Feb. 21, 1950

R. C. STUTZ

APPARATUS FOR CONDENSING REFRIGERANTS BY EVAPORATIVE COOLING

2,498,017

Filed April 9, 1948

2 Sheets-Sheet 1

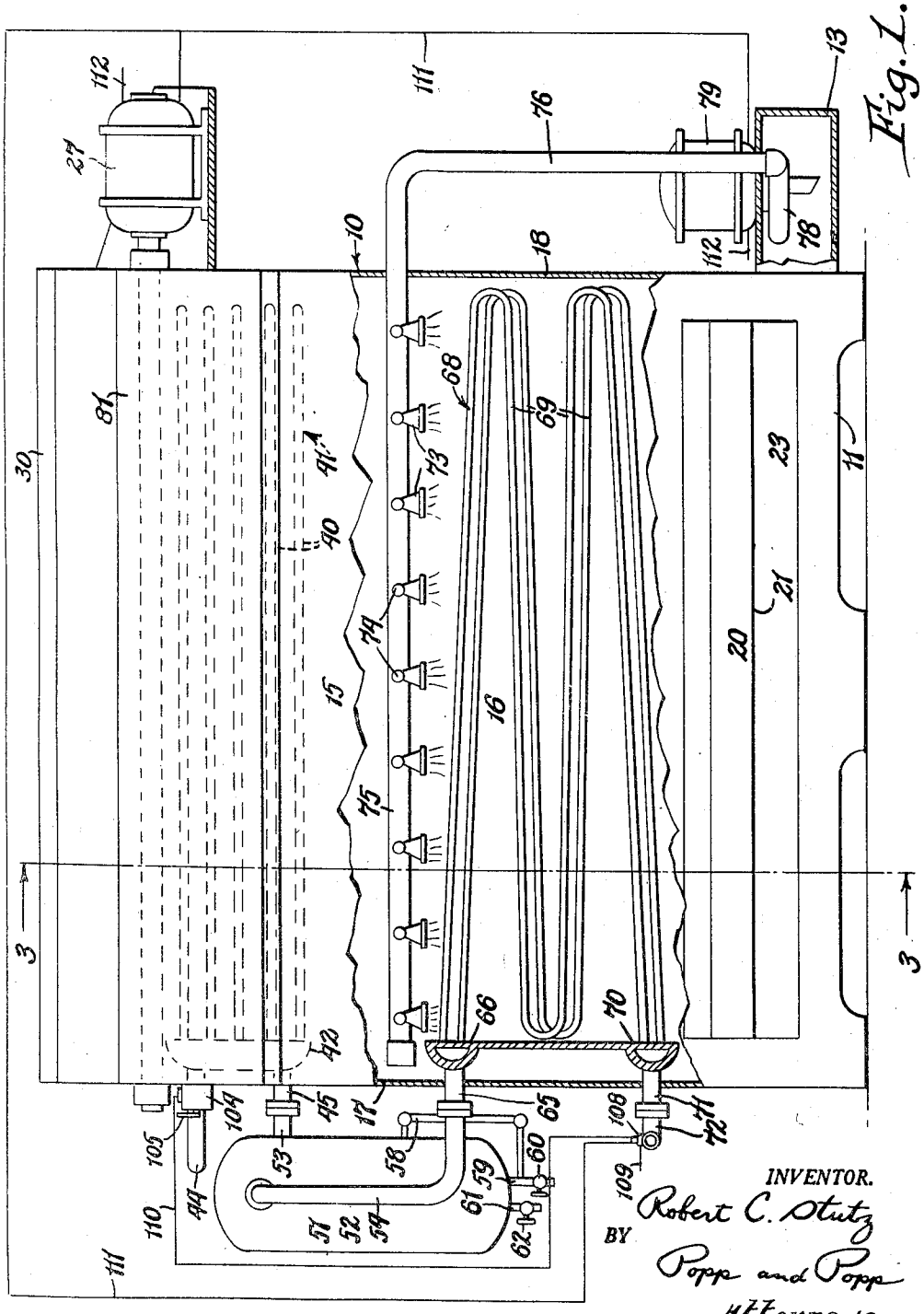


Fig. 1.

INVENTOR.
Robert C. Stutz
BY
Popp and Popp
Attorneys.

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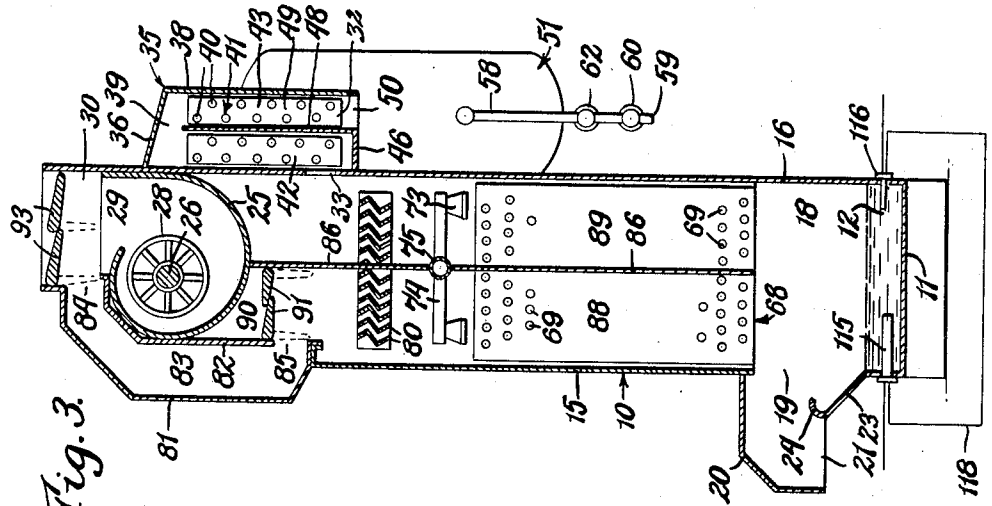


Fig. 3.

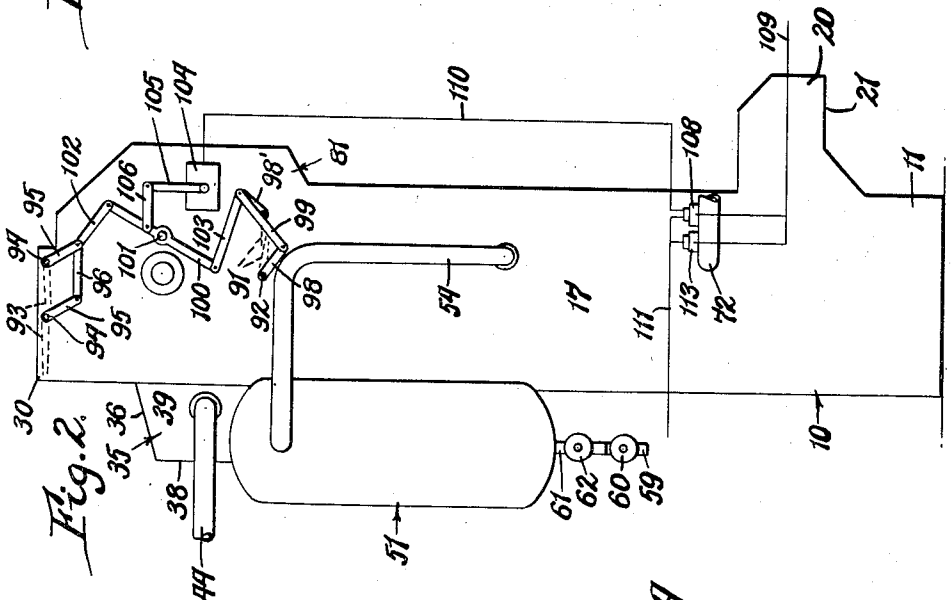


Fig. 2.

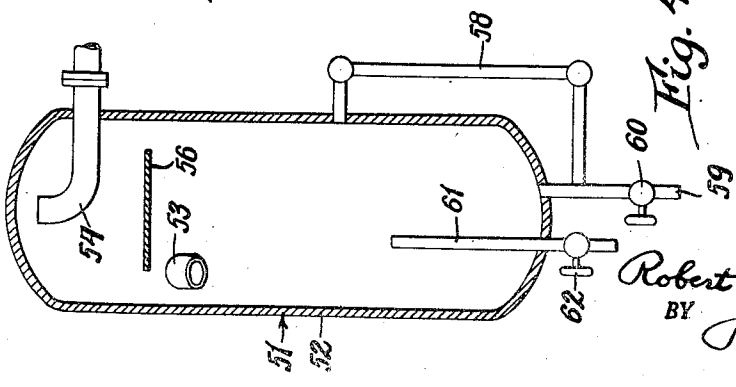


Fig. 4

INVENTOR.
Robert C. Stutz
BY
Popp and Popp
Attorneys.

Patented Feb. 21, 1950

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UNITED STATES PATENT OFFICE

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APPARATUS FOR CONDENSING REFRIGERANTS BY EVAPORATIVE COOLING

Robert C. Stutz, Buffalo, N. Y., assignor to Niagara Blower Company, New York, N. Y., a corporation of New York

Application April 9, 1948, Serial No. 19,931

21 Claims. (Cl. 62—2)

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This invention relates to a cooler and more particularly to a condenser for condensing refrigerating media such as ammonia, Freon, and the like in a compression refrigeration system and in which the cooling effect utilized in such condensation is provided by the evaporation of water. However, the use of the invention is not limited to a refrigerating system and can be employed wherever it is desired to cool a gas or liquid to a point near the wet bulb temperature of the atmosphere.

One of the objects of the present invention is to provide such a cooler which is extremely compact and requires the use of a minimum of sheet metal in its construction.

Another object is to reduce the number of dampers required without sacrifice of accurate control in maintaining the most efficient operating conditions with a minimum of maintenance.

Another object is to provide a cooler for cooling or condensing a gas or liquid, such as compressed, superheated refrigerant gas, in which the cooling water is recirculated and in which the cooling effect is achieved principally by evaporation of the cooling water on the pipes through which the liquid or gas is conducted. By this means an economy is effected in the cost of the cooling water and by its use the municipal sewer systems are not overtaxed by the installation of large refrigeration systems which normally require large amounts of cooling water for condensing the compressed refrigerant.

Another object is to provide such a cooler which is suitable for use in cooling fluids having a relatively high entering temperature. At temperatures above 115° F. spray water will evaporate rapidly and deposit scale upon the pipes conducting the medium to be cooled. In accordance with the present invention the temperature of the medium to be cooled is first reduced to at or below 115° F. by air-cooling before being subjected to evaporative cooling so that any deposit which does occur is so soft as to be immediately washed off the pipes by the sprays.

Another object of the invention is to provide such a condenser in which the first or air cooling stage merely removes sensible heat from the gas to be condensed to bring it below the point at which scale would form with evaporative cooling and to remove the balance of the sensible heat and the latent heat in a second stage of evaporative cooling. By this means the preponderance of the heat is removed by evaporative cooling.

Another object is to provide such a condenser which has a relatively small amount of cooling coils operating at high efficiency and which is comparatively inexpensive in construction.

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Another object of the invention is to provide such a cooler or condenser in which the leaving temperature or head pressure of the fluid being treated can be maintained within very close limits, thereby to relieve the operator of the almost impossible job of manually balancing the condenser or cooler capacity against the compressor or other load.

Another object is to provide such a cooler or condenser which is fully automatic in maintaining the desired leaving temperature or head pressure of the fluid being treated.

Another object is to provide a simple and effective control for the minimum leaving temperature or head pressure of the fluid being treated by the adjustment of the character of the air supplied to the spray chamber.

Another aim is to provide such apparatus in which such control can be effected entirely automatically in response to the temperature or pressure of the fluid being treated.

Another object is to provide for dewaxing the cooling surface, when required, so as to insure the proper heat transfer between the cooling surface and the fluid being treated at all times.

Another object is to provide for heating the fluid being treated, when required to bring the fluid up to proper initial operating temperature or to maintain this temperature.

Another object is to prevent freezing of the spray water during cold weather.

Another object is to provide such a condenser in which the maximum amount of oil is removed from the fluid being condensed, thereby to prevent such oil from building up and caking on the heat transfer surfaces over which the fluid is subsequently passed.

Another object of the invention is to provide an oil eliminator in a condenser in which the oil is conveniently available for reuse.

Another object is to provide such an oil eliminator which does not have any moving parts other than the necessary valves to remove the oil collected therein.

Another aim is to provide such an oil eliminator which is particularly adaptable to an evaporative type of condenser.

Another object is to provide such an oil eliminator in combination with a condenser which is, without special control, self-balancing under varying load and wet bulb conditions, such self-balancing operating to remove the maximum

amount of oil from the fluid being condensed under all operating conditions.

Another object is to provide such an oil eliminator in combination with a condenser in which the maximum removal of oil from the fluid being condensed can be placed under accurate instrument control.

Another object is to provide such an evaporative type of cooler which can be located at any convenient place, the air being discharged by means of fans through a duct which can be arranged to discharge the air as may be desired.

Another object is to provide such apparatus which is simple and inexpensive in construction and which will stand up under conditions of severe and constant use without getting out of order or requiring repairs.

Other objects and advantages will be apparent from the following description and drawings in which

Fig. 1 is a side elevation, with parts broken away, of a condenser embodying the present invention.

Fig. 2 is an end elevational view viewed from the left-hand end of Fig. 1.

Fig. 3 is a vertical sectional view taken on line 3—3, Fig. 1.

Fig. 4 is an enlarged vertical section through the shell of the oil separator.

The invention is shown as embodied in a condenser having a sheet metal casing 10 supported on the rim of a bottom pan or tank 11 which forms a sump containing a body of water 12 which is evaporated to provide the cooling effect. The bottom pan or tank 11 is shown as extended beyond one end of the casing, as indicated at 13.

The casing 10 has a front wall 15, a rear wall 16 and end end walls 17 and 18, the latter being adjacent the extension 13 of the bottom pan or tank 11. Immediately above the bottom pan or tank 11, the front wall 15 of the casing is provided with an air inlet opening 19 which extends substantially the full length of this front wall and is provided with a hood 20 projecting forwardly from the casing and having an air inlet opening 21 in its underside. To prevent the escape of spray water from this air inlet opening 20, the sheet metal front wall 23 which engages the forward rim of the bottom pan or tank 11 inclines upwardly and forwardly and immediately in rear of the air inlet opening 21 is formed with a reversely curved lip 24 which extends into the casing.

A plurality of fan housings 25 are mounted in the upper part of the casing 10, the inlets of these fan housings being in communication with the interior of the casing 10 so as to exhaust air therefrom. A common shaft 26 extends through through the several fan housings 25 and is shown as driven by a motor 27 mounted on a bracket at one end of the casing 10. Within each fan housing 25 the shaft 26 carries a fan 28, of any suitable construction, these fans drawing the air from the interior of the casing 10 and discharging it through outlets 29 which are directed upwardly into an air outlet or discharge duct 30 formed by the front, rear and end walls of the casing 10 and hence extending the full length thereof.

Air is also admitted to the upper part of the casing 10 through an inlet 33 in the rear wall 16 of the casing immediately below the fan housing 25 and extending substantially the full length of the casing. Mounted on the rear wall 16 of the casing 10 over this secondary air inlet opening

33 is a second sheet metal casing 35, this casing extending substantially the full length of the casing 10 and including a top wall 36, a rear wall 38, and opposite end walls 39 connecting these top and side walls 36, 38 with the adjacent rear wall 16 of the casing beyond the ends of the secondary air inlet opening 33 therein. Within this casing is arranged a series of hairpin tubes 40 of a dry superheat precooling coil 41, each having one leg connected with an inlet header 42 and its other leg connecting with an outlet header 43. These headers are shown as arranged vertically, side by side, adjacent one end wall 39 of the casing, the inlet header 42 having at its upper end an inlet 44 for the hot gas to be condensed and the outlet header 32 having an outlet 45 for the gases leaving the coil 41, these inlet and outlet connections 44, 45 extending through the adjacent end wall 39 of the casing 35.

The secondary air inlet opening 33 of the casing 10 is arranged at the bottom of the casing 35 and from the bottom of this secondary air inlet opening 33 a bottom wall 46 extends halfway across the lower otherwise open bottom of the casing 35. This bottom 46 of the casing 35 extends between the end walls 39 thereof and from the rear or outer edge of this bottom wall 46 a central partition 48 extends upwardly through the casing 35 short of the top wall 36 thereof. This partition extends between the legs of the hairpin tubes 40 and it will therefore be seen that the partition 48 provides a U-shaped passage 49 for the air, the air entering through the inlet 50 passing upwardly along the rear side of the partition 48 and thence downwardly along the inner side thereof and then passing out through the secondary air inlet opening 33 of the casing 10. In its travel through the passage 49, this air passes in heat exchange relation with the tubes of the coil 41 in the casing 35, this coil being a dry primary coil to precool and remove the superheat from the gases being condensed.

This dry primary superheat or precooling coil 41 is proportioned to remove only the superheat from the gases to be condensed and to a temperature slightly above the condensing temperature of these gases. It has been found that the gas at this temperature presents the optimum conditions for the separation of the maximum amount of oil therefrom by a simple oil separator. At higher temperatures the oil tends to remain in a volatile state and since both the gas to be condensed and a large proportion of the oil are in a vapor state, the separation through their difference in specific gravity is difficult. At the critical temperature of the fluid to be condensed, just above its condensing temperature, the fluid to be condensed is in a gaseous state and the oil vapor has been condensed to a liquid state so that the separation of the maximum amount of oil from the gas can be effected in a simple oil separator.

This separator, indicated generally at 51, is shown as comprising a cylindrical shell 52 having heads at its upper and lower ends. The outlet 45 from the superheat or dry primary cooling coil 41 is connected with an inlet pipe 53 extending tangentially through one side of the shell 52 and having its discharge end bent downwardly. The pipe 53 thereby provides a downwardly directed tangential inlet so that the entering gas, together with the entrained oil, is induced to travel in a downwardly moving helical path, thereby to set up a rotating and downwardly moving column of gas within the separator shell 52. This gas escapes through an outlet

pipe 54, extending through the side wall of the shell 52 near the top thereof. The inlet end of this pipe 54 is bent upwardly and arranged coaxially of the shell 52. Further to impede the escape of gas from the separator shell 52, a horizontal baffle plate 56 is shown as disposed across the center of the separator shell 52, this baffle preventing any tendency of the gas to shortcircuit from the inlet 53 to the outlet 54. In passing through the separator shell 52, the velocity of the gas is greatly reduced, particularly as the downwardly moving helically rotating column of gas is slowed almost to a standstill before it can escape in a reverse direction to the top of the separator casing. Further, the direction of movement of the gas is constantly and abruptly being changed. With such reduction in velocity and change in direction of the flow of gas, the condensed oil separates from the gas and drops to the bottom of the separator shell 52.

The level of the oil in the bottom of the separator shell 52 can be observed through a sight glass 58. When a sufficient amount of oil accumulates in the separator shell 52, as indicated by the sight glass 58, the accumulated oil can be withdrawn. For this purpose the shell 52 is provided with a drain pipe 59 having a valve 60 and is provided with another drain pipe 61 having a valve 62, this latter drain pipe 61 extending a substantial distance upwardly into the shell 52. In a Freon system, the drain line 59 would be connected with the crank case of the compressor. In an ammonia system, the withdrawal of oil can be through a rubber hose applied to the drain pipe 61 into a bucket. The ammonia has a lower specific gravity than the oil and hence after the oil has been drained below the level of the top of the ammonia drain line 61, as indicated by the sight glass 58, it will be seen that any liquid ammonia in the separator can be drained by opening the drain valve 60.

From the outlet pipe 54 of the oil separator 51, the gas passes into the inlet 65 of a secondary or condensing coil 68 arranged across the interior of the casing 10 immediately above the main air inlet 19 thereof. The tubes 69 of this coil 68 can be of serpentine form, each having its upper leg connected with the inlet header 66 and its lower leg connected with an outlet header 70. The outlet 71 for the condenser from the coil 68 can connect with a line 72 leading to the receiver (not shown).

To provide evaporative cooling the tubes 69 of the coil 68 are wetted from overhead spray nozzles 73. These nozzles are shown as mounted on the horizontal branches 74 of a longitudinal spray water pipe 75 which extends through the end wall 18 of the casing 10. This horizontal spray pipe connects with the vertical outlet pipe 76 of a spray water pump 78 which withdraws water from the body 12 in the bottom pan or tank 11 on which the casing 10 is supported. This pump 78 is shown as driven by an electric motor 79. Makeup water can be supplied to this body 12 of water in the bottom pan or tank 11 in any usual and well known manner. The usual eliminator plates 80 are shown as arranged above the spray nozzles 73 to remove entrained water from the air stream.

An important feature of the invention resides in the delivery of different proportions of outside air from the main air inlet 19 and recirculated or return air from the outlet duct 30. For this purpose the upper part of the front wall 15 of the casing is formed to provide a forwardly projecting offset 81, this offset 81 extending substantially the full length of the casing 10 in front of the fan casings 25. Within this offset 81 is arranged a spaced inner wall 82 which extends the full length of the casing 10 and which conforms to the shape of the offset 81 so as to provide a recirculation air duct 83. This recirculation air duct 83 has an inlet opening 84 communicating with the outlet or discharge duct 30 at the front side thereof and has a vertical outlet opening 85 communicating with the interior of the casing 10 at the front side thereof and intermediate the fan housings 25 and the eliminator plates 80.

The interior of the casing 10 is divided by a longitudinally extending vertical central partition 86 into two vertical passages 88 and 89. The lower edge of this partition is arranged generally in line with the top of the main air inlet opening 19 and extends upwardly to the fan housings 25. At the upper end of the passage 88 this partition forms, with the inner or rear wall 82 of the recirculation air duct 83, a duct 90 leading to the inlets of the fan housings 25. It will be seen that this partition 86 divides the wetted coil 68 into two parts each arranged in one of the passages 88, 89 and further divides the stream of air entering the inlet 19 into two parts each flowing through the corresponding passage 88, 89.

The duct 90 is shown as being capable of being closed by a pair of dampers 91 which extend the full length of the casing 10 and have their shafts 92 journalled in the end walls 17, 18 thereof. The front damper 91 is pivoted adjacent the lower edge of the inner wall 82 of the recirculation air duct 83 and swings downwardly so as to close the outlet 85 of this recirculation air duct 83. It will therefore be seen that in the full line position of these dampers as shown in Fig. 3 the duct 90 leading to the inlets of the fan housings 25 is fully closed and the outlet 85 from the recirculation air duct 83 is fully opened, whereas in the opposite extreme positions of these dampers 91, as indicated by dotted lines, the duct 90 leading to the inlets of the fan housings 25 is fully opened and the forward damper 91 is in a vertical position fully closing the outlet 85 of the recirculation air duct 83. In any intermediate position these dampers 91 serve to proportion the relative amounts of closure of this duct 90 and the recirculation air duct outlet 85.

These dampers 91 work in conjunction with a pair of dampers 93 arranged in the air outlet or exhaust duct 30 and extending the full length of the casing 10 with the end of their shafts 94 journalled in the end walls 17, 18 of the casing. The front damper of this pair of dampers 93 is pivoted adjacent the upper edge of the inlet opening 84 of the recirculation air duct 83 so that when these dampers are moved into a vertical position this forward damper closes this inlet opening 84 of the recirculation air duct 83. It will be seen that in the horizontal full line position of these dampers, as shown in Fig. 3, the outlet of the exhaust air duct 30 is fully closed and the inlet 84 to the recirculation air duct 83 is fully opened. When these dampers 93 are moved to their opposite extreme positions, as indicated by dotted lines in Fig. 3, the outlet opening from the exhaust air duct 30 is fully opened and the forward damper 93 has been moved to fully close the inlet 84 of the recirculation air duct 83. Intermediate positioning of these dampers 93 serves to proportion the amounts of air exhausted

through the duct 30 or recirculated through the recirculation air duct 83.

The dampers 91 and 93 operate in conjunction with one another, these dampers moving from the full line positions shown in Fig. 3 to the dotted line positions also shown in this figure in unison. While any suitable mechanism can be provided for so moving these dampers 91 and 93 in unison, they are shown as interconnected by the linkage shown in Fig. 2. This linkage comprises an arm 95 fast to the end of each damper shaft 94 journalled in the end wall 17, the outer ends of these arms 95 being interconnected by a link 96. The corresponding projecting ends of the damper shafts 92 are also each fast to an arm 98, the free ends of which are connected by a link 99. An operating lever 100 is shown as pivoted at its center, as indicated at 101, to the end wall 17 and as having its upper end connected by a link 102 with the rear end of the link 96 and as connected at its lower end by a link 103 with the rear end of the link 99. This operating lever 100 is shown as actuated by an electric damper motor 104 suitably mounted on the end wall 17 of the casing and shown as having a swinging operating arm 105 connected by a link 106 with the operating lever 100 to actuate the same. It will be seen that when the operating arm 105 of this damper motor 104 is swung counterclockwise as viewed in Fig. 2, the operating lever 100 is swung counterclockwise to move the arms 95 clockwise and to swing the forward arm 98' clockwise and the rear arm 98 counterclockwise. This movement swings the dampers 93 and 91 from the full toward the dotted line positions shown in Fig. 3.

The condenser is automatically controlled, and for this purpose a controller 108 is mounted on the condenser outlet line with its sensitive parts immersed in the fluid passing therethrough. This controller is preferably in the form of an electrical pressure switch which is responsive to variations in head pressure in the line 72 but it will be understood that this controller could be a thermostat. This pressure switch is connected to one side 109 of an electric line and by a line 110 with the electric damper motor 104. Another line 111 from the pressure switch 108 connects with the motors 27 and 79, the other terminals of which are connected with the other side 112 of the main power line. This pressure switch 108 is set to maintain the lowest practical operating pressure. Through the line 110 it operates the damper motor 104 which in turn positions the dampers 91 and 93 to balance the proportion of fresh and recirculated air passing through the spray chamber against the refrigeration load. If the fresh air temperature is cold or the load drops off, the pressure switch 108 automatically raises the amount of recirculated air returned to the spray chamber through the recirculation air duct 83. When, under no-load or extreme weather conditions, the dampers 91 and 93 completely close the ducts 30 and 90, respectively, the pressure switch 108 through the line 111 de-energizes the fan motor 27 and the spray pump motor 79.

In addition, safety features are provided which include an additional safety pressure switch or thermostat 113 which is mounted on the liquid refrigerant outlet line 72, and with its sensitive parts responsive to the pressure or temperature of the liquid refrigerant passing through. This safety pressure switch 113 is set a few pounds higher than the control switch 108. This safety switch is connected with the side 109 of the power line and also with the line 111 to the electric motors 27 and 79. If the outside dampers 93 are frozen shut the safety switch 113 operates to start the fan motor 28 and spray pump motor 79, thereby to recirculate air through the casing until the dampers are freed when the normal control switch 108 takes over again. As an additional safety feature, a small electric immersion heater 115 is preferably disposed in the bottom pan or tank 11 so as to keep the spray water 12 therein from freezing during no-load condition in winter. This immersion heater can be under control of a thermostat 116, also immersed in the body 12 of spray water and connected with the immersion heater through a control line 118.

Operation

In the operation of the apparatus as above described, and assuming the dampers 91 and 93 to be in the dotted line position shown in Fig. 3, and hence in a position in which the ducts 30 and 90 are open and the recirculation duct 83 completely closed off, two streams of atmospheric air are drawn into the casing 10 by the fan wheels 28 and discharged through the outlet or exhaust duct at the top of the casing 10.

One of these air streams enters the casing 35 through the inlet 50 and travels up and then down the U-shaped passage 49 provided in this casing by the partition 48 and thence is drawn into the casing 10 through the air inlet opening 33. This air stream passes the tubes 40 of the dry primary or superheat precooling coil 41 and thereby cools the gas which enters this primary coil at 44 and leaves at 45. This primary or superheat cooling coil 41 is proportioned to remove the superheat from the gas to be condensed and to cool it to a temperature slightly above its condensing temperature. The gas to be condensed therefore leaves this primary dry superheat coil in the form of a gas and at a temperature slightly above its condensing temperature.

At this temperature it has been found that the maximum amount of oil can be separated from the fluid to be condensed. In cooling the gas to be condensed to this temperature slightly above its condensing temperature, the oil vapor in the gas is condensed so that it is in liquid form. At the same time the fluid to be condensed is still in the form of a gas so that the separation is of a liquid from a gas and not of a liquid from a liquid as would be the case if the temperature of the gas to be condensed were permitted to fall below its condensing temperature.

To separate the entrained liquid oil from the gas to be condensed, it passes from the outlet 45 of the primary dry superheat cooling coil 41 to the tangential and downwardly directed inlet 53 extending through the cylindrical shell 52 of the oil separator 51. The inlet velocity sets up a downwardly moving and rotating column of gas in this separator shell, the gas from which escapes upwardly in opposition to this downwardly moving column. In so escaping the gas passes around the baffle 56 and thence through the upwardly directed central inlet of the outlet pipe 54. In so traveling through the shell 52 of the oil separator 51 the velocity of the gas is greatly reduced and the direction of its flow changed whereby the entrained oil falls by gravity to the bottom of the separator casing 41. The accumulation of the oil can be removed through either of the condensate drains 59 or 61.

From the outlet 54 of the oil separator the gas passes to the inlet 65 of the condensing coil 68,

this coil being arranged in the casing 10 and across the divided stream of air flowing upwardly on opposite sides of the partition 86. This air enters the main air inlet opening 21 of the hood 20 and flows through the inlet opening 19 into the shell 10. This air stream is then divided into two parts by the partition 86, one part flowing upwardly through the passage 88 and the other part flowing upwardly through the passage 89, both parts passing in contact with the tubes 69 of the wetted condensing coil 68. The part passing up through the passage 89 passes the spray nozzles 73 and eliminator plates 80 directly into the inlets of the fan casings 25 to be discharged directly through the now open exhaust outlet of the outlet duct 30. The part of this air stream flowing upwardly through the passage 88 passes the spray nozzles 73 and eliminator plates 80 and thence passes through the now open duct 90 into the inlets of the fan casings 25 also to be discharged through the now open exhaust outlet of the outlet duct 30.

The entire condensing coil 68, that is, that part arranged in the passage 88 as well as that part arranged in the passage 89, is sprayed with water withdrawn from the body 12 of water in the bottom pan or sump 11 supporting the casing 10 by the spray water pump 78 which delivers this water to the horizontal spray pipe 75 and its branches 74. This water is discharged downwardly by the nozzle 73 against the tube 69 of the condenser coil 68 thereby to wash these coils and maintain them in a wetted condition.

The cooling of the fluid passing through the wetted condensing coil 68 is thereby effected essentially by the evaporation of the water sprayed on these coils. At the same time, the fluid being treated has been cooled to such an extent on passing through the dry primary superheat precooling coil 41 that there is no tendency for scale to form on the condensing coil 68 from the water sprayed thereon. By employing evaporative cooling with the condensing coil 68, this coil has many times the cooling capacity of a dry surface cooling coil of the same size. Further, since an evaporative cooling coil operates in response to the wet bulb temperature of the outside air, and since, under normal conditions, the wet bulb temperature of the outside air is substantially lower than its dry bulb temperature, the condensate leaves at a very much lower temperature. This condensate leaves the outlet header 70 of the secondary evaporative cooling coil 68 through the outlet line 72 through which the condensate is conducted to the usual receiver (not shown).

In so passing through the outlet line 72, the condensate contacts the sensitive parts of the pressure switch 108. When the head pressure of this condensate drops below the setting of this pressure switch 108, this switch, through the electric line 111, operates the electric damper motor 104 to move the dampers 91 and 93 from the dotted line position shown in Fig. 3 toward the full line positions there shown. When this occurs, the inlet 84 and outlet 85 of the recirculation air duct 83 are opened to a corresponding extent and a part of the air discharged into the exhaust duct 30 by the fan wheels 28, flows through the inlet 84 of the recirculation air duct 83 and through its outlet 85 into the upper end of the passage 88. This air from the outlet 85 of the recirculated air duct 83 joins the air entering the duct 90 past the partly opened dampers 91. This air is supplied from the main air inlet hood 20, this air entering the hood inlet 21 and casing inlet

19 into the bottom of the casing 10 and being divided into two parts by the partition 86, one part flowing up the passage 88 past the wetted tubes of the condenser coil 68, spray nozzles 73, eliminator plates 80 and through the duct 90 into the inlets of the fan housings 25, and the other part flowing up the passage 89 past the wetted tubes of the condenser coil 68, spray nozzles 73, and eliminator plates 80 to the inlets of the fan housings 25. Since with the dampers 91 and 93 moved partly away from their vertical positions a part of the air handled by the fan wheels 28 is recirculated air, it is apparent that less fresh air is drawn into the casing 10 and since the cooling effect is provided by the evaporation of water by the stream of fresh air drawn into the casing, it is apparent that the effective cooling of the condenser is reduced.

If the head pressure in the outlet line 72 continues to rise the pressure switch 108, through the damper motor 104, continues the movement of the dampers 91 and 93 toward their horizontal positions. When these dampers reach approximately 10° of their horizontal position, the principal amount of the air from the outlet 85 of the recirculated air duct 83 no longer passes directly to the duct 90 but flows downwardly through the passage 88 along the front wall 15 of the casing and joins the stream of air flowing in through the inlet 19 from the hood 20. A part of this recirculated air, of course, joins the air stream flowing upwardly through the passage 88 but as this stream has been largely cut off by the almost horizontal dampers 91, the preponderance of the recirculated air so flowing down the front casing wall 15 joins the stream of air flowing up the passage 89. Since this recirculation air passing through the recirculated air duct 83 has been heated by passing the precooling coil 41 and the secondary condenser coil 68 and also is substantially saturated with the moisture in passing over the exterior of the wetted condenser coil 68 and through the sprays from the nozzles 73, it will be seen that the mixed fresh and recirculated air now supplied to the bottom of the casing 10 has a higher wet bulb temperature and hence the evaporative cooling effect of the water and air in passing over the wet condenser coils 68 is reduced.

It will therefore be seen that the pressure switch 108 maintains a constant minimum head pressure and temperature of the condensate leaving the condenser through this outlet line 72 by the operation of the dampers 91 and 93, a falling temperature and head pressure of the condensate moving these dampers to provide a greater proportion of recirculated air and a lower proportion of fresh air. This modulating control of the dampers 91 and 93 allows the intermediate position of these dampers to hold a constant minimum temperature and head pressure of the condensate by the use of recirculated air and cold fresh air. The recirculation of the necessary amount of air from the air discharge duct 30 to the bottom of the casing 10 in so maintaining a constant minimum temperature and head pressure of the condensate also keeps the amount of evaporated moisture at a minimum.

If a condition of no-load, or extreme weather condition, causes the pressure switch 108 to move the dampers 93 to the horizontal full line position shown in Fig. 3 in which no air is discharged from the casing and all of the air therein is recirculated, the pressure switch 108 closes the circuit through the electric line 111 to the fan

motor 27 and the spray water pump motor 79. This de-energizes these motors so as to cut the condenser out of operation as an evaporative type of condenser.

As an additional safety feature, if the dampers 93 should become frozen shut in winter operation, and the head pressure in the outlet line 72 rises in calling for evaporative cooling the safety switch 113, which is set a few pounds higher than the control pressure switch 108, will establish a circuit through the line 111 to energize the fan motor 27 and the spray pump motor 79. Hot air is thereby recirculated through the casing 10 until the dampers 93 are freed when the control pressure switch 108 again takes over control, as above indicated.

As a further safety feature, to prevent freezing of the spray water 12 in winter operation under no-load condition, this spray water is heated by the immersion heater 115 under control of the thermostat 116 which is set to establish a circuit through this immersion heater when the temperature of the body of spray water 12 drops to the freezing point. Further, this heater can be used to dewax the condenser coil 68 by holding the dampers 91 and 93 to recirculate the air and by energizing the immersion heater 115 so as to heat the air and water being recirculated to a temperature sufficient to melt the wax in the coil 68.

From the foregoing it will be seen that the present invention provides a cooler in which the cooling effect is provided principally by the evaporation of water and in which the cooling effect is balanced against the load by the recirculation of air through the sprayed coils. It will also be seen that by providing the short recirculation air duct 83 as shown, the cooler is very much more compact and requires less sheet metal as compared with a structure where the recirculation duct connects with the main air inlet hood 20. Further, the controller can be set to maintain the lowest practical operating pressure of the refrigeration system; full safety provisions are made against the danger of freezing in cold weather; danger of scaling or incrustation on the wetted coil is eliminated; and maximum oil separation is effected in a simple oil separator and in a manner permitting convenient return to the compressor.

1. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, walls forming a recirculation air duct having its inlet end opening into said outlet duct and its outlet end opening adjacent said fan into one of said passages, and dampers regulating the proportion of air discharged from said outlet duct through its outlet and through said recirculation air duct.

2. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, a wall arranged within said casing and forming therewith a recirculation air duct having its inlet end opening into said outlet duct and its outlet end opening adjacent said fan into one of said passages, and dampers regulating the proportion of air discharged from said outlet duct through its outlet and through said recirculation air duct.

3. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, walls forming a recirculation air duct having an inlet at one end opening into said outlet duct and having an outlet adjacent said fan opening into one of said chambers and said walls also forming a fan inlet duct adjacent said recirculation air duct outlet and leading from said one of said passages to said fan, at least one damper movably arranged to close said recirculation air inlet as it opens said outlet of said outlet duct and vice versa, and at least one other damper movably arranged to close said recirculation air outlet as it opens said fan inlet duct and vice versa.

4. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of

said cooling coil, walls forming a recirculation air duct having an inlet at one end opening into said outlet duct and having an outlet adjacent said fan opening into one of said chambers and said walls also forming a fan inlet duct adjacent said recirculation air duct outlet and leading from said one of said passages to said fan, at least one damper movably arranged to close said recirculation air inlet as it opens said outlet of said outlet duct and vice versa, at least one other damper movably arranged to close said recirculation air outlet as it opens said fan inlet duct and vice versa, and means interconnecting said dampers to move them simultaneously to close said recirculation air duct and vice versa.

5. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, walls forming a recirculation air duct having its inlet end opening into said outlet duct and its outlet end opening adjacent said fan into one of said passages, dampers regulating the proportion of air discharged from said outlet duct through its outlet and through said recirculation air duct, and a controller responsive to one of said streams and regulating said dampers.

6. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts, and each passage containing a part of said cooling coil, walls forming a recirculation air duct having its inlet end opening into said outlet duct and its outlet end opening adjacent said fan into one of said passages, dampers regulating the proportion of air discharged from said outlet duct through its outlet and through said recirculation air duct, and a controller responsive to the temperature of one of said streams and regulating said dampers.

7. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and

chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, walls forming a recirculation air duct having its inlet end opening into said outlet duct and its outlet end opening adjacent said fan into one of said passages, dampers regulating the proportion of air discharged from said outlet duct through its outlet and through said recirculation air duct, and a controller responsive to the pressure of said fluid passing through said cooling coil and regulating said dampers.

8. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, walls forming a recirculation air duct having an inlet at one end opening into said outlet duct and having an outlet adjacent said fan opening into one of said passages and said walls also forming a fan inlet duct adjacent said recirculation air duct outlet and leading from said one of said passages to said fan, at least one damper movably arranged to close said recirculation air inlet as it opens said outlet of said outlet duct and vice versa, at least one other damper movably arranged to close said recirculation air outlet as it opens said fan inlet duct and vice versa, and a controller responsive to one of said streams and regulating said dampers to move them simultaneously to close said recirculation air duct and vice versa.

9. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, walls forming a re-

circulation air duct having an inlet at one end opening into said outlet duct and having an outlet adjacent said fan opening into one of said passages and said walls also forming a fan inlet duct adjacent said recirculation air duct outlet and leading from said one of said passages to said fan, at least one damper movably arranged to close said recirculation air inlet as it opens said outlet of said outlet duct and vice versa, at least one other damper movably arranged to close said recirculation air outlet as it opens said fan inlet duct and vice versa, and a controller responsive to the temperature of one of said streams and regulating said dampers to move them simultaneously to close said recirculation air duct in response to a rising temperature of said one of said air streams and vice versa.

10. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, walls forming a recirculation air duct having an inlet at one end opening into said outlet duct and having an outlet adjacent said fan opening into one of said passages and said walls also forming a fan inlet duct adjacent said recirculation air duct outlet and leading from said one of said passages to said fan, at least one damper movably arranged to close said recirculation air inlet as it opens said outlet of said outlet duct and vice versa, at least one other damper movably arranged to close said recirculation air outlet as it opens said fan inlet duct and vice versa, and a controller responsive to the pressure of said stream of fluid passing through said cooling coil and regulating said dampers to move them simultaneously to close said recirculation air duct in response to a rising pressure of said stream of fluid and vice versa.

11. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, a wall arranged within said casing and forming therewith a recirculation air duct arranged alongside said fan and having an inlet at one end opening into said outlet duct and having an outlet adjacent said fan opening into one of said passages and said wall also forming a fan inlet duct alongside said recirculation duct leading from said one of said passages to said fan, a damper mounted in said outlet duct to swing about an axis adjacent one of its edges and arranged generally parallel with and adjacent to that edge of said inlet of said recirculation duct remote from said fan whereby said damper closes said recirculation air inlet as it opens said outlet of said outlet duct and vice versa, another damper arranged in said one of said passages to swing about an axis adjacent one of its edges and arranged generally parallel with and adjacent to that edge of said wall forming the outlet of said recirculation air duct and the inlet of said fan inlet duct whereby said another damper closes said outlet of said recirculation air duct as it opens said inlet of said fan inlet duct and vice versa, and means interconnecting said dampers to move them simultaneously to close said recirculation air duct and vice versa.

12. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, walls forming a recirculation air duct having its inlet end opening into said outlet duct and its outlet end opening adjacent said fan into one of said passages, dampers regulating the proportion of air discharged from said outlet duct through its outlet and through said recirculation air duct, a dry precooling coil, means arranged to pass air over said dry precooling coil, and means arranged to pass said stream of fluid through said dry precooling coil prior to its passage through said first cooling coil.

13. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, walls forming a recirculation air duct having its inlet end opening into said outlet duct and its outlet end opening adjacent said fan into one of said passages, dampers regulating the proportion of air discharged

from said outlet duct through its outlet and through said recirculation air duct, said casing being provided with a second air inlet, a dry precooling coil in the path of the stream of air entering said second air inlet, and means arranged to pass said stream of fluid through said dry precooling coil prior to its passage through said first cooling coil.

14. A heat exchange device for cooling a stream of fluid, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged within said casing to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil for said stream of fluid arranged between said air inlet and fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, walls forming a recirculation air duct having its inlet end opening into said outlet duct and its outlet end opening adjacent said fan into one of said passages, dampers regulating the proportion of air discharged from said outlet duct through its outlet and through said recirculation air duct, said casing being provided with a second air inlet leading to the other of said passages, a dry precooling coil in the path of the stream of air entering said second air inlet, and means arranged to pass said stream of fluid through said dry precooling coil prior to its passage through said first cooling coil.

15. A condenser for gases containing a higher boiling point vapor, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided with an air outlet, a fan arranged to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil arranged between said air inlet and said fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, walls forming a recirculation air duct having its inlet end opening into said outlet duct and its outlet end opening adjacent said fan into one of said passages, dampers regulating the proportion of air discharged from said outlet duct through its outlet and through said recirculation air duct, a dry precooling coil proportioned to remove the superheat from said gas and to reduce its temperature close to and above the condensing temperature thereof, and a liquid separator, and conduits arranged to pass a stream of the gas to be condensed in series from said dry precooling coil and through said liquid separator and said cooling coil wetted by said stream of water.

16. A condenser for gases containing a higher boiling point vapor, comprising a casing forming a chamber having an air inlet at one end and having at its opposite end an air outlet duct provided

with an air outlet, a fan arranged to draw a stream of air through said inlet and chamber and to discharge said stream of air through said outlet duct, a cooling coil arranged between said air inlet and said fan in the stream of air passing through said chamber, means arranged to discharge and distribute water over said cooling coil to wet the exterior of said cooling coil and to evaporate and absorb heat therefrom, a partition in said casing extending from said fan toward said one end of said casing and dividing said casing into two air passages dividing said air stream entering said fan into two parts and each passage containing a part of said cooling coil, walls forming a recirculation air duct having its inlet end opening into said outlet duct and its outlet end opening adjacent said fan into one of said passages, dampers regulating the proportion of air discharged from said outlet duct through its outlet and through said recirculation air duct, said casing being provided with a second air inlet, a dry precooling coil in the path of the stream of air entering said second air inlet and proportioned to remove the superheat from said gas and to reduce its temperature close to and above the condensing temperature thereof and thereby to condense said higher boiling point vapor, a liquid separator, and conduits arranged to pass a stream of the gas to be condensed in series from said dry precooling coil and through said liquid separator and said cooling coil wetted by said stream of water.

17. A heat exchange device for maintaining a fluid in a selected temperature range determined by the character of the fluid, and preventing the temperature from falling below said range, comprising a casing forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in said chamber in the stream of air passing through said chamber, means arranged to continuously conduct the said stream of fluid to be cooled through said cooling coil, means for discharging and distributing a stream of water over said cooling coil to wash the exterior of said cooling coil and to evaporate thereon and absorb heat therefrom, said streams of water and air being normally heated through heat derived from said stream of fluid passing through said cooling coil, air recirculation means arranged to conduct at least a part of the stream of air leaving said chamber back to said chamber and again contact said cooling coil, means responsive to the condition of one of said streams and arranged to adjust the amount of air so conducted back by said air recirculation means to prevent the temperature of said fluid in said cooling coil from falling below said temperature range, a dry precooling coil, means arranged to pass air over said dry precooling coil, and a conduit arranged to pass said stream of fluid from said dry precooling coil through said first cooling coil.

18. A heat exchange device for maintaining a fluid in a selected temperature range determined by the character of the fluid, and preventing the temperature from falling below said range, comprising a casing forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in said chamber in the stream of air passing through said chamber, means arranged to continuously conduct the said stream of fluid

to be cooled through said cooling coil, means for discharging and distributing a stream of water over said cooling coil to wash the exterior of said cooling coil and to evaporate thereon and absorb heat therefrom, said streams of water and air being normally heated through heat derived from said stream of fluid passing through said cooling coil, air recirculation means arranged to conduct at least a part of the stream of air leaving said chamber back to said chamber to again contact said cooling coil, means responsive to the temperature of one of said streams and arranged to adjust the amount of air so conducted back by said air recirculation means to prevent the temperature of said stream of fluid passing through said cooling coil from falling below said temperature range, said casing being provided with a second air inlet, a dry precooling coil in the path of the stream of air entering said second air inlet, and a conduit arranged to pass said stream of fluid from said dry precooling coil through said cooling coil wetted by said stream of water.

19. A heat exchange device for maintaining a fluid in a selected temperature range determined by the character of the fluid, and preventing the temperature from falling below said range, comprising a casing forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in said chamber in the stream of air passing through said chamber, means arranged to continuously conduct the said stream of fluid to be cooled through said cooling coil, means for discharging and distributing a stream of water over said cooling coil to wash the exterior of said cooling coil and to evaporate thereon and absorb heat therefrom, said streams of water and air being normally heated through heat derived from said stream of fluid passing through said cooling coil, air recirculation conduits arranged to conduct at least a part of the stream of air leaving said chamber back to said chamber to again contact said cooling coil, a heater arranged to apply heat to said stream of water and to said stream of fluid passing through said cooling coil, means responsive to the temperature of one of said streams and arranged to adjust the amount of air so conducted back by said air recirculation means and also to adjust said heater to prevent the temperature of said stream of fluid passing through said cooling coil from falling below said temperature range, a dry precooling coil, and a conduit arranged to pass said stream of fluid from said dry precooling coil through said cooling coil wetted by said stream of water.

20. A condenser for gases containing a higher boiling point vapor, comprising a casing forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in said chamber in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wash the exterior of said cooling coil and to evaporate thereon and absorb heat therefrom, said streams of water and air being normally heated through heat derived from said cooling coil, air, air recirculation means arranged to conduct at least a part of the stream of air leaving the chamber back to said chamber to again contact said cooling coil, a dry precooling coil, proportioned to remove the superheat from said gas and reduce its temperature close to and above the condensing temperature thereof, a liquid separator, conduits arranged to pass a stream of the gas to be condensed in series from said dry precooling coil and through said liquid separator and said cooling coil wetted by said stream of water, and means responsive to the condition of one of said streams and arranged to adjust the amount of air so conducted back by said air recirculation means to prevent the temperature of said stream of gas passing through said cooling coil wetted by said stream of water from falling below said temperature range.

21. A condenser for gases containing a higher boiling point vapor, comprising a casing forming a chamber having an air inlet and an air outlet, a fan arranged to force a stream of air from said inlet, through said chamber and out through said outlet, a cooling coil arranged in said chamber in the stream of air passing through said chamber, means for discharging and distributing a stream of water over said cooling coil to wash the exterior of said cooling coil and to evaporate thereon and absorb heat therefrom, said streams of water and air being normally heated through heat derived from said cooling coil, air, air recirculation means arranged to conduct at least a part of the stream of air leaving the chamber back to said chamber to again contact said cooling coil, a dry precooling coil proportioned to remove the superheat from said gas and reduce its temperature close to and above the condensing temperature thereof, a liquid separator, conduits arranged to pass a stream of the gas to be condensed in series from said dry precooling coil and through said liquid separator and said cooling coil wetted by said stream of water, a heater arranged to apply heat to said stream of water and to said stream of fluid passing through said cooling coil washed by said stream of water, and means responsive to the temperature of one of said streams and arranged to adjust the amount of air so conducted back by said air recirculation means and also to adjust said heater to prevent the temperature of the stream of gas passing through said cooling coil from falling below said temperature range.

ROBERT C. STUTZ.

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The following references are of record in the file of this patent:

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