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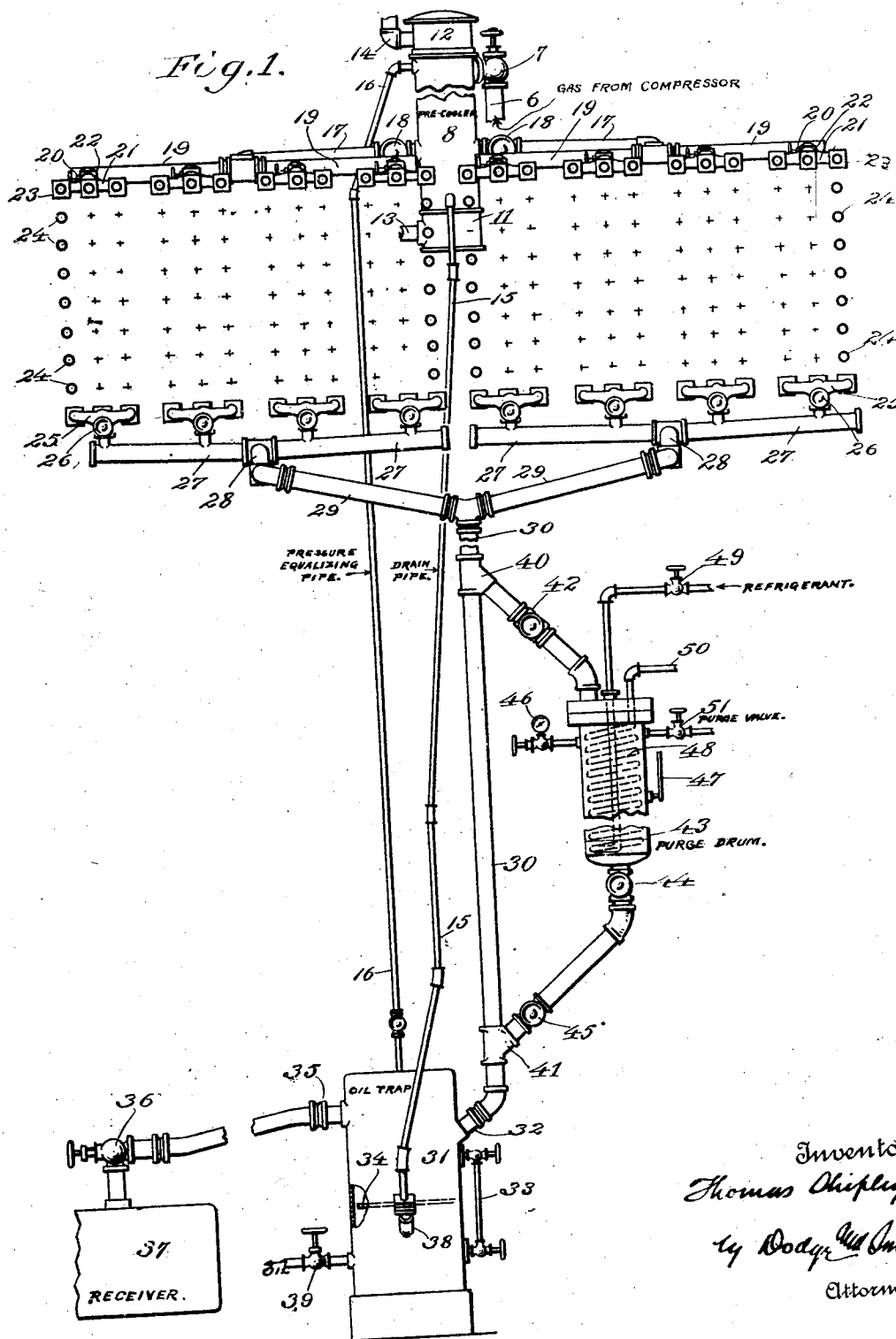
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T. SHIPLEY

CONDENSER

Filed May 31, 1924

3 Sheets-Sheet 1



Inventor
Thomas Shipley
by Dodge & Sons
Attorneys

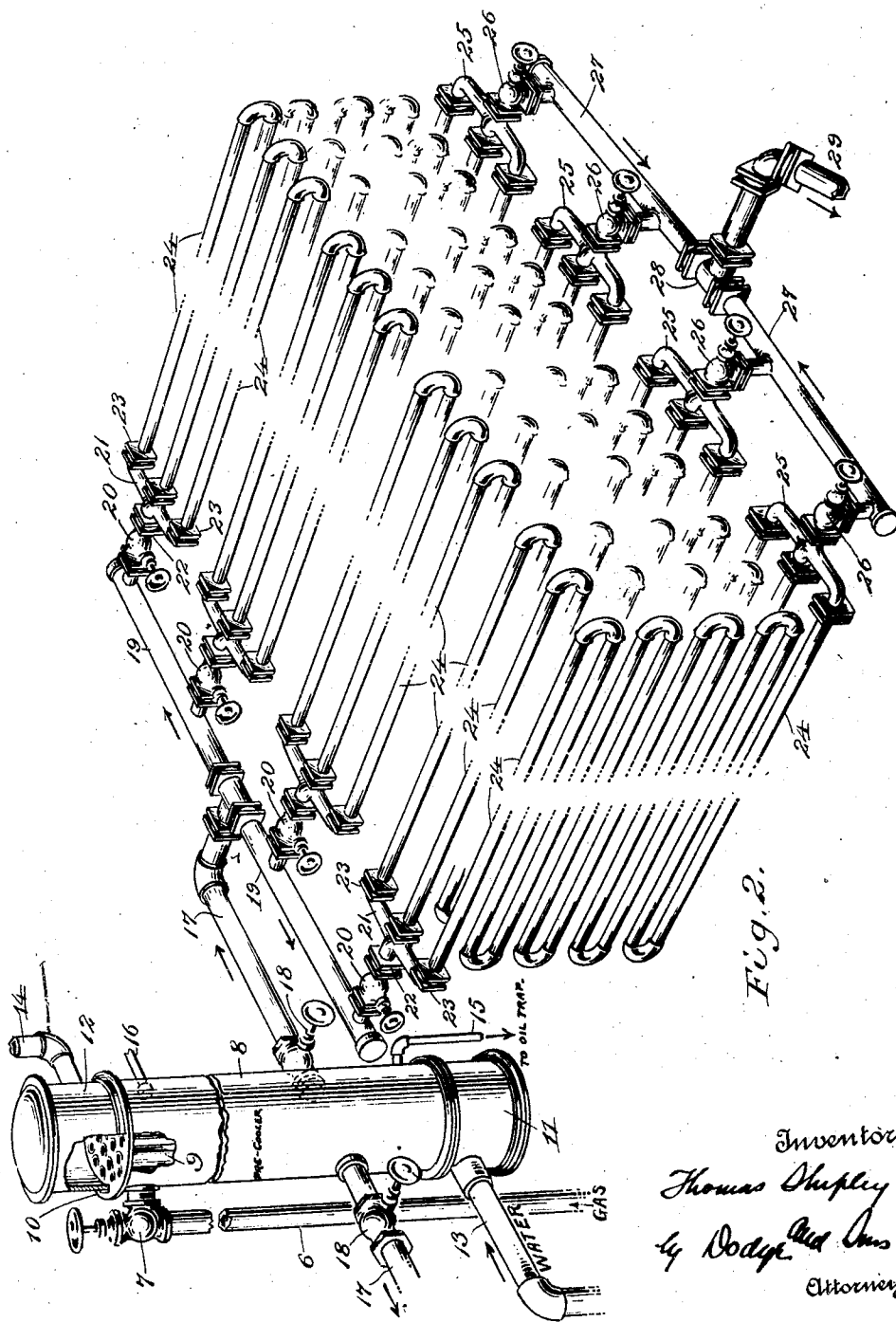
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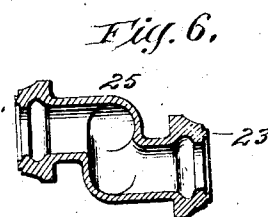
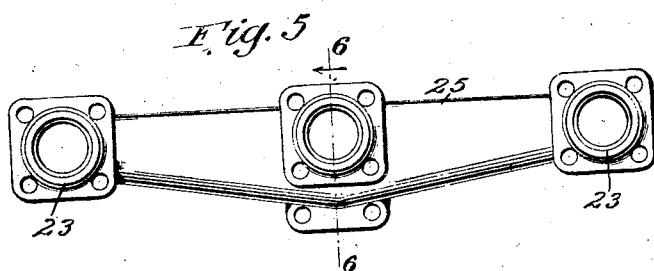
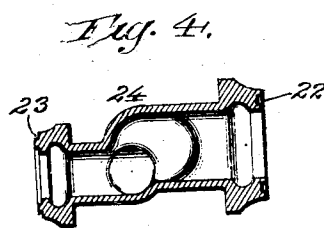
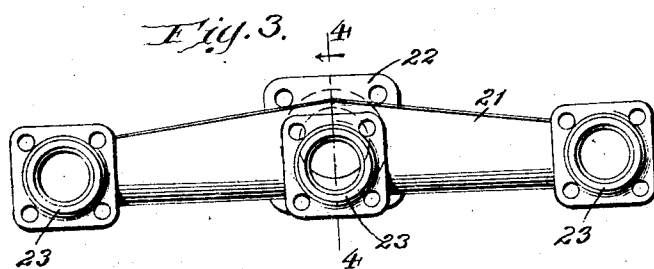
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Inventor
Thomas Shipley
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Attorneys

UNITED STATES PATENT OFFICE.

THOMAS SHIPLEY, OF YORK, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO YORK ICE MACHINERY CORPORATION, OF YORK, PENNSYLVANIA, A CORPORATION OF DELAWARE.

CONDENSER.

Application filed May 31, 1924. Serial No. 717,072.

This invention relates to condensers of the so-called atmospheric type for use in refrigerating systems and particularly in those systems using anhydrous ammonia.

5 In two prior applications, Ser. Nos. 691,057 and 691,058, filed Feb. 6, 1924, which have since the filing of the present application resulted in Letters Patent Nos. 1,525,006 and 1,525,007, I describe and claim a method of
10 and apparatus for purging refrigerating systems, in which the foreign gases are drawn from the bottom of the condenser and are trapped by a liquid seal in a part of the liquid line, such trap being located preferably be-
15 tween the condenser and the receiver.

In operating according to the method just alluded to, it is necessary specially to operate or specially to construct the condenser in such manner that the formation of liquid seals,
20 either by the refrigerant or by such lubricating oil as may be present, either in the bottom of the condenser or at points in the liquid line leading to the purging apparatus, shall be precluded.

25 The present invention provides a condenser which has special utility in and of itself, and which, when combined with a purging system of the type just described, offers peculiar practical advantages.

30 The purging method and mechanism are claimed in my applications above identified and consequently are not claimed herein, except in combination with the special condenser. The scheme for returning recovered
35 refrigerant to the liquid line or receiver disclosed in the present application is claimed in a related application Serial No. 744,469, filed October 18, 1924, and hence is not claimed herein.

40 Obviously, atmospheric condensers vary considerably in their specific form, according to the space available and the particular requirements of the plant. I have selected for illustration a simple and more or less
45 arbitrary arrangement of the apparatus designed to bring out the fundamental principles of the invention, and I have purposely omitted accessory apparatus such as pump-out connections, etc., not necessary to an un-
50 derstanding of the invention. Accordingly, the showing in the accompanying drawings is largely limited to the features of the present invention and is in some degree diagrammatic.

In the drawings:

Fig. 1 is a diagrammatic view of the pre-cooler, condenser, purging apparatus, oil trap, and part of the receiver showing the pipe connections between these elements;

Fig. 2 is a perspective view showing the pre-cooler and one of the two main condenser units together with various pipe connections. In this view, certain of the pipe coils of the condenser are merely suggested;

Fig. 3 is an elevation of a gas header casting used to connect the inlet ends of condenser coils;

Fig. 4 is a section on the line 4—4 of Fig. 3;

Fig. 5 is an elevation of a liquid header casting used to connect the outlet ends of con-
70 denser coils;

Fig. 6 is a section on the line 6—6 of Fig. 5.

The high pressure gas line, which is connected to the discharge of the compressor or compressors, is shown at 6. It discharges
75 through a valve 7 into the body of the pre-cooler 8. This is shown as a vertical condenser of the water tube type, in which the water tubes are shown at 9, one of the tube sheets at 10, and the water boxes at 11 and
80 12 (see Fig. 2). The water supply and discharge connections to the respective water boxes are shown at 13 and 14.

As is understood by those skilled in the art, atmospheric condensers are usually
85 cooled by water flowing over them from a cooling tower (not shown) to a collecting basin and sump (not shown), from which the water is pumped back to the cooling tower. It is conveniently possible to use the water on
90 its way from the sump to the cooling tower for the purpose of cooling the preliminary cooler 8, as the refrigerant gas is at a relatively high temperature as it enters the pre-
95 liminary cooler, and hence can be effectively cooled by this water. However, the water for cooling the preliminary cooler 8 may be drawn from any preferred source.

The action of the preliminary cooler 8 is to cool the refrigerant partially. This re-
100 sults, first, in the condensation and precipitation in the cooler 8 of practically all the lubricating oil which is carried from the compressor by the compressed refrigerant. There may be, and commonly will be, some
105 liquefaction of the refrigerant in the pre-cooler 8, depending, of course, on the size of the pre-cooler, the pressure and temperature

of the arriving gas, and the temperature and quantity of the cooling water available.

The removal of the lubricating oil before the refrigerant enters the main or atmospheric condenser is important because, unless the oil is removed, a considerable portion of it will be deposited in the condenser, will coat the interior surface of the tubes, and consequently will retard the heat transfer which takes place in the condenser.

The oil intercepted in the pre-cooler 8, together with such refrigerant as is there liquefied, is withdrawn from the bottom of the pre-cooler 8 through the drain connection 15, which leads to an oil trap hereinafter described. In order to equalize the pressures of the oil trap and pre-cooler, an equalizing connection 16 is made between the top of the pre-cooler 8, and the top of the oil trap. This equalizing connection assures gravity flow of oil and liquid refrigerant from the bottom of the pre-cooler 8 through drain connection 15 to the oil trap.

The balance of the refrigerant, together with any foreign gases or vapors which may be present, is withdrawn from the body of the cooler 8 by the connections 17, two such connections being shown, each controlled by a corresponding valve 18. The connections 17 leave the pre-cooler 8 at a level above that of the drain connection 15, and each leads to a corresponding gas manifold 19. The connections 17 lead the gas to points at mid-length of the manifolds 19 and these manifolds are preferably exactly level so that there will be no tendency for any liquefied refrigerant, if any be present, to accumulate in the header.

I will now describe, with reference to Fig. 2, one of the two main condenser units, these two units being identical, as is clearly indicated in Fig. 1.

A number of branch connections lead from the manifold 19, and each is controlled by a corresponding globe valve 20. It is important that these valves be set with their stems horizontal, so that the valves will drain themselves, by gravity, of any liquid ammonia which might find its way into them, thus avoiding the formation of any liquid seals or traps at the valve seats, and insuring the equal distribution of the refrigerant to all the condenser coils.

Four branch connections from the manifold 19 are shown in Fig. 2, but there may be more or fewer. Each such connection is controlled by a valve 20 and each leads to a plurality of condenser coils (three being a convenient number) by means of a self-draining manifold fitting 21. This fitting is shown in detail in Figs. 3 and 4, and, as shown in that figure, each fitting includes a main connection 22 and three branch connections 23. The main connection receives refrigerant from the corresponding valve 20,

and the branch connections 23 are connected to corresponding sinuous condenser coils 24.

Each coil 24 is so formed and arranged that, as the refrigerant is condensed in it, it drains freely by gravity to the bottom of the coil. Furthermore, the pipe of which the coil is made is of such size that its bore will never be filled by the liquid refrigerant flowing through it. In other words, each convolution of each coil is more than adequate to conduct all the refrigerant which may be condensed within it and within all the convolutions above it.

The fittings 21 are so formed that the branch connections 23 are all at a decidedly lower level than the main connection 22, and the ports are so shaped that no pockets for the accumulation of liquefied refrigerant are offered.

The three coils 24 of each group are similarly connected at their lower ends by a manifold connection 25 (see Figs. 5 and 6), which is practically identical in form with the manifold connection 21, but inverted so as to permit free gravity flow of the liquid refrigerant from the coils 24 to a globe angle valve 26, which also stands with its stem in a horizontal position to preclude the formation of any pockets at or around its seat.

There is a fitting 25 for each group of condenser coils so that, in the example illustrated there are four such fittings 25, and four angle valves 26. The angle valves 26 are connected by vertical branches to two reversely inclined manifolds 27. These manifolds are of such size and are sufficiently steeply inclined to feed all the liquid refrigerant to the T fitting 28 without permitting any branch manifold 25, any valve 26, or any part of the manifold 27 to become completely flooded. The T fitting 28 is connected to an inclined branch 29 and these, like the parts just described, are adequate to convey all the liquid refrigerant which they receive, without flooding.

The condenser unit just described is one of two, and consequently there are two branches 29 which are connected to the main liquid line 30. This is a vertical pipe which extends downward to an oil separating trap 31 and enters the side of said trap through an inclined opening 32. The purpose in so entering the trap is to assist the gravity separation of oil and liquid refrigerant in the trap 31.

This trap is provided with a gauge glass 33, and a horizontal baffle 34, below the inlet 32, and preferably at or slightly above a normal level of oil in the trap. The liquid refrigerant passes off through the connection 35, which is above the connection 32, through a globe valve 36, to the receiver 37.

The drain connection 15 enters the trap through a downwardly inclined fitting 38 below the baffle 34 and the equalizing connection

16 is connected to the top of the trap. Since the liquid flowing to the trap through the connection 15 includes considerable oil, it is desirable to place the fitting 38 near the bottom of the trap and provide the baffle 34 to limit the agitation of the contents of the trap and thus assist the separation of the oil from the refrigerant. As the oil accumulates, it may be drawn off from time to time through the valved connection 39.

The foreign gas eliminator is formed as a sort of by-pass or extra volume in communication with the main liquid line 30. A branch leaves the line 30 by way of the fitting 40 and returns by way of the fitting 41. Flow through the fitting 40 is controlled by a valve 42. This branch leads to a shell 43, known as the purge drum. Between the bottom of the purge drum 43 and the lower fitting 41, there is a pipe connection controlled by two valves, the first of which, 44, is at or near the bottom of the drum 43, and the second of which, 45, is at or near the fitting 41. The essential thing is that there shall be an interval between the valves 44 and 45 affording a volume sufficient to receive all the refrigerant which may be trapped between the valves 42 and 45 after such refrigerant has been liquefied.

The purge drum 43 is provided with a valve controlled gauge 46 and a thermometer and well 47, and it may be chilled by an expansion coil 48 to which liquid refrigerant is admitted through the expansion valve 49 and from which the expanded refrigerant is withdrawn to the compressor through a connection 50. Purge valve 51 permits gases to be vented from the purge drum 43.

In the ordinary operation of the plant, the valves 42, 44, and 45 are open. The purge drum 43 and its pipe connections serve therefore merely as an extra volume connected with the liquid line. Foreign gases are not condensed in the condenser and being heavier than the gaseous refrigerant they flow downward through the coils 24, fittings 25, valves 26, manifolds 27, and connections 29 to the liquid line 30. They are free so to flow because the construction of the condenser is such that no liquid seals or traps impede the flow of the foreign gases.

The trap 31, however, is filled to the outlet 35 with liquid and consequently the foreign gases are held back and separated from the liquid refrigerant at this point and accumulate in the purge drum 43 and its connections.

When the foreign gases have accumulated in considerable volume, the head pressure will rise materially above that corresponding to the temperature of the refrigerant leaving the condenser. When this condition exists the system is purged as follows:

The valves 42 and 45 are closed, isolating the purge drum 43 from the liquid line 30. The expansion valve 49 is then opened to per-

mit liquid refrigerant to expand into the coil 48. This so chills the gases within the purge drum 43 that the refrigerant gas is liquefied practically completely and drains through the open valve 44 into the connection between this valve and the valve 45.

When all the refrigerant has been liquefied, this fact will be indicated by the relation of temperature to pressure in drum 43. Then the valves 44 and 49 are closed and the valve 45 is opened. This permits the liquid refrigerant to flow by way of the fitting 41 through liquid line 30 to the trap 31 while the foreign gases are retained in drum 43. The valve 51 is then opened to vent the foreign gases to the atmosphere after which the valve 51 is closed and the valves 42 and 44 are opened.

This completes the purging operation and restores the purge drum 43 to communication with the liquid line 30.

The purging mechanism and method just described are essentially the same as those described and claimed in my prior applications, except for the arrangement of the valves 44 and 45, by which the liquefied refrigerant recovered from the purge drum is delivered to the liquid line instead of being fed to the low pressure gas line, i. e., to the suction of the compressor.

The arrangement shown in the present application is simpler and somewhat more economical.

The condenser above described is simple in construction and has proved to be highly efficient in operation. The preliminary cooler effects a quite thorough removal of oil and maintains the efficiency of the main condenser units by preventing them from becoming coated with oil.

The construction of the main condenser units and their connections is such that liquefied refrigerant is quickly led away so that practically the entire surface of the condenser is effective for condensing purposes. Furthermore, because of the free flow of liquid from the condenser and the avoidance of all liquid seals, the foreign gases are not trapped in the condenser and hence do not reduce its efficiency, but gradually accumulate in a volume provided therefor in a part of the system where they do not retard the useful transfer of heat.

Connections between the pre-cooler and the oil trap are such as to be favorable to active separation of the oil and liquid refrigerant. The entire plant is one which tends to operate at high efficiency and which may be maintained in this condition by occasional purging of the drum 43 practically without the loss of refrigerant.

While the general principles involved in the design of the condenser can doubtless be understood by those skilled in the art, from the above description, I wish to point out one or two important factors to insure a full

appreciation of their importance, and to insure a clear understanding of certain terms used in the following claims.

Each condenser coil must either be set with its pipes exactly level, or such fittings must be used as will produce a slight gradient in successive convolutions, favorable to gravity flow of condensed refrigerant to the bottom of the coil. In coils of the usual construction successive convolutions are parallel and where this construction is used, the exact leveling of the coils is a matter of importance. Furthermore, the total length of the coil, and the diameter of the piping used, must be so correlated that the liquid flow capacity at all points in the coil is more than sufficient to discharge under the available gravity head more condensed refrigerant than that coil and all the coils above it can supply. In other words, the liquid flow rate must be so great, relatively to the rate of condensation, that a gas passage is maintained throughout the length of the coil continuously or substantially so. Otherwise, heavy foreign gases, which are non-condensable, will be trapped in the condenser.

Another important point in the design is the construction of the liquid offtakes in such manner that their liquid flow capacity is more than sufficient to discharge all the liquid refrigerant delivered by the condensing coils which discharge into them. This result is secured partly by using unusually large offtake fittings and partly by increasing the flow gradient through the offtake fittings and the headers progressively, so that as the various streams of condensate join, their speed of flow will be increased. By increasing the speed of flow in the manner described, it is possible to use fittings of smaller size than would otherwise be practicable and still maintain within the fitting a free passage for the foreign gases.

What is claimed is:

1. A condenser for refrigerating systems, comprising in combination, a plurality of pipe coils arranged to drain themselves of liquid refrigerant by gravity flow; a manifold offtake for the condensed liquid arranged for gravity flow, and having at all points a gravity liquid flow capacity in excess of the condensing capacity of the coils discharging therein, whereby a gravity flow outlet for heavy gases is afforded by said offtake; a chamber in communication with said offtake; a liquid seal beyond said chamber arranged to intercept gases and pass liquid refrigerant; means serving to segregate the non-condensable portion of said intercepted gases within said chamber; and means for venting said chamber.

2. A condenser for refrigerating systems comprising in combination, a plurality of pipe coils arranged to drain themselves of liquid refrigerant by free gravity flow; a

manifold offtake for the condensed liquid arranged for free gravity flow and having at all points a gravity liquid flow capacity in excess of the condensing capacity of the coils discharging therein, whereby a gravity flow outlet for heavy non-condensable gases is afforded through said offtake; and means for arresting and accumulating outside the condenser the off-flowing non-condensable gases while permitting the flow of condensed refrigerant.

3. A condenser for gaseous refrigerants comprising in combination a plurality of coils so constructed and arranged that the rate of liquid flow is so great relatively to the rate of condensation, that a gas passage is maintained throughout the length of the coil; a manifold offtake for said coils having a gravity liquid flow capacity greater than the condensing capacity of said coils; means for intercepting uncondensed gases discharging through said offtake; and means for isolating and discharging the non-condensable portions of said intercepted gases.

4. A condenser for gaseous refrigerants comprising in combination a plurality of coils so constructed and arranged that the rate of gravity liquid flow is so great relatively to the rate of condensation, that a gas passage is maintained throughout the length of the coil; a manifold offtake for said coils having a gravity liquid flow capacity greater than the condensing capacity of said coils, and including multiple-branched units having a steep flow gradient and devoid of liquid retaining pockets; means for intercepting uncondensed gases discharging through said offtake; and means for isolating and discharging the non-condensable parts of said intercepted gases.

5. In a refrigerating plant, the combination of a pre-cooler connected to receive refrigerant to be condensed; a condenser connected to receive gaseous refrigerant from the pre-cooler; an oil removing trap; a receiver; and connections for conducting condensed liquids from the pre-cooler and condenser to said receiver through said trap.

6. In a refrigerating plant, the combination of a pre-cooler connected to receive refrigerant to be condensed; a condenser connected to receive gaseous refrigerant from the pre-cooler; a receiver connected to receive liquefied refrigerant from the condenser; an oil removing trap interposed in the last-named connection and provided with a baffle below the liquid level therein; and connections arranged to drain condensed liquids from the pre-cooler and discharge them into said trap below said baffle.

7. A condenser for refrigerating systems comprising in combination, a pre-cooler arranged partially to cool refrigerant, and thereby liquefy entrained oil and condense a part of the refrigerant; a main condenser

arranged to receive from the pre-cooler the uncondensed portion of the refrigerant together with such non-condensable gases as may be present, said condenser including a plurality of coils arranged for free gravity flow of liquid refrigerant and a gravity discharge of sufficient capacity to discharge all condensed refrigerant and simultaneously maintain a constant gravity outflow passage for heavy non-condensable gases; a liquid line leading from said condenser and including a trap arranged to pass liquid refrigerant and arrest oil and gases; and a drain connection for leading condensed liquids from said pre-cooler to said liquid line.

8. A condenser for refrigerating systems comprising in combination, a pre-cooler arranged partially to cool refrigerant, and thereby liquefy entrained oil and condense a part of the refrigerant; a main condenser arranged to receive from the pre-cooler the uncondensed portion of the refrigerant together with such non-condensable gases as may be present, said condenser including a plurality of coils arranged for free gravity flow of liquid refrigerant and gravity discharge connections of sufficient capacity to discharge all condensed refrigerant and simultaneously maintain a constant gravity outflow passage for heavy non-condensable gases; a liquid line leading from said condenser and including a trap arranged to pass liquid refrigerant and arrest oil and gases; a drain connection for leading condensed liquids from said pre-cooler to said liquid line; and a purge drum associated with said liquid line and arranged to accumulate non-condensable gases discharged therein by said condenser.

9. In a condensing plant for treating the refrigerant gases containing small quantities of oil-mist, and non-condensable gases, the combination of a pre-cooler arranged to liquefy substantially all said oil and more or

less of said refrigerant; a drain connection for conducting such liquid from said pre-cooler; a gas connection leading from said pre-cooler at a level above said drain connection; a main condenser connected to be fed by said gas connection and arranged to discharge liquefied refrigerant together with non-condensable gases; a trap arranged to prevent the passage of oil and of non-condensable gases, connected to receive liquid from said drain connection and also the discharge from said condenser; a receiver fed with liquid refrigerant by said trap; and means for isolating and discharging non-condensable gases, interposed in the connection between said condenser and said trap.

10. In a condensing plant for treating the refrigerant gases containing small quantities of oil-mist, and non-condensable gases, the combination of a pre-cooler arranged to liquefy substantially all said oil and more or less of said refrigerant; a drain connection for conducting such liquid from said pre-cooler; a gas connection leading from said pre-cooler at a level above said drain connection; a main condenser connected to be fed by said gas connection and arranged to discharge liquefied refrigerant together with non-condensable gases; a trap arranged to prevent the passage of oil and of non-condensable gases, connected to receive liquid from said drain connection and also the discharge from said condenser; a receiver fed with liquid refrigerant by said trap; and means for isolating and discharging non-condensable gases, interposed in the connection between said condenser and said trap, said means including a cooling coil for liquefying such refrigerant as may be present and a gravity drain connection operable to drain such liquefied refrigerant to said trap.

In testimony whereof I have signed my name to this specification.

THOMAS SHIPLEY.