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COMPRESSOR

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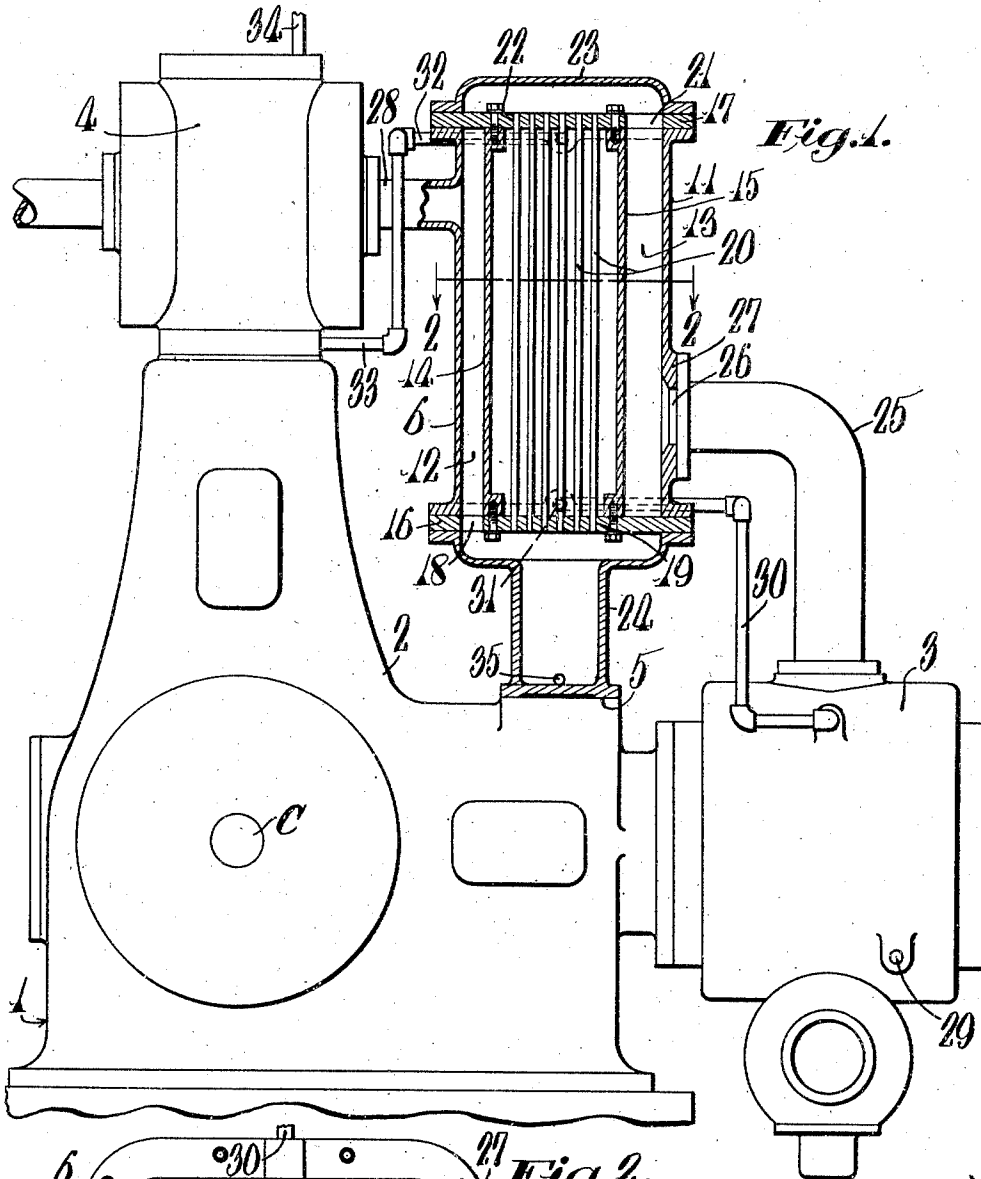


Fig. 1.

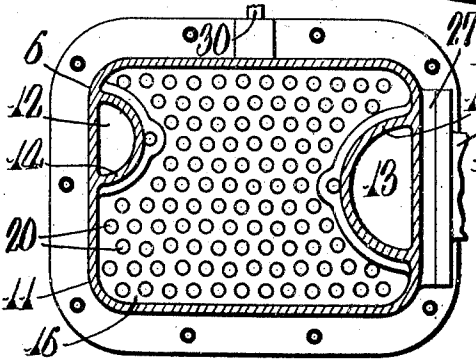


Fig. 2.

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UNITED STATES PATENT OFFICE.

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COMPRESSOR.

Application filed July 5, 1924. Serial No. 724,492.

My invention relates to compressors and particularly to cooling arrangements for use in connection with compressors.

5 An object of my invention is to provide an improved compressor mechanism. Another object of my invention is to provide an improved compressor comprising an improved cooling system. A further object of my invention is to provide an improved heat ex-
15 change device. Other objects and advantages of my invention will hereafter more fully appear.

In the accompanying drawings I have shown for purposes of illustration one form
15 which my invention may assume in practice.

In these drawings,—

Fig. 1 is a side elevation with parts broken
away of a compressor in which my improved
cooling system is employed.

20 Fig. 2 is a horizontal section on a plane corresponding to the section line 2—2 of Fig. 1.

It is now generally understood that the maximum cooling efficiency is obtainable in heat exchange devices by the employment of
25 the countercurrent principle; and in my present invention I have provided novel means for securing the benefits of this principle in a compressor system.

As illustrative of my invention, I have
30 shown the same embodied in a compressor generally designated 1 and comprising a frame 2 which supports the jacketed low pressure cylinder 3 and jacketed high pressure cylinder 4, these being arranged at an
35 angle of 90° to each other so that an angle compound compressor is produced. Usual pistons in the cylinders are actuated from the usual crank shaft C. Supported upon the frame upon a supporting surface 5 is the inter-
40 cooler 6, this being arranged in the air line between the low pressure cylinder 3 and the high pressure cylinder 4. This inter-cooler, which is of the countercurrent flow type, comprises a vertical, generally rectan-
45 gular casing 11 at whose opposite sides longitudinally extending passageways 12 and 13 are provided by the cooperation of semi-circular walls 14 and 15 with portions of the outer walls of the casing. At the opposite
50 ends of the casing 11 there are provided tube sheets 16 and 17, the tube sheet 16 being arranged at the lower end of the casing and comprising a passageway 18 communicating with the passageway 12 and a plurality of
55 openings 19 in which the lower ends of a num-

ber of tubes 20 are secured. The upper tube sheet 17 has an opening 21 therethrough communicating with the passageway 13 and has a series of openings 22 in which the upper ends of the tubes 20 are secured. Outside the
60 tube sheet 17 is a cover 23 which serves to provide a conducting chamber for the air from the passageway 13 to the upper ends of the tubes 20. Below the lower tube sheet 16 is a
65 hollow pedestal member 24 which serves as a conduit for the air discharged through tubes 20; that is, the member 24 receives the air from the tubes 20 and delivers it to the port 18 for transmission through the passage 12. The low pressure cylinder discharge chamber
70 is connected by a pipe 25 with an opening 26 through a boss 27 on the side of the casing 6. As shown in this embodiment, the pipe 25 and opening 26 serve to conduct the air into the lower end of the passage 13; while a pipe
75 28 connects the upper end of the passage 12 with the high pressure cylinder intake space. It is desired to point out at this time that the arrangement described, in so far as some of its details are concerned, is for purposes of
80 convenience, a very small percentage of the cooling efficiency being sacrificed in order that a more rugged and compact structure may be produced. It will be obvious that the passage 25 might communicate directly with
85 the space within the head 23, the passage 13 being wholly omitted; and also that the pipe 28 might communicate with the space within the pedestal 24, thereby eliminating the pas-
90 sage 12. A small improvement in efficiency would result, but at the cost of a considerable loss in ruggedness of construction. The cooling fluid system employed herein includes a water inlet connection 29 to the lower side of the low pressure cylinder jacket and a con-
95 nection 30 leading out from the upper side of the low pressure cylinder jacket to the bottom of the interior space of the casing 6, the inlet to this casing being shown at 31. The water then flows out through a connection 32 at the
100 extreme top of the casing 6 by way of a pipe 33 to the bottom of the jacket of the high pressure cylinder and is finally conducted away through a pipe 34 which connects to the top of the high pressure cylinder jacket.
105 It will therefore be apparent that there is no possible chance for this structure to become air bound and no possible opportunity of a loss of cooling efficiency due to that difficulty. The cooling water must first completely fill
110

all the space within the low pressure cylinder jacket, must then completely fill all the space within the casing 6 and surrounding the tubes 20, and must then fill all the space within the high pressure cylinder jacket before it can escape. It will be obvious that in case of leakage of air into the water space of the inter-cooler the air will at once rise to the top and pass over through the pipe 33, being carried along with the water therein, and then pass up to the top of the high pressure cylinder jacket from which it can readily escape through the top outlet 34. An opening controlled by a suitable pet cock, not shown, is provided in the base of the member 24 for drainage purposes.

From what has been pointed out already, it will be readily apparent how this device operates. The water circulation has been described; and it will have been observed that the flow of the cooling liquid is from the bottom to the top of the intercooler. It will be noted that the air flow is from the top to the bottom in the intercooler, the air passing, after moving up through the passageway 13, downward through the relatively small tubes 20 where it is very effectively cooled, and then into the chamber within the member 24 from which it passes up out through the passage 12 and connection 28. The heat interchange surface formed by the walls 14, 15 is so relatively small compared with the volume of air flowing through these passages that but little heat exchange is accomplished during the time the air is within these passages and the major cooling effect is secured during the counterflow of the air in the many small tubes 20. It will of course be understood that in practice the cooling liquid will be supplied in such volume that there will be no return of heat to the air in the passage 12 even at the upper portion of this passage.

While I have in this application specifically described one form which my 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 combination, in a compressor, a low pressure cylinder, a cylinder receiving compressed fluid from said low pressure cylinder and cooperating in the further compression thereof, a crank shaft, the axes of said cylinders making an angle with each other whose apex lies in said crank shaft, an intercooler intermediate said cylinders, said cylinders and intercooler all lying to one side of a plane passing through said crank shaft, means for supplying a liquid to the bottom of said intercooler and discharging the same at the top, and means for conducting fluid from

said first to said second cylinder causing the same to flow from the top to the bottom of said intercooler including a plurality of means providing paths for said fluid through the intercooler.

2. In combination, in a compressor, a low pressure cylinder, a cylinder receiving compressed fluid from said low pressure cylinder and cooperating in the further compression thereof, a crank shaft, the axes of said cylinders making angles with the opposite sides of a plane including the axis of said crank shaft, an intercooler intermediate said cylinders, said cylinders and intercooler all lying to one side of another plane including said crank shaft, means for supplying a liquid to the bottom of said intercooler and discharging the same at the top, and means for conducting fluid from said first to said second cylinder causing the same to flow from the top to the bottom of said intercooler including a plurality of means providing paths for said fluid through the intercooler.

3. In combination, in a compressor, a jacketed low pressure cylinder, a jacketed cylinder receiving compressed fluid from said low pressure cylinder and cooperating in the further compression thereof, a crank shaft, an intercooler intermediate said cylinders, said cylinders and intercooler all lying to one side of a plane passing through said crank shaft, means for supplying liquid to the bottom of the intercooler and discharging the same at the top, means for supplying cooling liquid to the bottoms of the jackets of said cylinders and discharging it from said tops, and means for conducting fluid from said first to said second cylinder to cause it to flow from the top to the bottom of the intercooler including means for providing plural paths for the fluid through the intercooler.

4. In combination, in a compressor, a jacketed low pressure cylinder, a jacketed cylinder receiving compressed fluid from said low pressure cylinder and cooperating in the further compression thereof, an intercooler intermediate said cylinders, means for supplying cooling liquid to the bottom of one of said cylinders, means for conducting said liquid from the top of said cylinder to the bottom of said intercooler, means for conducting said liquid from the top of said intercooler to the bottom of the other of said cylinders, and means for discharging said liquid from the top of said last mentioned cylinder.

5. In combination, in a compressor, a jacketed low pressure cylinder, a jacketed cylinder receiving compressed fluid from said low pressure cylinder and cooperating in the further compression thereof, an intercooler intermediate said cylinders, means for supplying cooling liquid to the bottom of one of said cylinders, means for conducting said

fluid from the top of said cylinder to the bottom of said intercooler, means for conducting said liquid from the top of said intercooler to the bottom of the other of said cylinders, means for discharging said liquid from the top of said last mentioned cylinder, and means for conducting fluid from the first mentioned cylinder to the second mentioned cylinder through said intercooler and causing the fluid to flow through said intercooler in a downward direction and in a plurality of paths.

6. In combination, in a compressor, a jacketed low pressure cylinder, a jacketed cylinder receiving compressed fluid from said low pressure cylinder and cooperating in the further compression thereof, an intercooler intermediate said cylinders, means for supplying cooling liquid to the bottom of said first mentioned cylinder, means for conducting said liquid from the top of said cylinder to the bottom of said intercooler, means for conducting said liquid from the top of said intercooler to the bottom of the other of said cylinders, means for discharging said liquid from the top of said last mentioned cylinder, and means for conducting fluid from the first mentioned cylinder to the second mentioned cylinder through said intercooler and causing the fluid to flow through said intercooler in a downward direction and in a plurality of paths.

7. In combination, in a compressor, a jacketed cylinder disposed with its axis vertical, a heat exchange device vertically disposed adjacent thereto, means for supplying a cooling liquid to the bottom of said heat exchange device and conducting the same from the top thereof to the bottom of said cylinder, and means for supplying fluid to said cylinder to be compressed therein through said intercooler comprising a plurality of passages extending longitudinally of said intercooler through which said fluid flows downwardly on its way to said cylinder.

8. In combination, in a compressor, a low pressure cylinder, a cylinder receiving compressed fluid therefrom and cooperating in the further compression of said fluid, an intercooler comprising a tank affording a cooling liquid chamber, means within said chamber constituting a plural path conducting means for compressed fluid, means for supplying a cooling liquid to the bottom of the chamber and discharging the same at the top, and means for conducting the fluid from the first mentioned cylinder to the top of the conducting means and leading it from the bottom of the latter to the second mentioned cylinder.

9. In combination, in a compressor, a low pressure cylinder having a cooling fluid jacket, a cylinder receiving compressed fluid from said low pressure cylinder and cooperating in the further compression of said fluid, said

second mentioned cylinder having a cooling jacket, an intercooler comprising a cooling liquid receptacle and conducting means therein for fluid being compressed comprising a plurality of parallel tubes, connections between said conducting means and said first and second mentioned cylinders, and means for conducting a cooling liquid comprising an inlet for said fluid to the jacket of the low pressure cylinder, means connecting said jacket to the bottom of the intercooler receptacle, and means connecting the top of the intercooler receptacle to the jacket of said second mentioned cylinder.

10. In combination, in a compressor, a low pressure cylinder, a jacketed cylinder receiving compressed fluid from said low pressure cylinder and cooperating in the further compression thereof, a crank shaft, the axes of said cylinders making an angle with each other whose apex lies in said crank shaft and the axis of said second mentioned cylinder being vertical, an intercooler intermediate said cylinders, said cylinders and intercooler all lying to one side of a plane passing through said crank shaft, means for supplying a liquid to the bottom of said intercooler and conducting the same directly from the top thereof to the bottom of the jacket of said vertically disposed cylinder, and means for conducting fluid by way of said intercooler from said first to said second cylinder causing the same to flow from the top to the bottom of said intercooler, including a plurality of means providing paths for said fluid through the intercooler.

11. In combination, in a compressor, a jacketed cylinder disposed with its axis horizontal, a jacketed cylinder disposed with its axis vertical and receiving compressed fluid from said horizontally disposed cylinder and cooperating in the further compression thereof, a crank shaft, the axes of said cylinders making an angle with each other whose apex lies in said crank shaft, a heat exchange device disposed within the space between said cylinders and having its longitudinal axis vertically disposed, means for supplying a cooling liquid to the jacket of said horizontal cylinder, means for conducting liquid from the jacket of said horizontal cylinder to the bottom of said heat exchange device and conducting the same directly from the top thereof to the bottom of the jacket of said vertically disposed cylinder, and means for conducting fluid from said horizontally disposed cylinder to said vertically disposed cylinder causing the same to flow from the top to the bottom of said heat exchange device including a plurality of means providing paths for said fluid through said heat exchange device.

12. In combination, in a compressor, a low pressure cylinder, a jacketed cylinder receiving compressed fluid from said low pressure

cylinder and cooperating in the further compression thereof, a crank shaft, the axes of said cylinders making an angle with each other whose apex lies in said crank shaft, an intercooler intermediate said cylinders, said cylinders and intercooler all lying to one side of a plane passing through said crank shaft, means for supplying a cooling liquid to the bottom of said intercooler and conducting the same directly from the top thereof to the bottom of the jacket of said second mentioned cylinder, and means for conducting fluid from said first to said second cylinder causing the same to flow vertically in contact with cooling walls from the point of entering the intercooler to adjacent the top thereof and to thereupon change direction and move in contact with cooling walls to the bottom of said intercooler including a plurality of means providing paths in the intercooler for said fluid.

13. In combination, in a compressor, a jacketed cylinder disposed with its axis horizontal, a jacketed cylinder disposed with its axis vertical and receiving compressed fluid from said horizontally disposed cylinder and

cooperating in the further compression thereof, a crank shaft, the axes of said cylinders making an angle with each other whose apex lies in said crank shaft, an intercooler disposed within the space between said cylinders and having its longest dimension vertically disposed, means for supplying a cooling liquid to the jacket of said horizontally disposed cylinder, means for conducting liquid from the jacket of said horizontally disposed cylinder to the bottom of said intercooler and conducting the same directly from the top thereof to the bottom of the jacket of said vertically disposed cylinder, and means for conducting fluid from said horizontally disposed cylinder to said vertically disposed cylinder causing the same to flow vertically in contact with cooling walls from the point of entering said intercooler to adjacent the top thereof and to thereupon change direction and move in contact with cooling walls to the bottom of said intercooler including a plurality of means providing paths in the intercooler for said fluid.

In testimony whereof I affix my signature.

FRED D. HOLDSWORTH.