W. PRELLWITZ.

UNLOADER FOR COMPOUND FLUID COMPRESSORS.

APPLICATION FILED MAY 31, 1907.

1,019,360.

Patented Mar. 5, 1912.

5 SHEETS—SHEET 1.

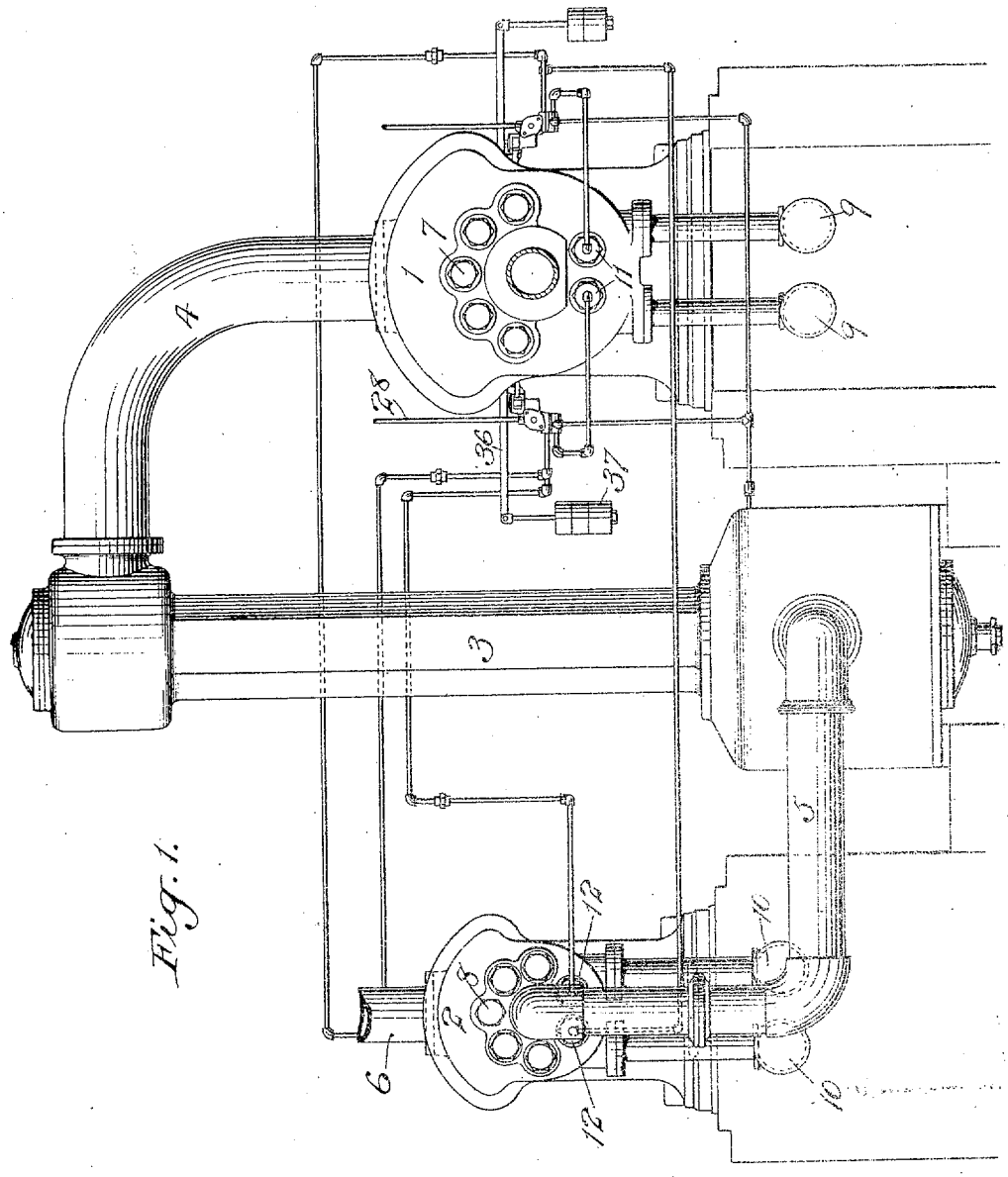

Fig. 1.

Witnesses:
F. George Barry
Henry Orkwine

Inventor:
William Prellwitz
by attorneys
Brownell & Brownell

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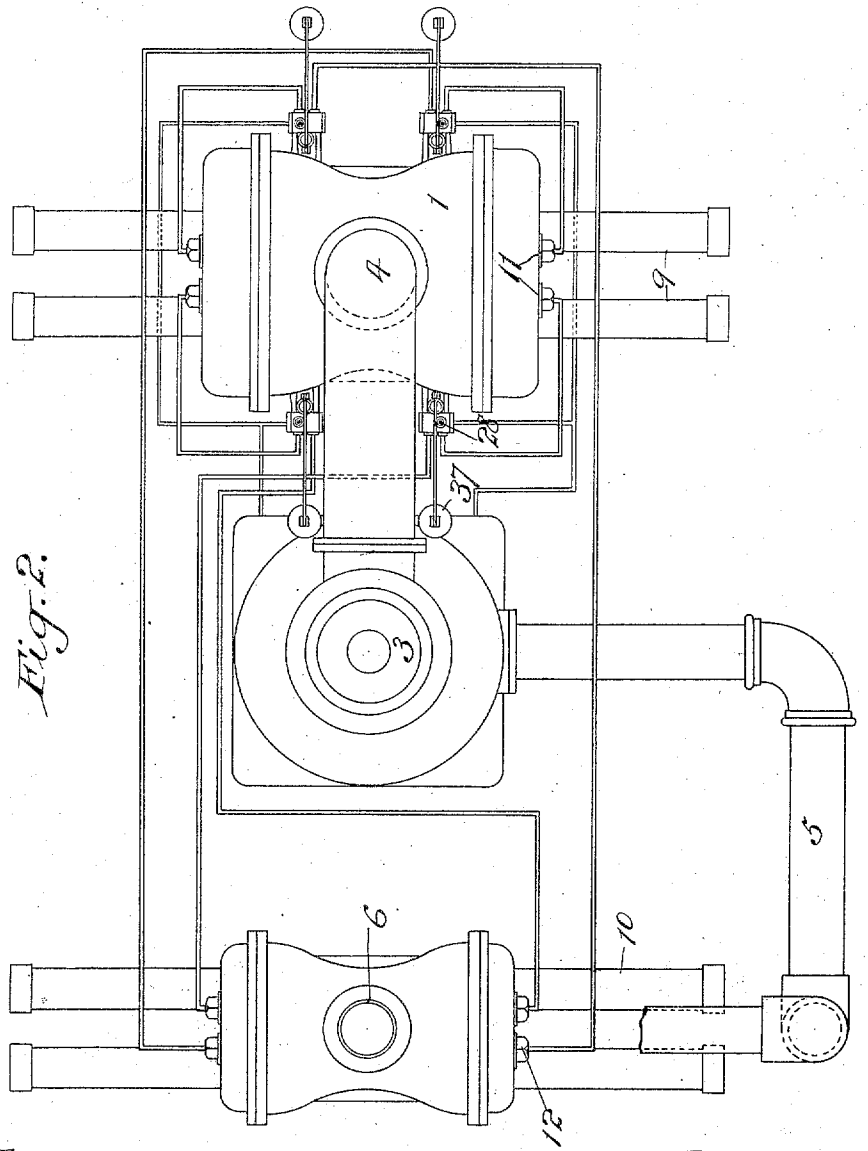

Fig. 2.

Witnesses:-
J. George Barry,
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5 SHEETS—SHEET 3.

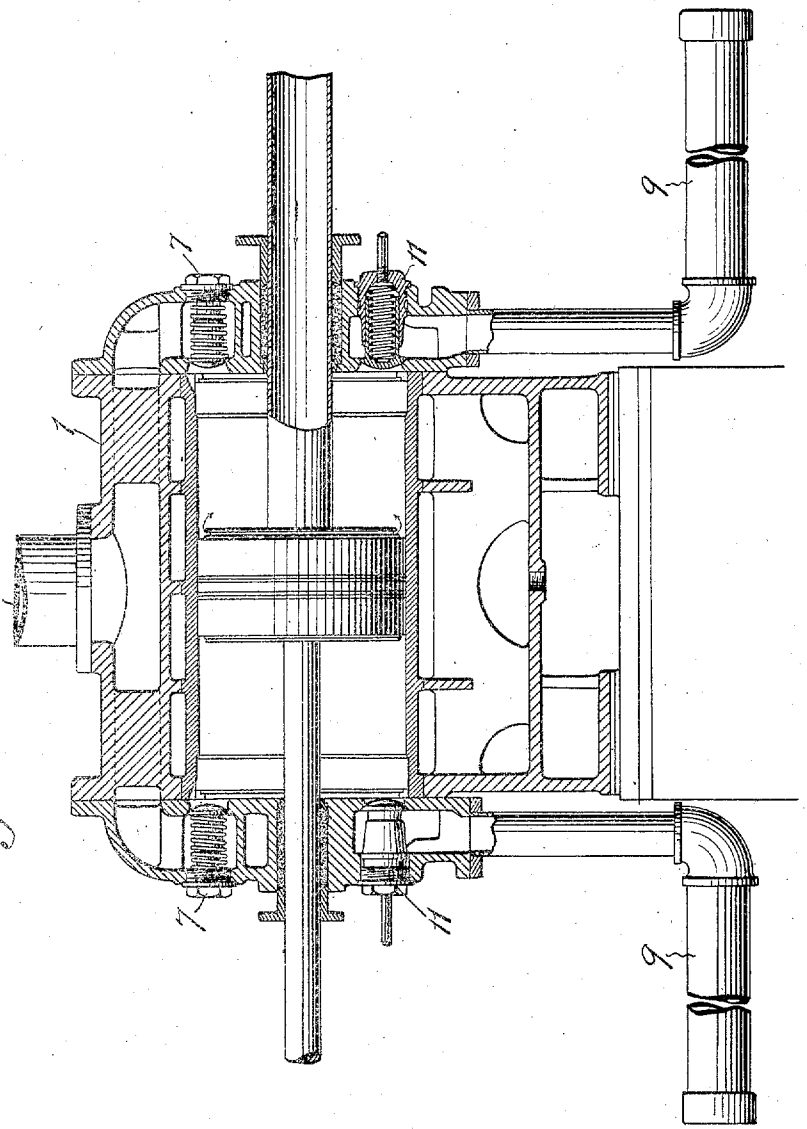

Fig. 3.

Witnesses:
F. George Barry,
Henry Cathcart.

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5 SHEETS—SHEET 4

Fig. 6.

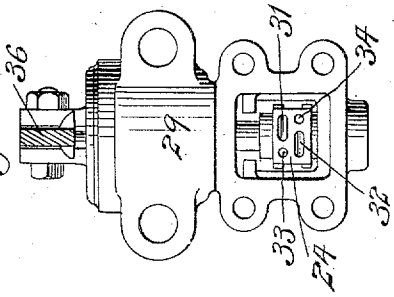


Fig. 8.

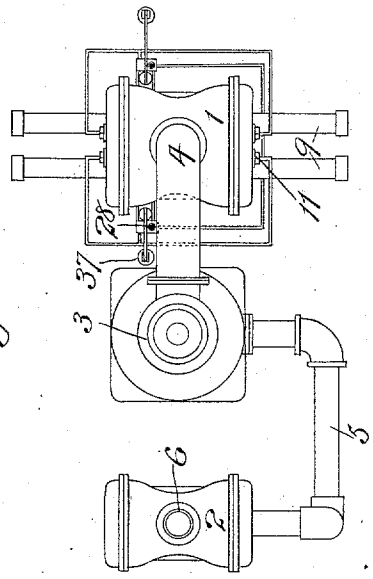


Fig. 4.

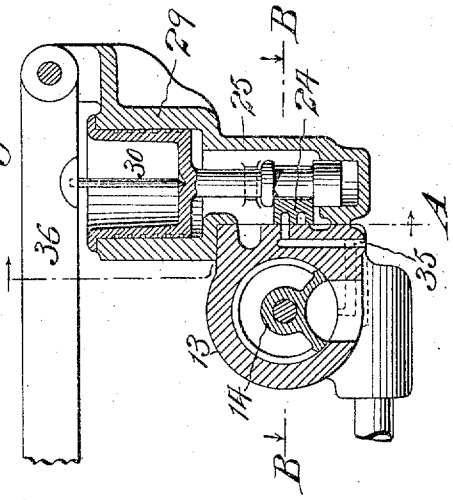


Fig. 7.

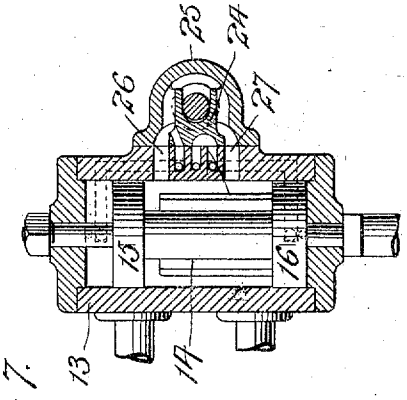
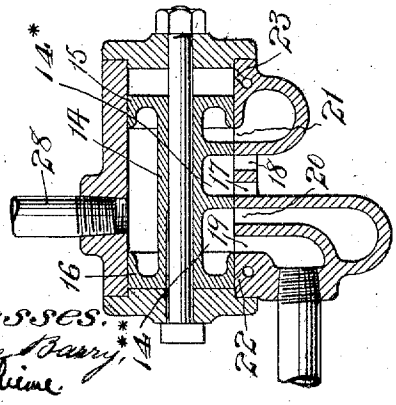


Fig. 5.



Witnesses:
F. George Basey,
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Inventor:
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5 SHEETS—SHEET 5.

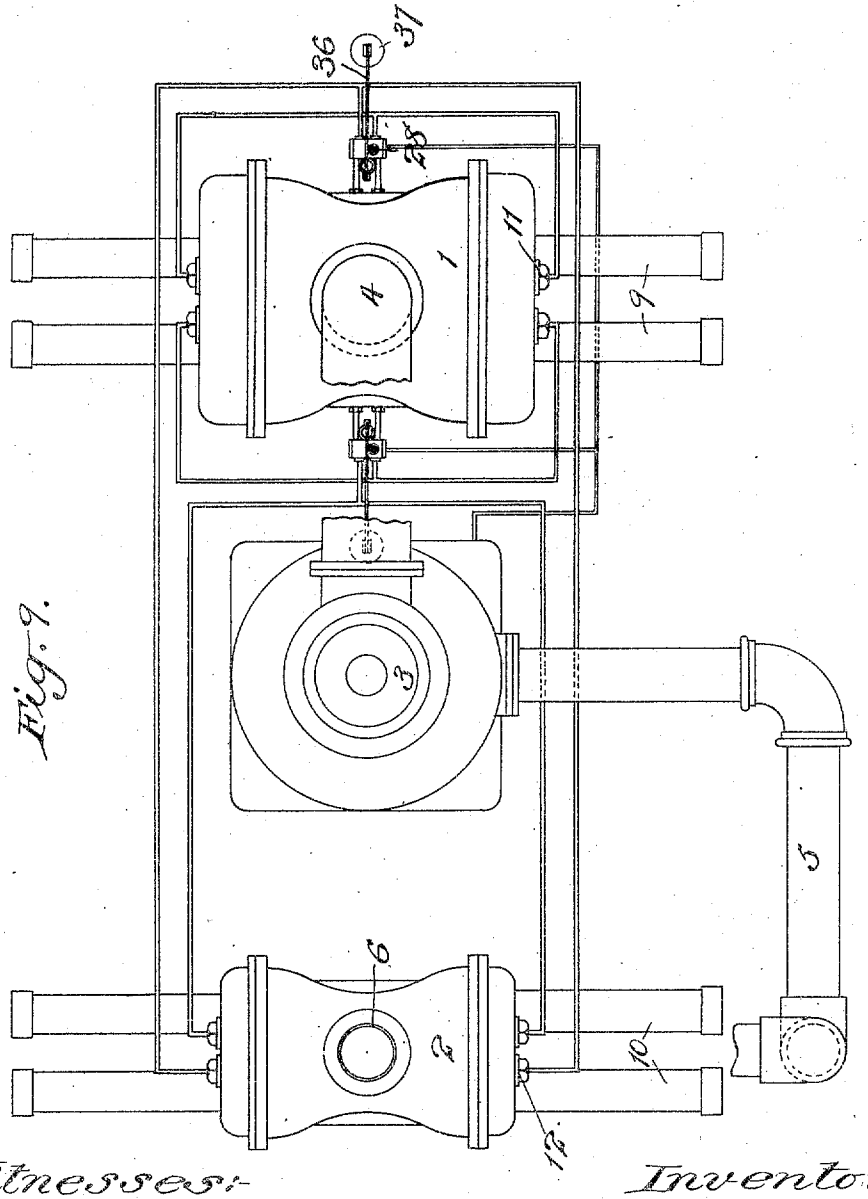

Fig. 9.

Witnesses:-
F. George Barry,
Henry A. Heine.

Inventor:-
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Bonnell & Brock

UNITED STATES PATENT OFFICE.

WILLIAM PRELLWITZ, OF EASTON, PENNSYLVANIA, ASSIGNOR TO INGERSOLL-RAND COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

UNLOADER FOR COMPOUND FLUID-COMPRESSORS.

1,019,360. Specification of Letters Patent. Patented Mar. 5, 1912.

Application filed May 31, 1907. Serial No. 376,703.

To all whom it may concern:

Be it known that I, WILLIAM PRELLWITZ, a citizen of the United States, and resident of Easton, in the county of Northampton and State of Pennsylvania, have invented a new and useful Improvement in Unloaders for Compound Fluid-Compressors, of which the following is a specification.

My invention relates to means for unloading compound fluid compressors and consists broadly in novel means arranged to automatically unload the compressor when the pressure rises to a predetermined point and load the compressor when the pressure falls to a predetermined point, said means comprising an auxiliary receiver, the valve for opening and closing communication between the compressor and auxiliary receiver and a regulating device, such as a fluid pressure governed regulator, connected to the back of the auxiliary receiver valve.

My invention further consists in means for unloading and loading the compound compressor step by step as the pressure rises and falls to predetermined points, said means comprising a plurality of auxiliary receivers, valves arranged to open and close communication between the compressor and the auxiliary receivers and a plurality of regulating devices, such as fluid pressure governed regulators, connected to the backs of the auxiliary receiver valves for unloading and loading the valves successively as the pressure rises and falls.

This present invention is also directed to the novel means above set forth applied either to both the high and low pressure cylinders or to the low pressure cylinder of a compound fluid compressor.

Practical embodiments of my invention are represented in the accompanying drawings in which—

Figure 1 represents an end view of a compound fluid compressor with my novel unloading means applied thereto. Fig. 2 is a diagrammatic plan view of the same, Fig. 3 is a longitudinal section through the low pressure cylinder, Fig. 4 is a central vertical section through the fluid pressure governed regulator which is shown in connection with my unloading means, Fig. 5 represents a central vertical section of the regulating valve, Fig. 6 is a view taken in the plane of the line A—A of Fig. 4, looking in the direction of the arrows, Fig. 7 is a horizontal section taken in the plane of the line B—B of Fig. 4, looking in the direction of the arrows, Fig. 8 is a diagrammatic plan view showing means for unloading and loading the low pressure cylinder only of the compound fluid compressor, and Fig. 9 is a diagrammatic plan view showing a modified arrangement of the unloading means in which two fluid pressure governed regulators are shown for unloading and loading both the high and low pressure cylinders instead of four as shown in the preferred form.

Proceeding to describe the form shown in Figs. 1 to 7 inclusive, the low pressure cylinder is denoted by 1, the high pressure cylinder by 2 and the intercooler by 3. The pipe leading from the low pressure cylinder to the intercooler is denoted by 4 and the pipe leading from the intercooler to the high pressure cylinder is denoted by 5. The pipe which leads from the high pressure cylinder to the final receiver (not shown), is denoted by 6. The main discharge valves of the low pressure cylinder are denoted by 7 and the main discharge valves of the high pressure cylinder by 8. It is to be understood that the compressor is driven from any suitable source of power, not shown herein. Auxiliary receivers 9 are provided for the low pressure cylinder and auxiliary receivers 10 are provided for the high pressure cylinder. Valves 11 are provided for opening and closing communication between the low pressure cylinder and the auxiliary receivers 9, and valves 12 are provided for opening and closing communication between the high pressure cylinder 2 and the auxiliary receivers 10. Four auxiliary receivers 9 and their valves may be provided for the low pressure cylinder 1, communicating at each end thereof. Four auxiliary receivers 10 and their valves may be provided for the high pressure cylinder 2, communicating with each end thereof. The backs of the auxiliary receiver valves are brought into communication with regulating devices, such as fluid pressure governed regulators of the form disclosed in United States Letters Patent No. 514,839 dated February 13, 1894, changed to suit a compound compressor, a general description of the construction, arrangement and operation of which

follows. 13 is a cylindrical valve box containing the main slide valve 14 having piston heads 15, 16 and bridge ports 14^{x}, 14^{xx}. This valve box is provided with ports 17, 18, leading to atmosphere and ports 19, for the intercooler, 20 for the auxiliary receiver valves of the low pressure cylinder and 21 for the auxiliary valves of the high pressure cylinder. The main valve 14 is operated by pressure upon one or the other of its piston heads 15, 16, by fluid admitted at the ends of the valve box through ports 22, 23, under the control of an auxiliary slide valve 24 in a box 25 which is always open to the valve box 13 through the passages 26, 27. A pipe 28 leads from the receiver to the space between the main valve piston heads 15, 16 so that this space and the interior of the box 25 are always open to receiver pressure. The main valve 14 is provided with ports arranged to open communication from the backs of the auxiliary receiver valves on the high and low pressure cylinders to atmosphere or to the receiver and intercooler respectively, according to the position of the valve. When the main valve is in one position the auxiliary valves of the high pressure cylinder are loaded by having their backs open to receiver pressure through the port 21, interior of box 13 and pipe 28, and the auxiliary receiver valves of the low pressure cylinder are loaded by having their backs open to intercooler pressure, through the ports 20, 14^{xx} and 19. When the main valve is in its other position, the auxiliary receiver valves of the high pressure cylinder are unloaded by having their backs open to atmosphere through ports 21, 14^{x} and 18, and the auxiliary receiver valves of the low pressure cylinder are unloaded by having their backs open to atmosphere through ports 20, 14 and 17. The top of the auxiliary valve box 25 is provided with a cylinder 29 which is open at the bottom to the interior of the said box. A piston 30 is fitted to slide in the cylinder 29, which piston is arranged to move the auxiliary valve 24 under the influence of receiver pressure. This auxiliary valve 24 is provided with upper and lower bridge ports 31, 32, and upper and lower through ports 33, 34. The main valve box 13 is provided with a port 35 intermediate the ports 22, 23. These several ports are so arranged that the movement of the auxiliary valve will control the movement of the main valve. The piston 30 for operating the auxiliary valve is weighted to hold the auxiliary valve in position to keep the loading on the auxiliary receiver valves until a predetermined high pressure has been reached, by means of a weighted arm 36, the weights 37 on which may be so regulated that the back of the auxiliary receiver valves will be unloaded by the movement of the main valve under the control of the movement of the auxiliary valve when said predetermined high pressure has been reached. In the form being described, four of these fluid pressure governed regulators are shown, each regulator being arranged to control the unloading of a valve of an auxiliary receiver 9 at one end of the low pressure cylinder and the valve of an auxiliary receiver 10 at the other end of the high pressure cylinder.

In the form shown in Fig. 9, two fluid pressure governed regulators only are shown, each regulator communicating with the backs of the valves of two auxiliary receivers at the opposite ends of the low pressure cylinder and the valves of two auxiliary receivers at the opposite ends of the high pressure cylinder. In Fig. 8, a form is shown in which the low pressure cylinder only is provided with auxiliary receivers and regulators for their valves. The several forms shown therein are for the purpose of illustrating the point that any number of auxiliary receivers may be employed and any number of regulators to suit different requirements.

The operation of the simplest form of my invention would be as follows. An auxiliary receiver of a predetermined size is connected to the low pressure cylinder and a regulating device, such as a fluid pressure governed regulator, is provided for the auxiliary receiver valve. When the compressor starts, the pressure is raised in the auxiliary receiver corresponding to the rise of pressure in the system. After the pressure has been raised to its regular working condition, the auxiliary receiver valve tends to remain closed because of the pressure from the receiver on the back of the valve. When the pressure has been raised to a predetermined high point, the regulator being controlled by receiver pressure will automatically unload the back of the auxiliary receiver valve by opening the same to atmosphere, thus allowing the fluid under pressure to be forced from the cylinder into the auxiliary receiver on the forward stroke of the piston and to pass back from the auxiliary receiver into the cylinder on the return stroke of the piston, the unloaded valve remaining open so long as the power of the valve spring, which is made very light, is less than the pressure on the valve of the fluid within the cylinder; thus automatically reducing the power of the compressor to a predetermined extent fixed by the relative capacities of the compressor cylinder and auxiliary receiver. As the fluid pressure falls in the receiver, the regulator will automatically load the auxiliary receiver valve by opening the back of the same to receiver pressure, thus closing the valve and permitting the compressor to

again operate under full power. In this form, as the low pressure cylinder is unloaded, the intercooler pressure will fall in proportion to the capacity of the auxiliary receiver to reduce the load on the low pressure cylinder, the high pressure cylinder taking the fluid from the intercooler and compressing it to the final receiver. While this would be satisfactory in some instances, it would not be so economical. It would reduce the capacity of the machine and reduce the amount of power required to drive it; the low pressure cylinder would not do its proportionate amount of work and there would not be as much heat abstracted by the intercooler. It is obvious that by varying the size of the auxiliary receiver, the compressor cylinder can be entirely unloaded or only partially unloaded, depending upon the size of the auxiliary receiver. To obtain the full benefit of extracting as much heat as possible from the fluid, it is preferable to use these unloading devices in connection with both the high and low pressure cylinders, the relative capacities of the auxiliary receivers for the high and low pressure cylinders being such that with normal pressures, each cylinder will have a proportionate amount of clearance, as for instance, if the auxiliary receivers for the low pressure cylinder reduce its capacity one-third, the auxiliay receivers for the high pressure cylinder will reduce its capacity one-third. With this arrangement the intercooler pressure would remain substantially constant and each cylinder would be compressing the same number of compressions, thus producing the most economical results. If it is desired to unload the compressor step by step, a plurality of sets of auxiliary receivers are provided for the high and low pressure cylinders and the regulators for the different auxiliary receiver valves are set by means of varying their weights 37 to successively unload the auxiliary receiver valves as the fluid pressure rises to predetermined points and load the valves as the pressure falls to predetermined points. This will permit the compressor to be gradually unloaded as the pressure rises and gradually loaded as the pressure falls and this is a valuable feature of my invention as it eliminates all shocks to the machine as the load is thrown on and off. One way of accomplishing this result and at the same time keep the forward and backward loads on the machine nearly uniform would be to first simultaneously unload one auxiliary receiver valve at the front end of the low pressure cylinder and one auxiliary receiver valve at the back end of the high pressure cylinder and then simultaneously unload the auxiliary receiver valve at the back end of the low pressure cylinder and the auxiliary receiver valve at the front end of the high pressure cylinder and so forth. When the auxiliary receiver valves are unloaded, they will stay open as long as the fluid pressure on the valves overbalances the power of the valve springs and therefore the amount of work required for filling the auxiliary receivers will be again given back to the machine on the return stroke as the volume of fluid is expanded. If the unloaded valves should close at the end of the piston stroke, away from said valves, due to the reduction of pressure below the power of their springs, they will be opened again as soon as the piston starts toward said valves and will remain open until the pressure in the auxiliary receivers is reduced to a point below the power of said springs.

When the machine is working with the auxiliary receiver valves closed, it will be seen that the auxiliary receivers remain full of fluid at maximum pressure as the valves prevent the fluid from passing back into the cylinder.

Attention is called to my co-pending application filed of even date herewith, Serial No. 376,702, in which claims are pending directed to the loading and unloading of fluid compressors of any type by a novel means while this present application is directed to the loading and unloading of a compound fluid compressor of any type by similar means.

It is to be understood that by the term "regulating device" I wish to include any mechanical, electrical or fluid means which can be employed for carrying out the objects of my invention; hence I do not wish to limit myself to the particular regulating device herein shown and described, but

What I claim is:

1. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers therefor, and means for opening or closing communication between the cylinders and their auxiliary receivers at successively attained pressures.

2. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers therefor, and fluid pressure controlled means for opening or closing communication between the cylinders and their auxiliary receivers at successively attained pressures.

3. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers therefor, and fluid pressure controlled valves for opening or closing communication between the cylinders and their auxiliary receivers at successively attained pressures.

4. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers therefor, valves for opening or closing communication

between the cylinders and their auxiliary receivers at successively attained pressures and unloading devices for the said valves.

5. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers therefor, valves for opening or closing communication between the cylinders and their auxiliary receivers at successively attained pressures and fluid pressure controlled unloading devices for the said valves.

6. In a compound fluid compressor, the combination with pumping mechanism, of means independent of the valves of the pumping mechanism for unloading it in successive well defined steps.

7. In a compound fluid compressor, the combination with pumping mechanism, of fluid pressure controlled means independent of the valves of the pumping mechanism for unloading it in successive well defined steps.

8. In a compound fluid compressor, the combination with pumping mechanism, of means independent of the valves of the pumping mechanism for loading or unloading it in successive well defined steps.

9. In a compound fluid compressor, the combination with pumping mechanism, of fluid pressure controlled means independent of the valves of the pumping mechanism for loading or unloading it in successive well defined steps.

10. The combination with the cylinders of a compound fluid compressor, of unloading devices independent of the compressor valves, fitted to operate at different successively attained pressures.

11. The combination with the cylinders of a compound fluid compressor, of fluid pressure controlled unloading devices independent of the compressor valves, fitted to operate at different successively attained pressures.

12. The combination with the low pressure cylinder of a compound fluid compressor, of auxiliary receivers therefor, valves for opening and closing communication between the low pressure cylinder and the auxiliary receivers and means connected to the backs of the valves for successively unloading them as different predetermined high pressures are reached.

13. The combination with the low pressure cylinder of a compound fluid compressor, of auxiliary receivers therefor, valves for opening and closing communication between the low pressure cylinder and the auxiliary receivers and fluid pressure controlled means connected to the backs of the valves for successively unloading them as different predetermined high pressures are reached.

14. The combination with the low pressure cylinder of a compound fluid compressor, of auxiliary receivers, valves for opening and closing communication between the low pressure cylinder and the auxiliary receivers, and regulators connected to the backs of the valves for successively unloading them as different predetermined high pressures are reached.

15. The combination with the low pressure cylinder of a compound fluid compressor, of auxiliary receivers, valves for opening and closing communication between the low pressure cylinder and the auxiliary receivers, and fluid pressure governed regulators connected to the backs of the valves for successively unloading them as different predetermined high pressures are reached.

16. The combination with the low pressure cylinder of a compound fluid compressor, of auxiliary receivers therefor, valves for opening and closing communication between the low pressure cylinder and the auxiliary receivers, and means for successively unloading the valves as the pressure rises to predetermined points and for successively loading the valves as the pressure falls to predetermined points, for automatically unloading and loading the compressor step by step.

17. The combination with the low pressure cylinder of a compound fluid compressor, of auxiliary receivers therefor, valves for opening and closing communication between the low pressure cylinder and the auxiliary receivers, and fluid pressure controlled means for successively unloading the valves as the pressure rises to predetermined points and for successively loading the valves as the pressure falls to predetermined points, for automatically unloading and loading the compressor step by step.

18. The combination with the low pressure cylinder of a compound fluid compressor, of auxiliary receivers, valves for opening and closing communication between the low pressure cylinder and the auxiliary receivers, and regulators for successively unloading the valves as the pressure rises to predetermined points and for successively loading the valves as the pressure falls to predetermined points, for automatically unloading and loading the compressor step by step.

19. The combination with the low pressure cylinder of a compound fluid compressor, of auxiliary receivers, valves for opening and closing communication between the low pressure cylinder and the auxiliary receivers, and fluid pressure governed regulators for successively unloading the valves as the pressure rises to predetermined points and for successively loading the valves as the pressure falls to predetermined points, for automatically unloading and loading the compressor step by step.

20. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers therefor, valves for opening and closing communication between the high and low pressure cyl-

inders and their auxiliary receivers and means connected to the backs of the valves for successively unloading them as different predetermined high pressures are reached, for unloading the compressor step by step.

21. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers therefor, valves for opening and closing communication between the high and low pressure cylinders and their auxiliary receivers and fluid pressure controlled means connected to the backs of the valves for successively unloading them as different predetermined high pressures are reached, for unloading the compressor step by step.

22. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers, valves for opening and closing communication between the cylinders and their auxiliary receivers and regulators connected to the backs of the valves for successively unloading them as different predetermined high pressures are reached, for unloading the compressor step by step.

23. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers, valves for opening and closing communication between the cylinders and their auxiliary receivers and fluid pressure governed regulators connected to the backs of the valves for successively unloading them as different predetermined high pressures are reached, for unloading the compressor step by step.

24. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers therefor, valves for opening and closing communication between the high and low pressure cylinders and their auxiliary receivers and means for successively unloading the valves as the pressure rises to predetermined points and for successively loading the valves as the pressure falls to predetermined points, for automatically unloading and loading the compressor step by step.

25. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers therefor, valves for opening and closing communication between the high and low pressure cylinders and their receivers and fluid pressure controlled means for successively unloading the valves as the pressure rises to predetermined points and for successively loading the valves as the pressure falls to predetermined points, for automatically unloading and loading the compressor step by step.

26. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers, valves for opening and closing communication between the cylinders and their auxiliary receivers and regulators for successively unloading the valves as the pressure rises to predetermined points and for successively loading the valves as the pressure falls to predetermined points, for automatically unloading and loading the compressor step by step.

27. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers, valves for opening and closing communication between the cylinders and their auxiliary receivers and fluid pressure governed regulators for successively unloading the valves as the pressure rises to predetermined points and for successively loading the valves as the pressure falls to predetermined points, for automatically unloading and loading the compressor step by step.

28. The combination with the high and low pressure cylinders of a compound fluid compressor, of a plurality of auxiliary receivers for each cylinder, valves for opening and closing communication between the high and low pressure cylinders and their auxiliary receivers and means connected to the backs of the valves for successively unloading them as different predetermined high pressures are reached, for unloading the compressor step by step.

29. The combination with the high and low pressure cylinders of a compound fluid compressor, of a plurality of auxiliary receivers for each cylinder, valves for opening and closing communication between the high and low pressure cylinders and their auxiliary receivers and fluid pressure controlled means connected to the backs of the valves for successively unloading them as different predetermined high pressures are reached, for unloading the compressor step by step.

30. The combination with the high and low pressure cylinders of a compound fluid compressor, of a plurality of auxiliary receivers for each cylinder, valves for opening and closing communication between the cylinders and their auxiliary receivers, and regulators connected to the backs of the valves for successively unloading them as different predetermined high pressures are reached, for unloading the compressor step by step.

31. The combination with the high and low pressure cylinders of a compound fluid compressor, of a plurality of auxiliary receivers for each cylinder, valves for opening and closing communication between the cylinders and their auxiliary receivers, and fluid pressure governed regulators connected to the backs of the valves for successively unloading them as different predetermined high pressures are reached, for unloading the compressor step by step.

32. The combination with the high and low pressure cylinders of a compound fluid compressor, of a plurality of auxiliary re-

ceivers for each cylinder, valves for opening and closing communication between the high and low pressure cylinders and their auxiliary receivers and means for successively unloading the valves as the pressure rises to predetermined points and for successively loading the valves as the pressure falls to predetermined points, for automatically unloading and loading the compressor step by step.

33. The combination with the high and low pressure cylinders of a compound fluid compressor, of a plurality of auxiliary receivers for each cylinder, valves for opening and closing communication between the high and low pressure cylinders and their auxiliary receivers and fluid pressure controlled means for successively unloading the valves as the pressure rises to predetermined points and for successively loading the valves as the pressure falls to predetermined points, for automatically unloading and loading the compressor step by step.

34. The combination with the high and low pressure cylinders of a compound fluid compressor, of a plurality of auxiliary receivers for each cylinder, valves for opening and closing communication between the cylinders and their auxiliary receivers, and regulators for successively unloading the valves as the pressure rises to predetermined points and for successively loading the valves as the pressure falls to predetermined points, for automatically unloading and loading the compressor step by step.

35. The combination with the high and low pressure cylinders of a compound fluid compressor, of a plurality of auxiliary receivers for each cylinder, valves for opening and closing communication between the cylinders and their auxiliary receivers and fluid pressure governed regulators for successively unloading the valves as the pressure rises to predetermined points and for successively loading the valves as the pressure falls to predetermined points, for automatically unloading and loading the compressor step by step.

36. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers, and means for opening and closing communication between the cylinders and their auxiliary receivers, the relative capacities of the auxiliary receivers of the high and low pressure cylinders being so proportioned that the intercooler pressure will remain substantially constant.

37. The combination with the high and low pressure cylinders of a compound fluid compressor, of auxiliary receivers and fluid pressure controlled means for opening and closing communication between the cylinders and their auxiliary receivers, the relative capacities of the auxiliary receivers of the high and low pressure cylinders being so proportioned that the intercooler pressure will remain substantially constant.

38. The combination with the high and low pressure cylinders of a compound fluid compressor, of a plurality of auxiliary receivers for each cylinder the relative capacities of the auxiliary receivers of the high and low pressure cylinders being so proportioned that the intercooler pressure will remain substantially constant and means for simultaneously opening and closing communication between each of the corresponding auxiliary receivers and its cylinder.

39. The combination with the high and low pressure cylinders of a compound fluid compressor, of a plurality of auxiliary receivers for each cylinder the relative capacities of the auxiliary receivers of the high and low pressure cylinders being so proportioned that the intercooler pressure will remain substantially constant and fluid pressure controlled means for simultaneously opening and closing communication between each of the corresponding auxiliary receivers and its cylinder.

In testimony, that I claim the foregoing as my invention, I have signed my name in presence of two witnesses, this 25th day of May 1907.

WILLIAM PRELLWITZ.

Witnesses:
F. GEORGE BARRY,
HENRY THIEME.