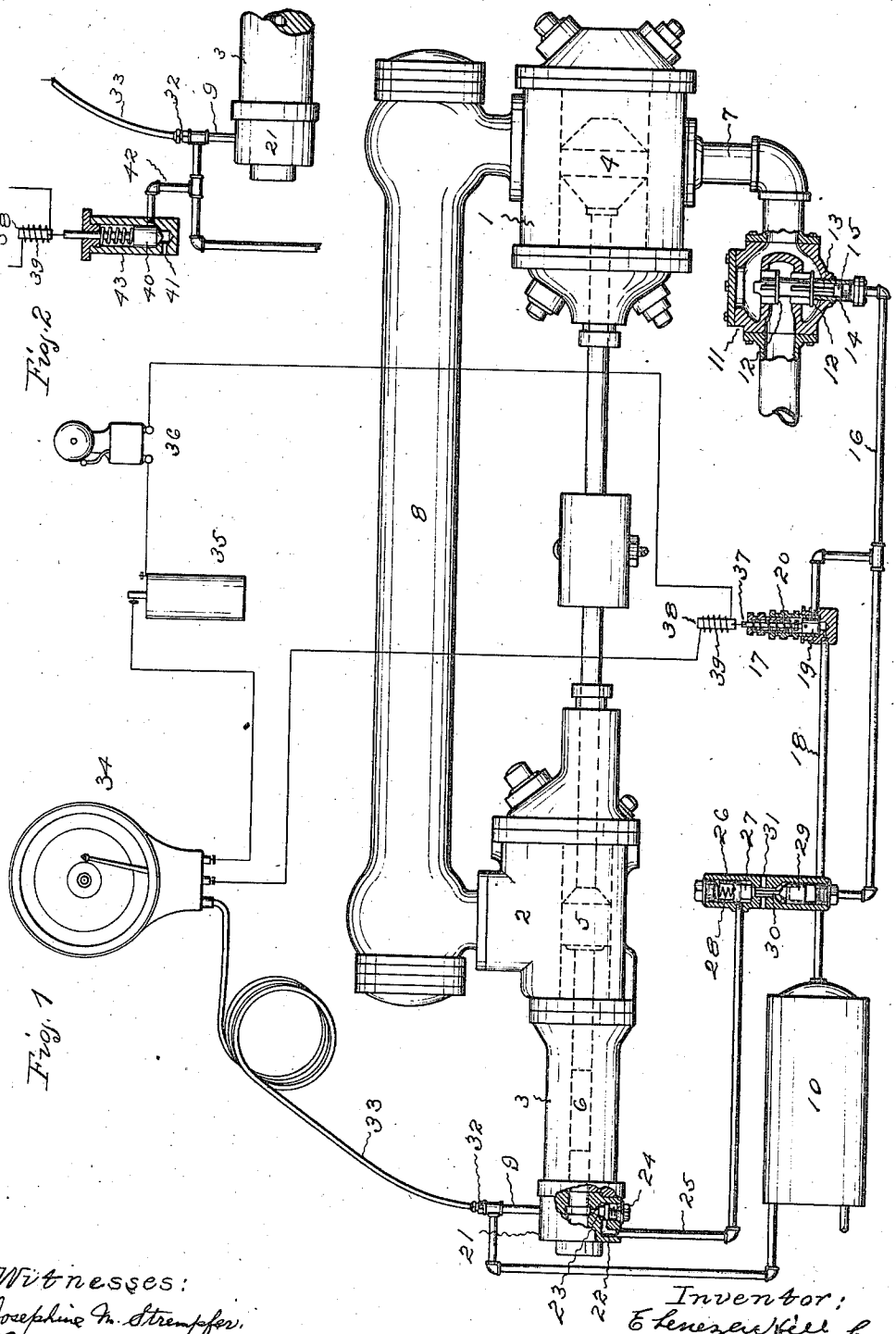
E. HILL.

THERMAL CONTROL FOR AIR COMPRESSORS.

APPLICATION FILED MAY 15, 1912.

1,068,432. Patented July 29, 1913.



Witnesses:
Josephine M. Strempfer.
Rebecca Itzkovitch

Inventor:
Ebenezer Hill by
Harry P. Williams
Atty.

UNITED STATES PATENT OFFICE.

EBENEZER HILL, OF NORWALK, CONNECTICUT.

THERMAL CONTROL FOR AIR-COMPRESSORS.

1,068,432. Specification of Letters Patent. Patented July 29, 1913.

Application filed May 15, 1912. Serial No. 697,403.

To all whom it may concern:

Be it known that I, EBENEZER HILL, a citizen of the United States, residing at Norwalk, in the county of Fairfield and State of Connecticut, have invented a new and useful Improvement in Thermal Control for Air-Compressors, of which the following is a specification.

This invention relates to means designed to exhaust or relieve the pressure in an air or gas compressor when the heat evolved by the act of compressing the air or gas raises the temperature above a predetermined degree.

In the ordinary operation of an air compressor heat is developed in the air undergoing compression. The amount of this heat depends upon the number of atmospheres of compression and is well known and provided for by the designers of compressors. It oftens happens, however, that a compressor will suddenly become superheated from no apparent cause—there being no change in either speed or pressure. Some times this heating increases to such an extent as to set the lubricating oil on fire, and some times even vaporizing the oil and causing disastrous explosions. Frequently when such heating occurs, after a short period of running warm the discharged air drops to its normal temperature. The cause of this rise in temperature is that some foreign body gets under an air valve and causes it to leak. When a leak occurs the air which is being compressed, instead of being held by the valve, flows backward through the valve on the return stroke of the piston. On the next forward stroke this air is again forced through the leaking valve while it is still hot, and being again compressed it becomes still hotter. Thus, in proportion to the degree of the leak, the temperature of the discharged air compressed is increased. The larger the leak, the greater the heat. A leak being constant it is evident that a leak which might be only a small per cent. of a compressor's capacity when it is running at normal full speed. becomes a very much larger per cent. of its capacity when the compressor is slowed down to a few revolutions per minute. Therefore, a leak which would be hardly noticed and cause but little heating at full speed becomes at slow speed an enormous leak, causing serious heating and often results in igniting the lubricating oils. Most of the disastrous compressor explosions have been recorded as having occurred when the machines were running slowly. It is therefore evident that when a compressor shows superheating, there is a certain degree of risk in attempting to stop the machine for the reason that no matter how quickly this may be accomplished, before it comes to a state of rest there must be some strokes of the pistons at a slow speed, and these strokes can do the damage.

The object of this invention therefore is to control the unloading of a compressor by thermally actuated means and thereby when the temperature reaches a predetermined degree eliminate danger of accident and put the compressor in a safe condition to be stopped. To accomplish this I propose, when the air becomes superheated, to relieve the pressure of the discharge until the temperature has become reduced to normal, and thus insure safety, and this is done in such a way as to remove all impediments to the proper valve actions, that is, to scavenge the cylinder of grease and gummy oils and clean the valves and the seats of foreign bodies which obstruct them and cause the leak, and contribute to the dangerous condition. This object is attained by the provision of means whereby whenever a compressor becomes superheated, a valve is opened so that the air will be exhausted directly from the cylinder to the atmosphere. This instantly relieves the pressure in the cylinder and stops the accretion of heat, and at the same time this opened valve allows a great out rush of air, vastly more rapid than the ordinary flow through the machine even when running at its highest speed. This air sweeping through the machine clears out all dirt and gumming oil from the cylinders, and from the faces of the valves and the valve seats cleans away all specks or foreign bodies. The opening of this relief valve is accomplished through the agency of electro-thermal means subjected to the influence of the hot discharge air, and, of course, when by reason of the relief and the cessation of flow in the discharge pipe of hot air, the thermometer again registers a lower temperature the reverse action takes place, allowing the relief valve to close and the machine to resume its work. The blast of

air thus exhausted having cleaned the cylinders and valves, normal temperatures are restored.

The invention is applicable to and may be advantageously used with either single or multiple stage compressors of various types for compressing air or gas. For the purpose of illustrating its utility, however, it is shown and described in connection with a three-stage compressor with such relief or unloading mechanisms as are illustrated and described in my U. S. Patent No. 1,000,809, granted August 15, 1911. The machine shown in that patent is provided with apparatus which, when the compressor is overloaded, throttles the supply of air at the intake and at the same time opens the discharge to the atmosphere so that no air will enter and all air will be pumped out allowing the pistons to move freely and relieve the engine of work. While the invention is depicted in connection with a compressor provided with a valve that throttles the intake at the same time that a discharge valve is opened to the atmosphere, it is not essential to the invention that the intake be thus throttled.

Figure 1 of the accompanying drawing shows the essential parts of a three-stage compressor of the type above mentioned provided with means which effect the object of this invention, the throttle valve, exhaust valve, discharge valve and controller being cut in section to expose their interiors. Fig. 2 shows a modified arrangement for effecting the exhaust of air to the atmosphere when the temperature at the discharge end of the cylinder becomes abnormal.

The cylinders 1, 2 and 3 of the three-stage compressor illustrated have ordinary pistons 4, 5 and 6 connected in the usual manner. These cylinders are fitted with the necessary inlet and outlet valves, which are not shown as they are of common form and arrangement and are well understood. Air enters the low pressure cylinder 1 through the intake pipe 7 and is pumped by the piston 4 from that cylinder through the well known intercooler 8 to the intermediate cylinder 2. From this it is pumped by the piston 5 to the high pressure cylinder 3, and from there, by the piston 6, it is pumped through the outlet 9 to any suitable reservoir 10. It is common to design such a compressor as that which is illustrated, so as to raise the air from 1 to 6 atmospheres in the low pressure cylinder, from 6 to 36 atmospheres in the intermediate cylinder, and from 36 to 216 atmospheres in the high pressure cylinder, or approximately 3160 pounds per square inch in the reservoir. In accomplishing this a large quantity of heat is generated, but under ordinary conditions this heat is taken care of by the design of the machine.

Connected with the intake pipe shown is a throttle valve 11. This is preferably of a balanced type so that it will work easily. In the interior this valve has two disks 12, which are designed to close the ports under predetermined pressure conditions, and thus cut off the supply of air to the cylinder 1. These valve disks are lifted for closing the ports by a piston rod 13 that is pushed up when air is admitted into the cylinder 14, below the piston 15. When there is no air pressure below the piston, this valve remains open. The air pipe 16 leads from the controller 17 to the cylinder 14 below the piston 15. The inlet to this controller is connected by a pipe 18 with the reservoir. In this air controller is a valve 19 which is held down to its seat by a spring 20. When the air pressure in the reservoir rises sufficiently to overcome this spring and lift the valve 19, air flows through the controller and is exerted beneath the piston that acts to lift and close the throttle valve. In the head 21 at the discharge end of the high pressure cylinder is a passage 22. This passage is normally closed by a discharge valve 23 that is held to its seat by a spring 24. A pipe 25 connects this passage in the head, beyond the discharge valve, with the interior of the exhaust valve casing 26. In the upper part of this casing is the exhaust valve 27 that is normally held closed by a spring 28. In the lower part of the casing is a piston valve 29. Extending between these two valves is a stem 30. Opening from the interior to the atmosphere through the casing between these two valves is an outlet 31.

When the air controller is opened by the maximum pressure in the reservoir, the air passes into the lower part of the exhaust valve casing, and the pressure lifts the piston valve therein. This raises the exhaust valve, allowing such air as is forced past the discharge valve in the head of the high pressure cylinder to flow through the pipe 25 and through the exhaust valve casing to the atmosphere. When the compressor is working normally, the discharge valve 23 in the head will allow air to pass it and fill the pipe 25 as far as the exhaust valve to a degree equal to the reservoir pressure. Then the pressure being equal on both sides, the discharge valve is held closed by its spring and becomes inoperative. When, however, the air pressure lifts the piston valve 29 and opens the exhaust, such air as is in the high pressure cylinder is forced past the discharge valve by the forward stroke of the piston and exhausts to the atmosphere.

The thermal means is preferably a thermometer bulb 32 inserted into the discharge pipe 9 from the high pressure cylinder. This may be of the common type which is filled with compressed gas, and it is connected by a flexible tube 33 with a registering instrument 34 of well known design.

This instrument, while adapted to register the temperature, is also constructed, as is commonly understood, so that when the temperature reaches a predetermined degree, an electric circuit is closed. In this circuit is the battery 35, and there may be an electric bell 36 which will sound an alarm when the maximum temperature is reached and the circuit is closed. This style of registering thermometer and alarm is a well known commercial article, and a more extensive description is unnecessary. Connected with the stem 37 of the air controller valve 19 is the core 38 of a solenoid, the coils 39 of which are connected with the electric circuit that is opened and closed by the action of the thermal means. A compressor provided with this apparatus unloads and works freely when a predetermined air pressure is reached. The thermal means also causes the compressor to be immediately unloaded whenever the temperature of the air in the discharge reaches a predetermined degree. When this predetermined degree of temperature is reached, and through the thermometer the circuit is closed, the air controller valve is lifted. When this valve is opened, with the apparatus above described, the air flows through the controller and lifts the exhaust valve so as to allow the air that is forced forward by the high pressure piston to pass the discharge valve and exhaust itself to the atmosphere. This affords instantaneous relief for the pressure and the rush of air that is permitted by the opening of the discharge and exhaust valves scavenges the cylinder and cleans the surfaces of the valves and valve seats. When the air controller is open the compressor continues in motion but no air passes to the reservoir, it escapes to the atmosphere, and as this air is not being subjected to repeated compressions a large amount of heat is not generated. As the air escapes, the thermometer bulb will soon cool and the electric current will then be cut off from the solenoid, allowing the controller to close so that the compressor will resume normal action and accomplish work. Should the previous blast of air have been effectual in clearing all the valves, the machine will continue to operate normally, but should heating again occur and a careful examination be desired, the compressor will automatically be placed in a safe condition to be slowed down and stopped for the purpose.

If desired, a controller valve may be connected directly with the discharge pipe, as shown in Fig. 2. In this case the valve 40 is arranged to close a passage 41 from a branch pipe 42 to the atmosphere. The valve is held shut by a spring 43 and is opened by the pull of the solenoid, when the circuit is closed by the action of abnormal temperature on the thermal means, as previously described.

The invention claimed is:

1. The combination with an air compressor cylinder having a piston, inlet and outlet valves, of means subject to the temperature at the outlet, an electric circuit adapted to be closed by said means when the temperature reaches a predetermined degree, and means designed to be actuated by the closing of the electric circuit for opening a discharge from the compressor cylinder.

2. The combination with an air compressor cylinder having piston, inlet and outlet valves and unloading mechanism, of thermal means subject to the temperature of the air at the outlet and operatively connected with the unloading mechanism, said means when the temperature of the air at the outlet reaches a predetermined degree, causing the unloading mechanism to be so actuated that the compressor ceases to compress air.

3. The combination with an air compressor having a piston, inlet and outlet valves, of means subject to the temperature at the outlet, an electric circuit adapted to be closed by said means when the temperature reaches a predetermined degree, means designed to be actuated by the closing of the electric circuit for opening a discharge to the atmosphere from the high pressure end of the cylinder, and an alarm adapted to be sounded by the closing of said circuit.

4. The combination with an air compressor cylinder having a piston, inlet and outlet valves and a discharge valve, of means subject to the action of the temperature at the outlet, an electric circuit adapted to be closed by said means when the temperature reaches a predetermined degree, and an air controller adapted to be opened by the closing of said electric circuit, said air controller being connected with the discharge valve, whereby when the controller is opened the cylinder will discharge air through said discharge valve.

5. The combination with an air compressor cylinder having a piston, inlet valves, outlet valves and a discharge valve, of a thermometer arranged at the outlet and subject to the action of the temperature, an electric circuit adapted to be closed by the action of the thermometer when the temperature reaches a predetermined degree, an air controller designed to be opened by the closing of said circuit, said discharge valve being connected with and relieved by the opening of the air controller so as to permit air to be discharged from the cylinder to the atmosphere when the temperature reaches a predetermined degree.

6. The combination with an air compressor cylinder having a piston, inlet and outlet valves and a discharge valve, of

means subject to the action of the temperature at the outlet, an electric circuit adapted to be closed by said means when the temperature reaches a predetermined degree, and means arranged to normally hold the discharge valve closed and adapted to be actuated by the closing of the electric circuit so as to relieve the discharge valve and allow it to be opened, whereby air will be discharged from the compressor to the atmosphere through the discharge valve when the temperature reaches a predetermined degree.

7. The combination with an air compressor cylinder having a piston, inlet and outlet valves and a discharge valve, of means subject to the action of the temperature at the outlet, a circuit adapted to be closed by said means when the temperature at the outlet reaches a predetermined degree, a normally closed exhaust valve connected with the discharge valve, a normally closed air control connected with the exhaust valve, and a solenoid connected with the electric circuit whereby when the circuit is closed by the action of the thermal means, the solenoid opens the air control and permits the exhaust valve to move and relieve the discharge valve so that air will be forced past the discharge valve through the exhaust valve to the atmosphere as long as the temperature remains at the predetermined high degree.

8. An air compressor provided on the high pressure side with a discharge valve, means subject to the temperature on the discharge side of the compressor, an electric circuit adapted to be closed by said means when the temperature reaches a predetermined degree, and means actuated by said circuit for releasing the discharge valve and permitting it to open.

9. The combination with an air compressor, of thermal apparatus subject to the temperature at the discharge end of the compressor, an electric circuit adapted to be closed by said thermal means when the temperature reaches a predetermined degree, means adapted to control an exhaust outlet from the discharge end of the compressor to the atmosphere, and electrical apparatus arranged to be actuated when the thermal means closes the circuit, for causing said controlling means to open the exhaust outlet.

EBENEZER HILL.

Witnesses:
E. HILL, JR.,
J. E. SLATER.