

Dec. 28, 1926.

1,612,639

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COMPRESSOR INTERCOOLER REGULATOR

Filed July 15, 1926

2 Sheets-Sheet 1

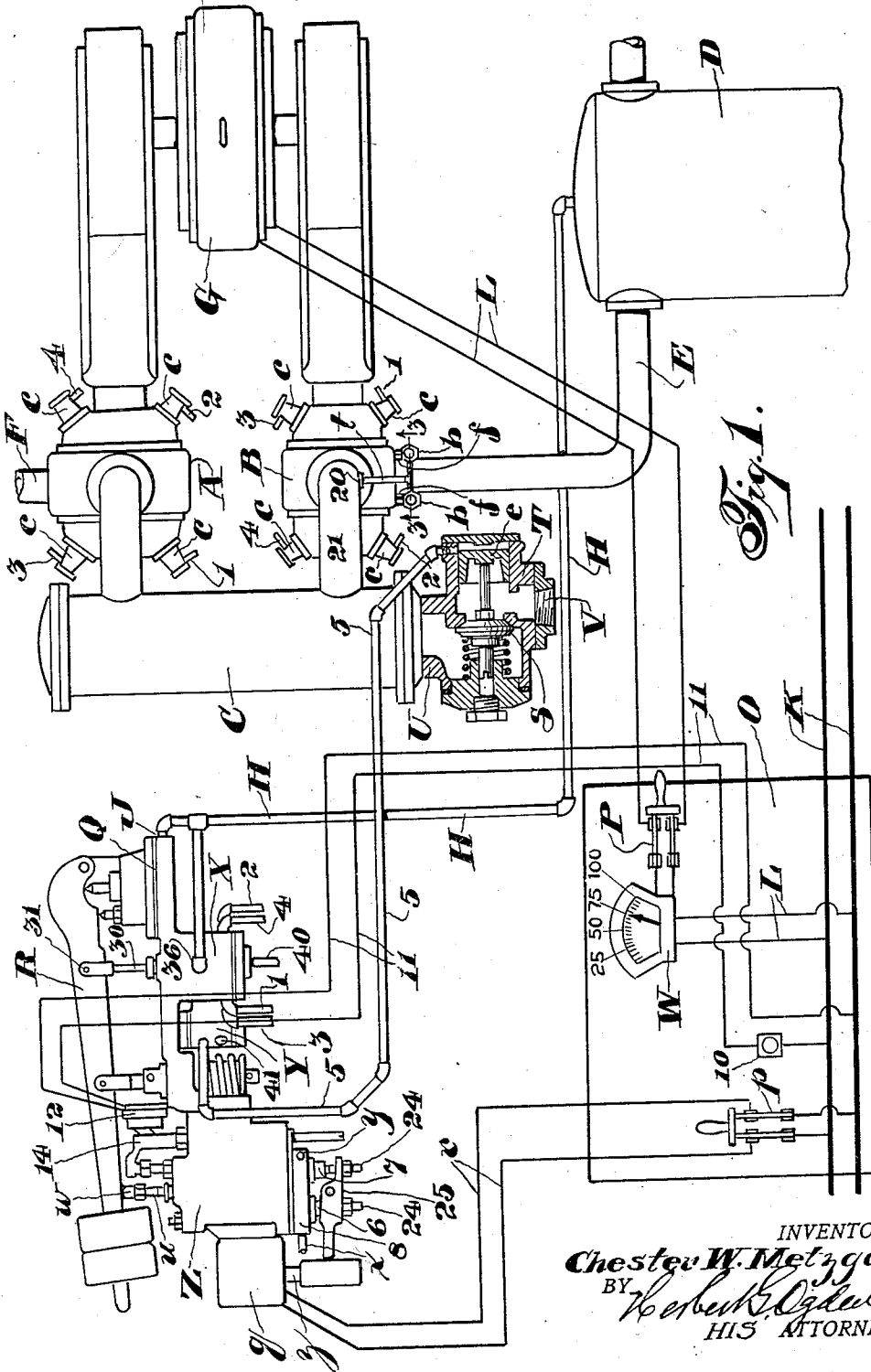


Fig. 1.

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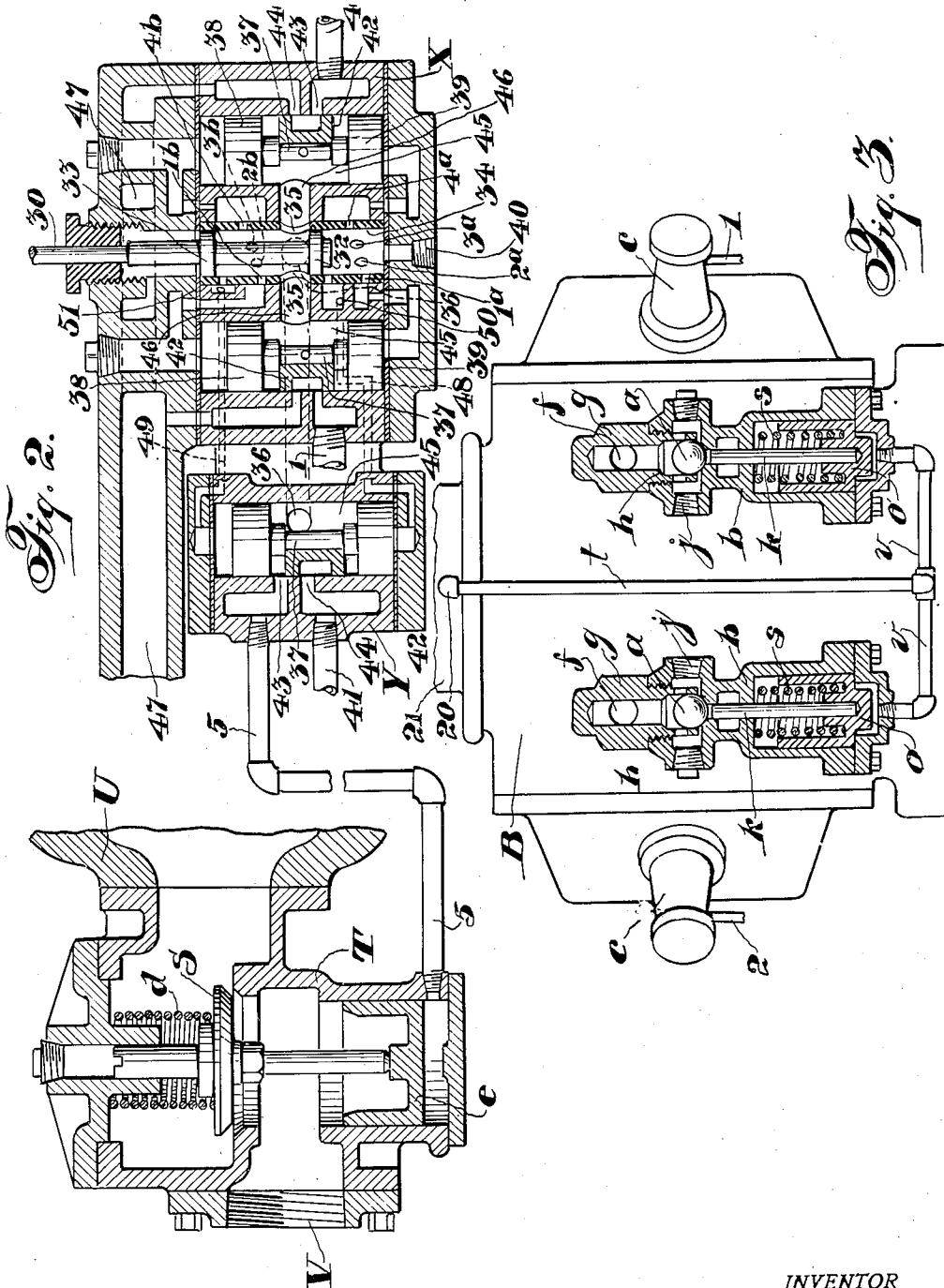
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COMPRESSOR INTERCOOLER REGULATOR

Filed July 15, 1926

2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE.

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COMPRESSOR-INTERCOOLER REGULATOR.

Application filed July 15, 1926. Serial No. 122,675.

This invention relates to compressor regulators, but more particularly to regulators controlling intercooler pressure and thereby causing unloading and loading of a cylinder.

The invention may be applied to multi-cylinder compressors, but especially to compound compressors, and the objects of the invention are to enable the high pressure cylinder to be completely unloaded when the intercooler is unloaded, as for instance in case the electric power for the motor fails. When the power is again restored, the apparatus is so constructed and connected that the high pressure cylinder will again be loaded when the pressure has been built up in the intercooler. The unloading and loading of the high pressure cylinder or the cylinder beyond the intercooler, thus follows automatically the unloading and loading of the intercooler.

The invention is shown applied to a compound compressor in connection with a step-by-step unloading system, like that disclosed in my copending application, Serial No. 66,492, filed November 3, 1925, for compressor regulator and unloader, although all the details of that application need not be shown here.

The invention is illustrated in one of its preferred forms in the accompanying drawings, in which—

Figure 1 is a diagrammatic view partly in vertical section, showing the regulator;

Figure 2 is an enlarged detail longitudinal sectional elevation taken through the main regulator and the unloading valve for the intercooler. In this view the intercooler unloading valve has been turned into a vertical position and located adjacent the main regulator for purposes of illustration, and the pipe connecting the regulator and unloading valve is shown broken to indicate that these two types of mechanism are more widely separated in Figure 1; and

Figure 3 is an enlarged detail sectional elevation of the cylinder relief valves or unloading mechanism taken on the line 3—3 of Figure 1 looking in the direction of the arrows.

Referring to the drawings, only so much of the apparatus will be described in detail as relates to the present invention, it being understood that the remainder of the appa-

ratus has been fully described and shown in copending application, Serial No. 66,492.

Referring to the drawings, the installation shown diagrammatically in Figure 1, for purposes of illustration, comprises the compressor having the low and high pressure cylinders A and B, the intercooler C and the discharge tank or receiver D connected to the discharge of the high pressure cylinder B by the usual pipe E. The intake for the low pressure cylinder is indicated at F and the compressor is shown driven by an electric motor G supplied with current from the mains K and leads L carried by the main switch board O on which the compressor switch P is mounted.

A volt meter W is preferably included in the circuits for indicating purposes and a second power unit, as for instance a mine hoist, may operate in conjunction with the compressor if desired, as shown in said former application, although this second power unit is omitted in the present instance.

The compressor is provided with a pressure responsive regulator and unloader X actuated in this instance by receiver pressure from the pipe H connecting the receiver D to the point J on the regulator casing and communicating with the diaphragm chamber Q having a diaphragm (not shown), operatively connected to actuate the weighted lever R in accordance with variations in the receiver pressure.

The regulator X is constructed similarly to and operates like the compressor regulator disclosed in Patent No. 1,430,578 granted to me October 3, 1922, with the exception, that in accordance with the present invention, a sixth step has been added to the regulator effected by the main operating valve in the auxiliary casing Y which causes the actuation of the intercooler unloader valve S in the casing T shown connected to the bottom portion U of the intercooler C. This sixth step is also indicated in the aforesaid pending application, but in that case, bypass connections are controlled between the ends of the cylinders A and B. In the present instance, the intercooler unloader valve S opens the intercooler to atmosphere through the atmospheric port V and when this has occurred, cylinder relief valves shown as ball valves *a* in the relief valve casing *b* mounted adjacent the high pressure

cylinder B are operated to vent or unload the high pressure cylinder. The apparatus of the present invention is so constructed that in case the electric power for the motor G fails, the cylinders are unloaded by means of clearance chambers and the intercooler is also automatically unloaded, which in turn causes complete automatic unloading of the high pressure cylinder through the operation of the relief valves *a*. When electric power is restored, the clearance chambers load the cylinders and the intercooler unloading valve is automatically closed so that as soon as pressure builds up in the intercooler, the cylinder relief valves are automatically closed and the cylinder is fully loaded again.

In this instance the unloading system in general is like that indicated in my former patent in which the cylinders A and B are provided with clearance valves *c* controlling clearance chambers (not shown), and the valves *c* are adapted to be connected by pipes 1, 2, 3 and 4 with correspondingly numbered pipes 1, 2, 3 and 4 on the regulator X. The auxiliary casing Y for the sixth or intercooler step of unloading is connected by pipe 5 to the casing T of the intercooler unloader valve S, and pressure fluid from the receiver is led to the regulator X and the auxiliary casing Y by the pipe 36 connected to the receiver pipe H. All the cylinder unloader valves *c* are adapted to be held closed by receiver pressure in the usual manner, and they open when receiver pressure is released from the valves successively. The intercooler valve S is held closed by the spring *d* and is opened by receiver pressure supplied behind the piston *e* from the pipe connection 5, as controlled by the mechanism in the auxiliary casing Y, shown in detail in Figure 2.

The auxiliary automatic device Z and its cooperating parts, shown diagrammatically at the upper left hand corner of Figure 1, for controlling the main regulator from the switch board, is like that disclosed in my aforesaid application, and is there described in detail so that only its principal features need here be described. The switch *p* on the switch board is connected by the leads *r* to the solenoid *g*, which in turn is adapted to control pressure fluid mechanism in the casing Z, for actuating the plunger rod *u* having a tip *w* bearing under the lever R.

Pressure fluid is adapted to be supplied from the receiver D to the casing Z by means of the pipe *x* shown broken away, and the casing has a vent to atmosphere at *y* and means are provided controlled by the solenoid *g* for controlling the admission and exhaust of pressure fluid to the casing Z, for actuating the plunger *u* and thus raising and lowering the lever R to a greater or less extent for partially or completely unloading the compressor at any desired time, regard-

less of the automatic control of the regulator. Operative connections are provided between the armature *z* of the solenoid *g* and inlet and release valves 6 and 7 are indicated below the lower head 8 of the casing Z. A pivoted lever 25 carrying the stops 24 is connected to be actuated by the solenoid core *z* and alternately open and close the inlet and release valves 6 and 7 as the lever is rocked on its pivot all as shown in the aforesaid application. By closing the switch *p* and energizing the solenoid *g*, the armature *z* is raised, thus closing the admission valve 6 and opening the release valve 7, which lowers the plunger rod *u* and permits the lever R to be loaded and function automatically as usual. By opening the switch *p* and deenergizing the solenoid *g* the action of the valves 6 and 7 is reversed and the plunger rod *u* is raised to raise the lever R and unload the compressor.

In order to indicate to the switch board tender that the auxiliary device Z has caused the unloading of the compressor, a signal light 10 on the switch board is connected by the connections 11 to a switch 12 mounted adjacent the auxiliary device Z and adapted to be actuated by a member 14 to close and open the switch as the plunger rod *u* moves upwardly and downwardly.

The construction and operation of the main regulator X with the exception of the additional main operating valve in the casing Y is fully described and shown in my aforesaid Patent No. 1,430,578 so that this regulator will be but briefly described, reference being had to said patent for further details. The auxiliary or pilot valve 30 of the regulator X is connected at the point 31 to the weighted lever R and is provided with the heads 32 and 33 operating in the valve chamber 34. The space between the heads 32 and 33 is constantly subjected to receiver pressure through the ports 35 communicating with the pipe 36, subject to receiver pressure. Main operating valves 37 of which there are four, are provided with the heads 38 and 39, and control the pipes 1, 2, 3 and 4 leading to the cylinder clearance valves *c*. The fifth main operating valve 37 is contained in the valve casing Y and controls the pipe 5 leading to the casing T of the intercooler unloader valve S. The main regulator X is provided with the atmospheric vent 40 and the auxiliary casing Y of the regulator is provided with the atmospheric vent 41. The shoes 42 of the main operating valves 37 control the ports 43 and 44. The spaces 45 between the valve heads 38 and 39 are constantly open to receiver pressure through the passages 46, and ports 1^a, 2^a, 3^a and 4^a, controlled by the head 32 of the auxiliary valve 30, and alternately supply pressure to and release pressure from the heads 39 of the main valves 37, while ports

1^b, 2^b, 3^b and 4^b function in the same manner for the heads 38 of the valves 37. The passage 47 is open to atmosphere and communicates through appropriate ports and passages with the end faces of the valve heads 38. Obviously, as the shoes 42 of the valves 37 move up and down, pressure is successively supplied from the valve spaces 45 to the pipes 1, 2, 3 and 4 leading to the pairs of cylinder clearance valves *c* for holding the clearance valves closed and for successively releasing the pressure in said pipes through the ports 43 and 44 and the atmospheric vent 47. The valve 37 in the auxiliary valve casing Y which controls the intercooler clearance valve operates in the same manner and is provided with auxiliary passages 48 and 49 leading to the ports 50 and 51 respectively which are also controlled by the valve heads 32 and 33 of the auxiliary valve 30. The valve 37 in the casing Y alternately supplies and releases pressure in the pipe 5 for controlling the opening and closing of the intercooler unloading valve S.

The cylinder relief valve casings *b* containing the unloading valves *a* are connected to the ends of the high pressure cylinder B by the connections *f* communicating with the caps *g* which contain the valve seats *h* for seating the ball valves *a*. The casings *b* are provided with the atmospheric vents *j* so that when the valves are unseated as shown in Figure 3, both ends of the cylinder are vented to atmosphere and completely unloaded.

Pins *k* under the ball valves *a* bear in plungers *o* in the casings *b* and retracting springs *s* return the plungers to the positions indicated in Figure 3 after they have been raised or forced forwardly by fluid pressure supplied through the pipe *t* and branches *v*, which pipe *t* is connected at the point 20 to the pipe connection 21 which connects the intercooler C with the high pressure cylinder B. The pressure in the high pressure cylinder normally maintains the ball valves *a* against their seats *h*, but when the pressure in the intercooler is reduced to atmospheric pressure or approximately that, the pressure in the pipe *t* leading to the relief valve casings is released and the ball valves *a* are allowed to open for completely unloading the high pressure cylinder.

In the operation of the apparatus, let it be assumed that the operator or switch board tender desires for some sufficient reason to unload the compressor completely. He will in that case throw the magnetic controller switch *p* to open position and thus deenergize the solenoid *q* which will in turn cause the plunger rod *u* to be moved upwardly or outwardly under the regulator lever R and cause the pilot valve 30 to be raised to its highest position. All the main valves 37 in the main regulator will then assume their

lowermost positions as indicated in Figure 2 and the cylinder clearance valves *c* will be vented to atmosphere through their respective pipes 1, 2, 3 and 4 so that the clearance chambers will all be open and at the same time the main valve 37 in the auxiliary casing Y will supply pressure fluid from the receiver from the pipe 36 to the pipe connection 5 which will actuate the piston *e* of the intercooler unloading valve S and open said valve to unload the intercooler. The drop in pressure in the intercooler will release the spring pressed plungers *o* of the relief valves or unloader valves *a* of the high pressure cylinder which will accordingly open as shown in Figure 3 and vent both ends of the high pressure cylinder to atmosphere, thus completely unloading the high pressure cylinder. To reverse the operation, the magnetic controller switch *p* is again closed so that the compressor cylinders will be loaded, the intercooler unloader valve S will be closed and as soon as pressure builds up in the intercooler, the cylinder relief valves *a* will be closed, thus fully loading the high pressure cylinder. In ordinary running position, the switch *p* is maintained closed and in that case, if the current for the driving motor G should fail the solenoid *q* will be deenergized, which will automatically unload the compressor as described, and when current is restored the compressor will be automatically loaded, so that the apparatus is automatic or may be controlled manually as desired.

I claim:

1. In a compressor, the combination of cylinders and an intercooler, means for unloading the intercooler, and means for automatically unloading the cylinder beyond the intercooler when the intercooler is unloaded.
2. In a multi-cylinder compressor, the combination of the cylinders and intercooler, means for unloading the intercooler, means for unloading the cylinder beyond the intercooler, and connections for automatically causing operation of the cylinder unloading means when the intercooler is unloaded.
3. In a compound compressor, the combination of high and low pressure cylinders, an intercooler, an unloading valve for the intercooler, relief valves for both ends of the high pressure cylinder, and means for automatically actuating the said relief valves to unload the high pressure cylinder when the intercooler is unloaded.
4. In a compressor, the combination of cylinders and an intercooler, means for unloading and loading the intercooler, and means for automatically unloading and loading the cylinder beyond the intercooler in accordance with unloading and loading of the intercooler.
5. In a multi-cylinder compressor, the combination of the cylinders and intercooler,

means for unloading the intercooler, means for unloading the cylinder beyond the intercooler, and connections for automatically causing loading and unloading operation of the cylinder unloading means in accordance with the loading and unloading of the intercooler. intercooler, an unloading valve for the intercooler, relief valves for both ends of the high pressure cylinder, and means for automatically actuating said relief valves to load and unload the high pressure cylinder when the intercooler is loaded and unloaded. 10 15

6. In a compound compressor, the combination of high and low pressure cylinders, an

In testimony whereof I have signed this specification.

CHESTER W. METZGAR.