R. CONRADER.

CONTROLLING DEVICE FOR TWO STAGE COMPRESSORS.

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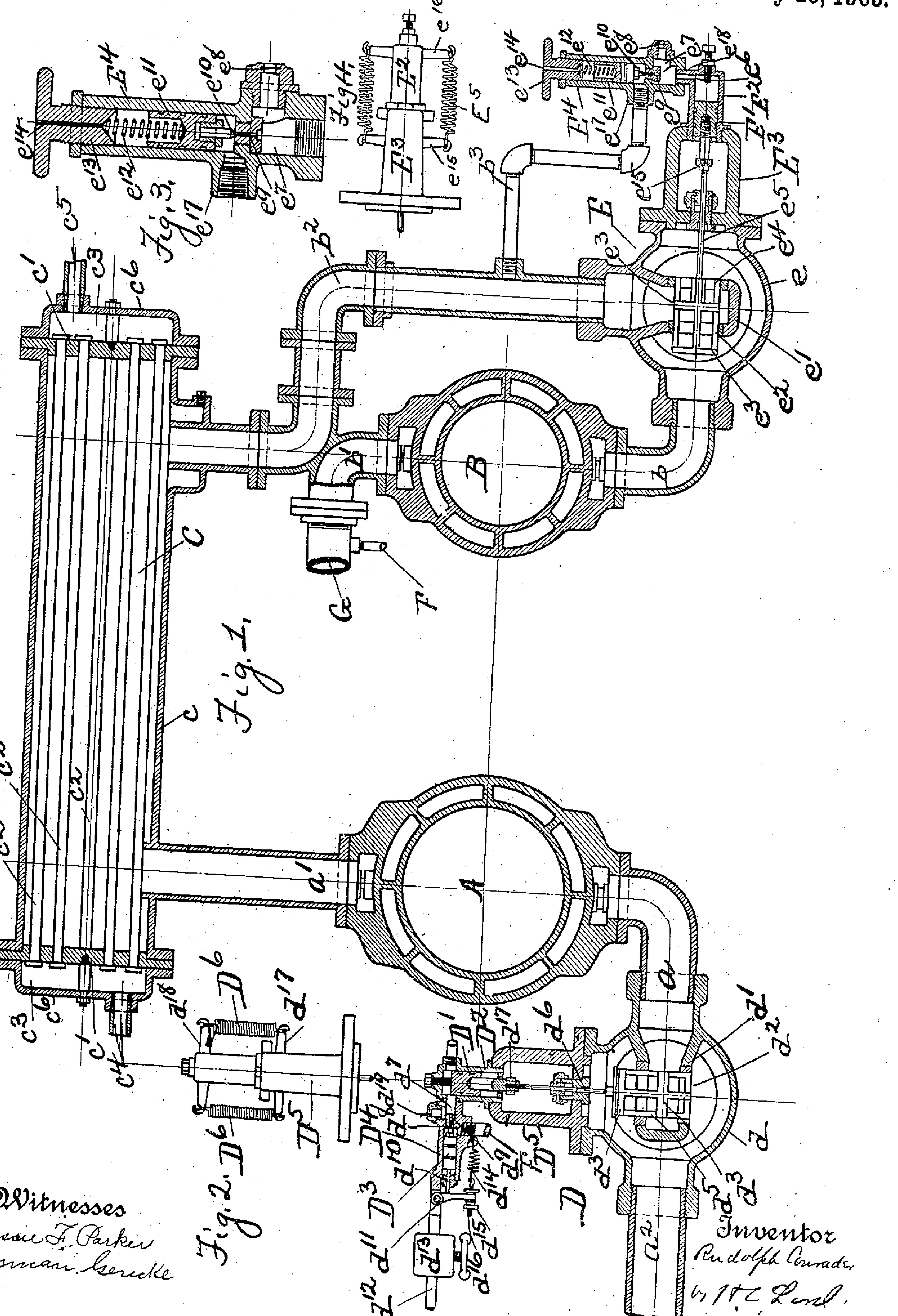
Patented May 18, 1909.



Witnesses

Bessie F. Parker

Herman Gerecke

Inventor

Rudolph Conrader

by H. L. Reed

Attorney

UNITED STATES PATENT OFFICE.

RUDOLPH CONRADER, OF ERIE, PENNSYLVANIA.

CONTROLLING DEVICE FOR TWO-STAGE COMPRESSORS.

No. 921,803. Specification of Letters Patent. Patented May 18, 1909.

Application filed January 24, 1906. Serial No. 297,595.

To all whom it may concern:

Be it known that I, RUDOLPH CONRADER, a citizen of the United States, residing at Erie, in the county of Erie and State of Pennsylvania, have invented new and useful Improvements in Controlling Devices for Two-Stage Compressors, of which the following is a specification.

This invention relates to controlling devices for two stage compressors, and consists in certain improvements in the construction thereof as will be hereinafter fully described and pointed out in the claims.

The main object of the invention is to prevent the development of an excess of heat at the discharge of the high pressure cylinder. It has been found that in two stage compressors or compressors having a plurality of cylinders in which the relieving device is arranged on the intake of the low pressure cylinder, that under certain conditions, practically the same amount of heat is developed at the discharge of the high pressure cylinder as would be developed in effecting the compression with a single stage compressor. Inasmuch as compressors are often used in mines and other places where such excessive heat is likely to cause explosions, the prevention of this becomes of great importance for such compressors.

The invention is illustrated in the accompanying drawings as follows: Figure 1 shows a cross section of a two stage compressor, with my devices thereon. Fig. 2 shows a detail view of the frame of the relief device for the low pressure cylinder. Fig. 3 is an enlarged view of the actuated mechanism for the regulator of the high pressure cylinder. Fig. 4 shows a side elevation of the frame of said regulating device.

A marks the lower pressure cylinder, B the high pressure cylinder, *a* the intake of the low pressure cylinder, *b* the intake of the high pressure cylinder, *a′* the discharge of the low pressure cylinder and *b′* the discharge of the high pressure cylinder. The low pressure cylinder discharges into an intermediate cooler C. This cooler comprises the shell *c*, the partition plate *c′* arranged on this shell, the connecting tubes c^2 extending from one plate to the other, the heads c^6 secured on the partition plates forming the chamber c^3, and the inlet c^4 and outlet c^5. The cooling medium is admitted at c^4, passing from the chamber c^3 through the tube c^2 to the outlet chamber c^8, and through the discharge tubes c^5. The air is cooled by contact with the tubes c^2.

Ordinarily the cylinders A and B are so proportioned that operating normally the high pressure cylinder will discharge exactly the same amount of air as is compressed by the low pressure cylinder. Of course, the volume under the higher compression is less.

I prefer to provide the low pressure cylinder with a relieving device similar to that shown by me in Patent No. 775,393 dated November 22, 1904. This relieving device D has the valve chamber *d*, in which there is the partition *d′*. The valve d^2 is of the throttling type, having the closure disks d^3 d^3, and connecting web d^5, a stem d^6 extending from this valve and connected with a piston D′. The piston is arranged in a cylinder D^2. The cylinder is carried by a frame D^5 secured to the walls of the valve chamber *d*. The upper end of the cylinder communicates with an air chamber d^7 and a passage d^9 connecting this chamber with a cylinder D^4. The needle valve d^8 controls this passage. The needle valve d^8 is carried by the piston D^3, the piston being arranged in the cylinder D^4. A stem d^{10} extends from the piston and engages the arm of the bell crank lever d^{11}. The other arm d^{12} of the bell crank lever has the weight d^{13} adjustably arranged upon it. A spring d^{14} is secured to the cylinder D^4 and to the bell crank lever by means of eye bolt d^{16} and adjusting nut d^{15}. By means of the adjusting nut and the adjustable weight any pressure desired may be put upon the piston D^3, so that the piston can be made to operate at any desired minimum pressure. A minute vent d^{19} leads from air chamber d^7. With the initial opening of the passage d^9 by the valve d^8, this vent permits a certain amount of air to escape. The size of the passage d^9 relatively to this vent is such, however, that when the valve is fully open. practically receiver pressure is maintained in the chamber d^7, so that the change of pressure in the chamber d^7 and cylinder D^2 is very much in excess of the change of pressure in the receiver. In other words, the change of pressure in the receiver is intensified in this device so that very close regulation may be maintained. This mechanism is not new in this instance, as it was shown in my former patent. A cross head

d^{17} is attached to the stem d^6 and springs are tensioned between said cross head and the arm d^{18} and the end of the cylinder. These tend to open the valve d and to maintain it in an open position until the receiver pressure exceeds the desired minimum. The valve is then moved so as to reduce the amount of air permitted to enter through the intake, and as the pressure continues the increase eventually entirely closes it. I prefer, however, that this valve act as a regulator, that is, that it does not go entirely from a closed to an open position, but its movement is graduated to open to supply the amount of air required, as was more fully set forth in my former patent.

It will be observed that if the relief device D is actuated with no other controlling device for the entire compressor, that the low pressure cylinder A will discharge a less amount of air than will be pumped by the high pressure cylinder, so that the pressure in the intermediate cooler C will gradually decrease. Eventually, if the supply drawn from the receiver happens to be such as to actuate the relief device D to pump only a very small amount of air, then the pressure of the air at the intake of the high pressure cylinder will be simply atmospheric pressure. Indeed the conditions may be such as to make it less than this, but still deliver some air. The result of this is that the high pressure cylinder alone boosts the pressure from that of the atmosphere, or less than atmospheric pressure, to the full receiver pressure, and this creates the dangerous amount of heat heretofore referred to. To prevent this, I provide the regulating device E. It comprises the valve chamber e, in which is arranged the diaphragm e'. The pipe b^2 connects the cooler C with the chamber. The valve e^2 of the throttling type is arranged in the partition. It has the closure disks e^3 e^3, and the connecting webs e^2 as usual in the balanced throttling type of the valve. A stem e^5 extends from this valve and is connected with a piston E′. This piston operates in a cylinder E^2, the cylinder being carried by a frame E^3 mounted on the valve chamber. The cylinder E^2 is connected with an air chamber e^7 and this air chamber is connected by a passage e^9 with a cylinder E^4. The valve e^{10} controls this passage. It is carried by the piston e^{11}. The piston is subjected to the pressure of the spring e^{12}. The pressure of the spring may be adjusted by the nut e^{13}. A passage e^{14} through the nut prevents the trapping of air back of the piston. The cylinder E^4 is connected by a pipe b^3 with the pipe b^2, and consequently with the cooler C. The air chamber e^7 is provided with a vent e^8 to permit the escape of the air from the cylinder E^2. Springs E^5 are tensioned between the cross heads e^{15} and the arm e^{16} on the cylinder E^2. In this device, the spring tends to or closes the valve while the air pressure operating on the piston E′ tends to or opens the valve. In this construction, I prefer that the valve e^{10} be so constructed and the vent e^8 be so proportioned to the passage e^9 that practically full cooler pressure is delivered to the cylinder E^2 with the initial opening of the valve e^{10}. Where the parts are so arranged, the vent simply acts as a leak to dispose of the air in the cylinder. When the cooler pressure is normal, it is sufficient to actuate the piston e^{11} to open the valve e^{10} and to maintain the valve in this position. The air acting on the piston E′, with these conditions, therefore, maintains the valve e^2 in an open position. Under these conditions, the high pressure cylinder simply boosts the pressure from the normal cooler pressure to the receiver pressure. Ordinarily the cooler pressure is mid-way between atmospheric pressure and receiver pressure, and under these conditions, the excessive heat is avoided. When, however, the supply taken from the receiver is so small as to require but a small part of the capacity of the pump, the relief device D acting upon the low pressure cylinder, so reduces the amount discharged by this cylinder to the cooler, that the cooler pressure falls. The regulating device E may be so adjusted by means of the screw e^{13} that when the cooler pressure reaches a dangerous pre-determined minimum, it will overcome the air pressure acting upon the piston e^{11}, and will close the valve e^{10}. The vent e^8 will allow the leakage of trapped air from the cylinder E^2 and the spring E^5 will entirely close the valve e^2. The high pressure cylinder will then immediately discharge itself, with the exception of the clearance, and will continue to operate in a partial vacuum and will cease to discharge air, so that no further heat will be developed. When the air pressure in the cooler has been raised above the pre-determined minimum, this pressure acts upon the piston e^{11} opening the valve e^{10} and operates as before described, opening the valve e^2, and air of the normal cooler pressure is again admitted to the high pressure cylinder. In the drawings, the pipe G which is connected with the discharge b, may be considered as the receiver, and the pipe F connects the receiver with the cylinder D^4 of the relief device D.

What I claim as new is:

1. In a controlling device for two stage compressors, the combination of the low and high pressure cylinders; an intervening cooler; a relief device for the low pressure cylinder acting independently of the cooler, and actuated by the pumped fluid; and a regulating device controlling the action of the high pressure cylinder to maintain a minimum pressure in the cooler.

2. In controlling devices for two stage compressors the combination with the low and high pressure cylinders; of a regulating device for the high pressure cylinder, controlled by pressure between the cylinders, and controlling the volume of fluid discharged by said high pressure cylinder; and a relief device for the low pressure cylinder, controlled by the pressure of the pumped fluid and acting upon the intake of said low pressure cylinder.

3. In controlling devices for two stage compressors the combination with the low and high pressure cylinders; of a regulating device for the high pressure cylinder controlled by the pressure between the cylinders, and controlling the volume of fluid discharged by said high pressure cylinder to control the action of the high pressure cylinder to decrease the discharge therefrom when the pressure between the cylinders reaches a pre-determined minimum; and a relief device for the low pressure cylinder controlled by the pressure of the pumped fluid and acting upon the intake of said low pressure cylinder.

4. In controlling devices for two stage compressors the combination with the low and high pressure cylinders; of a regulating device for the high pressure cylinder, controlled by pressure between the cylinders, and controlling the volume of fluid discharged by said high pressure cylinder, said regulating device being arranged to act on the intake of said high pressure cylinder; and a relief device for the low pressure cylinder controlled by the pressure of the pumped fluid and acting upon the intake of said low pressure cylinder.

5. In controlling devices for two stage compressors the combination with the low and high pressure cylinders; of a regulating device for the high pressure cylinder, controlled by pressure between the cylinders, and controlling the volume of fluid discharged by said high pressure cylinder; and a relief device for the low pressure cylinder controlled by the pumped fluid and acting on the intake of said low pressure cylinder, said relief device being arranged to graduate the charge pumped by the low pressure cylinder as the pressure of the pumped fluid changes.

6. In controlling devices for two stage compressors the combination with the low and high pressure cylinders; an intermediate cooler and a regulating device acting on the intake of the high pressure cylinder for maintaining pressure in the cooler and adapted to close abruptly when the cooler pressure falls below a predetermined minimum; and a relief device actuated by the pumped fluid in the low pressure cylinder, said relief device being arranged on the intake of said low pressure cylinder.

7. In controlling devices for two stage compressors the combination with the low and high pressure cylinders; and an intermediate cooler between said cylinders; of a relief device acting on the intake of the low pressure cylinder and actuated by the pumped fluid; and a regulating device controlling the action of the high pressure cylinder to maintain a minimum pressure in the cooler.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

RUDOLPH CONRADER.

Witnesses:

H. C. Lord,

Bessie F. Parker.