

June 2, 1931.

K. M. URQUHART

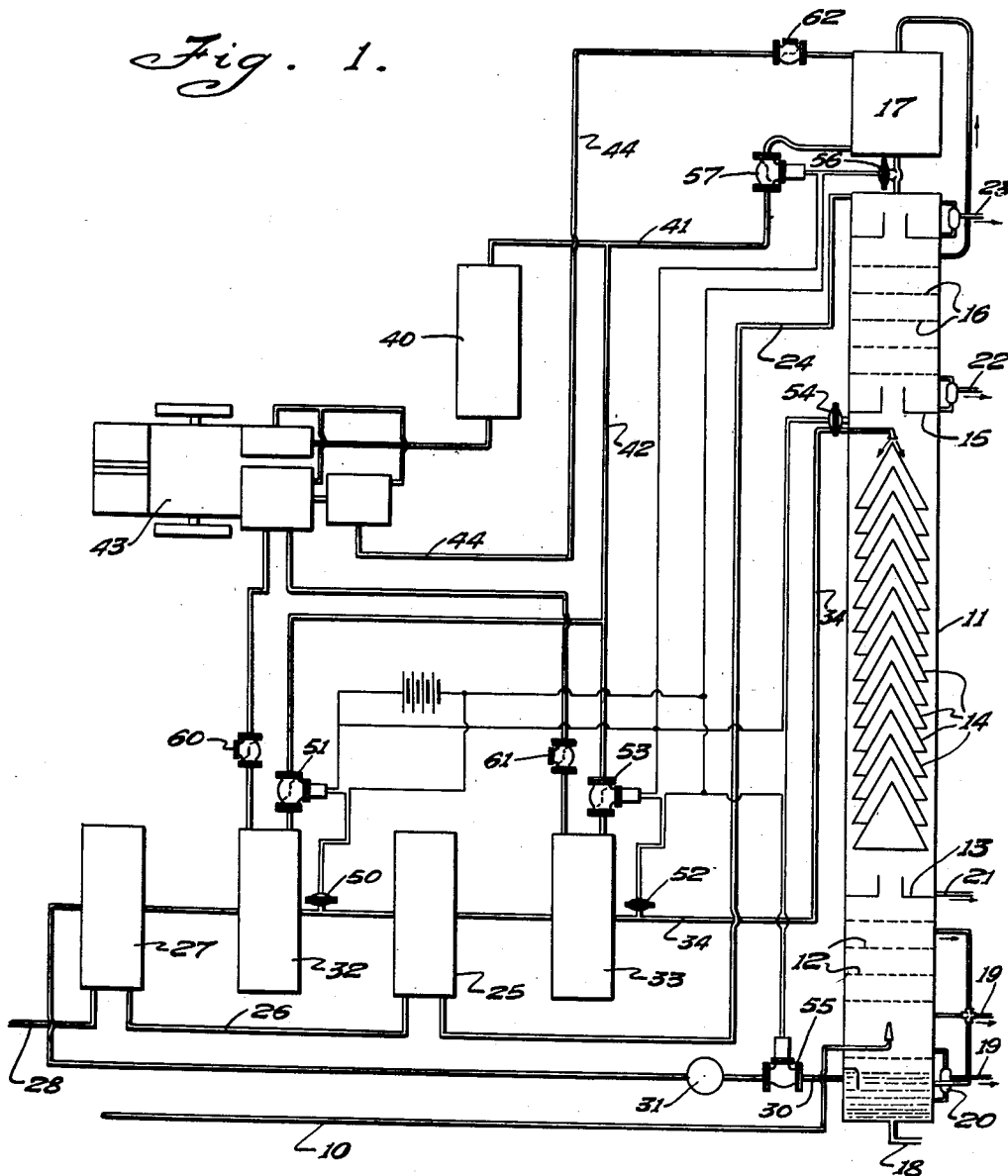
1,808,087

APPARATUS FOR TREATING GAS

Filed Jan. 29, 1929

4 Sheets-Sheet 1

Fig. 1.



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Fig. 2.

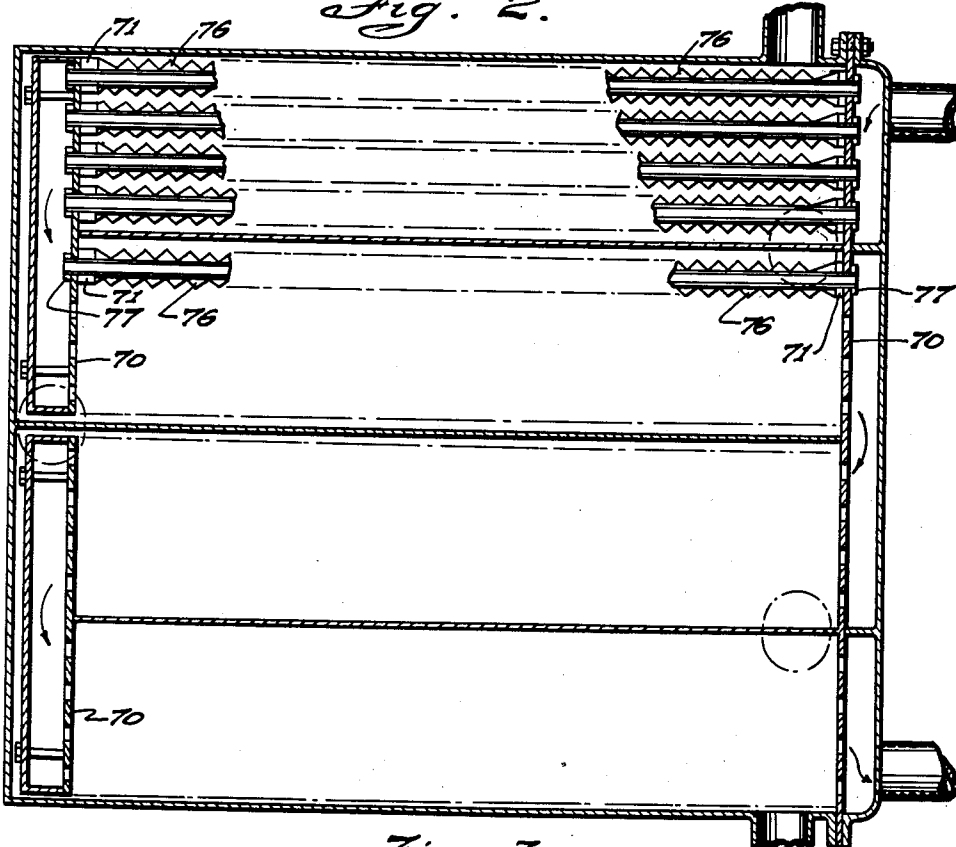
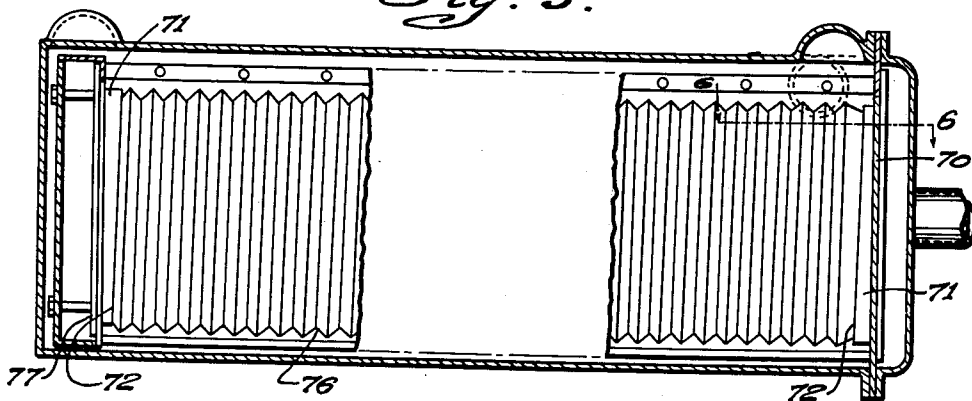


Fig. 3.



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Fig. 4.

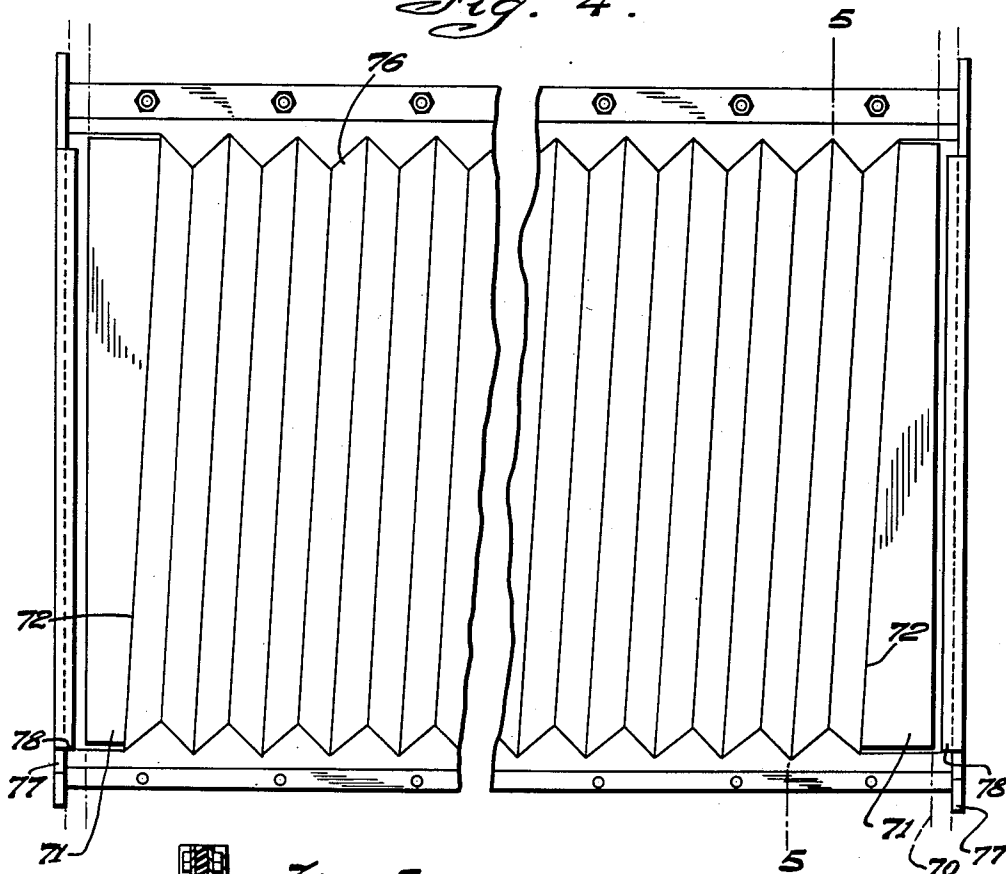


Fig. 5.

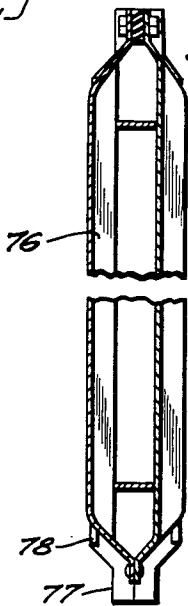
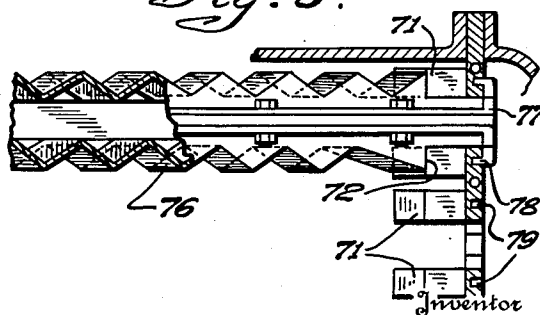


Fig. 6.



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APPARATUS FOR TREATING GAS

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Fig. 7.

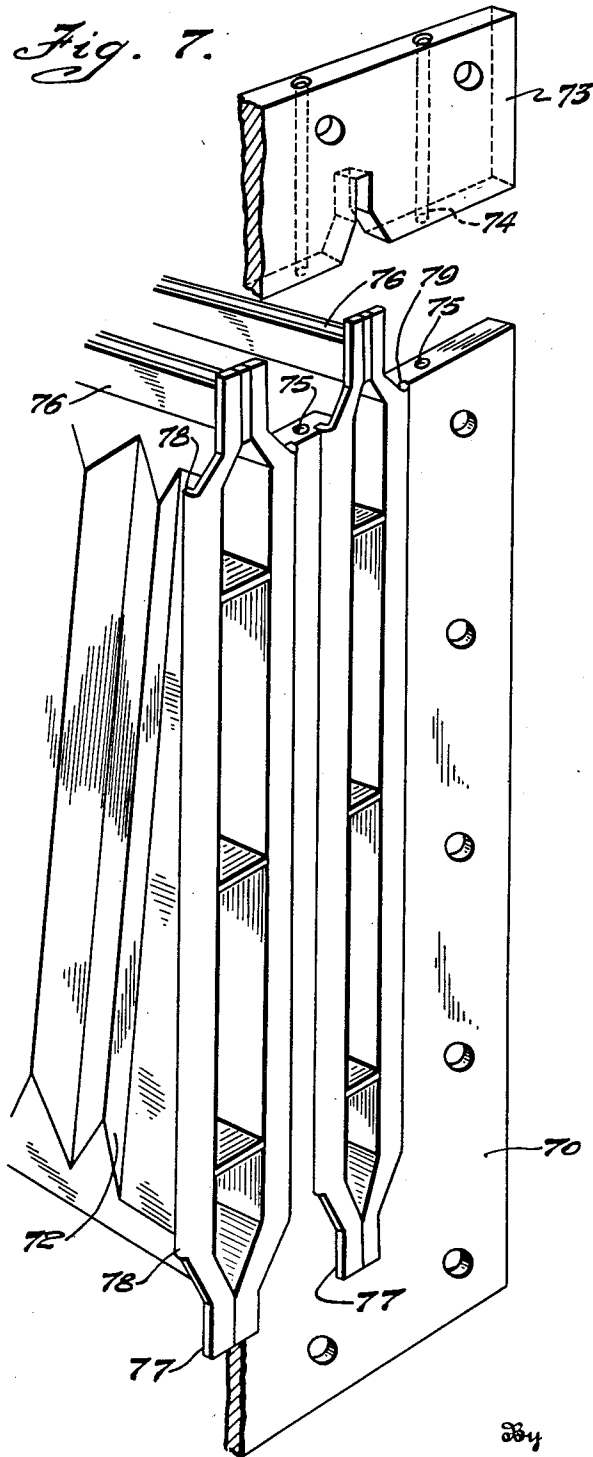


Fig. 8.

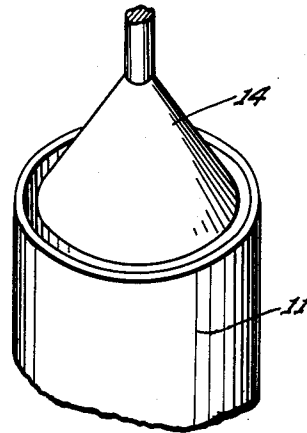
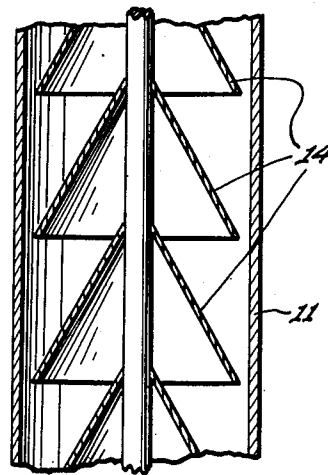


Fig. 9.



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UNITED STATES PATENT OFFICE

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APPARATUS FOR TREATING GAS

Application filed January 29, 1929. Serial No. 335,801.

This invention relates to a method of removing condensable hydrocarbons from gas such as natural gas and more particularly to the removal of hydrocarbons heavier than ethane. Coincidentally the invention embraces a method of removing other condensable substance from such gases, such as water vapor. In the conception of this method certain forms of apparatus have been developed peculiarly adapted to the special problems encountered therein, and this apparatus is included in this disclosure as being preferable in the practice of this method.

One object of this invention is to make it economically profitable to strip gas of the gasoline content to the benefit of the gas remaining in many cases and to the profit of the gas companies, thus enabled to produce a high grade of gasoline.

A further object of the invention is to remove moisture content from natural gases so as to leave a very low percentage of moisture in the treated gas. A further object of this invention is to remove such other solidifiable or condensable substances as may be desired.

Another object of the invention is to accomplish the foregoing objects with little expenditure of capital in plant fixtures and with a low cost of operation. Further objects of the invention will be obvious from the following detailed specification and claims.

In order to enable others to understand and practice the invention I have constructed certain figures as follow.

Figure 1 shows somewhat diagrammatically the plant in its entirety with certain parts in cross section.

Figures 2 and 3 show sectional views of heat exchangers particularly adapted to the problems encountered in this method.

Figure 4 shows a plan view of one removal unit of the heat exchangers shown in Figures 2 and 3.

Figure 5 shows a sectional view of Figure 4 on the line 5—5.

Figure 6 shows a sectional view of a portion of the heat exchangers as on line 6—6 of Figure 3.

Figure 7 shows an isometric view of a por-

tion of the heat exchanger device with units in place. Figures 8 and 9 are respectively isometric views and sectional views of a portion of a cooling system for the raw gas.

In Figure 1, 10 designates the pipe through which the raw gas enters the device. 11 is a tower for the stripping of the gas wherein 12 are bubble plates of known design through which the gas passes upwardly past a plate 13 and around inverted conical plates 14 which may be in the form shown in Figures 8 and 9.

15 is a plate allowing gas to pass upwardly but preventing liquid from passing downwardly. 16 is a device such as bubble plates wherein certain high boiling fractions in the gas condense and certain low boiling fractions in the liquid on said plates or the like vaporize. 17 is a reflux condenser where the gas is cooled to such a point as will condense the last fractions which it is desired to remove.

18 is a base outlet which may be float controlled to remove water from the lower end of the tower 11.

19 are outlets for the removal of gasoline from various levels which may be controlled by float controlled device 20.

21 is another outlet where water may be removed. 22 is a liquid level controlled outlet for the removal of a higher boiling fraction which is condensed in the reflux condenser or upon the plates 16.

23 is a like device for the removal of lower boiling fractions.

24 is a gas outlet pipe leading from the top of column 11 to low temperature heat exchanger 25, through this, through connection 26 into high temperature heat exchanger 27 and out of the same to the point of consumption through pipe 28.

For the first cooling of the gas there is provided a cycle of gasoline which leaves the lower end of the column 11 at 30, is impelled by pump 31 and passes through high temperature heat exchanger 27 to be cooled by the out flowing lean gas, from there it passes through high temperature cooler 32 where it is further chilled by a refrigeration system to be described later. It then passes into and

through low temperature heat exchanger 25 and from there through low temperature cooler 33. As will be obvious to one skilled

in the art these four devices, 27, 32, 25 and 33, may be enclosed in one case with suitable connections to each portion, as shown in Figure 2. The chilled gasoline then passes up through pipe 34 and is released on the top of the highest inverted cone 14. From there it flows down over the cones and chills the upwardly flowing gases so that the major portion of the moisture content therein is frozen or deposited as slush upon the cones 14, from which they are readily washed down by the down flowing gasoline. The higher boiling portions of gasoline in the upwardly flowing raw gas will be condensed while the lower boiling portions of gasoline in the liquid will be vaporized.

As was indicated previously, the excess gasoline or "make" is removed through pipes 19.

The cooling of the system is by a closed cycle refrigeration system wherein compressed and preferably liquefied refrigerant flows out of refrigerant condenser 40 through pipe 41 into the reflux condenser 17 where it chills the gas to remove the last low boiling fractions of gasoline. Another branch of pipe 42 carries liquid refrigerant to coolers 32 and 33 to chill the cyclic flowing gasoline as before described.

From 32 and 33 the gaseous refrigerant flows back to the compression system 43 having a first and second low pressure means and a high pressure cylinder or the like. The refrigerant from the reflux condenser 17 likewise flows back through 44 to the compressor. The compressor obviously may be constructed in known manner to obtain the desired effect of compressing the warmed refrigerant gas adequately so that the same will be condensed when cooled in condenser 40.

In order to make this system operate automatically with very little manual control an automatic system of valves may be installed to operate somewhat as follows.

Thermostat 50 may operate expansion valve 51, thus controlling the temperature maintained in the high temperature cooler 32.

Thermostat 52 will likewise control expansion valve 53 by the temperature within the low temperature cooler 33. Thermostat 54 may be made to control the cyclic outlet valve 55 or the pump 31 or both, in order that the temperature of the gas flowing upwardly through base plate 15 may be that desired.

Thermostat 56 may control the expansion valve 57 so that reflux condenser 17 is kept at the desired temperature. Back pressure valve 60 may be inserted in the refrigerant line from 32 to 43 to control the pressure of the evaporating refrigerant in the high temperature cooler 32. Analogously back pressure valve 61 may be inserted between 33 and

43 and back pressure valve 62 functions the same for the refrigerant passing from 17 to 43.

Obviously there may be made many changes in all of the parts shown but preferably they are essentially as shown and described. In the construction of the coolers and heat exchangers it is preferable to have the separators or "tubes" of such a nature that they can be removed separately for repairs or for replacement. In order to do so I have constructed them as shown in Figures 2 to 7.

The tube sheet is composed of two main parts. 70 is the tube sheet having separate ribs 71, and 73 is a tube sheet cap which is secured to the tube sheet by bolts which may be inserted through holes 74 and into holes 75 as is obvious in Figure 7.

The extremely long tube made long because corrugations maintain turbulence is corrugated and the last corrugation, or if desired all of the corrugations, are at a slight angle and are so fashioned that the side of them crimped to the tube contacts to fit flush with the wedge 71 when the same is forced into position. Gaskets not shown are fitted over the ends 77 so that when the tubes 76 are inserted and wedges forced in there will be a firm, gas tight connection between the tube ends 77 and tube sheet 70. This connection may be assisted by having the ends 77 of the tube 76 fashioned to have turned in lips 78 to fit into grooves 79 in the tube sheet 70. These will assist in making a tight connection and prevent collapse of tube ends 77 under wedging action of 71.

If the temperature within the chamber 11 around the baffles 14 is below the freezing point of water there will be a formation of ice therein if the raw gas contains any considerable quantities of water vapor. In the usual device of this type the forming ice would eventually clog the passageway and stop the flow of gas. For this reason I have invented a new and improved form of apparatus to be used in the practice of this invention and in other conditions where similar effects obtain.

Inverted cones 14 are supported preferably by a vertical rod through the center of each, one above the other, within a portion of the chamber 11. Any ice or snow that forms will of its own weight and due to the washing down effect of the gasoline slide off of the inverted cones and fall to the plate 13, and here or on the cones just above it will melt due to the fact that the incoming gas through 10 is above the melting point of ice. Some of the water will be removed through outlet 21 while the remainder condensed below plate 13 will be drained out through the base of the column 11 at point 18.

It is to be understood that I do not wish to be limited in the practice of my invention

to the specific procedure described or to the specific apparatus shown, though I have found the apparatus as shown to be preferable in the practice of this invention.

5 What I have invented and desire to protect by Letters Patent is:

1. An apparatus for the removal of condensable substance from a gas which comprises a tower having a gas inlet near the
10 base thereof, liquid outlets below said gas inlet, one of said liquid outlets leading to an impeller which drives the liquid removed through chilling devices, a liquid inlet at a point above the gaseous inlet where the
15 chilled liquid is allowed to flow counter to the upward flowing gas within the tower, baffles between the gas inlet and the liquid inlet, a plate above said liquid inlet preventing substantial down flow of liquid but permitting
20 up flow of gas, bubble plates above said plate, a reflux condenser above said bubble plates and a gaseous outlet in the upper portion of said tower from which a pipe leads the gas through two heat exchangers in series, where
25 the liquid before mentioned is consequently chilled by the out flowing gas, and a cooler operated by a refrigerant interposed between said two heat exchangers.

2. An apparatus as in claim 1 wherein a
30 second cooler is interposed between the lower temperature heat exchanger and the tower to cool the said liquid still further before it enters the tower.

3. An apparatus as in claim 1 wherein automatic valve means control the flow of liquid
35 through said impeller and the temperature maintained by the refrigerant within the specified devices which are cooled by said refrigerant.

40 In testimony whereof I affix my signature.

KENNETH M. URQUHART.

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