AIR CONDITIONING FOR CRANE CABS

Filed Aug. 10, 1945

Fig. 3

Fig. 4

Fig. 5

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ATTORNEYS
My invention relates to air-conditioning, particularly to the air-conditioning of industrial plants, where high atmospheric temperatures prevail, and the air is laden with dust and dirt.

The invention has been developed more particularly, though not exclusively, for conditioning the air within the control cab of a mill crane which travel overhead and carry hot red ingots, or ladles of molten metal. In steel mills, and like plants, the atmosphere is laden with particles of dust and ash, and the temperature prevailing around the cranes may average as high as one hundred and sixty degrees Fahrenheit.

The problem of air conditioning regions or rooms exposed to such excessive atmospheric conditions has never been satisfactorily solved heretofore. The problem, incidentally, is complicated by the violent vibration, to which the air-conditioning apparatus is subjected when the cranes are in service, and is further complicated by the practical desirability, if not necessity, of providing air-cooling or refrigerating mechanism which has capacity to operate with adequate cooling effect, while avoiding the use of cooling water, it being understood that the use of cooling water in overhead cranes presents a distinct hazard where molten metal is being handled.

The present invention consists in certain new and useful improvements in apparatus for and method of conditioning air under the abnormal or excessive atmospheric conditions outlined above.

The invention will be understood upon reference to the accompanying drawings, in which:

Figure 1 is a fragmentary view in perspective of a mill crane as used in the process of pouring molten steel from a ladle into ingot molds, the operator's cab of such crane being equipped with an air-conditioning unit which, in exemplary way, embodies the invention;

Figure 2 is a view in perspective and to larger scale of the air-conditioning unit;

Figure 3 is a view in yet larger scale, showing the air-conditioning unit in longitudinal section, on the vertical plane III—III of Figure 4;

Figure 4 is a view of the unit in longitudinal section, on the horizontal plane IV—IV of Figure 3;

Figure 5 is a view of the unit in longitudinal section, on the horizontal plane V—V of Figure 3;

Figure 6 is a view of the unit in cross section, on the vertical plane VI—VI of Figure 3;

Figure 7 is a view of the unit in cross section, on the vertical plane VII—VII of Figure 8;

Figure 8 is a fragmentary view of the unit in longitudinal section, on the vertical plane VIII—VIII of Figure 5; and:

Figure 9 is an electrical wiring diagram.

In Figure 1 of the drawings the reference numeral 2 indicates the traveling carriage of an overhead steel mill crane, and 3 the operator's cab which is suspended from the crane carriage and adapted to travel therewith. A ladle 4 of molten steel is sustained on the hoist tongs or hooks 5, which in turn are suspended from the trolley winch mechanism 6. Within the cab an operator is enclosed, and screened, by means of observation windows, from the excessive heat and dirt of the atmosphere surrounding hot metal ladle and cab. Within the cab are the controls, by means of which the travel of the crane carriage 2, the operation of the winch 5 to raise or lower the supported ladle 4, and the traversal of the winch and the supported ladle upon the carriage are all controlled by the operator, as need be, during the casting of molten steel into the ingot molds 1. The details of crane structure and operation are well known in the art, and further reference is not required for a full understanding of the present invention. Suffice it to say that the invention will be described as it has been embodied in a unit 8 which is mounted upon, or incorporated in, the cab structure 3, to serve in establishing and maintaining comfortable atmospheric conditions within the cab, with the effect that the efficiency of the cab operator is increased, and the need for frequent "spelling off" or rest periods substantially reduced.

The air-conditioning unit 8 consists in a housing having a frame 9 formed of sturdy structural steel. Lift lugs 10 are provided on the frame, whereby the unit may be picked up and hoisted to the point where installation is to be made, on the roof of the cab 3 in this case. At the four corners of the bottom of the frame 9 rigid lugs 11 extend laterally, to seat upon vibration-absorbing mounts 12 of any of the suitable types now available on the market, the mounts being secured to the cab roof structure and the lugs 11 of the unit 8 seated and anchored thereupon.

The top of the housing of the unit is formed of two covers 13 and 14 that may be removed to give access to the mechanism contained within, and the other walls and floor of the housing are constructed of sheet steel, with the qualifications presently to be described.

The interior of the housing is divided by a partition 15 into two chambers A and B. This partition, as well as the external side walls, the floor, and the cover of the chamber A are constructed of thermal insulating material 16, such as cork blocks, rock wool, or the like, confined
between steel sheets 17, thereby constituting the chamber a thermally insulated structure.

Within the insulated chamber A is a heat-absorbing device 18, consisting of a conventional type of evaporator, energized by means of a fluid refrigerant that refrigerating mechanism organized in chamber B, as will presently be described in greater detail, although at this point it is to be especially noted that the refrigerant is one that, under pressures in the order of from 120 to 150 pounds per square inch, and at a relatively high temperature, say of 190° F., may be condensed from gaseous to liquid state. The refrigerant known to the art as Freon No. 114 (dichlorotetrafluoroethane) has been found to comprise a refrigerant having these essential characteristics.

The heat-absorbing device or evaporator 18 is arranged adjacent to the top of a vertical sheet metal partition 19, as shown in Figures 5 and 7. In the floor of the insulated chamber A an outlet 20 opens on the right-hand side of the partition 18 (Figure 7), and an inlet 21 opens on the left-hand side. The roof of the crane cab 3 is provided with openings (not shown) corresponding to the openings 20 and 21, and tubes 22 and 23 are used to establish substantially air-tight communication between the outlet and inlet openings 20 and 21 of the refrigerating unit 8 and the said openings in the roof of the crane cab.

In the chamber A, a fan 24, driven by an electric motor 25, is arranged to impel air outward through the outlet 20 into the room or space within the crane cab, and at the delivery end of tube 22 a deflector 22c is positioned, to diffuse and spread the stream of air thus impelled into the cab.

Adjacent to the evaporator or heat-absorbing device 18 in the partition 19 is a fan 24, driven by an electric motor 25, is arranged to impel air outward through the outlet 20 into the room or space within the crane cab, and at the delivery end of tube 22 a deflector 22c is positioned, to diffuse and spread the stream of air thus impelled into the cab.

When the fan is set in operation and a stream of air is delivered into the cab from chamber A on the right-hand side of the partition 19, air is simultaneously drawn through the air filter 26 from the left-hand side of the partition, and such stream of air passes over the heat-absorbing surfaces of the evaporator 18. Under the suction thus produced in the space on the left of the partition 19, air is drawn from the cab 3 through the inlet 21. Accordingly, it will be understood that a stream of air is circulated from the chamber A to the interior of the cab 3 and back again. In the cyclic flow of such stream the air is cleansed by the filter 26 and dehydrated 46 in a tubular coil of metal tubing 46 within a heat-exchanger 41, wherein the liquid refrigerant is cooled below its boiling point, and the gaseous refrigerant is subject to the high temperature, say of 190° F., which, in the chamber B, is subject to the harmful effect of excessive temperature. More particularly, an outlet 27 opens laterally from the space to the left (Figure 7) of the partition 19.

in chamber A, and through such outlet cool air is drawn from the circulating stream and put to the advantageous use alluded to, as will be described in full detail hereinafter.

Air is introduced to the stream of cool cabinet air by-passed from the space paid by-passed from the steam, and this make-up air is drawn from the hot and dirty atmosphere surrounding the cab 3 and unit 8. To such end an air-filtering inlet 28 is provided in the side wall of the chamber A on the left of the partition 19 (cf. Figures 7 and 8). A deflector valve 29 extends, inclined, partly across the path of air flow through the passage to the left of the partition 19 (Figure 7), and it is under the aerodynamic effects established by such vane that the make-up air is drawn from the outer atmosphere into the circulating stream. The make-up air thus drawn into the circulating stream is cleansed by both the filter 26 and the filter 26, and is cooled by the heat-absorbing device 18 before entering the cylinder 25. This make-up air is by-passed from the circulating stream for the purpose alluded to, but also furnishes the essential “fresh” air to the interior of the occupied cab.

The refrigerating mechanism in chamber B which energizes or supplies the refrigerant to the heat-absorbing device 18 is shown in side elevation in Figure 3 and indicated diagrammatically in Figure 4. The compressor is driven by an electric motor 31 belted connected, as at 32, to the compressor. The compressor, receiving refrigerant in a gaseous condition from the evaporator 18, compresses the refrigerant and delivers it, by way of a pipe 33 (fragmentarily shown in Figure 5), to the coils 34 of a condenser 35; from the condenser 35 the refrigerant, condensed to liquid form, but approximately at its boiling point, is fed through a pipe 36 into a receiver 37; from receiver 37 the relatively hot liquid refrigerant is fed through a pipe 38 and a strainer 39 and dehydrator 46 into a tubular coil of metal tubing 46 within a heat-exchanger 41, wherein the liquid refrigerant is cooled below its boiling point, from the heat-exchanger 41 the cooled liquid refrigerant is led through a line 42 (Figure 4) to a thermostatic expansion valve 43, whence the liquid refrigerant under reduced pressure enters the usual inlet manifold 44 from which four feeders 45 open into the passages in the evaporator, in which the liquid refrigerant boils and/or evaporates, with the consequent absorption of heat from the air circulated over the external surfaces of the evaporator tubes. The cool gaseous refrigerant leaves the evaporator by way of an exhaust manifold 46, and, flowing through a pipe 47, enters the space in the heat-exchanger 41 that surrounds the coil 46 through which the liquid refrigerant flows on its way to the expansion valve 43. The gaseous refrigerant leaves the heat-exchanger and flows to the inlet of the compressor through a pipe 48. In this pipe 48, the air passing through it would tend to chill the heat-exchanger, the cool gaseous refrigerant absorbs heat from the liquid refrigerant advancing through the coil to the expansion valve 43, and thus the liquid refrigerant is sub-cooled below its saturation temperature, while the gaseous refrigerant and/or evaporator is correspondingly heated. The heat imparted to the gaseous refrigerant superheats it, and such superheating of the refrigerant is extremely important in an air-conditioning unit.
operating in excessive atmospheric temperatures, since by such superheating it becomes possible to compress the gaseous refrigerant to the high pressures, required for high temperature operation, without the gas condensing in the compressor, the compressor being essentially of the positive displacement type in which the presence of liquid would obviously prove very damaging.

The heat is removed from the condenser by means of an air blower, and driven by a blower 45 connected by a belt-and-pulley drive 50 to the same motor 31 that drives the compressor 30, and the intake air for this blower is drawn from the atmosphere in chamber B, the atmosphere in such chamber comprising air drawn from the outer atmosphere through air filters 51 mounted in one or more of the side walls of the said chamber B. This high temperature air from the outer atmosphere is effective to condense the refrigerant by virtue of the high compression pressures made feasible by the apparatus described, plus the character of the high-boiling point refrigerant employed, and plus the high velocity and quantity of air driven over the finned surfaces of the condenser tubes. The blast of air emerging from the nest of condenser tubes is discharged into the outer atmosphere through an opening 52 in the wall of the housing of the unit. The type of pressure blower used permits the use of a multiplicity of condenser units, as indicated at 35.

Since the air drawn by the blower into the chamber B is cleaned by the filters 51, it becomes practical to employ conventional motor starters and controls for the apparatus; that is to say, relatively expensive protected controls would have to be used but for the fact that all of the air within the housing of the unit is clean. While the air drawn into chamber B circulates within the chamber and affords a certain degree of beneficial cooling effect upon the various pieces of apparatus therein, the cooling effect thus gained from the air at 160° F., more or less, is not adequate for the motor 31. It is the motor 31 in this case which is treated with the cool air by-passed through openings 27 from the stream circulating within and between the ends A and the interior of the crane cab. The by-passed air is drawn through a duct 53 by means of a fan 54 whose impeller is mounted upon an extension of the shaft of blower 49, and from the fan 54 the cool air is delivered through a duct 55 (Fig. 6) to the casing of motor 31, and serves to keep the motor windings from overheating. This air, upon flowing through the motor casing, emerges in chamber B, where it is mingled with the air delivered by blower 49 to the condenser, wherefore any capacity for cooling that remains in the air emerging from the motor casing is lost but is placed at the disposal of the condenser 35.

The casing of the motor starter is indicated at 55 in Figure 3 of the drawings, and the wiring of the various controls is represented in the wiring diagram in Figure 9. The controls within the broken-line rectangle 57 are arranged within the case 3, while the rectangle 58 are located within the air-conditioning unit 8. The motor starter 55 is a known piece of electrical control apparatus that is connected in conventional manner to the windings of the motor 31, as indicated diagrammatically in Figure 9, and a detailed description of such conventional practice is not required for an understanding of this invention, other than in the following particulars:

1. The electric power is furnished by lines 59 through a fused disconnect switch 60, junction-box 61 and lines 52 to the motor starter 55, which operates to control the motors 31 and 25 in a manner conventional in pre-existing air-conditioning units, although it may be mentioned that a pressurestat 63 responsive to the pressure of the gaseous refrigerant leaving the evaporator 58 is arranged to open and close line 64 that extends between the motor starter 55 and the switch 65 in the cab, that controls the air-circulating fan motor 23 which is energized through circuit 65. The circuit 64 includes a manual open-and-close switch 67.

Various modifications and changes may be made in the exemplary structure illustrated and described, without departing from the spirit of the invention defined in the appended claims.

I claim:

1. An industrial air-conditioning unit for a room exposed to abnormally high atmospheric temperatures, said unit including two chambers, at least one of which is provided with heat-insulated walls, a heat-absorbing device in said insulated chamber, an inlet and an outlet opening through the walls of the insulated chamber, means for circulating air in a stream exiting through said outlet to said room and returning from said room through said inlet into said insulated chamber, refrigerating mechanism arranged in the other of said chambers, the latter chamber having extensive walls formed of air-filtering panels and including an air outlet, said refrigerating mechanism including a compressor, a condenser, a blower having an inlet in said latter chamber, an electric motor connected to drive said compressor and blower, and motor controls, and said blower being arranged to draw filtered air from said latter chamber and to direct such air upon said condenser and through the outlet in the wall of the chamber.

2. An industrial air-conditioning apparatus for operation in an ambient atmosphere having an unnaturally high temperature, said unit comprising a heat-insulated chamber having an inlet and an outlet opening through its walls, means for circulating air in a stream entering through said inlet and exiting through said outlet, a heat-absorbing device arranged in said chamber in the line of air circulation, a refrigerant, and refrigerating mechanism arranged externally of said chamber for supplying said refrigerant to said device, said mechanism comprising a compressor for said refrigerant, a condenser connected to receive compressed refrigerant from the compressor, an electric motor for driving said compressor, a duct connected to said motor for by-passing air from said circulating stream to the windings of said motor, and an air filter through which air is admitted to said circulating stream from the outer atmosphere to replace the motor-cooling air by-passed from the stream.

3. An industrial air-conditioning apparatus for operation in an ambient atmosphere having an unnaturally high temperature, said apparatus comprising a heat-insulated chamber having an inlet and an outlet opening through its walls, means for circulating air in a stream that enters through said inlet and exits through said outlet, an evaporator in said chamber in the line of air flow between said inlet and outlet, a refrigerant, refrigerating mechanism arranged externally of said chamber comprising a compressor connected
to receive refrigerant in gaseous condition from said evaporator, an electric motor for driving said compressor, a duct leading from a point communicating with said circulating air stream to the housing of said motor, means for impelling air through said duct into said motor housing, a condenser connected to receive compressed refrigerant from said compressor, connections including an expansion valve for delivering the condensed refrigerant to said evaporator, and means arranged externally of said insulated chamber for abstracting heat from the condensed refrigerant flowing from said condenser to said evaporator while superheating the gaseous refrigerant flowing from said evaporator to said compressor.

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

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,047,249</td>
<td>Ballard</td>
<td>July 14, 1936</td>
</tr>
<tr>
<td>2,112,221</td>
<td>Sargent</td>
<td>Mar. 22, 1938</td>
</tr>
<tr>
<td>2,155,831</td>
<td>Hull</td>
<td>Apr. 2, 1939</td>
</tr>
<tr>
<td>2,163,023</td>
<td>Blood</td>
<td>June 13, 1939</td>
</tr>
<tr>
<td>2,167,380</td>
<td>Whitlock</td>
<td>July 25, 1939</td>
</tr>
<tr>
<td>2,228,834</td>
<td>Kramer</td>
<td>Jan. 14, 1941</td>
</tr>
<tr>
<td>2,248,859</td>
<td>Christman</td>
<td>July 15, 1941</td>
</tr>
<tr>
<td>2,290,973</td>
<td>Jewell</td>
<td>July 28, 1942</td>
</tr>
<tr>
<td>2,303,865</td>
<td>Roper</td>
<td>Dec. 1, 1942</td>
</tr>
<tr>
<td>2,317,104</td>
<td>Moore</td>
<td>Apr. 20, 1943</td>
</tr>
</tbody>
</table>