

March 21, 1950

R. HORTON ET AL

2,501,518

CONDENSER

Filed Oct. 22, 1945

2 Sheets-Sheet 1

Fig. 2.

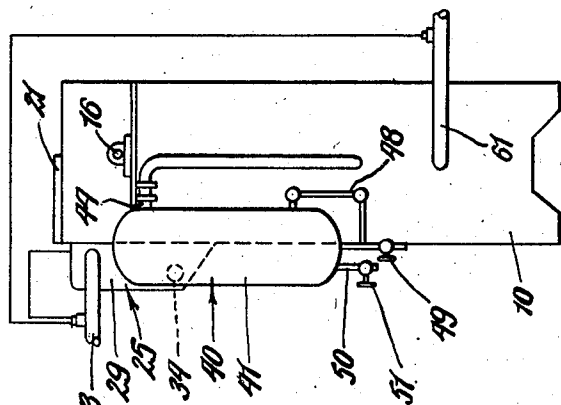
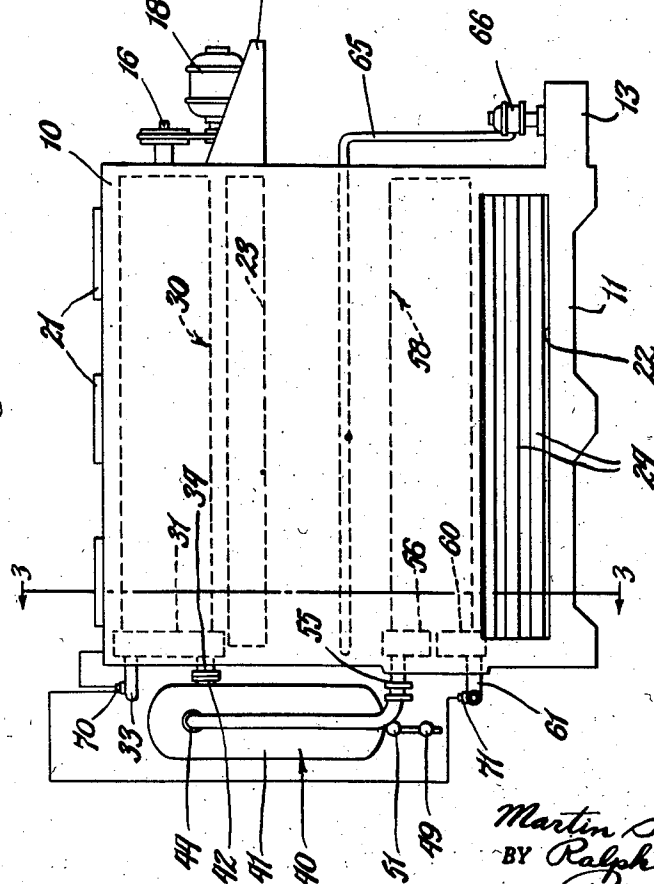


Fig. 1.



INVENTOR.

Martin H. Olstad +
BY Ralph Horton
Popp and Popp
ATTORNEYS

March 21, 1950

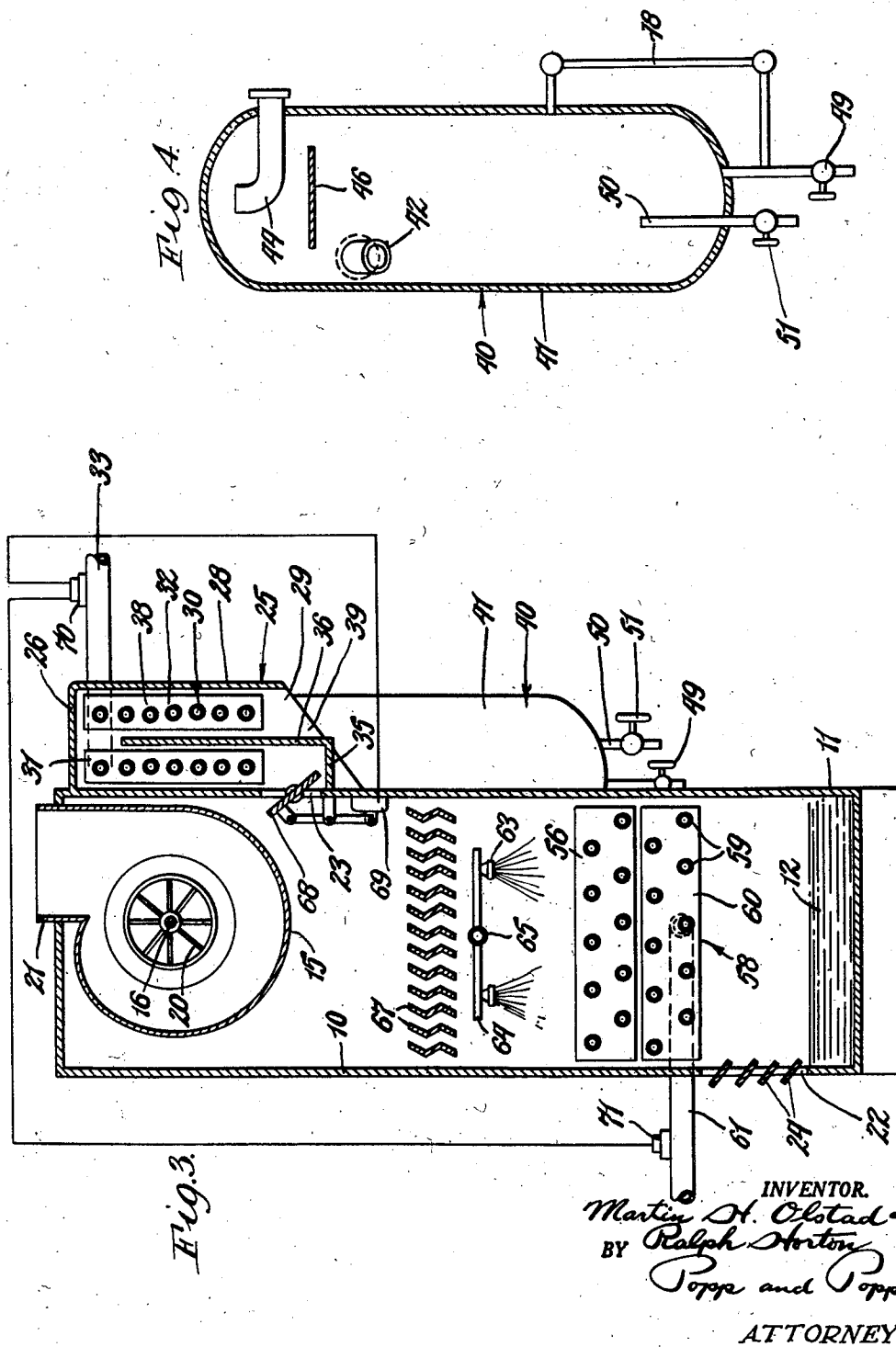
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

2,501,518

CONDENSER

Ralph Horton, Groton, Conn., and Martin H. Olstad, Port Washington, N. Y., assignors to Niagara Blower Company, New York, N. Y., a corporation of New York

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10 Claims. (Cl. 257—2)

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This invention relates to a condenser and more particularly to a condenser for condensing the refrigerant, such as ammonia or Freon, in a compressor-condenser-expander system where lubricating oil is picked up by the refrigerant in the compressor. However, the use of the invention is not limited to a refrigerating system and is applicable wherever the gas to be condensed contains a higher boiling point vapor which is advantageously removed from the gas as a part of the condensing process.

In a compressor-condenser-expander refrigeration system, the gaseous ammonia, Freon or other refrigeration medium on being compressed in the compressor carries with it a part of the oil used to lubricate the compressor. The oil laden refrigerating medium is then condensed in the condenser and on being expanded in the expansion coil a part of the oil congeals in the expansion coil. The coating of oil thus built up on the inner surfaces of the expansion coil not only reduces the heat transfer efficiency of the coil but in time this coating cakes on the expansion coil surfaces so as to permanently impair the heat transfer, this reduction in heat transfer efficiency being progressive. Further, with Freon, a constant addition of lubricating oil to the compressor is required, and the present invention provides a controlled return of such oil to the compressor, thereby to meet the lubricating requirements of the compressor as well as to effect a saving in oil.

It is one of the principal objects of this invention to provide, in combination with a condenser, means for removing the maximum amount of oil from the fluid being condensed thereby to prevent such oil from building up and caking on heat transfer surfaces over which the condensed fluid is subsequently passed.

A further object is to provide such 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 adapted to an evaporative type of condenser in which the cooling effect is obtained principally from the evaporation of water on the cooling coil which is arranged in an air stream passing over the coil. Such an evaporative condenser has many times the cooling capacity of a dry coil of the same size and under normal conditions cools the fluid being condensed

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to a much lower temperature than is possible with a dry coil.

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 aim is to provide such an oil eliminator, in combination with a condenser, in which the maximum removal of oil from the fluid being condensed under all load and atmospheric conditions can be placed under accurate instrument control.

Another object is to provide such an oil eliminator in combination with an evaporative type of condenser which will not scale, a feature of the invention residing in the removal of superheat from the gas to be condensed in an air coil and in which the temperature of the fluid is reduced to a point where scale does not form on the sprayed coil through which the fluid is subsequently passed to remove the latent heat of the fluid.

Other objects and advantages will appear from the following description and drawings in which:

Fig. 1 is a front elevation of an evaporative type of condenser and oil eliminator embodying the present invention.

Fig. 2 is an end elevational view thereof.

Fig. 3 is an enlarged vertical transverse section, 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 of rectangular form, the bottom of which is closed to form a tank or sump 11 which contains a body of water 12 which is evaporated to provide the cooling effect. The tank 11 is shown as extended beyond one end of the casing, as indicated at 13.

A plurality of fan housings 15 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 16 extends through the several fan housings 15 and is shown as driven by a rotor 18 mounted on a bracket 19 at one end of the casing 10. Within each fan housing the shaft 16 carries a fan 20 of any suitable construction, these fans drawing the air from the interior of the casing 10 and discharging it through outlets 21 which project upwardly through the top of the casing 10. Air is admitted to the lower

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part of the casing 10 through an inlet 22 and in one side wall of the casing, and air is also admitted to the upper part of the casing 10 through an inlet 23 in the opposite side wall of the casing. The inlet 22 is shown as having fixed louvers 24 to prevent the escape of spray water. Both of the air inlets 22 and 23 extend substantially the full length of the casing 10.

Mounted on the side of the casing 10 over the air inlet opening 23 is a second sheet metal casing 25, this casing 25 extending substantially the full length of the casing 10 and including a top wall 26, a side wall 28 and opposite end walls 29 connecting these top and side walls 26, 28 with the adjacent side wall of the casing 10 beyond the ends of the air inlet opening 23 therein. Within this casing is arranged a series of hairpin tubes of a dry superheat cooling coil 30, each having one leg connecting with an inlet header 31 and its other leg connecting with an outlet header 32. These headers are shown as arranged vertically, side by side, adjacent one end wall 29 of the casing, the inlet header 31 having at its upper end an inlet 33 for the hot gas to be condensed, and the outlet header 32 having an outlet 34 for the gases leaving the coil 30, these inlet and outlet connections 33, 34 extending through the adjacent end wall 29 of the casing 25. The air inlet opening 23 of the casing 10 is arranged at the bottom of the casing 25 and from the bottom of the air inlet opening 23 a bottom wall 35 extends half way across the lower otherwise open end of the casing 25. This bottom 35 of the casing 25 extends between the end walls 29 thereof and from the outer edge of this bottom wall 35 a central partition 36 extends upwardly through the casing 25 short of the top wall 26 thereof. This partition extends between the legs of the hairpin tubes 30 and it will therefore be seen that the partition 36 provides a U-shaped passage 38 for the air, the air entering through the inlet 33 and passing upwardly along the outer side of the partition 36 and thence downwardly along the inner side thereof and then passing out through the inlet opening 23 of the casing 10. In its travel through the passage 38 this air passes in heat exchange relation with the tubes of the coil 30 in the casing 25, this coil being a dry primary coil to remove the superheat from the gases being condensed.

This dry primary superheat cooling coil 30 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 the oil are in a vapor state, the separation through their difference in specific gravity is difficult. At lower temperatures condensation of the gas to be condensed takes place and hence since both the oil and the condensate are in a liquid 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 40, is

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shown as comprising a vertical cylindrical shell 41 having heads at its upper and lower ends. The outlet 34 from the superheat or primary cooling coil 30 is connected with an inlet pipe 42 extending tangentially through one side of the cylindrical shell 41 and having its discharge end bent downwardly. The pipe 42 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 41. This gas escapes through an outlet pipe 44 extending through the side wall of the shell 41 near the top thereof. The inlet end of this pipe 44 is bent upwardly and arranged coaxially of the shell 41. Further, to impede the escape of gas from the separator shell 41, a horizontal baffle plate 46 is shown as disposed across the center of the separator shell 41, this baffle preventing any tendency of the gas to short circuit from the inlet 42 to the outlet 44. In passing through the separator shell 41 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 41.

The level of oil in the bottom of the separator shell 41 can be observed through a sight glass 48. When a sufficient amount of oil accumulates in the separator shell 41, as indicated by the sight glass 48, an oil drain valve 49 in the bottom of the shell 41 can be opened to withdraw the accumulated oil. In an ammonia system this withdrawal can be through a rubber hose into a bucket. In a Freon system the drain valve 49 would be connected to the crank case of the compressor. To drain such ammonia as condenses in the separator 40, an ammonia drain pipe 50 is provided in the bottom of the oil separator shell 41, this ammonia drain pipe 50 extending a substantial distance upwardly into the shell and being provided with an ammonia drain valve 51. 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 pipe 50, as indicated by the sight glass 45, it will be seen that any liquid ammonia in the separator can be drained by opening the ammonia drain valve 49.

From the outlet pipe 44 of the oil separator 40, the gas passes into the inlet 55 of an inlet header 56 of a secondary or condensing coil 58 arranged across the interior of the casing 10 immediately above the air inlet 22 thereof. The tubes 59 of this coil 58 can be of hairpin form, each having one leg connected with the inlet header 56 and its opposite leg connected with an outlet header 60. The outlet for the condensate from the coil 58 can connect with a line 61 leading to the usual receiver (not shown).

To provide evaporative cooling, the tubes 59 of the coil 58 are wetted from overhead spray nozzles 63. These nozzles are shown as mounted on the branches 64 of a longitudinal spray water pipe 65 which extends through the end wall of the casing 10 adjacent to the base extension 13 of this casing. This spray water pipe connects with the outlet of a spray water pump 66 which

withdraws water from the body 12 of water in the sump or tank 11 at the bottom of the casing 10. Makeup water can be supplied to this body 12 of water in the sump 11 in any usual and well known manner.

The usual eliminator plates 67 are arranged above the sprays 63 to remove entrained water from the air stream.

In the operation of the condenser and oil separator, as above described, two streams of atmospheric air are drawn into the casing 10 by the fan wheels 20 and discharged through the fan casing outlets 21 extending through the top of the casing 10. One of these air streams enters the casing 25 through its inlet 39 and travels up and then down the U-shaped passage 38 provided in this casing by the partition 36 and thence is drawn into the casing 10 through its air inlet opening 23. The other air stream enters the air inlet opening 22 at the bottom of the casing 10 and travels upwardly through the interior of this casing.

The first air stream passes the tubes of the dry primary or superheat cooling coil 30 and thereby cools the gas to be condensed in this primary coil and which enters at 33 and leaves at 34. This primary or superheat cooling coil 30 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 34 of the primary dry superheat cooling coil 30 to the tangential and downwardly directed inlet pipe 42 extending through the cylindrical wall of the shell 41 of the oil separator 40. 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 these gases pass around the baffle 46 and thence through the upwardly directed central inlet of the outlet pipe 44. In so traveling through the shell 41 of the oil separator 40 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 this oil can be removed through the oil drain 49 and any superposed liquid body of the fluid to be condensed can be removed through the drain line 50, the conditions within the separator shell being observable through the sight glass 48.

From the outlet 44 of the oil separator the gas passes to the inlet 55 of the condensing coil 58, this coil being arranged in the casing 10 and across the stream of air flowing upwardly there-through from the air inlet 22. This coil is sprayed with water withdrawn from the body 12

of water in the sump or tank 11 at the bottom of the casing 10 by the pump 66 and discharged from the spray pipe 65 and its branches 64 through the nozzles 63 against the tubes 59 of this coil 58.

The cooling of the fluid passing through the wetted condensing coil 58 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 cooling coil 30 that there is no tendency for scale to form on the condensing coil 58 from the water sprayed thereon. By employing evaporative cooling with this secondary coil 58, 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 60 of the secondary evaporative cooling coil 58 through the outlet line 61 through which the condensate is conducted to the usual receiver (not shown).

An important feature of the invention resides in the fact that the apparatus as above described is self-balancing in response to variations in load and in response to variations in atmospheric conditions influencing the operation of the condenser. Under normal conditions the outside dry bulb temperature rises and falls with the outside wet bulb temperature. With a light load upon the condenser, or a low wet bulb temperature of the outside air drawn into the air inlet 22 greater cooling is effected by the sprayed condenser coil 58 and consequently the head pressure drops. The condensing temperature rises and falls with the head pressure and hence under light load or low wet bulb conditions the condensing temperature of the gas being condensed drops. At the same time with such a light load or low dry bulb temperature of the outside air the primary dry superheat cooling coil 30 cools the gas to be condensed to a lower temperature. Hence, with light load or low outside wet and dry bulb conditions, while the head pressure and condensing temperature of the gas is lowered, the primary dry superheat coil 30 effects a greater amount of cooling and hence brings the gas to its lowered condensing temperature. Conversely, with heavy load or high outside wet bulb temperature conditions, a higher head pressure and higher condensing temperature is maintained by the sprayed condensing coil 58 and at the same time, because of the higher entering temperature of the gas or the higher dry bulb temperature of the outside air the primary cooling coil 30 is less effective and the gas leaves this coil at a higher temperature. The apparatus is self-balancing, therefore, in that under varying load or outside temperature conditions the sprayed coil 58 adjusts the head pressure and connecting temperature to accord with the increased or decreased cooling effect of the dry primary coil 30. Hence this dry primary superheat cooling coil 30 can be designed to bring the gas close to but not below the condensing temperature under all normal conditions of operation.

While the apparatus as above described is self-balancing, for greater accuracy of control, particularly in bringing the gas leaving the dry pri-

mary superheat coil 30 accurately to a temperature slightly above its condensing temperature under all conditions of operation, it may be desirable to provide a positive thermostatic control. For this purpose a damper 68 is shown as arranged in the air inlet opening 23, this damper being actuated by a damper motor 69. This damper motor is controlled by a sub-thermostat 70 the sensitive parts of which are immersed in the gas entering the dry primary superheat cooling oil 30 through the line 33. The setting of this sub-thermostat 70 is in turn controlled by a master thermostat 71 which is responsive to temperature changes of the condensate leaving through the outlet line 61. By this arrangement the amount of cooling effected by the dry primary pre-cooling coil 30 is adjusted in accordance with the entering temperature of the gas to be condensed. Thus, if the temperature of the gas entering at 33 should rise, the sub-thermostat 70 in this line actuates the damper motor 69 to open the damper 68 and hence admit more air to the dry primary superheat cooling coil 30. In consequence more cooling is effected by this primary coil 30 and hence the gas leaves this primary coil 30 slightly above its condensing temperature even though its entering temperature is higher. If, however, this condensing temperature should, say, lower, due to a falling head pressure in the outlet line of the condenser, the master thermostat 71, responsive to the leaving temperature of the condensate, and hence its head pressure, adjusts the setting of the sub-thermostat 70. This setting would be adjusted downwardly whereby the sub-thermostat 70, through the damper motor 69, would further open the damper 68. This would lower the temperature of the gas leaving the dry primary superheat cooling coil 30 thereby bringing this leaving temperature close to the lowered condensing temperature responded to by the master thermostat 71. It will therefore be seen that the master and sub-thermostats in combination insure that the temperature of the gas leaving the dry primary superheat cooling coil 30 is at all times close to but higher than the condensing temperature of the gas regardless of varying head pressures or climatic conditions.

From the foregoing it will be seen that with the condenser and oil separator forming the subject of this invention the oil is extracted from the gas to be condensed when the temperature of this gas is slightly above the condensing temperature of the gas and when conditions are most favorable to oil separation. Further, with or without the thermostat controls the condenser is self-balancing to insure the oil separation from the gas when close to but above its condensing temperature regardless of variations in load or variations in climatic conditions. With this balanced operation and with the resulting removal of the maximum amount of oil the tendency of the oil to congeal and cake on the tubes of the evaporating coil to thereby reduce and destroy its heat transfer efficiency is largely eliminated.

We claim as our invention:

1. In a condenser for gases containing a higher boiling point vapor, a primary dry cooling coil, means for passing air over said dry primary coil to absorb heat therefrom, said dry primary coil being proportioned to remove the superheat from said gas and to reduce its temperature close to the dry bulb temperature of the air passing there-
over thereby to condense said higher boiling point

vapor, a liquid separator adapted to separate a liquid from a gas, means for passing the gas leaving said dry primary coil through said liquid separator to remove said condensed higher boiling point vapor, a secondary condensing coil, means for passing the gas leaving said liquid separator through said secondary condensing coil, means for passing atmospheric air over said secondary condensing coil, and means for discharging and distributing water over said secondary condensing coil to wash the exterior of said secondary condensing coil and to evaporate and absorb heat therefrom thereby to reduce the temperature of the gas passing therethrough close to the wet bulb temperature of said atmospheric air and to condense said gas passing therethrough.

2. In a condenser for gases containing a higher boiling point vapor, a casing having two air inlets, a fan drawing separate streams of atmospheric air into said casing through said two air inlets, a primary cooling coil in the path of the stream of air entering one of said air inlets and cooled thereby, said primary coil being proportioned to remove the superheat from said gas and to reduce its temperature close to the dry bulb temperature of the atmospheric air thereby to condense said higher boiling point vapor, a liquid separator adapted to separate a liquid from a gas, means for passing the gas leaving said primary coil through said liquid separator to remove said condensed higher boiling point vapor, a secondary condensing coil in the path of the stream of air entering the other of said air inlets and cooled thereby, means for passing the gas leaving said liquid separator through said secondary condensing coil, and means for discharging and distributing water over said secondary condensing coil to wash the exterior of said secondary condensing coil and to evaporate and absorb heat therefrom thereby to reduce the temperature of the gas passing therethrough close to the wet bulb temperature of said atmospheric air and to condense said gas passing therethrough.

3. In a condenser for gases containing a higher boiling point vapor, a casing having an air inlet at its upper end and a second air inlet near its lower end, a fan in the upper part of said casing and drawing separate streams of atmospheric air into said casing through said two air inlets, a dry primary cooling coil in the path of the stream of air entering said first air inlet and cooled thereby, said dry primary coil being proportioned to remove the superheat from said gas and to reduce its temperature close to the dry bulb temperature of the atmospheric air thereby to condense said higher boiling point vapor, a liquid separator adapted to separate a liquid from a gas, means for passing the gas leaving said dry primary coil through said liquid separator to remove said condensed higher boiling point vapor, a secondary condensing coil in said casing in the path of the stream of air entering said second air inlet and cooled thereby, means for passing the gas leaving said liquid separator through said secondary condensing coil, and means for discharging and distributing water over said secondary condensing coil to wash the exterior of said secondary condensing coil and to evaporate and absorb heat therefrom thereby to reduce the temperature of the gas passing therethrough close to the wet bulb temperature of said atmospheric air and to condense said gas passing therethrough.

4. In a condenser for gases containing a higher boiling point vapor, a casing having an air inlet

at its upper end and a second air inlet near its lower end, a second casing secured to the exterior of said first casing and through which the air entering said first air inlet is required to pass, a fan in the upper part of said first casing and drawing separate streams of atmospheric air into said first casing through said two air inlets, a dry primary cooling coil in said second casing in the path of the air entering said first air inlet and cooled thereby, said dry primary coil being proportioned to remove the superheat from said gas and to reduce its temperature close to the dry bulb temperature of the atmospheric air thereby to condense said higher boiling point vapor, a liquid separator adapted to separate a liquid from a gas, means for passing the gas leaving said dry primary coil through said liquid separator to remove said condensed higher boiling point vapor, a secondary condensing coil in said first casing in the path of the stream of air entering said second air inlet and cooled thereby, means for passing the gas leaving said liquid separator through said secondary condensing coil, and means for discharging and distributing water over said secondary condensing coil to wash the exterior of said secondary condensing coil and to evaporate and absorb heat therefrom thereby to reduce the temperature of the gas passing therethrough close to the wet bulb temperature of said atmospheric air and to condense said gas passing therethrough.

5. In a condenser for gases containing a higher boiling point vapor, a primary cooling coil, means for passing air over said primary coil to absorb heat therefrom, said primary coil being proportioned to remove the superheat from said gas and to reduce its temperature close to the dry bulb temperature of the air passing thereover thereby to condense said higher boiling point vapor, a liquid separator adapted to separate a liquid from a gas, means for passing the gas leaving said primary coil through said liquid separator to remove said condensed higher boiling point vapor, a secondary condensing coil, means for passing the gas leaving said liquid separator through said secondary condensing coil, said secondary condensing coil being maintained at a temperature to condense said gas passing therethrough, a thermostat responsive to the temperature of said gas being condensed, and means actuated by said thermostat and controlling the flow of said air over said primary coil to maintain the temperature of the gas leaving said primary coil close to and above the condensing temperature thereof.

6. In a condenser for gases containing a higher boiling point vapor, a primary dry cooling coil, means for passing air over said dry primary coil to absorb heat therefrom, said dry primary coil being proportioned to remove the superheat from said gas and to reduce its temperature close to the dry bulb temperature of the air passing thereover thereby to condense said higher boiling point vapor, a liquid separator adapted to separate a liquid from a gas, means for passing the gas leaving said dry primary coil through said liquid separator to remove said condensed higher boiling point vapor, a secondary condensing coil, means for passing the gas leaving said liquid separator through said secondary condensing coil, said secondary condensing coil being maintained at a temperature to condense said gas passing therethrough, a sub-thermostat responsive to the temperature of the gas entering said dry primary coil, a master thermostat controlling the setting of said sub-thermostat and responsive to the

temperature of the condensate leaving said secondary condensing coil, and means actuated by said sub-thermostat and controlling the flow of said air over said dry primary coil to maintain the temperature of the gas leaving said dry primary coil close to and above the condensing temperature thereof at all head pressures at the outlet from said secondary condensing coil.

7. In a condenser for gases containing a higher boiling point vapor, a casing having two air inlets, a fan drawing separate streams of atmospheric air into said casing through said two air inlets, a primary cooling coil in the path of the stream of air entering one of said air inlets and cooled thereby, said primary coil being proportioned to remove the superheat from said gas and to reduce its temperature close to the dry bulb temperature of the atmospheric air thereby to condense said higher boiling point vapor, a liquid separator adapted to separate a liquid from a gas, means for passing the gas leaving said primary coil through said liquid separator to remove said condensed higher boiling point vapor, a secondary condensing coil in the path of the stream of air entering the other of said air inlets and cooled thereby, means for passing the gas leaving said liquid separator through said secondary condensing coil, means for throttling the air entering said one of said air inlets supplying air to said primary cooling coil, and a thermostat responsive to the temperature of said gas being condensed and controlling said throttling means to maintain the temperature of the gas leaving said primary coil close to and above the condensing temperature thereof.

8. In a condenser for gases containing a higher boiling point vapor, a casing having two air inlets, a fan drawing separate streams of atmospheric air into said casing through said two air inlets, a dry primary cooling coil in the path of the stream of air entering one of said air inlets and cooled thereby, said dry primary coil being proportioned to remove the superheat from said gas and to reduce its temperature close to the dry bulb temperature of the atmospheric air thereby to condense said higher boiling point vapor, a liquid separator adapted to separate a liquid from a gas, means for passing the gas leaving said dry primary coil through said liquid separator to remove said condensed higher boiling point vapor, a secondary condensing coil in the path of the stream of air entering the other of said air inlets and cooled thereby, means for passing the gas leaving said liquid separator through said secondary condensing coil, means for throttling the air entering said one of said air inlets supplying air to said primary cooling coil, a sub-thermostat responsive to the temperature of the gas entering said dry primary coil, a master thermostat controlling the setting of said sub-thermostat and responsive to the temperature of the condensate leaving said secondary condensing coil, and means operatively connecting said sub-thermostat with said throttling means to maintain the temperature of the gas leaving said dry primary coil close to and above the condensing temperature thereof at all head pressures at the outlet from said secondary condensing coil.

9. In a condenser for gases containing a higher boiling point vapor, a primary cooling coil, means for passing air over said primary coil to absorb heat therefrom, said primary coil being proportioned to remove the superheat from said gas and to reduce its temperature close to the dry bulb

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temperature of the air passing thereover thereby to condense said higher boiling point vapor, a liquid separator, a liquid separator adapted to separate a liquid from a gas, means for passing the gas leaving said primary coil through said liquid separator to remove said condensed higher boiling point vapor, a secondary condensing coil, means for passing the gas leaving said liquid separator through said secondary condensing coil, means for passing atmospheric air over said secondary condensing coil, means for discharging and distributing water over said secondary condensing coil to wash the exterior of said secondary condensing coil and to evaporate and absorb heat therefrom thereby to reduce the temperature of the gas passing therethrough close to the wet bulb temperature of said atmospheric air and to condense said gas passing therethrough, a thermostat responsive to the temperature of said gas being condensed, and means actuated by said thermostat and controlling the flow of air over said primary coil to maintain the temperature of the gas leaving said primary coil close to and above the condensing temperature thereof.

10. In a condenser for gases containing a higher boiling point vapor, a primary dry cooling coil, means for passing air over said dry primary coil to absorb heat therefrom, said dry primary coil being proportioned to remove the superheat from said gas and to reduce its temperature close to the dry bulb temperature of the air passing thereover thereby to condense said higher boiling point vapor, a liquid separator adapted to separate a liquid from a gas, means for passing the gas leaving said dry primary coil through said liquid separator to remove said condensed higher boiling point vapor, a secondary condensing coil, means for passing the gas leaving said liquid sep-

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arator through said secondary condensing coil, means for passing atmospheric air over said secondary condensing coil, means for discharging and distributing water over said secondary condensing coil to wash the exterior of said secondary condensing coil and to evaporate and absorb heat therefrom thereby to reduce the temperature of the gas passing therethrough close to the wet bulb temperature of said atmospheric air and to condense said gas passing therethrough, a sub-thermostat responsive to the temperature of the gas entering the dry primary coil, a master thermostat controlling the setting of said sub-thermostat and responsive to the temperature of the condensate leaving said secondary condensing coil, and means actuated by said sub-thermostat and controlling the flow of said air over said dry primary coil to maintain the temperature of the gas leaving said dry primary coil close to and above the condensing temperature thereof at all head pressures at the outlet from said secondary condensing coil.

RALPH HORTON.
MARTIN H. OLSTAD.

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