H. T. HERR.

AUTOMATIC CONTROLLING DEVICE FOR FLUID COMPRESSORS.

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953,617. Patented Mar. 29, 1910.

Fig. 1.

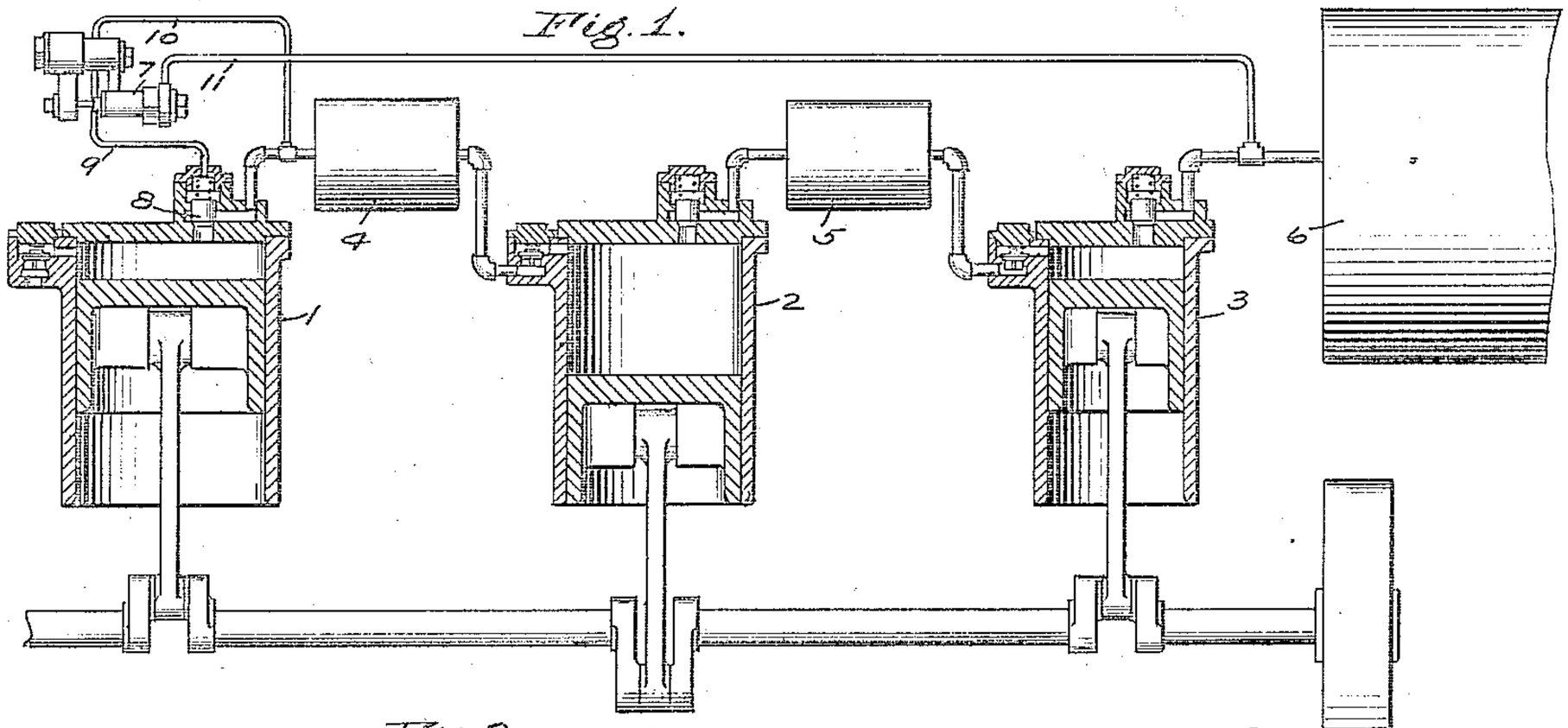
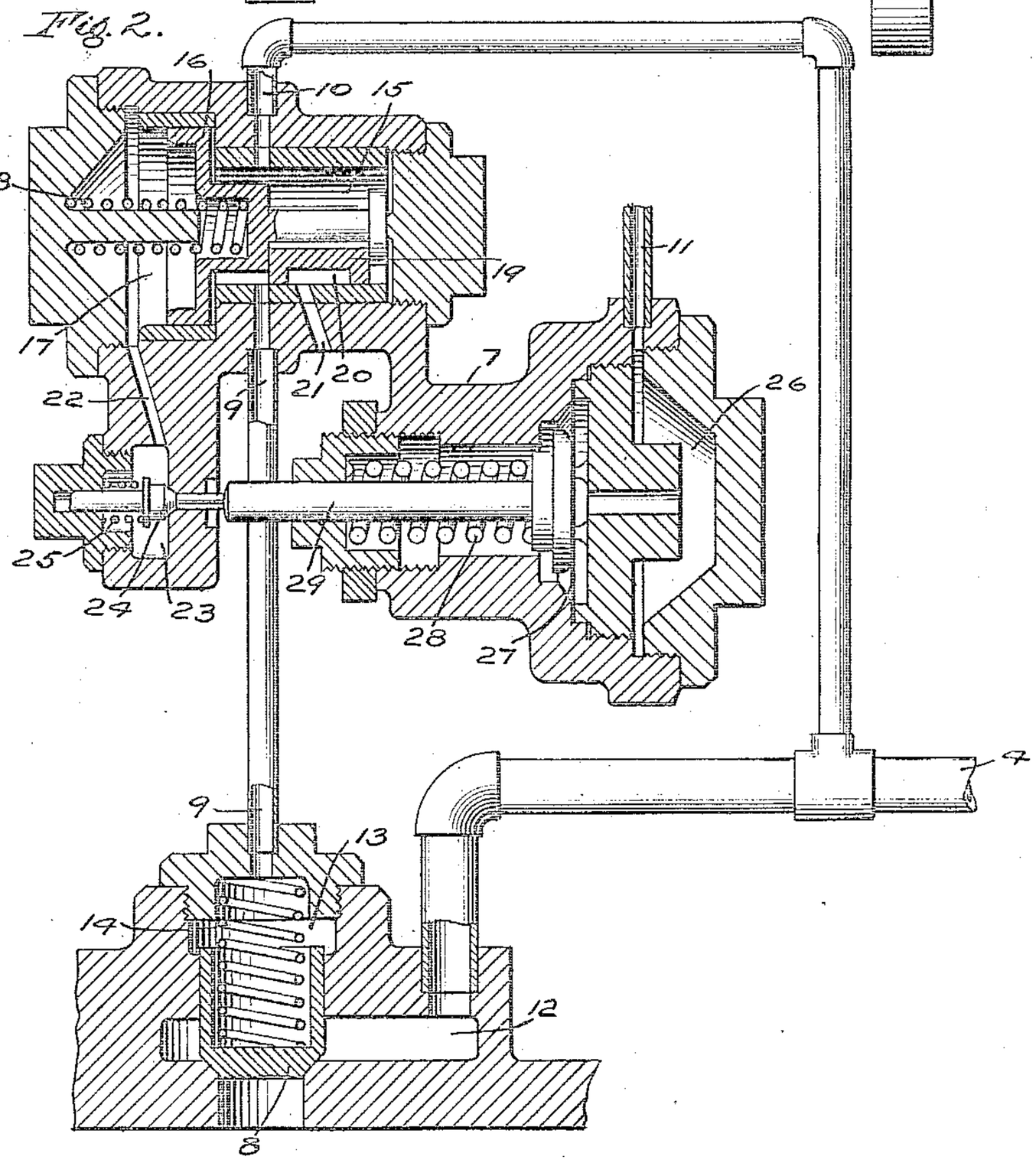



Fig. 2.




WITNESSES

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## AUTOMATIC CONTROLLING DEVICE FOR FLUID-COMPRESSORS.

953,617. Specification of Letters Patent. Patented Mar. 29, 1910.

Application filed June 26, 1908. Serial No. 440,481.

*To all whom it may concern:*

Be it known that I, HERBERT T. HERR, a citizen of the United States, residing at Denver, in the county of Denver and State of Colorado, have invented new and useful Improvements in Automatic Controlling Devices for Fluid-Compressors, of which the following is a specification.

This invention relates to fluid compressors and more particularly to that class of compressors which are run more or less continuously or for long periods of time without intermittent rest, one of the objects being to provide an improved automatic controlling device or governing mechanism whereby the compressor may run free with little or no resistance when a certain predetermined fluid pressure has been obtained, but adapted to do effective work in compressing fluid when the ultimate pressure falls below a predetermined point.

Another feature of my improvement relates particularly to multi-stage compressors and comprises means operated in accordance with the pressure produced at the final stage of compression for controlling the effective action of the primary or first-stage compressor, and thereby govern the amount of the final pressure.

In the accompanying drawing; Figure 1 is a diagrammatic view illustrating my improvements as applied in connection with a three-stage fluid compressor, the cylinders being shown in section; and Fig. 2 a central section of the valve mechanism of my improved controlling device and the discharge valve of the compressor.

As shown in Fig. 1 of the drawing I have illustrated my improvement in connection with a three-stage air compressor having a first or primary cylinder 1, intermediate cylinder 2 and final cylinder 3, each being provided with suction and discharge valves, the discharge from the first cylinder leading to intercooler 4 between the first and second cylinders, that from the second cylinder to intercooler 5 between the second and third cylinders, and the final cylinder discharging into the reservoir 6 in which it is desired to maintain a high degree of air pressure substantially constant.

The compressor is adapted to be driven more or less continuously for long periods of time, as for instance by being connected to an internal combustion engine or other motor used for propelling a vehicle or for other purposes, or driven by the momentum of the vehicle itself, and when the desired degree of pressure is produced and maintained in the final reservoir 6 it is, of course, desirable to have the compressor run free with substantially no resistance and without further compressing air into the reservoir until the pressure therein has diminished below the desired predetermined degree. For this purpose I have provided an improved controlling valve mechanism 7 preferably governed by the final pressure in reservoir 6 and operating to control the action of the first or primary compressor by means of its discharge valve 8, as illustrated in Fig. 1.

Referring to Fig. 2, a preferred form of my improved valve device 7 comprises a casing containing a chamber 15 having a slide valve 19 actuated by a piston 16 subject to the opposing pressure of the valve chamber 15 on one side and the pressure in chamber 17 and spring 18 on the other side, the slide valve being provided with a cavity 20 for connecting ports 9 and 21 in one position of the valve. The valve chamber 15 may be connected by a pipe or passage 10 with the intercooler 4 and the piston 16 is made of a loose fit in its bushing to permit the fluid under pressure to readily leak past the same into chamber 17, the pressure in this chamber being controlled by regulating valve 24 in chamber 23 communicating with piston chamber 17 through passage 22. This regulating valve is normally held seated by a light spring 25 but is adapted to be opened by the stem 29, actuated by a device from diaphragm 27 which is subject on one side to pressure in chamber 26 which communicates by pipe 11 with the main reservoir, and on the opposite side to the adjustable spring 28. The port 9 communicates with the chamber 13 back of the cylindrical extension of the discharge valve 8 of the primary cylinder 1 of the compressor.

The operation of my improved device is as follows; the spring 28 being adjusted to the predetermined degree of pressure that it is desired to maintain in the final reservoir 6, say 800 pounds per sq. in.; until this pressure is obtained in the reservoir and in chamber 26 on the opposite side of the diaphragm, the regulating valve 24 remains closed, and as the piston 16 is then balanced as to the fluid pressure of the first intercooler which pressure obtains in valve cham-

ber 15 and also readily equalizes around the piston into chamber 17, the spring 18 holds the control valve 19 in position shown, in which the port 9 is open to chamber 15 and the intercooler so that the same pressure exists in chamber 13 back of the discharge valve 8 of the first compressor cylinder as in passage 12 which leads to the same intercooler or space. Consequently the discharge valve 8 of the first compressor cylinder will operate in its usual manner to control the discharge of compressed air to the intercooler 4, while the other cylinders and pistons also operate in the usual and well known manner to compress the air to the higher degree of pressure and force the same into the reservoir 6. As soon as the pressure in the reservoir reaches or rises slightly above the predetermined degree for which the spring 28 of my improved device is adjusted, the spring will be slightly compressed by the air pressure in chamber 26 and the stem 29 will open the regulating valve 24 thereby venting air from chamber 17 to the atmosphere. By means of the lowering of pressure on one side of piston 16, the intercooler pressure acting upon the other side in valve chamber 15 moves the piston and slide valve 19 against the spring 18 to a position in which the cavity 20 establishes connection from chamber 13 and port 9 to port 21 and the atmosphere, whereupon the discharge valve, now having only atmospheric pressure upon its back, rises and is held in its raised and open position seated against its cap by the pressure in passage 12 and the intercooler 4.

As the discharge valve 8 is held in its open position, it will be seen that no air will be taken into the cylinder of the first stage of compression, as the admission valve will not open against the preponderance of pressure in the intercooler between the first and second stages of compression. I so proportion the clearances in the cylinders 2 and 3 that these cylinders will be unloaded simultaneously with the unloading of the cylinder 1. I accomplish this by proportioning the clearances in the cylinder 2 so that the cylinder will not draw fluid from the receiver 4 except when the cylinder 1 is working at maximum capacity, and by proportioning the clearances in the cylinder 3 so that it will not draw fluid from the receiver 6 except when the cylinder 2 is delivering fluid to that receiver. I may also accomplish this by so proportioning the clearances in the cylinder 2 that it will not draw fluid from the receiver 4 except when the pressure in the receiver 4 is maximum or close to maximum working pressure. The clearances in the cylinder 3, with this arrangement, will be proportioned as above outlined.

When the cylinder 1 is unloaded by the operation of the governor mechanism, the fluid in the receiver 4 expands, during the operation of the cylinder 1, through the cylinder and the receiver and consequently the pressure in the receiver drops and is only periodically raised to the normal working pressure. If, however, the cylinder 2 draws fluid from the receiver at the time or immediately after the cylinder 1 is unloaded by the operation of the governor valve, the pressure in the receiver 4 will not rise to the normal pressure until the cylinder 1 is again in operation, and the cylinders 2 and 3 will consequently be unloaded. By unloading, I mean that the fluid confined in the cylinder will be first compressed by the cylinder's piston and then expanded so as to impart energy to the piston. I may also gradually unload the cylinders 2 and 3 by proportioning the clearances in the cylinder 2 so that the cylinder will receive fluid from the receiver 4 after the valve 8 is raised and by maintaining the clearances in the cylinder 3 as above described. With such an arrangement, the load on the engine will be gradually decreased from a maximum to a very low minimum, at which the only work required to operate the compressor will be that necessary to overcome the friction of the machine. As soon as the cylinder 1 is unloaded, the pressure in the receiver 4 starts to drop and consequently the capacity of the cylinder 2 is reduced proportionately to the drop in pressure. The reduction in the capacity of the cylinder 2 will cause a corresponding reduction in the capacity of the cylinder 3. The capacities of the cylinders 2 and 3 will decrease until a predetermined pressure is reached in the receiver 4, at which the cylinder 2 is unloaded. Care must be taken to maintain a pressure in the receiver 4 such that the spring 18 cannot shift the controller valve 19 and cause hunting of the valve 8.

Should the pressure in chamber 26, passage 11, and reservoir 6 decrease below the predetermined amount, the tension of spring 28 will cause spindle 29 to force diaphragm 27 inward, allowing the regulating pin valve 24 to seat, and air pressure from chamber 15 will leak by piston 16 into chamber 17, passage 22, and chamber 23 until the pressures are equalized, when spring 18 will return piston 16 and valve 19 to the position as shown in Fig. 2; thus allowing air from chamber 15 to pass through port 9 into chamber 13, and as this pressure in chamber 15 is equivalent to the pressure obtaining in the intercooler 4 between the first and second stages of compression, it is apparent that spring 14 will cause discharge valve 8 to seat as usual in the ordinary operation of compressors. Another advantage of my invention is that there is

no tendency for the governor valve to leak pressure except when the pressure in the main reservoir has exceeded the maximum working pressure. The chamber 26, to which the pipe 11 leads, is air-tight, since it is closed by the diaphragm 27, and the chamber 17 is also air-tight when the valve 24 is closed.

While I have described my improved controlling valve mechanism as preferably applied to a three-stage air compressor, it will be evident that it is not limited to such construction but is equally applicable to any fluid compressor of one or more stages, and in case of a single stage compressor the same ultimate reservoir pressure may be connected to both the diaphragm chamber and valve chamber of the device.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. A controlling device for fluid compressors comprising a compressor discharge valve, a governing device actuated by the pressure pumped by said compressor, a fluid actuated reciprocating piston, a control valve actuated by said piston and a regulating valve actuated by said governing device for controlling the operation of said piston.

2. A controlling device for fluid compressors comprising a compressor discharge valve, a governing device actuated by the pressure pumped by said compressor, a control valve for delivering fluid pressure behind said compressor valve and for exhausting pressure therefrom, a fluid actuated reciprocating piston for actuating said control valve and a regulating valve actuated by said governing device for exhausting fluid pressure from behind said piston and causing said control valve to exhaust fluid from behind said compressor valve.

3. A controlling device for fluid compressors comprising a compressor discharge valve, a governing device actuated by the pressure pumped by said compressor, a fluid actuated piston, means operated by said piston for controlling the operation of said discharge valve and a regulating valve actuated by said governing device for controlling the operation of said piston.

4. In a multi-stage compressor, a primary stage, a governing mechanism controlled by final-stage pressure, a valve controlled by said mechanism for unloading the primary stage and a secondary stage, the clearances of which are so proportioned that the secondary stage is rendered ineffective by the unloading of the primary stage.

5. In a multi-stage compressor, a primary stage, a governing device controlled by final-stage pressure for unloading said primary stage and a secondary stage, the clearances of which are so proportioned that the secondary stage is rendered ineffective by the unloading of the primary stage.

6. In a multi-stage compressor, a primary stage, a governing mechanism controlled by final-stage pressure, a discharge valve for said primary stage controlled by said mechanism to unload the primary stage and a plurality of stages of successively increasing pressure, the clearances of which are so proportioned that they are rendered ineffective by the unloading of the primary stage.

7. In combination with a multi-stage compressor, a governing mechanism comprising a primary-stage discharge valve, a governing device actuated by final-stage pressure, means for subjecting said discharge valve to primary-stage pressure, a fluid actuated reciprocating piston for controlling the operation of said means and a regulating valve actuated by said governing device to control the operation of said piston.

8. In combination with a multi-stage compressor, a governing mechanism comprising a primary-stage discharge valve, a governing device actuated by final-stage pressure, means for controlling the operation of said discharge valve, a fluid actuated piston for controlling the operation of said means and a regulating valve actuated by said governing device to exhaust fluid from behind said piston to cause said piston to open said discharge valve through the agency of said means.

9. In combination with a multi-stage compressor, a governing mechanism comprising a primary-stage discharge valve, a governing device actuated by final-stage pressure, means subjected to primary-stage pressure for controlling the operation of said discharge valve and a regulating valve actuated by said governing device for controlling the operation of said means.

In testimony whereof I have hereunto set my hand.

HERBERT T. HERR.

Witnesses:
G. P. LINDSLEY,
FRANK M. HARKER.