Aug. 20, 1935. W. F. NICKEL 2,012,136

CONTROLLING DEVICE FOR REFRIGERATING APPARATUS

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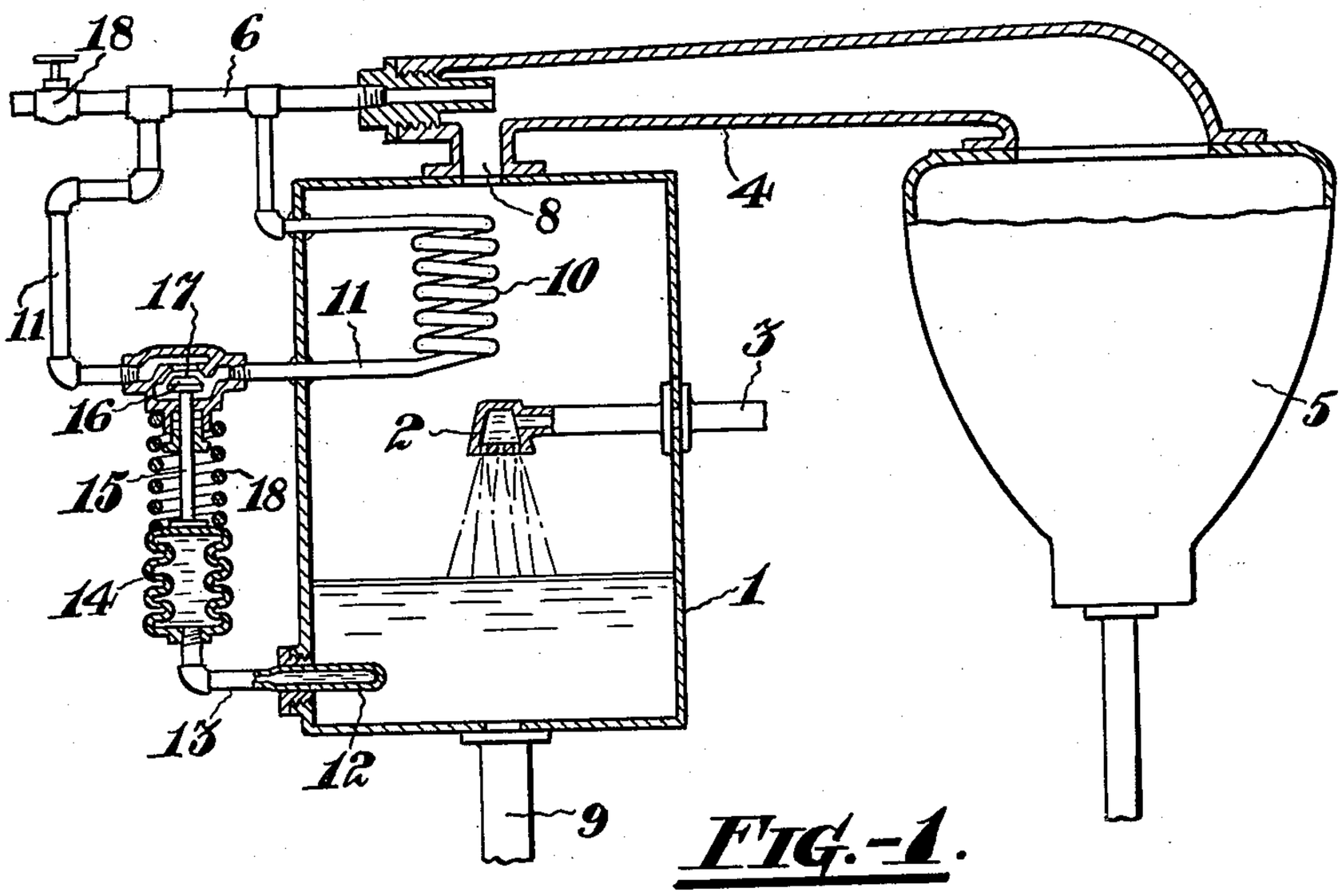

FIG.-1.

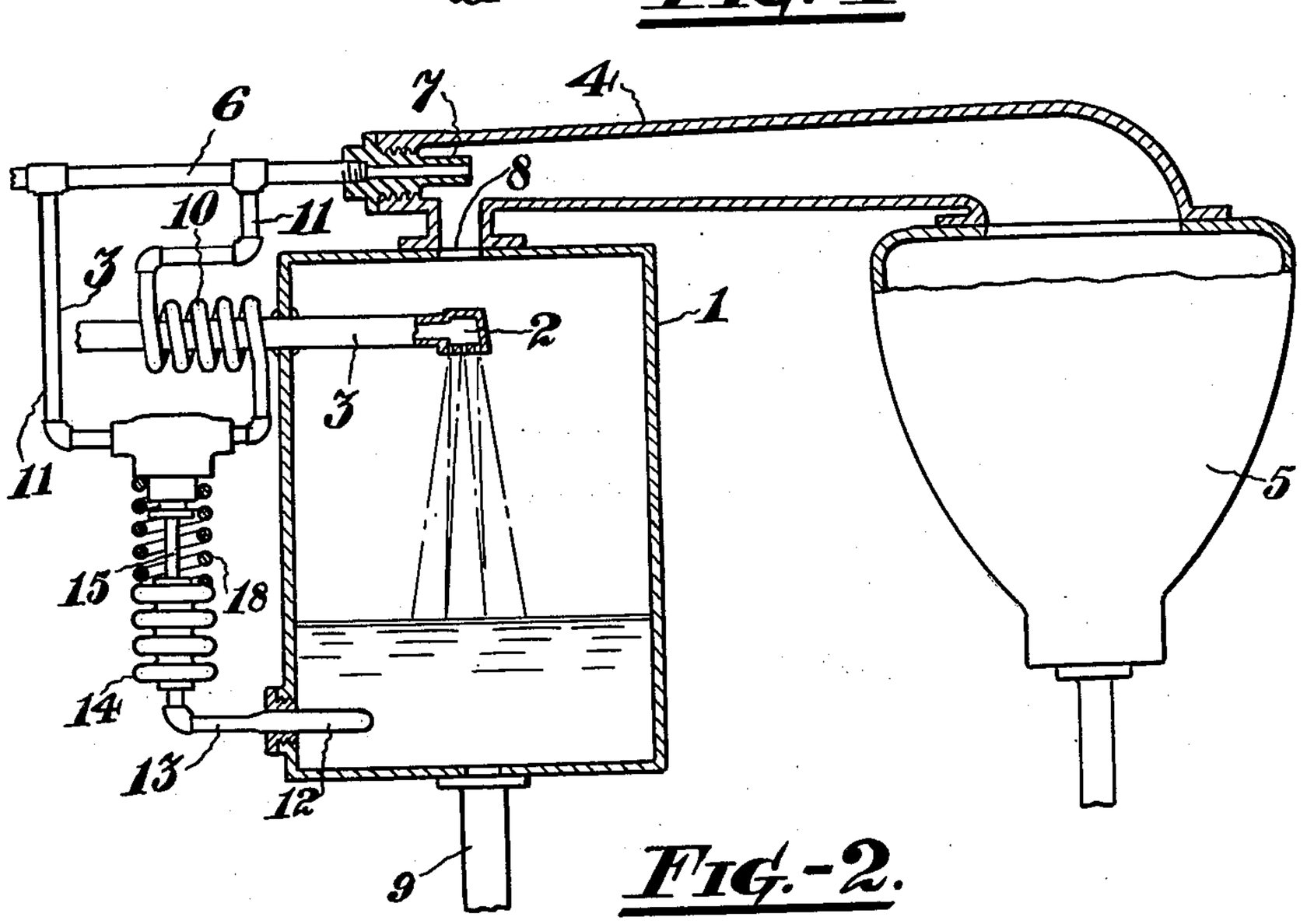

FIG.-2.

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CONTROLLING DEVICE FOR REFRIGERATING APPARATUS

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13 Claims. (Cl. 62—152)

My invention relates to refrigerating apparatus, and especially to a device for controlling the operation thereof.

This improvement is especially designed for use with refrigerating systems of the vapor type; comprising an evaporator in which a liquid refrigerant, such as water, is partly converted into vapor; so that heat becomes latent and brings about the cooling of the remainder of the water. To remove the vapor, a suitable evacuator such as a steam ejector member is employed, the steam and vapor going to a condenser wherein they are liquefied. The chilled water is piped away and passed through a cooling coil, for instance, where it absorbs heat, and is then conducted back to the evaporator to be cooled again.

In practice it is difficult to regulate such a system, because a steam ejector which will work satisfactorily and effect cooling of the water to the desired temperature at full load, the water then entering the evaporator in a relatively warm state, is apt to cause cooling of the chilled water down to a lower temperature than desired when the load falls and the returned water admitted to the evaporator is heated to a less degree. If, in a closed system delivering at full capacity, the water enters the evaporator at 55° and the pressure in the evaporator is about .35 inches of mercury, or less, for example, enough vaporization will take place to cool the water to 50°. When, however, the load drops, so that the incoming water is below 55°, less vaporization will result; but the steam jet operating as before will now cause the pressure in the evaporator to drop under the point above mentioned; thus increasing the vaporization and reducing the temperature of the water to less than 50° in consequence. At such low pressures in the evaporator the amount of vapor which a steam jet can extract from the evaporator is to some extent independent of the amount of steam which the ejector takes, and the pressure thereof. Consequently cutting down the steam ejector so as to reduce the steam and pressure thereof at light loads will not give the regulation needed.

My invention aims to control the apparatus and to prevent the water cooled in the evaporator from dropping too much in temperature at part loads by increasing the quantity of heat available in the evaporator; while allowing the pressure therein to be varied by the action of the ejector at different temperatures of the incoming water as before. Under these circumstances when the load falls, the ejector may continue in action and reduce the pressure in the evaporator so that the formation and removal of water vapor are continued; but, through the addition of heat from without to the supply of heat carried by the water as it enters the evaporator, the temperature of the chilled water is kept from falling below a predetermined value.

In its preferred form the regulating device of this invention is governed by the temperature of the water in the evaporator after cooling, so that the amount of heat which is added to the evaporator is automatically determined by operating conditions.

With these and other objects and advantages in view the invention consists in the novel features herein described and set forth in the accompanying drawing. But the disclosure is illustrative only, and I may make changes that do not depart from the principle of the invention.

On the drawing, Figure 1 shows in outline a construction according to my invention largely in section, and

Figure 2 presents a modification thereof.

The numeral 1 indicates a closed vessel or evaporator to which water is admitted through a spray nozzle 2 connected to a supply or return water pipe 3. At 4 is shown the casing of a steam ejector which connects the top of the evaporator to a condenser 5. This ejector receives steam through a pipe 6, connected to a nozzle 7 in the casing 4. In operation the vacuum in the evaporator will be maintained low enough by the ejector to cause some of the incoming water to be vaporized at once; the vapor being removed by the ejector from the evaporator through an outlet 8; and the remaining water cooled as required can be drawn out through the pipe 9 and delivered to the place of use.

Within the evaporator is a heating coil 10 connected by piping 11 at two points to the pipe 6. Steam passing out of this coil 10 may thus reenter the pipe 6 and flow to the ejector 4 to be discharged into the condenser. In the evaporator 1 is a thermostatic element or bulb 12 immersed in the chilled water at the bottom thereof, and having a tubular connection 13 leading to an expansible chamber 14 connecting to the stem 15 of a valve 16 in a casing 17 in the pipe which leads from the conduit 6 to the coil 10. A spring 18 surrounding the stem of this valve tends to hold it open. The end of the chamber 14 connected to the tube 13 is fixed, but the opposite end is movable.

When the load on the system drops, the water returning through the pipe 3 from the place of

use is not warmed as when the load is full. If the pressure were the same less of the water would be converted into vapor; but with the steam ejector 4 continuing to operate, the pressure in the evaporator 1 will now be somewhat reduced. Consequently enough water vapor will still be formed and extracted from the evaporator to cause the final temperature of the chilled water to be lowered. Ordinarily regulation can not be accomplished by reducing the quantity or the pressure of steam, because at low loads the water vapor extracted is, within certain limits, independent of these factors. However, under such conditions, the tendency of the chilled water to drop too far in temperature, will be counteracted by the effect of the heat supplied because of the presence of the coil 10. At a given point the valve 16 will open, because of the contraction of the medium in the parts 12, 13 and 14; so that steam will flow through into coil; and even if the amount of water vapor now generated is the same at full load, not so much heat will be extracted from the chilled water; and the water in the evaporator will, therefore, not be cooled too much. At the same time the steam might be reduced to some extent by partly closing the hand valve 19 but not below the amount and pressure necessary for continued vaporization. It has been proved by experiment that for low pressures in the evaporator 1 a steam jet deliverying a relatively large amount of steam at high pressure may not remove any more water vapor than a jet working at lower pressure and delivering a smaller volume of steam. Hence, within the limits permitted, the steam may be decreased somewhat by hand when the load drops to such a point as to open the valve 16.

In Figure 2, the heating coil 10, instead of being in the evaporator 1, is wound around the water admission pipe 2 near the evaporator and the effect is the same as before.

With this construction the steam ejector will operate in the usual way when the load falls to cause a lowering of pressure in the evaporator 1 and maintain vaporization and removal of water vapor. The final temperature of the chilled water, however, never decreases below a predetermined minimum, and the steam and the pressure thereof may be cut down to a level where the steam is just sufficient to continue the operation of the apparatus without waste of power. The expense of consuming an unnecessarily large amount of steam is thus saved, and the apparatus is regulated as above set forth.

From this description it will be seen that the construction is well adapted to serve the purposes of the invention, is certain in operation, simple in design and adds but little to the cost of an ordinary installation of this kind.

The invention may be used with open as well as closed systems. To remove any water condensing in the coil 10, a suitable trap may be provided and adapted to discharge into the water at the bottom of the evaporator 1.

I claim:

1. Refrigerating apparatus comprising an evaporator for liquid refrigerant to be partly vaporized therein, evacuating means for removing the vapor so formed, means for supplying a power medium to operate said evacuating means, means connected to the power-supplying means to receive part of said power medium, and disposed to vary the available quantity of heat in the evaporator to regulate said apparatus, and means comprising a thermostatic element in the evaporator to be influenced by the final temperature of the refrigerant to control said medium admitted to said second-named means.

2. A refrigerating apparatus comprising an evaporator for liquid refrigerant to be partly vaporized therein, said evaporator having an outlet, evacuating means for removing the vapor of said refrigerant through outlet, said means for supplying a power fluid to said evacuating means, means associated with the evaporator and connected to the power-supplying means to receive part of said power fluid and vary the quantity of the available heat in the evaporator, said last-named means being arranged to discharge said fluid at a point remote from said outlet, and means comprising a thermostatic element in the evaporator to control the means receiving said fluid.

3. Refrigerating apparatus comprising an evaporator for liquid refrigerant to be partly vaporized therein, evacuating means for removing the vapor so formed, means for supplying a power medium to operate said evacuating means, means connected to the power-supplying means to receive part of said power medium, and disposed to vary the available quantity of heat in the evaporator to regulate said apparatus, and means comprising a thermostatic element in the evaporator to be influenced by the final temperature of the refrigerant to control said medium, said receiving means comprising a coil in the evaporator.

4. Refrigerating apparatus comprising an evaporator having an inlet for liquid refrigerant to be partly vaporized therein, means for removing vapor so formed, and means for containing a heating medium associated with said evaporator and disposed to increase the available quantity of heat therein to regulate the apparatus, said containing means comprising a coil outside the evaporator adjacent said inlet.

5. Refrigerating apparatus comprising an evaporator having an inlet for liquid refrigerant to be partly vaporized therein, means for evacuating said vapor, means connected to the evacuating means for enclosing a heating medium associated with the evaporator and disposed to increase the available quantity of heat therein to regulate the apparatus, said enclosing means comprising a coil outside the evaporator adjacent said inlet.

6. Refrigerating apparatus comprising an evaporator having an inlet for liquid refrigerant to be partly vaporized therein, means for removing the vapor so formed, means for enclosing a heating medium associated with the evaporator, and disposed to increase the available quantity of heat therein, and means comprising a thermostatic element in the evaporator to be influenced by the final temperature of said refrigerant to control the means enclosing said medium, said last-named means comprising a coil outside the evaporator adjacent said inlet.

7. Refrigerating apparatus comprising an evaporator having an inlet for liquid refrigerant to be partly vaporized therein, means for removing the vapor so formed, said means being connected to receive a power medium to operate it, means connected to the first means to receive part of said power medium, and associated with the evaporator and disposed to vary the available quantity of heat therein to regulate said apparatus, and means comprising a thermostatic element in the evaporator to be influenced by the

final temperature of the refrigerant to control said receiving means, said last-named means comprising a coil outside the evaporator adjacent said inlet.

8. Refrigerating apparatus comprising an evaporator for liquid refrigerant to be partly vaporized therein, evacuating means for removing the vapor so formed, means for supplying a power medium to operate said evacuating means, means connected to the power-supplying means to receive part of said power medium, and disposed to vary the available quantity of heat in the evaporator to regulate said apparatus, and means comprising a thermostatic element in the evaporator to be influenced by the final temperature of the refrigerant to control said receiving means, said last-named means comprising a coil which receives said heating medium.

9. Refrigerating apparatus comprising an evaporator for liquid refrigerant to be partly vaporized therein, evacuating means for removing the vapor so formed, means for supplying a power medium to operate said evacuating means, and means connected to the power-supplying means to receive a part of said power medium and disposed so as to vary the available quantity of heat in the evaporator to regulate said apparatus.

10. A refrigerating apparatus comprising an evaporator for liquid refrigerant to be partly vaporized therein, said evaporator having an outlet, evacuating means for removing the vapor of said refrigerant through said outlet, means for supplying a power fluid to said evacuating means, and means associated with the evaporator and connected with the power-supplying means to receive part of said power fluid and vary the quantity of available heat in the evaporator, said last named means being arranged to discharge said fluid at a point remote from the outlet.

11. Refrigerating apparatus comprising an evaporator for a liquid refrigerant to be partly vaporized therein, evacuating means for removing the vapor so formed, means for supplying a power medium to operate said evacuating means, and means connected to the power-supplying means to receive part of said power medium, and disposed to vary the available quantity of heat in the evaporator to regulate said apparatus, said receiving means comprising a coil in the evaporator.

12. Refrigerating apparatus comprising an evaporator for liquid refrigerant to be partly vaporized therein, evacuating means for removing the vapor so formed, means for supplying a power medium to operate said evacuating means, and means connected to the power-supplying means to receive part of said power medium and disposed to vary the available quantity of heat in the evaporator to regulate said apparatus, said last named means comprising a coil which receives said power medium.

13. Refrigerating apparatus comprising an evaporator having an inlet conduit for liquid refrigerant to be partly vaporized therein, means for removing the vapor so formed, and means encircling said inlet conduit and disposed to increase the available heat in the evaporator to regulate said apparatus.

WILLIAM F. NICKEL.