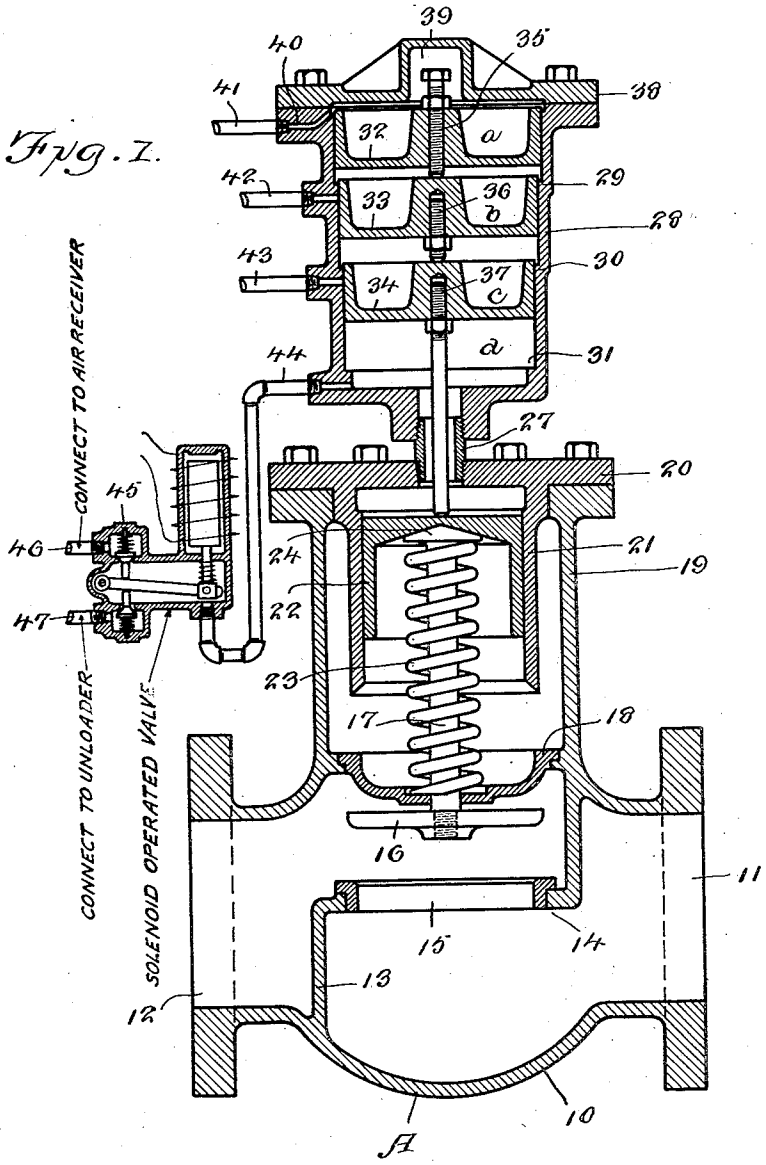
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MULTISTEP INTAKE UNLOADER

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Fig. 1.




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Fig. 2.

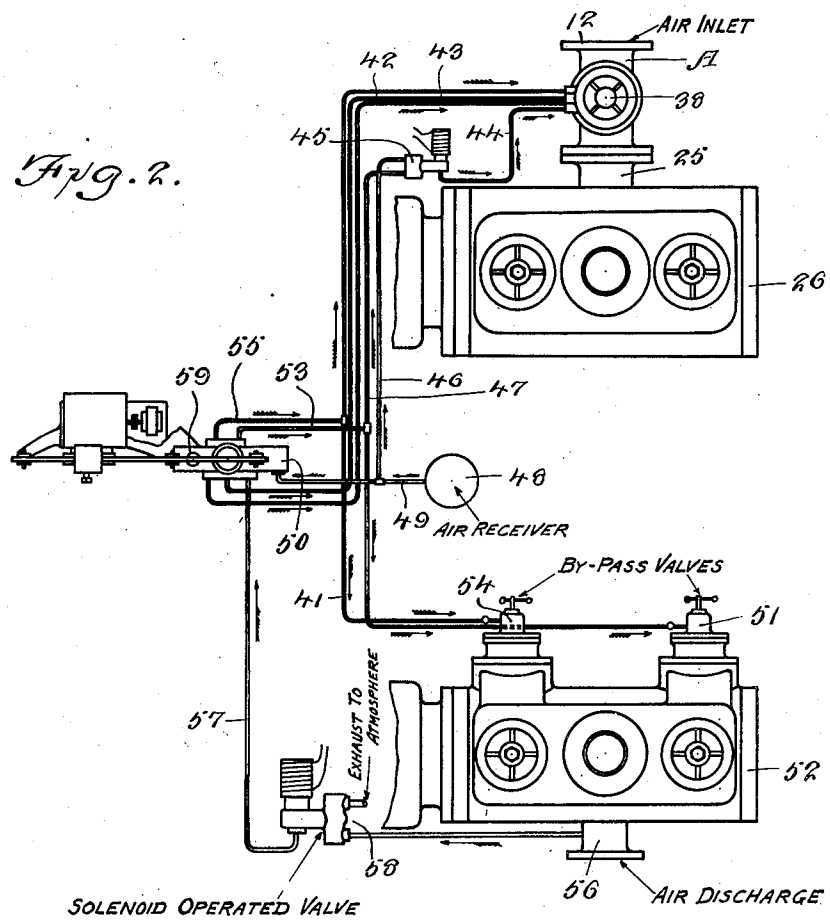
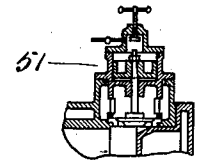



Fig. 3.




SECTION THRU BY-PASS VALVE

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Patented Aug. 22, 1939 2,170,358

# UNITED STATES PATENT OFFICE

2,170,358

## MULTISTEP INTAKE UNLOADER

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Application March 25, 1936, Serial No. 70,903

9 Claims. (Cl. 230—25)

The invention relates to an intake unloader for compressors and more especially to a multi-step intake unloader.

The primary object of the invention is to provide an appliance of the kind indicated which is effective for unloading purposes when used in combination with the intake of a compressor and a multi-step governor of the general character of that disclosed in application No. 70,902, filed March 25, 1936, and is automatic in operation to make possible the complete unloading of a high pressure cylinder of the compressor when the multi-step governor is working at no load.

Another object of the invention is the provision of a device of this character, wherein the construction thereof is novel in form and assures a step by step unloading of a compressor so as to relieve the same from a compression load and particularly when starting or stopping such compressor.

A further object of the invention is the provision of a device of this character, which is comparatively simple in its construction, thoroughly reliable and efficacious in its operation, durable, automatic in the working thereof and inexpensive to manufacture and install.

With these and other objects in view, the invention consists in the features of construction, combination and arrangement of parts as will be hereinafter more fully described, illustrated in the accompanying drawings, which disclose the preferred embodiment of the invention and pointed out in the claims hereunto appended.

In the accompanying drawings:

Figure 1 is a sectional view through an unloader constructed in accordance with the invention for service in a four-step unloading operation for a compressor.

Figure 2 is a fragmentary plan view of the unloader associated with a two-cylinder two-stage compressor and a governor, respectively.

Figure 3 is a fragmentary sectional view of an unloading valve, sometimes termed a by-pass valve, as equipped with the compressor.

Similar reference characters indicate corresponding parts throughout the several views in the drawings.

Referring to the drawings in detail, A designates generally a globe valve casing constituted by the body 10 having the open ends 11 and 12, respectively, and interiorly of this body is a partition 13 formed with a valve opening 14 fitted with a replaceable valve seat 15 for a disk valve 16, its stem 17 being slidable through a centering piece 18 fitted within the body 10 at the inner end of a cylinder extension 19 on said body 10. Fitting this extension 19 is a closure cap 20 having a guide cylinder 21 projected into said extension 19 and accommodating a slidable guide piston 22 fitting said stem 17. Surrounding the stem 17 is a coiled unseating valve spring 23, which is supported by the centering piece 18 and contacts with a shoulder 24 formed on the stem 17 next to the piston 22 so that the valve 16 will be normally raised from its seat 15 thus allowing flow through the body 10 from one opening 11 to the other opening 12 therein.

The open end 11 has communication with the intake 25 of the low pressure cylinder 26 of a two-cylinder two-step compressor while the open end 12 affords an air inlet to said body 10.

Fitted centrally in the cap 20 of the extension 19 is a nipple 27 for the joining therewith of an unloader shell 28 having interiorly thereof stepped annular seats 29, 30 and 31, respectively, while coacting with these seats are the pistons 32, 33 and 34, respectively, these dividing the said shell 28 into separated unloading chambers *a*, *b*, *c* and *d*, respectively. Fitting the pistons 32, 33 and 34 are the adjustable reach bolts 35, 36 and 37, the latter bolt working through the nipple 27 for contact with the piston 22 fitting the guide cylinder 21 while the bolts 35 and 36 have contact with the pistons 33 and 34, respectively, maintaining the division of the chambers *a*, *b*, *c* and *d* as constituted within the shell 28. The shell 28 is fitted with an end head 38 having a depression 39 affording a clearance for the reach bolt 35 carried by the piston 32. These bolts 35, 36 and 37 are centrally located in the said pistons.

Communicating with each of the chambers *a*, *b*, *c* and *d* is a duct 40 and extending from these are pipes 41, 42, 43 and 44, the pipe 41 being in communication with the chamber *a*, the pipe 42 in communication with the chamber *b*, the pipe 43 in communication with the chamber *c* and the pipe 44 in communication with the chamber *d*. The pipe 44 through a standard electric solenoid operated valve 45 alternately communicates with branch leads 46 and 47, the lead 46 being connected with an air receiver 48 by a line 49 extending to a governor 50 which is structurally like that shown in the application hereinbefore referred to. The air receiver 48 is that for the compressor and the line 49 communicates with the air cylinder of said governor 50. The lead 47 extends to an unloading or by-pass valve 51 of the high pressure cylinder 52 of the compressor and also by line 53 with the cylinder of the governor 50. The other unloading or by-

pass valve 54 of said cylinder 52 has the pipe 41 leading thereto and this pipe by line 55 has communication with the cylinder of the governor 50. The pipes 42 and 43 extend to the cylinder of the governor 50.

Leading from the discharge side 56 of the high pressure cylinder 52 to the distributor chamber of the governor 50 is a pipe 57 and fitted with this pipe is a manually or automatically operated three-way valve 58, the purpose of the latter being that when in one position compressor air to the governor 50 and its connections is exhausted to the atmosphere and when in another position it furnishes compressor air to the said governor 50, the valve 58 being shown as of the electric solenoid type similar to the valve 45 hereinbefore referred to. The valves 51 and 54 form communication between the ends of the cylinder 52 and the intake chamber of such cylinder so that when these valves are open each at the particular end of the cylinder renders such end inoperative and when closed operative.

The stem 17 of the valve 16 is limited in an upward travel so that the valve 16 has a definite upper limit of movement. The governor 50 in its type is of a five-step control and the exhaust of this governor is indicated at 59.

In the operation of the unloader a predetermined terminal pressure is chosen for the compressor and the governor 50 is set to operate at this pressure. When this pressure is reached by the compressor the governor 50 goes into action and for the first step compressed air is admitted through the pipe 41 into the chamber *a* forcing the piston 32 to its seat 29 and concurrently therewith moving the piston 22 downwardly in the cylinder 21 a distance equal thereto, that is, one-fourth of the distance to be traveled toward the seat 15 of the valve 16. If terminal air pressure still goes higher compressed air admitted through line 55 to unloading valve 54 making that end of the cylinder 52 inoperative and at the same time furnishing compressed air to pipe 42 driving the piston 33 downward to its seat 30 will cause the piston 22 and the valve 16 to move another one-fourth of its total downward travel and thus such valve 16 will then be half closed. If the terminal air pressure still goes higher compressed air is admitted through pipe 43 into chamber *c* forcing the piston 34 to its seat 31 with the result that the piston 22 and the valve 16 will have moved another definite distance so that the valve 16 will have approached its seat 15 another one-fourth travel of total downward movement and further increase in terminal air pressure compressed air is admitted through the pipes 44 and 47 into chamber *d* causing the piston 22 to be moved downwardly in the cylinder 21 to have the valve 16 come in contact with the seat 15 thus completely closing communication between the open ends 11 and 12 in the body 10 and at the same time compressed air through the connection 47 with the unloading valve 51 is carried to said valve and thereby effecting the high pressure cylinder or compressor to be completely unloaded.

By means of the solenoid valve 45, fluid pressure from the receiver 48 can be introduced directly into the chamber *d*, since the operation of closing the circuit on the solenoid will shift the valve 45 to open position, closing the complemental valve. On the introduction of receiver pressure into the chamber *d*, it will be effective on the piston 22 to move the valve 16 into contact with its seat 15. Thus, in the automatic starting and stopping of the compressor the compression load may be taken off or put on as may be deemed necessary.

From the foregoing it will be apparent that the unloading device is of a multi-step intake unloader for compressors and such unloading through these steps may be had of any fractional part of the maximum capacity of such compressor, in this instance the unloader being in quarter steps of maximum load capacity.

What is claimed is:

1. In combination with a compressor, an air receiver, and a multi-step governor operatively connected with the receiver and with the compressor to unload the latter, the improvement which comprises a valve disposed at the intake of the compressor and interposed in the connections between that and the governor to automatically vary the fluid volume admitted and yieldingly impelled to open position, said valve being interposed in the connections between the governor and the compressor and provided with means coordinated with the governor to be moved toward closed position a distance in accordance with any step assumed by the governor in its unloading functions.

2. In combination with a compressor having high pressure and low pressure cylinders, an air receiver, and a multi-step governor operatively connected with the receiver and with the compressor cylinders to unload the latter, the improvement which comprises a valve disposed at the intake of the low pressure cylinder and interposed in the connections with the governor, the valve being normally impelled to open position and governor controlled for movement toward closed position to varying extents dependent on the position assumed by the governor in its unloading functions.

3. In combination with a compressor having high pressure and low pressure cylinders, an air receiver, and a multi-step governor operatively connected with the receiver and with the compressor cylinders to unload the latter, the improvement which comprises a valve positioned at the intake of the low pressure cylinder and yieldingly impelled to open position, said valve being interposed in the connections between the governor and the cylinder and provided with means coordinated with the governor to be moved toward closed position a distance in accordance with any step assumed by the governor in its unloading functions.

4. In combination with a compressor having high pressure and low pressure cylinders, an air receiver, and a multi-step governor operatively connected with the receiver and with the compressor cylinders to unload the latter, the improvement which comprises a valve disposed at the intake of the low pressure cylinder and spring impelled to open position, the valve being interposed in the connections between the governor and the low pressure cylinder and provided with governor responsive means to move it to closing position and divide the closing movement into fractional parts of the full movement so that the fluid volume admitted to the low pressure cylinder will be determined by the position of the governor in its unloading functions.

5. In combination with a compressor having high pressure and low pressure cylinders, an air receiver, and a multi-step governor operatively connected with the receiver and with the compressor cylinders to unload the latter, the improvement which comprises a valve disposed at

the intake of the low pressure cylinder and spring impelled to open position, the valve being interposed in the connections between the governor and the low pressure cylinder and provided with governor responsive means to move it to closing position and divide the closing movement into fractional parts of the full movement so that the fluid volume admitted to the low pressure cylinder will be determined by the position of the governor in its unloading functions, one of the connections between the governor and said valve being provided with means for selectively admitting receiver pressure direct to the valve to effect full closing movement of the latter.

6. In combination with a compressor having high pressure and low pressure cylinders, an air receiver, and a multi-step governor operatively connected with the receiver and with the compressor cylinders to unload the latter, the improvement which comprises a valve disposed at the intake of the low pressure cylinder and spring impelled toward open position, a series of superposed operatively connected pistons, a shell surmounting the valve and enclosing the pistons and divided by the latter into chambers respectively in communication with the steps of the governor, the uppermost chamber being continuously in communication with its step of the governor and communication between the remaining chambers and the governor steps being controlled by the pistons, whereby movement of the valve toward closed position to control the fluid volume admitted to the low pressure cylinder is varied in accordance with the particular step or steps of the governor that are functioning.

7. In combination with a compressor having high pressure and low pressure cylinders, an air receiver, and a multi-step governor operatively connected with the receiver and with the compressor cylinders to unload the latter, the improvement which comprises a valve disposed at the intake of the low pressure cylinder and spring impelled toward open position, a series of superposed operatively connected pistons, a shell surmounting the valve and enclosing the pistons and divided by the latter into chambers respectively in communication with the steps of the governor, the uppermost chamber being continuously in communication with its step of the governor and communication between the remaining chambers and the governor steps being controlled by the pistons, whereby movement of the valve toward closed position to control the fluid volume admitted to the low pressure cylinder is varied in accordance with the particular step or steps of the governor that are functioning, the operative connections between the pistons being adjustable to vary the spacing between the same.

8. In a compressor system, compressor means having an air inlet, an intake unloader associated with the air inlet, the unloader comprising a valve, a housing provided with a plurality of axially aligned communicating bores of different diameters with each bore terminating in a ledge, a piston slidable in each bore, spacing means cooperable with said pistons for holding the latter in predetermined spaced relation, the spaces between the pistons constituting air inlet chambers and the piston of the largest diameter being spaced from an end wall of the housing to provide an air inlet chamber, said valve including a port and a valve element, a stem secured to said valve element guided for movement longitudinally of the common axis of said bores, said valve element being movable toward and away from said port, a multi-step governor having connections with said housing for respective communication with said chambers, said multi-step governor responding to predetermined compressor discharge pressure for selectively admitting compressed air to said chambers, for successively moving said pistons to move said valve element corresponding distances toward a closed position with respect to said port, each piston being movable into seating relation upon the ledge associated with its respective bore, and resilient means for urging the valve element toward an open position.

9. In a compressor system, compressor means having an air inlet, an intake unloader associated with the air inlet, the unloader comprising a valve body having a port and a valve element for closing the port, a housing provided with a plurality of axially aligned communicating bores of different diameters with each bore terminating in a ledge, a piston slidable in each bore, spacing means cooperable with said pistons for holding the latter in predetermined spaced relation, the spaces between the pistons constituting air inlet chambers and the piston of the largest diameter being spaced from an end wall of the housing to provide an air inlet chamber, a stem secured to said valve element guided for movement longitudinally of the common axis of said bores, a cylinder having a closing piston abutting said stem and said closing piston being engaged by one of said spacing means, said valve element being movable toward and away from said port, a multi-step governor having connections with said housing for respective communication with said chambers and said cylinder, said multi-step governor responding to predetermined compressor discharge pressure for selectively admitting compressed air to said chambers and said cylinder, for successively moving said pistons to move said valve element corresponding distances toward a closed position with respect to said port, each piston being movable into seating relation upon the ledge associated with its respective bore, resilient means cooperable with the closing piston and said stem for urging the valve element toward an open position, and means interposed in one of said connections for admitting compressed air to said cylinder for closing the valve element independent of the other pistons.

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