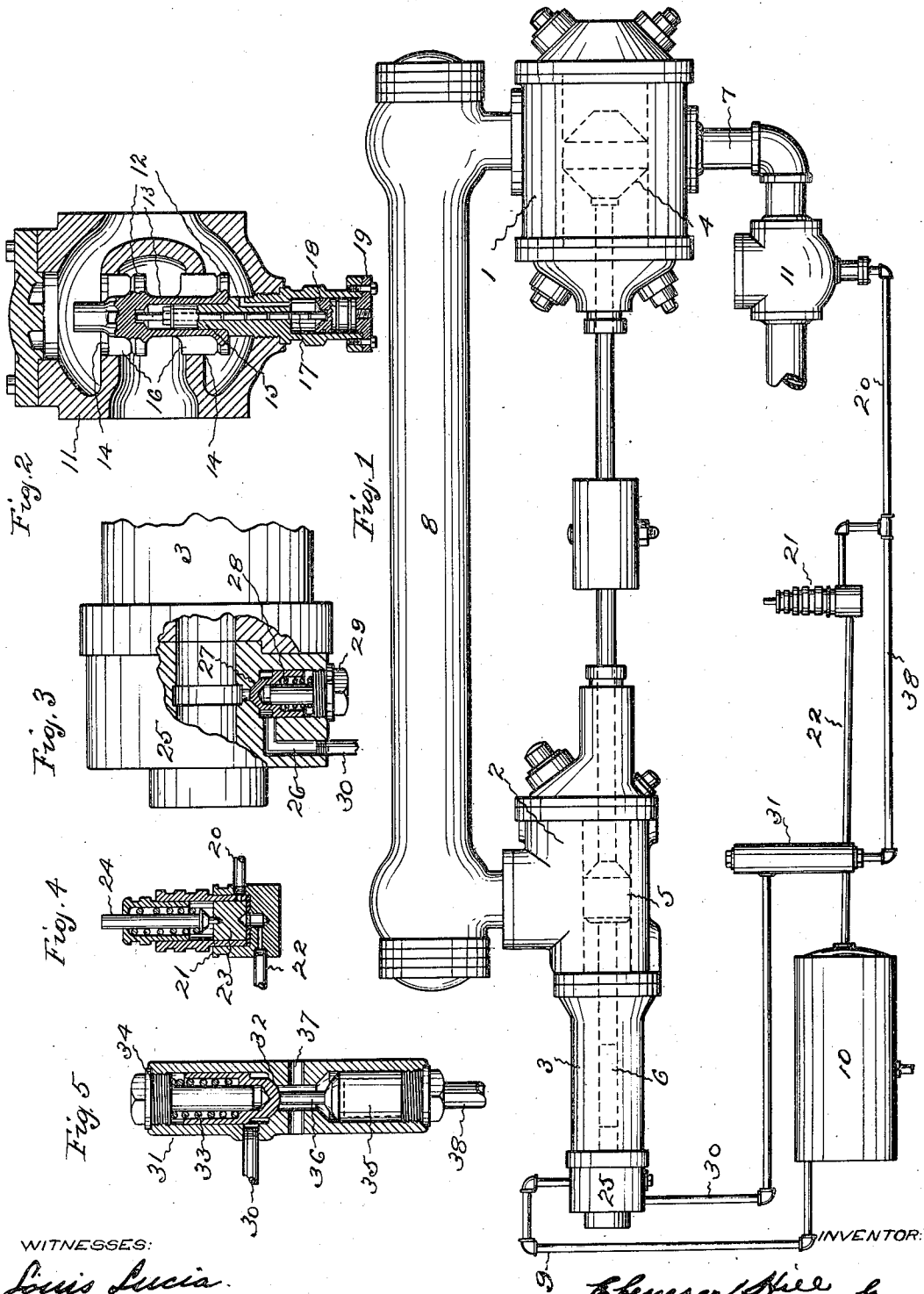


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 AIR COMPRESSOR.
 APPLICATION FILED APR. 11, 1911.

1,000,809.

Patented Aug. 15, 1911.



WITNESSES:

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UNITED STATES PATENT OFFICE.

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AIR-COMPRESSOR.

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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 Air-Compressors, of which the following is a specification.

This invention relates to that apparatus which is provided for the purpose of relieving an air compressor from work at such times as the supply of compressed air or gas is greater than the demand therefor. Such an apparatus is commonly known in this art as an unloader.

As the invention is especially advantageous for use in connection with multiple stage compressors, although it is applicable to single stage compressors, it is illustrated and described herein in connection with a three-stage compressor.

It is old in the art to provide a relief valve which opens and allows air to escape to the atmosphere when the pressure has reached a predetermined degree, but in such cases while no more air is pumped into the reservoir or system with which the compressor is connected, the compressor pistons are required to do work. It is also common to provide a compressor with an intake valve which, when the pressure reaches a predetermined degree, closes and thus stops the inflow of any air. With such an apparatus as the latter, however, especially with a compressor designed to raise air to high pressures, disastrous results are liable to follow its use; for example,—a three-stage compressor as commonly proportioned takes air at atmospheric pressure and by the first cylinder compresses it to 6 atmospheres; this air enters the second cylinder under a pressure of 6 atmospheres and is there compressed 6 times, or to a pressure of 36 atmospheres; from the discharge of the second cylinder it enters the third cylinder at a pressure of 36 atmospheres, and in this cylinder is further compressed 6 times, or 216 atmospheres, and at this pressure is discharged into the reservoir at a gage pressure of something like three thousand one hundred and sixty pounds. If, when the compressor is working under these conditions, the intake valve is closed, the pistons still being in motion, the discharge pressure of the first cylinder soon falls by reason of the lack of supply, consequently the pressure at the intake, also at the discharge, of the sec-

ond cylinder becomes less. As the machine continues in operation, the third piston pumps against a pressure of 216 atmospheres, while receiving air from other portions of the compressor at varying pressures from 36 atmospheres down to practically no pressure if the machine continues in operation for a length of time sufficient for the third piston to pump all of the air out of the cylinders, intercoolers and passages of the machine. Under these conditions, therefore, the third piston might be pumping air from a pressure of one atmosphere to a pressure of 216 atmospheres. The cylinder being designed to raise air from 36 atmospheres to 216 atmospheres, this excessive degree of compression in that one cylinder develops an enormous quantity of heat which is liable to cause injury to the working parts, burning of the lubricants, and explosions of gas. In fact, many disastrous explosions of this character have resulted. It has been proposed to eliminate this danger by by-passing the air about the piston in the high pressure cylinder when the air supply is reduced by means of a choke valve at the intake. Under these last conditions, however, the compressor is still doing some work and consequently is not entirely unloaded.

The object of this invention is to, in a very simple manner, as far as possible, relieve the compressor from all work when the supply exceeds the demand for air, and at the same time to eliminate all possible chance for injury or danger of explosion. This object is attained by providing a throttle valve at the intake which is closed by the air pressure when it reaches a predetermined degree, and providing means which at the same time that the throttle is closed, is operated by the air pressure to cause the discharge into the atmosphere of such air as is pumped by the compressor, whereby no air, or possibly a very small quantity of air, can enter the compressor and all air therein is pumped out when the supply exceeds the demand so that the pistons will work in practically a vacuum, thus moving very freely and relieving the engine of work.

Figure 1 of the accompanying drawings shows a side elevation of parts of a three-stage compressor provided with an unloading apparatus which embodies this invention. Fig. 2 shows a section on larger scale of the automatic intake throttle valve. Fig. 3 is a view of the discharge end of the high

pressure cylinder with a portion broken away in order to show the unloading discharge valve at that end of the cylinder. Fig. 4 shows a section of the air controller which operates when the pressure reaches a predetermined degree to allow the air to close the throttle and at the same time to open an exhaust valve so that air from the high pressure cylinder can pass the discharge valve and escape to the atmosphere. Fig. 5 shows a section of the exhaust valve that is operated by the pressure when the air-control is opened.

The cylinders 1, 2 and 3, of the three-stage compressor illustrated, have ordinary pistons 4, 5 and 6, connected in the common manner. These cylinders are fitted with the usual valves, which are not shown as they form no feature of the present invention. The 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 pipe 9 to any reservoir 10. As previously stated, it is common to design such a compressor as is illustrated, to raise the air from 1 to 6 atmospheres in cylinder 1, from 6 to 36 atmospheres in cylinder 2, and from 36 to 216 atmospheres in cylinder 3, or approximately 3,160 pounds per square inch in the reservoir.

Connected with the intake pipe is the throttle valve 11. The valve shown is preferably of the balanced type so that it will work easily. This valve in the interior has two disks 12 mounted on a sleeve 13, which disks are designed to close the ports 14 under predetermined conditions, and thus cut off the supply of air to the cylinder 1. The valve sleeve is loosely mounted on a stem 15 and is guided by the wings 16 which fit the walls of the port openings. Extending through the stem is a rod 17. The upper end of this rod engages the valve sleeve, and the lower end is engaged by a piston 18. On the end of the valve stem is a head 19, through which opens an air pipe 20. When air is admitted into the lower part of the valve stem, this piston is raised and through the rod closes the valve.

The air pipe 20 leads from the throttle valve stem to the outlet of an air controller 21. The inlet to this air controller is connected by a pipe 22 with the reservoir. In this air controller is a valve 23 that is held down to its seat by a spring pressed plunger 24. When the air pressure in the reservoir rises sufficiently high to lift the valve 23, the air flows through the controller and is exerted beneath the piston in the throttle valve stem so as to close the throttle valve.

In the head 25 at the discharge end of the

high pressure cylinder 3 is a passage 26. This passage is normally closed by the discharge valve 27 that is pressed to its seat by a spring 28 thrusting between the valve and a plug 29. A pipe 30 connects this passage, beyond the discharge valve, with the interior of the exhaust valve casing 31. In this casing is a valve 32 that is normally held closed by a spring 33 thrusting between it and the plug 34. In the lower part of the exhaust valve casing is a plunger valve 35. This valve has an upwardly projecting stud 36. Between the seats of these two valves in this exhaust valve casing is a passage 37 that opens to the atmosphere. The lower end of the exhaust valve casing is connected by a pipe 38 with the discharge of the air controller, or with the pipe leading therefrom to the chamber in the valve stem of the throttle valve.

When the air controller opens the air passes into the lower part of the exhaust valve casing and lifts the plunger 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 exhaust valve casing and escape to the atmosphere. When the compressor is working normally, the discharge valve will allow air to pass it and fill the pipe 30 as far as the exhaust valve 31 to a degree equal to the reservoir pressure. Then the pressure being equal on both sides the discharge valve becomes inoperative. When, however, the air pressure lifts the plunger valve and opens the exhaust, such air as is in the high pressure cylinder is forced past the discharge valve by the forward stroke, which valve of course prevents air from entering on the backward stroke of the piston in the high pressure cylinder.

When the excess pressure in the reservoir opens the air control and closes the throttle valve so as to prevent ingress of air to the machine, and opens the exhaust valve so that such air as is being pumped will escape to the atmosphere, the machine runs with practically no load on the engine. Under these conditions, the discharge pressure of the low pressure cylinder soon falls by reason of the lack of supply. The pressure in the intake of the second cylinder consequently becomes less, and as the machine continues in operation, the air pressure on the intake of the high pressure cylinder also becomes less. This continues until practically all of the air is pumped out of the cylinders, intercoolers and passages of the machine, leaving the pistons free to move back and forth in practically a vacuum.

If, for any reason, air should leak in through the throttle valve, it will be pumped into the high pressure cylinder and past the discharge valve and exhaust valve, but inasmuch as under any circumstances the amount

of air which can get into the compressor in this way must of necessity be very little, the discharge valve can be small and but little work will be done by the machine. As a result of the action of this simple arrangement for simultaneously cutting off the ingress of air and permitting the escape of all air that remains in, or could leak into the compressor, the load is reduced to a minimum, when unloaded by this simple apparatus, without any possible danger of overheating and damaging any of the parts of the mechanism, or burning up the lubricant or exploding any gases.

15 The invention claimed is:

1. In an air compressor the combination with pumping mechanism, of means actuated at a predetermined pressure for simultaneously cutting off the ingress of air to the pumping mechanism, and permitting the discharge of air from the pumping mechanism to the atmosphere.

2. In an air compressor the combination with a multiple stage pumping mechanism, of means actuated at a predetermined pressure for simultaneously cutting off the ingress of air to the low pressure pumping mechanism, and permitting the discharge of air from the high pressure pumping mechanism to the atmosphere.

3. In an air compressor the combination with pumping mechanism, of a normally open throttle valve governing a passage thereto, a normally closed exhaust valve governing a passage therefrom, and means actuated at a predetermined pressure for permitting the air compressed to close said throttle valve and open said exhaust valve.

4. In an air compressor the combination with pumping mechanism, of a throttle valve governing a passage thereto, an exhaust valve governing a passage therefrom, and an air controller adapted to open and close with varying pressures for the purpose of allowing the air pressure to actuate the throttle valve and the exhaust valve.

5. In an air compressor the combination with pumping mechanism, of a throttle valve governing a passage thereto, an exhaust valve governing a passage therefrom, and means operated by air pressure for simultaneously closing the throttle valve and opening the exhaust valve and thereby automatically causing a vacuum to be established in the compressor by the continued running of the pumping mechanism after the air pressure has reached a predetermined degree.

6. In an air compressor the combination with pumping mechanism, of a normally open throttle valve governing a passage

thereto, a discharge valve governing an outlet therefrom, a normally closed exhaust valve also controlling said passage therefrom, and an air control opened at a predetermined pressure to permit the air pressure to act upon and close the throttle valve and act upon and open the exhaust valve so as to permit the discharge valve to open.

7. In an air compressor the combination with pumping mechanism, of a balanced throttle valve governing the intake, a piston for closing said throttle valve, a spring actuated discharge valve controlling an outlet from the pumping mechanism, a normally closed exhaust valve governing said outlet, a plunger adapted to open said exhaust valve, and an air control automatically opened at a predetermined pressure to allow the air to act upon the piston for closing the throttle valve, and to act upon the plunger and cause it to open the exhaust valve.

8. In an air compressor the combination with pumping mechanism, of a throttle valve governing the intake of the low pressure cylinder, a discharge valve controlling a discharge passage from the high pressure cylinder, an exhaust valve normally closing the discharge passage, a valve arranged to open the exhaust valve, and an air control normally held closed by spring pressure and adapted to be opened at a predetermined air pressure to allow the air to close the throttle valve and simultaneously cause the exhaust valve to be opened.

9. In a multiple stage control, the combination with the pumping mechanism, of means actuated by the air pressure at a predetermined pressure to simultaneously close the intake of the low pressure cylinder and open an outlet from the discharge side of the high pressure cylinder, and thereby cause a partial vacuum to be established in the cylinders when the air pressure reaches the predetermined degree.

10. In an air compressor the combination with the pumping mechanism, of means for controlling the intake of the low pressure cylinder, means controlling the outlet from the high pressure cylinder, and means operated by air pressure at a predetermined degree to allow said air pressure to actuate said intake and outlet controlling means, and cause the exhaustion of air from the cylinders when the pressure reaches the predetermined degree.

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Witnesses:

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