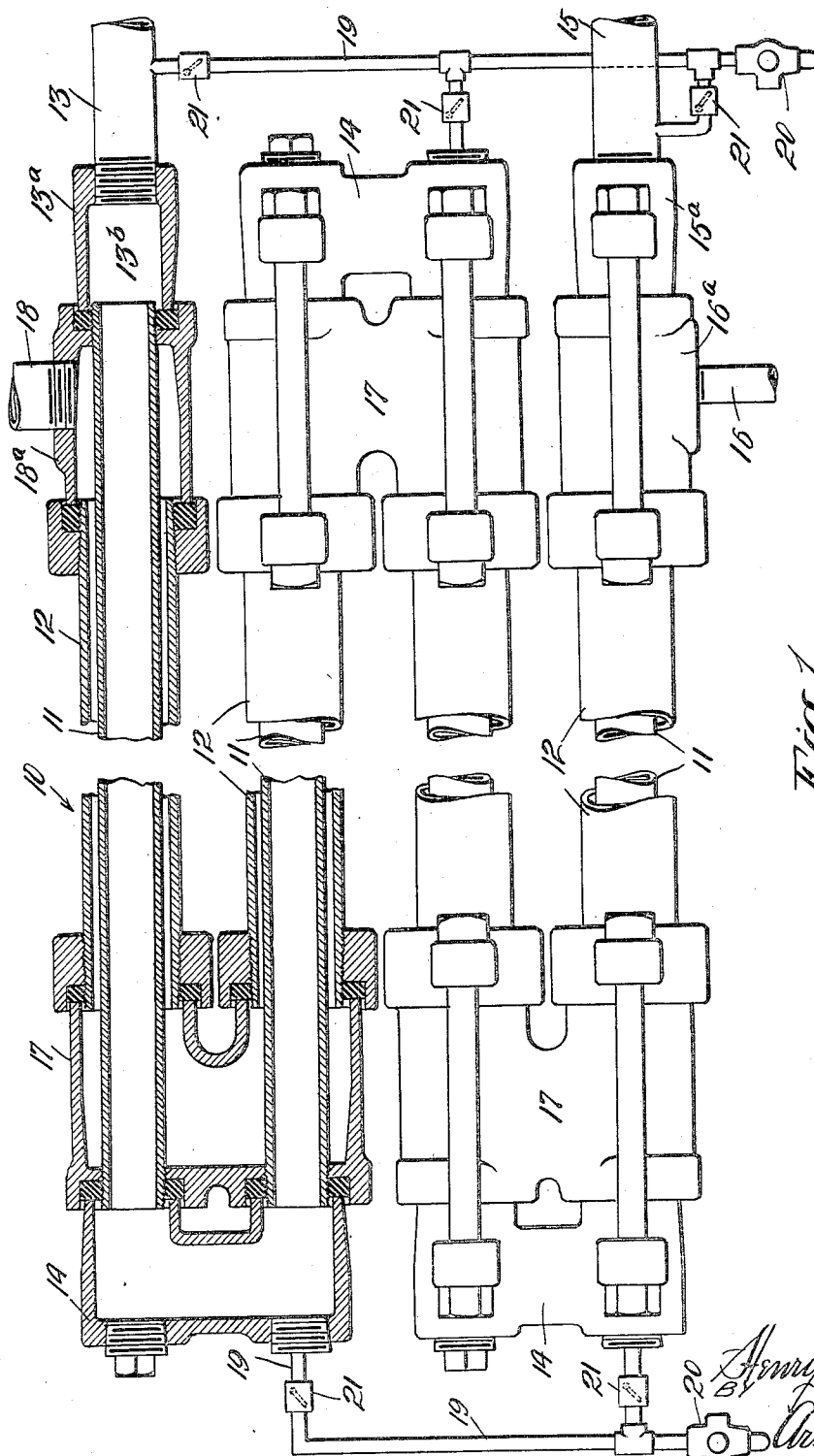


Fig. 1.

INVENTOR
H. H. Marshall
BY
Archibald Coy
ATTORNEY

Oct. 6, 1931.

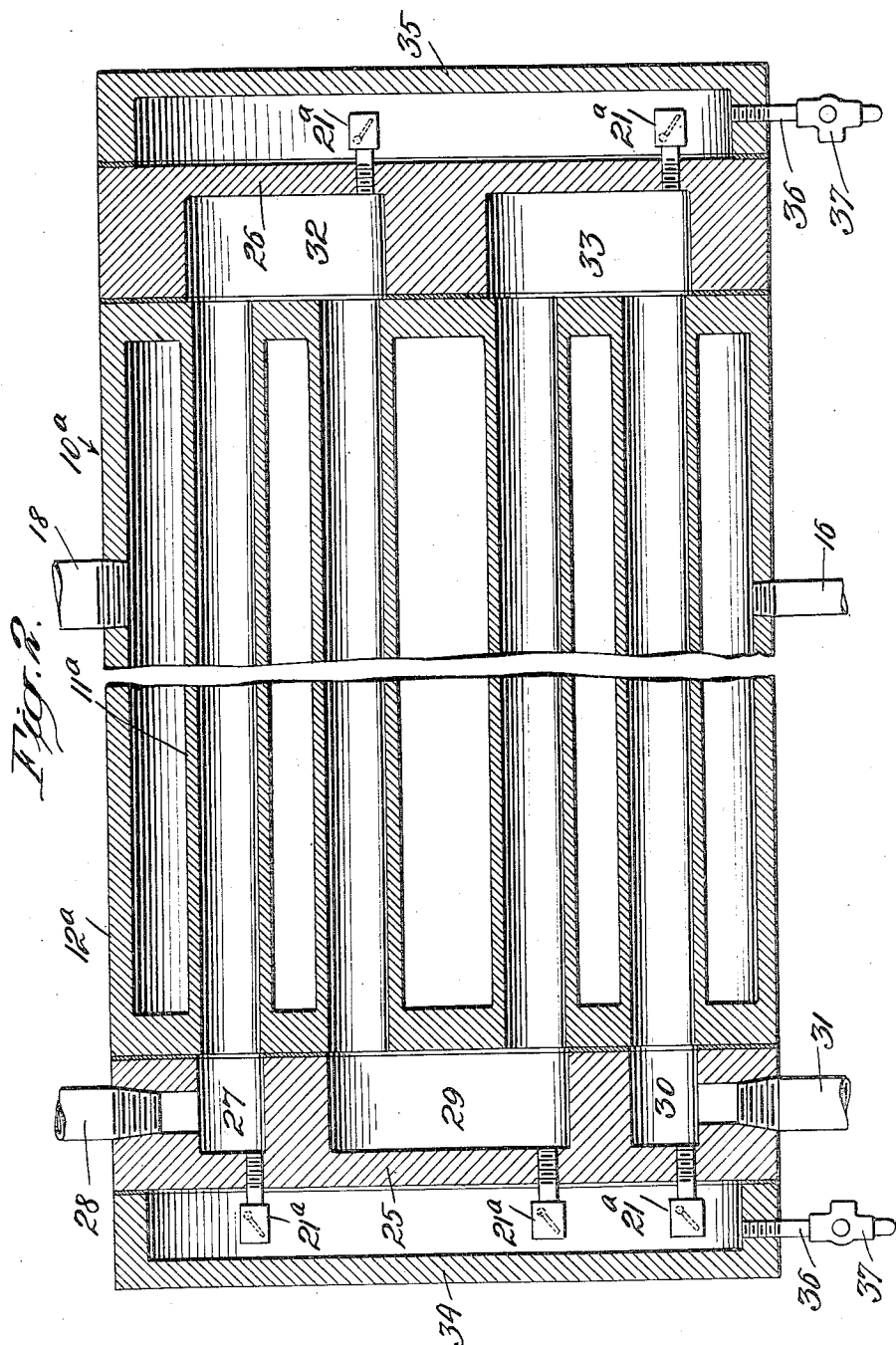
H. H. MARSHALL

1,826,253

LIQUID COOLING APPARATUS

Filed June 25, 1930

2 Sheets-Sheet 2



INVENTOR
Henry S. Marshall
BY
Archibald Coy
ATTORNEY

UNITED STATES PATENT OFFICE

HENRY H. MARSHALL, OF HIGHLAND PARK, NEW JERSEY, ASSIGNOR TO BRUNSWICK-KROESCHELL COMPANY, OF NEW BRUNSWICK, NEW JERSEY, A CORPORATION OF NEW JERSEY

LIQUID COOLING APPARATUS

Application filed June 25, 1930. Serial No. 463,677.

This invention relates to improvements in liquid cooling systems, and more particularly to a safety device for liquid coolers whereby damage to said coolers by freezing is avoided.

Heretofore, in the refrigerating industry it has been a practice to cool the brine, water and other liquids in coolers, such, for example, as double pipe coolers or shell and tube coolers. The refrigerants used in such coolers are usually at temperatures below that at which water or weak brine will freeze. Consequently it has been necessary to exercise great care in the operation of such coolers in order to prevent their destruction by freezing. Various automatic safeguards and devices have been proposed for preventing the further reduction of the temperature of the cooled liquid at times when some conditions prevail which would cause the liquid to freeze in the coolers. The proposed devices have not however been satisfactory, due to various conditions, such, for example, as failure to operate properly due to tampering therewith or change of adjustments thereof.

The main object of the present invention is to provide improved coolers which will not be destroyed even if the liquid therein is frozen solid. Another object is to provide coolers of this kind such that their normal operation cannot easily be affected by tampering.

The above and other objects are accomplished by apparatus of which two embodiments are illustrated in the accompanying drawings, in which: Fig. 1 is a fragmentary view, partly broken away, of a cooler of the double tube type embodying one form of the invention; and Fig. 2 is a section of a shell and tube cooler embodying another form of the present invention.

Referring to Fig. 1 of the drawings, 10 designates a double pipe cooler, including a set of inner pipes or tubes 11 having connections at their ends so that the liquid to be cooled will pass through all of said inner tubes 11 in succession, and outer tubes 12 surrounding said inner tubes so as to provide therebetween space for the circulation of suitable refrigerant and also connected so that refrigerant circulated therethrough will pass

from one of said outer tubes 12 to another in succession until it has been passed through all of them.

The liquid to be cooled enters the cooler through an inlet pipe 13 and passes through a connection 13a containing a chamber 13b into one of said inner tubes 11 from which it passes through return bends 14 and the other inner tubes to a discharge pipe 15 which is connected with the last inner tube by a connection 15a similar to connection 13a. The refrigerant is admitted at the bottom through an inlet pipe 16 and a tubular member 16a surrounding the discharge end of the lowest inner tube 11 into the space between the same and the corresponding outer tube 12 and after passing through outer tubes 12 and return bends 17, connecting the same, is finally discharged from the last outer tube 12 through a discharge pipe 18 connected with this tube 12 by a tubular member 18a surrounding the discharge end thereof.

At each end of the double pipe cooler 10, each return bend 14 of the inner tube connections is connected by a small pipe 19 to a liquid relief valve 20. Also each of the inlet and outlet pipes 13 and 15 is similarly connected with a pipe 19. A suitable check valve 21 is placed in each connection with the pipes 19 so that the liquid may pass through the check valves 21 into the pipes 19, but may not pass in the opposite direction. Each relief valve 20 is so adjusted as to open at a pressure slightly in excess of the maximum operating pressure imposed on the liquid being cooled.

In the event that the temperature of the cooled liquid is lowered sufficiently to cause freezing, ice accumulates at the inner surfaces of the tubes 11 and, inasmuch as the change from liquid to ice is accompanied by an increase in volume, the pressure on the remaining water is increased and, as the tubes close at their middle points, the water is pushed to the dead ends of the tubes. The check valves 21 are then forced open and as the pressure reaches the predetermined point, the water is forced out through the valves 20. This action continues spasmodically as the ice continues to form and any confined

water is pressed out of its confinement through the ice crystals to the point where it may be relieved by a valve 20.

The passages through the heads 14 are made of sufficient depth or volume to provide for such expansion so that when the ice finally fills all of the space, it will do so without having created at any time a bursting pressure at any point. The chambers in the connections 13a and 15a serve a similar purpose. It will be seen that the entire arrangement operates in such a way as to make the equipment operative in an ordinary manner as soon as thawing has progressed sufficiently to allow circulation of liquid through all of the tubes.

In some cases it may be desirable to install in place of the relief valves 20 rupture diaphragms or elements designed to break under a suitable pressure to give corresponding protection. It would, of course, be necessary to install new rupture elements before placing the cooler in service again.

It should be understood that the parts of the double tube cooler may be fastened together in any suitable manner.

In Fig. 2, the invention is illustrated as applied to a cooler 10a of the shell and tube type, which includes a central section having tubular portions 11a to accommodate the passage of the liquid to be cooled and which are surrounded by refrigerant in the shell 12a. The refrigerant is admitted through an inlet 16 at the bottom of the shell and discharged from the top thereof through an outlet 18. At opposite ends of the central section are heads 25 and 26. As here shown the head 25 is provided with a chamber 27 communicating with the upper tubular portion 11a and also with an inlet pipe 28 to supply liquid to be cooled. The head 25 is also provided with a chamber 29 to connect the second and third tubular portions 11a, and with a chamber 30 communicating with the lowest tubular portion 11a and with an outlet 31. The head 26 is provided with a chamber 32 connecting the right hand ends of the first and second tubular sections 11a and with a chamber 33 connecting the corresponding ends of the third and fourth tubular sections 11a.

It will be apparent that liquid entering the cooler through the pipe 28 will be guided back and forth through the tubular sections 11a and finally discharged through the discharge or outlet pipe 31. In its passage through the cooler it will be acted upon by refrigerant in the various passages of the shell 12a and will be cooled as desired. The chambers in the heads 25 and 26 correspond with the return bends 14 and inlet and outlet chambers 13a and 18a of the shell and tube structure of Fig. 1, and are designed so as to act in connection with outwardly opening check valves 21a to accommodate the in-

crease in volume of the contained liquid when it is frozen to form ice.

The check valves 21a could be connected with pipes provided with relief valves, as shown in connection with the double tube cooler of Fig. 1, but, as here shown, the check valves 21a discharge into chambers in false heads 34 and 35, each of which is provided at the bottom thereof with an outlet tube 36 controlled by an automatic relief valve 37. In the event of freezing of the water in the cooler, the action will be similar to that described in connection with the double tube cooler in that ice will form in the tubular sections 11a and shove the water out into the chambers in the heads 25 and 26.

When the pressure in the chambers in the heads reaches a certain predetermined degree, the check valves 21a will permit the water to be discharged therethrough into the chambers in the heads 34 and 35, and when the pressure in said false heads 34 and 35 becomes sufficiently great, the liquid discharged into the same will be forced out through the relief valves 37. After such freezing, the apparatus will again be in condition for use as soon as the ice therein melts. In this form, as in the double tube form, the relief valves 37 may be replaced by suitable rupture diaphragms.

I claim:

1. In liquid cooling apparatus including a tube to conduct the liquid to be cooled through a refrigerant container, the combination of said tube and means for preventing damage to the apparatus by the freezing of the liquid in the tube, including chambers at the inlet and outlet ends of the tube and outside of the refrigerant container to accommodate the liquid forced out of the ends of said tube.

2. In liquid cooling apparatus including a tube to conduct the liquid to be cooled through a refrigerant container, the combination of said tube and means for preventing damage to the apparatus by the freezing of the liquid in the tube, including chambers at the inlet and outlet ends of the tube and outside of the refrigerant container to accommodate the liquid forced out of the ends of the tube and means including outwardly opening relief valves to discharge liquid from said chambers when the pressure exceeds a predetermined degree.

3. In liquid cooling apparatus including a tube to conduct the liquid to be cooled through a refrigerant container, the combination of said tube and means for preventing damage to the apparatus by the freezing of the liquid in the tube, including chambers at the inlet and outlet ends of the tube and outside of the refrigerant container to accommodate the liquid forced out of the ends of the tube, outwardly opening check valves to discharge liquid from said chambers when

the pressure exceeds a predetermined degree, means for receiving liquid from said check valves and relief means to discharge liquid from the receiving means at a pressure slightly in excess of the maximum pressure
5 for normal operation.

4. In liquid cooling apparatus including a plurality of parallel tubes to conduct the liquid to be cooled through refrigerant containing means, the combination of said tubes
10 and means for preventing damage to the apparatus by the freezing of the liquid in said tubes including chambers in return bends connecting successive tubes and outside of
15 the refrigerant containing means to accommodate the liquid forced out of the corresponding ends of the tubes, outwardly opening check valves individual to said chambers, a container at each end of the apparatus
20 to receive the liquid from the check valves, and a relief device for each of said containers to discharge the liquid therefrom at a pressure slightly in excess of the maximum pressure for normal operation.

5. In liquid cooling apparatus including a plurality of parallel tubes to conduct the liquid to be cooled through refrigerant containing means, the combination of said tubes
25 and means for preventing damage to the apparatus by the freezing of the liquid in said tubes including chambers in return bends connecting successive tubes and outside of the refrigerant containing means to
30 accommodate the liquid forced out of the corresponding ends of said tubes, chambers at the inlet end of the first tube and the outlet end of the last tube respectively, outwardly opening check valves individual to
35 said chambers, a container at each end of the apparatus to receive liquid from the check valves at such ends, and a relief device for each of said containers to discharge the liquid therefrom at a pressure slightly in
40 excess of the maximum pressure for normal operation.

HENRY H. MARSHALL.