

March 23, 1937.

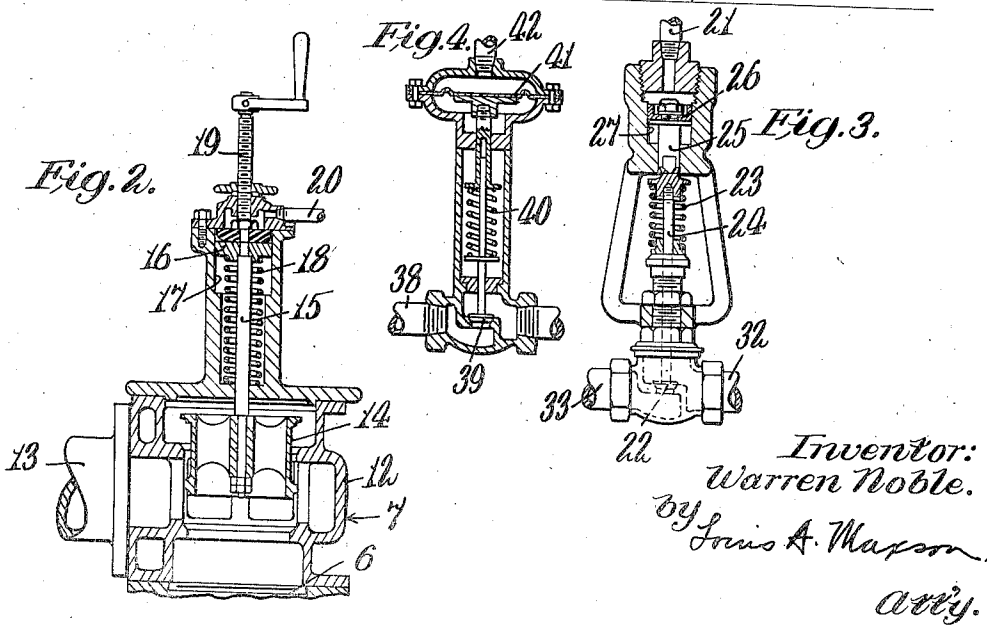
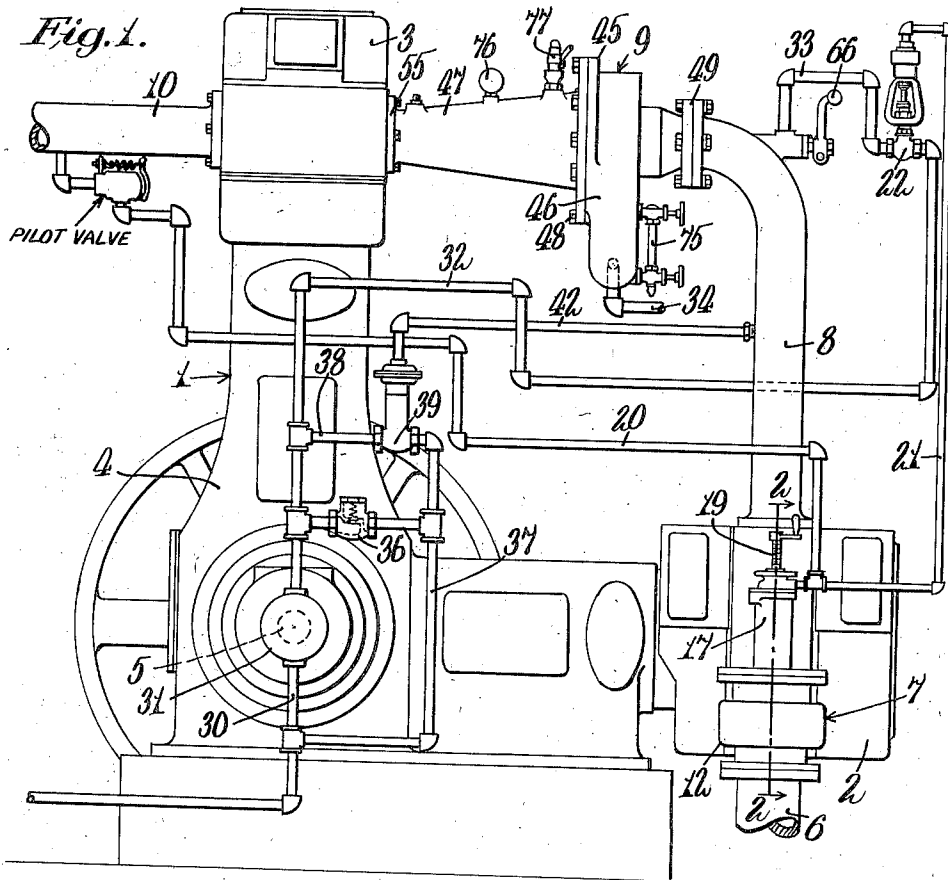
W. NOBLE

2,074,801

HEAT EXCHANGE AND AIR WASHING DEVICE

Filed Feb. 28, 1934

2 Sheets-Sheet 1



March 23, 1937.

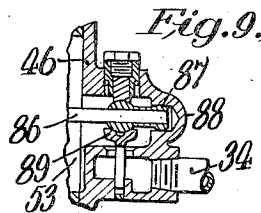
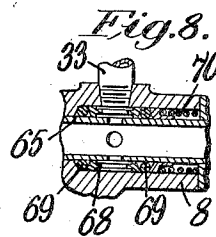
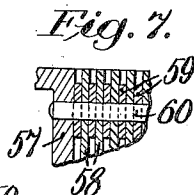
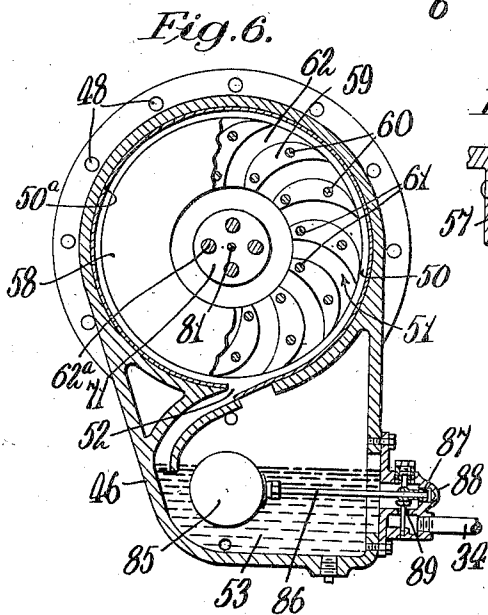
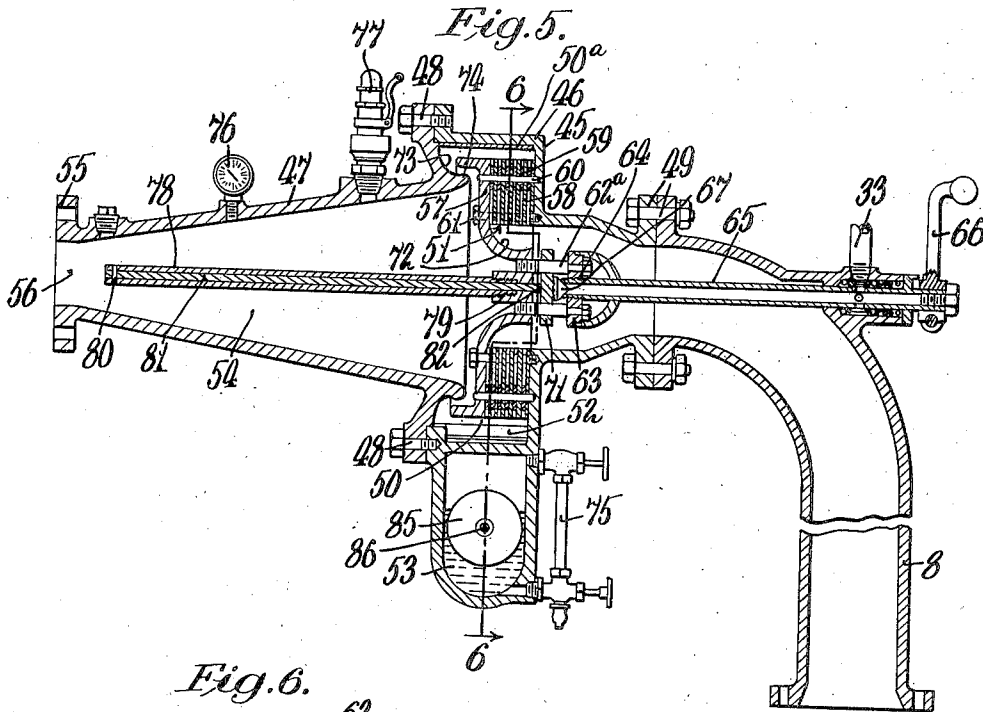
W. NOBLE

2,074,801

HEAT EXCHANGE AND AIR WASHING DEVICE

Filed Feb. 28, 1934

2 Sheets-Sheet 2



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Atty.

UNITED STATES PATENT OFFICE

2,074,801

HEAT EXCHANGE AND AIR WASHING
DEVICEWarren Noble, Michigan City, Ind., assignor to
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of Massachusetts

Application February 28, 1934, Serial No. 713,333

16 Claims. (Cl. 261-116)

This invention relates, in one aspect thereof, to heat exchange devices, and, in another aspect, to air washing devices.

In its first aspect, it relates more particularly, but not exclusively, to improvements in the cooling system for the air compressed in a compound compressor.

In its second aspect, it relates more particularly to an air washing device for use with a pump forming a part of a conditioned air system.

The object of this invention is to provide an improved heat exchange device, especially designed for use in a fluid compressor or pump. Another object is to provide an improved cooling device for a fluid compressor or pump, whereby the compressed fluid is cooled in an improved manner. A further object is to provide an improved intercooler for a fluid compressor or pump. A still further object is to provide an improved cooling device which may be applied, when suitably constructed, to after-cooling, if desired. Yet another object is to provide an improved intercooler, having improved cooling means, wherein the gaseous fluid to be cooled is commingled with the cooling liquid, and having therein improved means for effecting intimate contact between the gas and liquid, and for effectually separating the cooled compressed fluid from the cooling liquid. A still further object is to provide an intercooler of the above character, having improved automatic controlling means for regulating the temperature of the compressed fluid flowing through the intercooler. A still further object is to provide an improved cooling system for a compressor having improved cooling liquid supply and controlling means, governed by automatic means, in accordance with the loaded or unloaded condition of the compressor, and with control in accordance with pressure conditions, in addition. Yet another object of the invention is to provide an improved cooling device for flowing air, serving not only the cooling but also an air washing function. A still further object of the invention is to provide an improved air and liquid mingling device for flowing air, which shall not only cool the air to the desired temperature, but effectually wash it, and then deliver it, completely humidified if desired. These and any other objects and advantages will, however, hereinafter more fully appear.

In the accompanying drawings there is shown for purposes of illustration one form which the invention may assume in practice.

In these drawings,—

Fig. 1 is a side elevational view showing a fluid

compressor or pump having associated therewith the illustrative form of the improved cooling structure.

Fig. 2 is a detail sectional view taken substantially on line 2—2 of Fig. 1 and showing the intake unloading means for the low pressure cylinder.

Fig. 3 is a detail sectional view showing an automatic controlling valve for the cooling liquid supply, operative to interrupt supply on unloading.

Fig. 4 is a section through an automatic bypass valve for regulating the pressure of the cooling liquid.

Fig. 5 is an enlarged vertical sectional view showing the illustrative form of the improved cooling device.

Fig. 6 is a cross sectional view taken substantially on line 6—6 of Fig. 5.

Fig. 7 is a fragmentary sectional view showing the detail structure of the separating discs.

Fig. 8 is a detail sectional view showing the packing gland for the cooling fluid inlet.

Fig. 9 is a fragmentary sectional view showing the detail structure of the liquid drain control valve.

In the illustrative embodiment, the cooling structure is shown as an intercooler on a compound compressor. Its other uses as an air washer and humidifier will be explained hereafter.

In this illustrative construction there is shown a fluid compressor or pump generally designated 1 herein of the well known angle compound type comprising a low pressure cylinder 2 and a high pressure cylinder 3, the cylinders mounted upon a suitable frame 4 and each containing a usual piston actuated from the compressor crank shaft 5. The low pressure cylinder is provided with an intake pipe 6, controlled by an intake unloading mechanism generally designated 7, and with a discharge pipe 8 connected to the intake of the improved intercooler generally designated 9. This intercooler is herein arranged in the space between the low and high pressure cylinders, and the discharge connection of this intercooler is connected to the intake of the high pressure cylinder and the compressed fluid is discharged from the latter cylinder through a discharge pipe 10.

The unloading mechanism 7 is herein of the total closure intake type having a casing 12 to which fluid is supplied directly from the atmosphere through the intake pipe 6 and low pressure fluid is supplied from this casing through a pipe 13 under the control of a double seat valve 14 which is actuated through a stem 15 by a piston

16 contained in a cylinder 17 mounted on top of the casing 12. The valve 14 is normally held in its upper or loading position by a spring 18, thereby permitting fluid to flow freely to the intake 5 of the low pressure cylinder 2. This unloader valve is actuated to closed or unloading position by pressure fluid acting on the piston 16 in the cylinder 17 and the amount of opening movement is controlled by an adjustable stop 19. For the 10 purpose of controlling pressure supply to the unloader operating cylinder, the unloading mechanism includes a usual pilot valve mechanism, marked "Pilot valve", (details not shown) which may be of any of the well known types, as, for 15 instance, the type known as the R. Conrader pilot valve, which operates in a well known manner in response to a predetermined high discharge line pressure to establish a connection between the discharge line and the unloader cylinder 17 by way 20 of a pipe line 20 leading from the discharge pipe 10 to the upper end of the cylinder 17, as shown in Fig. 2. Also connected to the pipe line 20 is a pipe line 21 which supplies pressure fluid to an automatic control valve for the cooling liquid 25 supplied to the intercooler, in a manner to be presently described, to effect interruption of liquid supply during unloading. This water control valve, as shown in Fig. 3, comprises an end seating valve 22 of the usual design normally held 30 open by a coiled spring 23 acting on a plunger 24 connected to the valve element. Secured to the upper end of this plunger is a piston rod 25 of a piston 26 reciprocally mounted in a cylinder 27. The pipe line 21 communicates with the upper 35 end of the cylinder 27 so that when pressure fluid is supplied to the pipe line, the piston 26 is moved downwardly to effect seating or closure of the valve element of the valve 22. It will thus be seen that when the compressor discharge pressure reaches a predetermined minimum the pilot 40 valve mechanism operates to interrupt fluid supply and to vent the line leading from the unloader cylinder 17 and also to vent the line 21 leading to the automatic cooling liquid control valve 22. 45 When the pressure in the compressor discharge line reaches a predetermined maximum, the pilot valve mechanism operates to supply pressure fluid through the pipe line 20 leading to the unloader cylinder 17, thereby causing the piston 16 to be 50 moved downwardly to effect closure of the unloading valve 14, and as a result the compressor is unloaded. At the same time pressure fluid flows through pipe line 21 to the control means for the automatic liquid control valve 22, effecting closure 55 of the latter, thereby cutting off flow of cooling fluid to the intercooler. Since the unloading mechanism and water control valve heretofore mentioned are of a well known design, and do not per se enter into this invention, further detailed description thereof is considered unnecessary. There are other features of the cooling 60 system which now call for consideration, however.

The cooling liquid for the intercooler 9 is conducted from any suitable source through a pipe 65 line 30 to a pump 31 of a suitable design driven by the compressor crank shaft 5, and the cooling liquid is pumped under relatively high pressure from this pump through a pipe line 32 to the automatic liquid control valve 22 and from the automatic control valve passes through a pipe line 70 33 to the intercooler. When city water pressure is available, the pump 31 may be eliminated and the pipe line 32 connected to the city water supply.

75 The cooling liquid after use within the intercooler

9 is discharged from the latter through a pipe line 34.

When the cooling water supply has been supplied by the pump 31 it is necessary to maintain an appropriate pressure, which must exceed by a 5 substantial amount the pressure at the discharge side of the low pressure cylinder in order to create and maintain an effective liquid screen. For safety purposes it is, of course, necessary to employ a spring loaded by-pass check-valve, and such an 10 arrangement is shown at 36 in a by-pass connection 37 leading from the discharge line of the pump 31 back to the intake side of the latter. A second by-pass connection is also provided at 38 15 between the pump discharge and intake, controlled by a valve 39 which is adapted to be held seated by a spring 40. The spring 40 is not substantially tensioned during the unloaded operation of the compressor and, therefore, permits the pump 31 to operate without material loss of 20 power when no liquid needs to be supplied to the intercooler. When, however, liquid must be supplied to the intercooler, means including a diaphragm 41 supplied with pressure through a line 25 42 leading from the low pressure cylinder discharge line 8 imposes a pressure upon the spring 40 and thus upon the valve 39, and permits the flow over to the suction side of the pump only when the pressure very substantially exceeds the amount desired in the intercooler, a condition not 30 likely to occur.

Now referring to the structure of the improved intercooler per se, it will be noted that the same 35 comprises a casing 45 herein composed of two parts 46 and 47 bolted together at 48, and this casing is secured by a bolted flanged connection 49 to the discharge pipe 8 of the low pressure cylinder 2 of the compressor. The section 46 of the intercooler casing has formed therein a circular 40 chamber 50 in which an improved cooling and separator unit generally designated 51 is arranged and which discharges liquid through a bottom opening 52 to a cooling liquid discharge 45 chamber 53 to the bottom of which the discharge pipe line 34 is connected. The chamber 50 is lined with a noncorrosive liner 50a, preferably of stainless steel, providing an extremely smooth inner-surface water race, and one end of this liner is bent downwardly to form the discharge 50 opening 52. The section 47 has a fluid discharge passage 54 communicating with the intake of the high pressure cylinder of the compressor, the casing section 47 being connected to the high pressure cylinder by a flange and bolt connection 55. The discharge passage 54 tapers inwardly from 55 the cooling and separator unit chamber 50 and communicates with the high pressure cylinder intake through a relatively restricted passage 56, the compressed fluid, after separation from the cooling liquid within the chamber 50, discharging 60 through the opening 54 to the high pressure cylinder intake, and the liquid separated from the compressed fluid draining into the chamber 53 from which it is discharged, as hereinafter described, through the discharge pipe 34. Secured 65 to the casing section 46 is a built up separator unit or scrubbing device comprising a separator plate 57, and a series of discs 58 spaced apart by a series of thin spirally arranged vanes 59, the component elements being positioned by pins 60 and held in place by screws 61. Between adjacent discs the space is broken up into a series of curved passages 62 having relatively large surface areas as compared with their flow areas and the curve 70 of these passages is formed to accelerate fluid 75

flow therethrough. Through these passages the mingled air and water pass with a whirling motion which both increases the washing action while effecting an efficient separation on the centrifugal principle, a separation which is completed in the chamber surrounding the unit described. In this instance, secured by rods 62a threadedly secured to the hub of the separator plate 57 is a plate 63 having adjustably secured thereto as by threads 64 a cooling liquid supply pipe 65. This supply pipe has secured thereto at its outer extremity a handle 66 whereby the pipe may be rotated and thereby, due to its threaded connection with the plate 63, moved axially with respect to a controlling valve or plug 67, which, when the parts are in the position shown in Fig. 5, maintains the inner end of the liquid supply pipe closed. By moving the pipe 65 axially in and out with respect to the valve 67, the flow of cooling liquid through the pipe 65 may be manually regulated as desired. The cooling liquid supply pipe 33 communicates with the supply pipe 65 through a packing ring 68 and packing collars 69, 69 held in sealing engagement by a coil spring 70 so that a fluid tight seal is maintained between the pipe 33 and the pipe 65 irrespective of the adjusted position of the latter. The valve 67 is formed on a liquid disc deflector or spray 71, and when the pipe 65 is moved axially to open the inner end thereof with respect to the valve 67, cooling liquid flows from the pipe 33 through the pipe 65, and as it is discharged from the latter it impinges against the disc 71 and is deflected laterally in the manner of a spray across the stream of compressed gaseous fluid flowing from the low pressure cylinder discharge pipe 8 of the compressor, the cooling liquid commingling with and traversed by the compressed gaseous fluid cooling the latter, and the commingled gaseous liquid and compressed fluid flowing past the deflecting surfaces 72 formed on the hub of the separator plate 57 and through the arcuate or spiral passages 62 formed by the separator discs 58, causing the commingled liquid and compressed gaseous fluid to be whirled about the interior wall of the chamber 50 of the intercooler casing, thereby effecting separation of the compressed gaseous fluid from the cooling liquid. Any excess liquid in the gaseous fluid discharged from the low pressure cylinder to the intercooler is at the same time removed by this centrifugal separating action, and all impurities are washed out of the air. The separated cooling liquid is drained into the liquid drain chamber 53, while the compressed gaseous fluid, then cooled, flows past a deflecting surface 73 formed on the inner wall of the casing section 47 and past an annular liquid retaining and flow forming lip 74 to the discharge opening 54, from which the cooled gaseous fluid is discharged through the opening 56 to the intake of the high pressure cylinder of the compressor. A water gage having a usual sight tube 75 is provided for determining the level of the separated cooling liquid in the liquid discharge chamber 53, while the compressed gaseous fluid in the discharge opening 54 is provided with a pressure gage 76 to determine the pressure of the cooled gaseous fluid and a usual automatic safety valve 77 so that when the pressure in the opening 54 becomes too high, the valve 77 will automatically open to relieve the pressure.

Improved means is provided for automatically controlling the regulating valve 67 for the cooling liquid flowing through the supply pipe 65 automatically in accordance with the temperature of

the cooled compressed gaseous fluid in the discharge opening 54 of the intercooler and herein comprises a thermostatic element 78 arranged centrally within the opening 54 and secured at 79 to the hub of the separator plate 57. This thermostatic element 78 is connected at 80 to a thermostat plunger rod 81 guided centrally within the thermostatic element and connected at 82 to the cooling liquid regulating valve 67. The tube 78 and rod 81 are made of elements of different coefficients of expansion, that of the tube being the higher. It will thus be seen that if the temperature of the compressed gaseous fluid in the discharge opening 54 of the intercooler becomes too high, the thermostat acts to move the regulating valve 67 away from the discharge end of the supply pipe 65, thereby to supply a larger quantity of cooling liquid to the intercooler. If the temperature of the compressed gaseous fluid in the passage 54 becomes too low, the thermostatic element acts to move the regulating valve 67 inwardly toward the discharge end of the liquid supply pipe 65, thereby to diminish or cut off the flow of cooling liquid to the intercooler.

For controlling the level of the cooling liquid discharged from the cooling and separator unit 51, there is provided in the chamber 53 a trap with a float 85 having a lever 86 pivoted at 87 within a casing 88 attached to the side of the intercooler casing. This lever engages a valve 89 which controls the flow of the discharged cooling liquid from the chamber 53 to the discharge pipe 34.

As a result of this invention, it will be noted that an improved intercooler is provided wherein the cooling liquid is directly intermingled with the compressed gaseous fluid and thereafter separated from the compressed gaseous fluid in an improved manner. It will further be noted that an improved intercooler of the direct type is provided having embodied therein improved automatic controlling means for the cooling liquid whereby the flow of cooling liquid to the intercooler is regulated automatically in accordance with the temperature of the discharge of cooled gaseous fluid in the intercooler. It will further be evident that an effective washing action is provided. Moreover, if the device be arranged in appropriate manner in an air line, there would, of course, be effected a cooling, humidifying and purifying action.

These and other uses and advantages of the improved heat exchange device will be clearly apparent to those skilled in the art.

While there is in this application specifically described one form which the invention may assume in practice, it will be understood that this form of the same is shown for purposes of illustration, and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent is:

1. In a heat exchange device, a casing through which a gaseous fluid to be cooled is adapted to flow, said casing having a cylindrical portion, means within said casing for spraying a cooling liquid into the path of the gaseous fluid stream flowing through said casing for intermingling the cooling liquid with the gaseous fluid, annular means stationary with respect to said casing and arranged centrally within said cylindrical casing portion for imparting a rapid whirling motion to the commingled gaseous fluid and liquid to direct

the same in an annular path completely about the circular interior periphery of the cylindrical casing portion for effecting separation by a centrifugal whirling action of the gaseous fluid and liquid, said annular whirling means having a central entrance for the commingled gaseous fluid and liquid and the circular interior periphery of said cylindrical casing portion providing an annular water race surrounding said annular whirling means for receiving the separated liquid, and discharge means for the cooled gaseous fluid and liquid respectively for discharging the cooled gaseous fluid and the separated liquid from the casing.

2. In a heat exchange device, a casing through which a gaseous fluid to be cooled is adapted to flow, said casing having a cylindrical portion, means within said casing for spraying a cooling liquid across the path of the gaseous fluid stream, and means comprising an annular centrifugal motion creating means stationary with respect to the casing and arranged centrally within said cylindrical casing portion for imparting a rapid whirling motion to the commingled liquid and gaseous fluid to direct the same in an annular path completely about the circular interior periphery of said cylindrical casing portion for separating the liquid and gaseous fluid by a centrifugal whirling action, said annular centrifugal motion creating means having a central entrance for the commingled gaseous fluid and cooling liquid and the circular interior periphery of said cylindrical casing portion providing an annular water race surrounding said annular centrifugal motion creating means for receiving the separated liquid, and discharge means for the cooled gaseous fluid and liquid respectively for discharging the cooled gaseous fluid and the separated liquid from the casing.

3. In a heat exchange device, a casing through which a gaseous fluid to be cooled is adapted to flow, means for spraying a cooling liquid into the gaseous fluid stream, means for thereafter separating the liquid and gaseous fluid comprising a centrifugal motion creating means whereby the commingled liquid and gaseous fluid are whirled about the interior of the casing to effect separation thereof, and means controlled by the temperature within said casing for regulating the flow of the liquid sprayed into the gaseous fluid stream.

4. In a heat exchange device, a casing through which a gaseous fluid to be cooled is adapted to flow, said casing having a cylindrical portion, means within said casing for spraying a cooling liquid into the gaseous fluid stream, means comprising a plurality of discs and vanes mounted within said cylindrical casing portion and forming spiral grooves in transverse planes through which the commingled liquid and gaseous fluid are adapted to flow, the spiral grooves imparting to the liquid and gaseous fluid a rapid whirling motion completely about the interior periphery of said cylindrical casing portion to effect separation of the liquid and gaseous fluid, said casing having a common annular passageway surrounding said discs and vanes within which the liquid and gaseous fluid are discharged, and means communicating with said common passageway for respectively discharging the cooled fluid and liquid from said casing.

5. In a heat exchange device, a cylindrical casing through which a gaseous fluid to be cooled is adapted to flow, means for spraying a cooling liquid into the gaseous fluid stream, means com-

prising a plurality of discs and vanes forming spiral grooves through which the commingled liquid and gaseous fluid are adapted to flow, the spiral grooves discharging the liquid and gaseous fluid with a whirling motion about the interior of the casing to effect separation thereof, means for respectively discharging the cooled gaseous fluid and the separated liquid from said casing, and means controlled by the temperature of the cooled gaseous fluid for regulating the flow of cooling liquid to the gaseous fluid stream.

6. In a heat exchange device, a casing through which gaseous fluid to be cooled is adapted to flow, said casing having a cylindrical portion, means within said casing for effecting a direct intermingling of a cooling liquid with the gaseous fluid, and means stationary with respect to the casing and arranged within said cylindrical casing portion for imparting a rapid centrifugal whirling motion to the commingled gaseous fluid and liquid completely about the interior periphery of said cylindrical casing portion for effecting separation of the gaseous fluid and liquid, the interior periphery of said cylindrical casing portion providing an annular water race for the separated liquid, and means for respectively discharging the cooled gaseous fluid and separated liquid from the casing.

7. In a heat exchange device, a casing through which a gaseous fluid to be cooled is adapted to flow, said casing having a cylindrical portion, means within said casing for forming a water spray across the entrance to said casing, means within said cylindrical casing portion forming a plurality of spiral flow passages of small flow area lying in planes transverse to the direction of flow into said casing, said spiral flow passages imparting a rapid whirling motion to the commingled gaseous fluid and water completely about the interior periphery of said cylindrical casing portion for separating the gaseous fluid and water, the interior periphery of said cylindrical casing portion providing an annular water race for the separated water, discharge means for the separated water, and a discharge from said casing for the cooled gaseous fluid in the same general line with the entrance to the casing.

8. In a heat exchange device, a casing through which a gaseous fluid to be cooled is adapted to flow, means forming a plurality of spiral flow passages of small flow area lying in planes transverse to the direction of flow into said casing, means for forming a water spray across the entrance to said casing, and varying the quantity thereof in accordance with the temperature in the discharge from said casing, and a discharge from said casing in the same general line with the entrance thereto.

9. In a device of the character described, a casing having a circular chamber, a liner in said casing of non-corrosive metal having a smooth inner surface, said liner being formed to provide a bottom discharge opening, means for supplying commingled air and liquid to said chamber, and means in said casing for imparting to said air and liquid a whirling motion about the smooth inner surface of said liner, said liquid discharging from said chamber through said bottom opening, and means for discharging the air from said chamber.

10. In a heat exchange device, a casing through which a gaseous fluid to be cooled is adapted to flow, means in said casing for spraying a cooling liquid into the fluid stream, means in said casing for thereafter separating the liquid and gaseous

fluid comprising a centrifugal motion creating means stationary with respect to said casing whereby the commingled liquid and gaseous fluid during flow thereof therethrough are whirled about the interior of the casing to effect separation thereof, and means controlled by the temperature within said casing for regulating the flow of gaseous liquid sprayed into the fluid stream.

11. In a moisture separating and heat exchange device, a casing through which gaseous fluid to be treated is adapted to flow, means in said casing for spraying a cooling liquid radially of said casing into the gaseous fluid stream for mingling the liquid with the fluid, and stationary means in said casing beyond said spraying means for requiring all of the commingled gaseous fluid and liquid to traverse like spiral paths to impart a rapid whirling motion to the commingled gaseous fluid and liquid about the interior periphery of the casing to effect separation of the liquid from the gaseous fluid by centrifugal action.

12. In a moisture separating and heat exchange device, a casing through which gaseous fluid to be treated is adapted to flow, means in said casing for spraying a cooling liquid radially of said casing into the gaseous fluid stream for mingling the liquid with the fluid, and stationary means in said casing beyond said spraying means for requiring all of the commingled gaseous fluid and liquid to traverse like spiral paths in parallel planes transverse to the initial direction of gaseous fluid flow.

13. In a moisture separating and heat exchange device, aligned gaseous fluid supply and delivery conduits, and an intermediate cooling and separating device for mixing the gaseous fluid with a cooling liquid and having a coaxial automatically controlled liquid spray screen forming device at the side thereof adjacent the supply conduit and having a thermostatic control device projecting therefrom into the delivery conduit for regulating the liquid spray.

14. In a moisture separating and heat exchange device, aligned gaseous fluid supply and delivery passage forming means and an intermediate cooling and separating device comprising a spray screen forming device for spraying a cooling liquid across the path of the gaseous fluid stream flowing through said passage forming means, a scrubbing device comprising means forming a circularly arranged series of stationary spiral conduits for

imparting a rapid whirling motion to the commingled gaseous fluid and liquid to effect separation thereof by the centrifugal action thereon, an annular discharge for the cleansed and cooled gaseous fluid disposed radially inwardly of the discharge zone of said conduits, and a liquid discharge means for the separated liquid radially outside the discharge zone of said conduits.

15. In a moisture separating and heat exchange device, aligned gaseous fluid supply and delivery passage-forming means and an intermediate cooling and separating device comprising a spray screen forming device for spraying a cooling liquid across the path of the gaseous fluid stream flowing through said passage forming means, a scrubbing device comprising means forming a circularly arranged series of stationary spiral conduits for imparting a rapid whirling motion to the commingled gaseous fluid and liquid to effect separation thereof by the centrifugal action thereon, an annular discharge for the cleansed and cooled gaseous fluid disposed radially inwardly of the discharge zone of said conduits, and a liquid discharge means for the separated liquid radially outside the discharge zone of said conduits and comprising a liquid raceway for receiving the liquid discharge from said spiral conduits and having a tangential liquid discharge.

16. In a moisture separating and heat exchange device, aligned gaseous fluid supply and delivery passage-forming means, and an intermediate cooling and separating device comprising means forming an annular passage provided with a transverse water screen for spraying cooling water across the path of the gaseous fluid stream flowing through said passage forming means, means providing a series of spirally arranged passages for imparting a rapid whirling motion to the commingled cooling water and gaseous fluid to effect separation thereof by the centrifugal action thereon and whose inner ends terminate in the zone of the periphery of said annular passage and whose outer ends are surrounded by an annular raceway for receiving the liquid and gaseous fluid discharged from said spirally arranged passages, means for discharging liquid from said raceway, and means disposed radially inwardly of the zone of the discharge ends of said spiral passages for delivering cooled gaseous fluid to said delivery passage-forming means.

WARREN NOBLE.

CERTIFICATE OF CORRECTION.

Patent No. 2,074,801.

March 23, 1937.

WARREN NOBLE.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, line 39, strike out the word "gaseous" and insert the same after "compressed" in line 40; page 5, first column, line 8, claim 10, strike out "gaseous" and insert the same after "the" in same line and claim; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 16th day of November, A. D. 1937.

(Seal)

Henry Van Arsdale,
Acting Commissioner of Patents.