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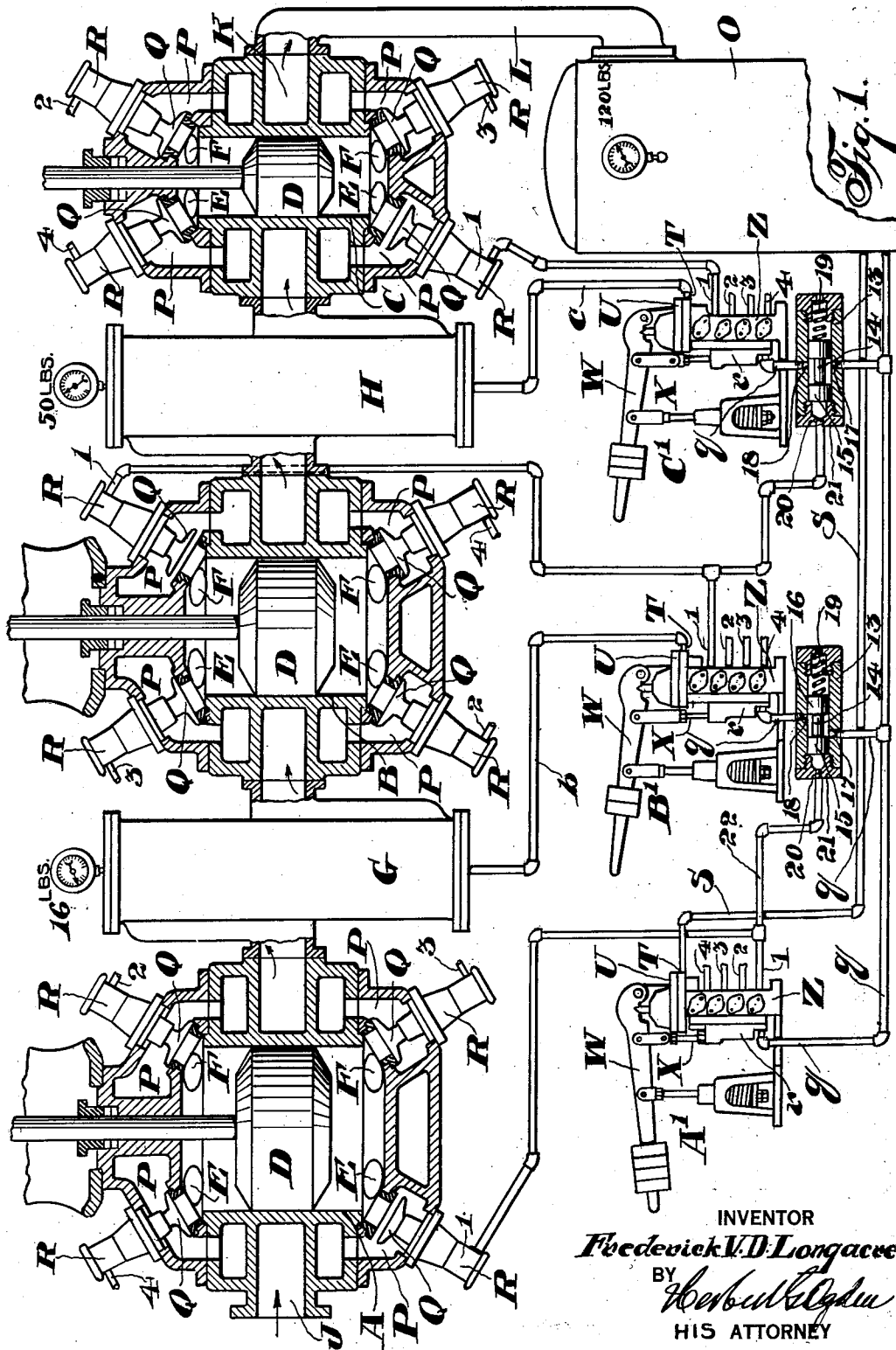
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COMPRESSOR UNLOADER

Filed June 18, 1926

3 Sheets-Sheet 1



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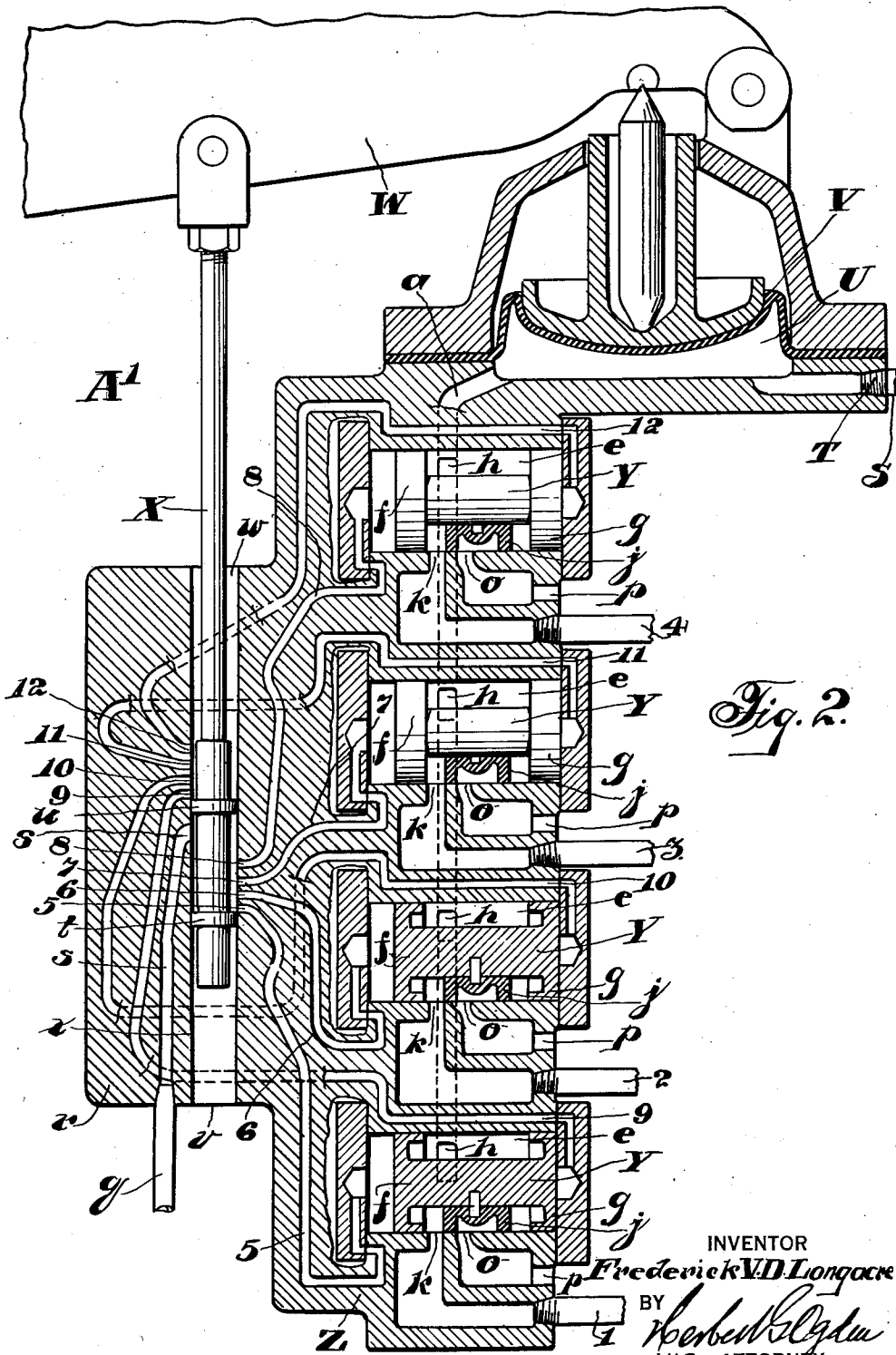
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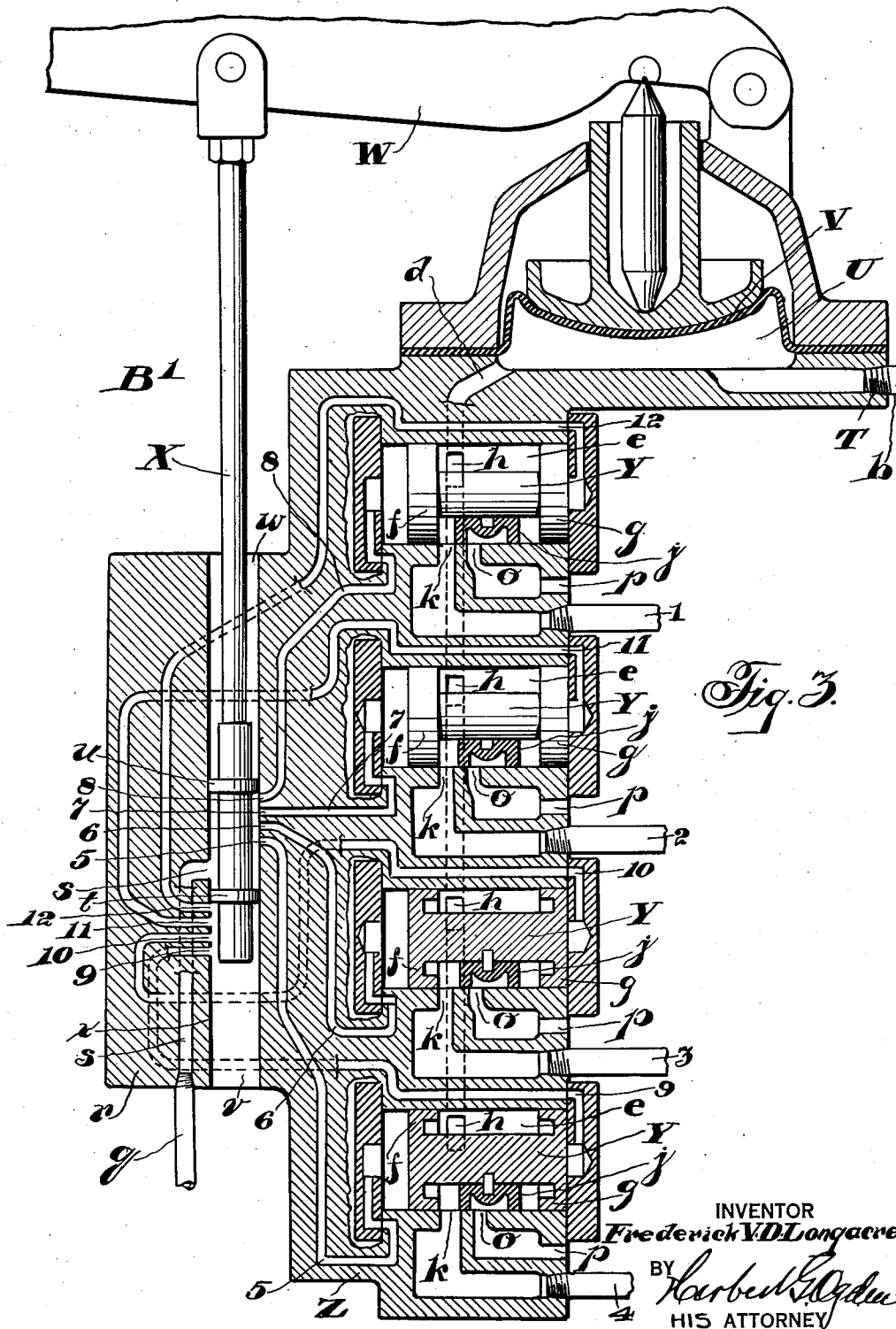
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UNITED STATES PATENT OFFICE.

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COMPRESSOR UNLOADER.

Application filed June 18, 1926. Serial No. 116,909.

This invention relates to compressor unloaders for compound compressors and the objects of the invention are to enable the cooler pressures to be automatically maintained at or closely approximate to the most economical pressure for complete compression in two or more stages to any predetermined final discharge pressure.

The regulation of the output is preferably effected by devices automatically responsive to variations in discharge pressure, while the regulation of the intermediate pressures is preferably effected by devices automatically responsive to variations in the cooler pressures themselves, although the invention is not to be understood as limited to this precise form of regulation.

Another object of the invention is to automatically prevent the operation of each succeeding regulating device until the next preceding regulating device has operated at least partially, so that the cylinders are unloaded successively and in proper order.

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

Figure 1 is a diagrammatic representation partly in horizontal section showing the invention applied to a three-stage compressor,

Figure 2 is an enlarged longitudinal sectional elevation taken through the regulator for the low pressure cylinder, and

Figure 3 is an enlarged longitudinal sectional elevation taken through one of the regulators for the intermediate and high pressure cylinders.

Referring to the drawings, the three cylinders A, B and C of a three stage compressor shown for purposes of illustration are provided with the pistons D and inlet and discharge valves E and F in the usual manner. First and second intercoolers G and H are connected between the cylinders and the inlet of the compressor is indicated at J and the discharge K is connected by the pipe L to a receiver O.

In the present instance the invention is shown applied to a compressor having a plurality of clearance chambers P, in this instance four clearance chambers being shown for each cylinder, controlled by the clearance valves Q, operating in the clearance valve cylinders R on each of the compressor cylinders in the usual manner, it being

understood that the clearance valves Q are held closed by the application of pressure fluid to the cylinders R and may be assisted in opening by springs (not shown).

Each cylinder is provided with its own automatic regulator A', B' and C' and in accordance with this invention each regulator automatically controls the unloading and loading of its respective cylinder in successive steps. The regulator A' is preferably automatically responsive to receiver pressure from the pipe S connecting the receiver O with the regulator A' at the point T and communicating with a diaphragm chamber U, shown in Figure 2, having the diaphragm V which controls the movement of the weighted lever W having the auxiliary valve X connected thereto, which in turn controls the movements of the main operating valves Y in the regulator casing Z. These main operating valves Y in turn control the supply and release of receiver pressure from the connection a at the diaphragm chamber U to and through the pipe connections 1, 2, 3 and 4 respectively which are adapted to be connected as indicated in the drawings to the unloader valve cylinders R.

The auxiliary valve X of the regulator A' is normally in its lowermost position as indicated in Figure 2 and is raised step by step by predetermined increase in receiver pressure beneath the diaphragm V which causes the main valves Y to operate one after another from the bottom upwards to unload the cylinder A step by step and load the cylinder by operation of the main valves Y in reverse order.

The regulators B' and C' for the intermediate and high pressure cylinders B and C are constructed alike and are indicated in detail in Figure 3. Each of these regulators B' and C' are preferably automatically responsive to intercooler pressures in the first and second intercoolers G and H respectively through the pipes b and c connected to the diaphragm chambers U of the regulators. The auxiliary valves X of the regulators B' and C' are normally in raised position as indicated in Figure 3 and these regulators are automatically responsive to a drop in the intercooler pressures so that as the auxiliary valves X move downward, the main operating valves Y are actuated one after the other from the top downward to

control the supply and release of intercooler pressure from the diaphragm chamber connection *d* to and through the pipes 1, 2, 3 and 4 adapted to be connected to the unloader valve cylinders R of the cylinders B and C respectively as indicated in the drawings. As the auxiliary valves X of the intermediate and high pressure regulators B' and C' move upwardly, the cylinders B and C are loaded step by step.

Referring more particularly to Figures 1 and 2, the spaces *e* between the heads *f* and *g* of the main operating valves Y of the regulator A' are constantly open to receiver pressure from the connection *a* through the ports *h* and each of the valves Y is provided with a shoe *j* controlling the ports *k* and *o* so that when the valves Y are in the right hand positions, as indicated in Figure 2, receiver pressure passes to all of the pipes 1, 2, 3 and 4 and all of the unloader valves are held closed. As the valves Y are moved successively to their left hand positions, the pipes 1, 2, 3, and 4 are opened one after the other to atmosphere through the ports *p*, since the ports *k* and *o* will be connected by the shoes *j*.

Automatic connections controlled by the auxiliary valve X are provided for alternately supplying receiver pressure to the heads *f* and *g* of the valves Y to actuate said valves. The receiver pipe *q* is connected to the valve casing *r* of the auxiliary valve X and the passage *s* leads to a point between the valve heads *t* and *u* so that the space between said valve heads is constantly subject to receiver pressure. The ends *v* and *w* of the valve chamber *x* are open to atmosphere and passages 5, 6, 7, and 8 connect the left hand heads *f* of the valves Y with the central portion of the valve chamber *x* as shown. Passages 9, 10, 11 and 12 connect the opposite heads *g* of the valves Y with the valve chamber *x* so that when the valve X is in the position indicated in Figure 2, passages 5, 6, 7 and 8 are all subject to receiver pressure while the passages 9, 10, 11 and 12 are all open to atmosphere. By means of the ports and passages shown, the valves Y are successively operated for the purposes described.

The regulators B' and C' are constructed in a similar manner to the regulator A' with the exception that the space *e* between the heads of the valves Y are constantly open to intercooler pressure through the connection *d* and the ports *h* and the passages 5, 6, 7 and 8 and the passages 9, 10, 11 and 12 are so connected to the valve chamber *x* of the auxiliary valve X that the valves Y are successively operated from the top downwards as the auxiliary valve X moves downward step by step, due to a drop in cooler pressure, for unloading the intermediate and high pressure cylinders step by step

and for loading the cylinders as the auxiliary valve X moves upwardly.

Instead of connecting the receiver pipe *q* directly to the auxiliary valve casings *r* of the regulators B' and C', I prefer to place an automatic interlocking or controlling valve in each of these connections, so that the regulator B' is rendered inoperative until the first regulator A' for the low pressure cylinder has operated, and similarly the regulator C' cannot operate until the preceding regulator B' for the intermediate compressor cylinder B has operated. Any suitable interlocking valves or change valves as they may be called may be provided for this purpose and such change valves may be connected in any suitable location in the pipe systems, but I have indicated these valves in the receiver connections *q* for the regulators B' and C' as a suitable and convenient location.

As shown, these interlocking or change valves comprise a cylinder 13 having a valve 14 therein provided with the heads 15 and 16 controlling the ports 17 and 18. A branch from the pipe *q* is connected through the change valve at the ports 17 and 18 to the casing *r* of the auxiliary valve X. A spring 19 tends to force the interlocking valve 14 to a position to open the ports 17 and 18 and a port 20 in the bushing 21 of the change valve for the regulator B' is connected by the pipe 22 with the unloader valve pipe 1 of the preceding regulator A' which is the regulator for the low pressure cylinder. Similarly, the port 20 of the change valve for the regulator C' is connected by the pipe 22 with the unloader valve pipe 1 of the preceding regulator B' for the intermediate pressure cylinder B.

With all the unloader valves Q of the low pressure cylinder closed and subject to receiver pressure through the pipes 1, 2, 3, and 4, there will obviously be receiver pressure in the pipe 22 and the change valve 14 will be held to its right hand position against the tension of the spring 19 so that receiver pressure will be cut off from the regulator B' and said regulator will be inoperative until the first step of unloading for the low pressure cylinder takes place. The pipes 1 and 22 connected to the regulator A' will then be opened to atmosphere and the change valve 14 will operate to supply receiver pressure through the pipe *q* for the operation of the main valves of the intermediate regulator B'.

Similarly the regulator C' remains inoperative until the first step of unloading of the intermediate pressure cylinder B has been effected by the regulator B'. By the means described, the succeeding regulators B' and C' cannot operate until the immediate preceding regulator has at least partially operated.

In the operation of the apparatus let it be assumed that the normal discharge pressure is 120 lbs. as marked on the receiver O, that the pressure to be maintained in the first cooler G is to be 16 lbs. as indicated, and that the pressure in the second cooler H is to be 50 lbs. for most economic operation. A predetermined increase of receiver pressure will cause the auxiliary valve X of the regulator A' to rise a sufficient distance to open the passage 5 of the regulator to atmosphere and place the passage 9 in communication with the receiver pipe q so that the first valve Y of the regulator will be actuated and the pipes 1 and 22 will be opened to atmosphere through the port p. The unloader valve Q of the cylinder A to which pipe 1 is connected will open for the first step of unloading. The change valve 14 will be moved to opened position by the spring 19 owing to the release of receiver pressure against the head 15 of the valve and the regulator B' is in a condition to operate for unloading purposes in case the pressure of the cooler G falls a predetermined amount. When this occurs and the first step of unloading of the cylinder B takes place, the regulator C' will be placed in condition for operation and will operate to unload the cylinder C upon a predetermined decrease of pressure in the second cooler H.

I claim:

1. In a multi-stage compressor, the combination of cylinders and inlet and discharge valves, intercoolers and a receiver, means automatically responsive to rise in receiver pressure for unloading the low pressure cylinder, unloading means for each of the other cylinders automatically responsive to drop in the intercooler pressures respectively, and means for automatically preventing the operation of each of the unloading devices subject to intercooler pressure until the unloading device for the low pressure cylinder has operated.

2. In a multi-stage compressor, the combination of cylinders and inlet and discharge valves, intercoolers and a receiver, means automatically responsive to rise in receiver pressure for unloading the low pressure cylinder, unloading means for each of the other cylinders automatically responsive to drop in the intercooler pressures respectively, and means for automatically and successively preventing the operation of each of the unloading devices for the intermediate and high pressure cylinders until the next preceding unloading device has operated.

3. In a compound compressor, the combination of high and low pressure cylinders, inlet and discharge valves therefor, an intercooler, a plurality of clearance chambers and unloading valves for each cylinder for step by step unloading and loading, means automatically responsive to rise in discharge

pressure for unloading the low pressure cylinder, and means automatically responsive to drop in intercooler pressure for unloading the high pressure cylinder.

4. In a compound compressor, the combination of high and low pressure cylinders, inlet and discharge valves therefor, an intercooler, a plurality of clearance chambers and unloading valves for each cylinder for step by step unloading and loading, means automatically responsive to rise in discharge pressure for unloading the low pressure cylinder, means automatically responsive to drop in intercooler pressure for unloading the high pressure cylinder, and means for automatically preventing the operation of the unloading device for the high pressure cylinder until the unloading device for the low pressure cylinder has operated.

5. In a multi-stage compressor, the combination of cylinders and inlet and discharge valves, intercoolers and a receiver, a plurality of clearance chambers and unloading valves for each cylinder for step by step unloading and loading, means automatically responsive to rise in receiver pressure for unloading the low pressure cylinder, and unloading means for each of the other cylinders automatically responsive to drop in the intercooler pressures respectively.

6. In a multi-stage compressor, the combination of cylinders and inlet and discharge valves, intercoolers and a receiver, a plurality of clearance chambers and unloading valves for each cylinder for step by step unloading and loading, means automatically responsive to rise in receiver pressure for unloading the low pressure cylinder, unloading means for each of the other cylinders automatically responsive to drop in the intercooler pressures respectively, and means for automatically preventing the operation of each of the unloading devices subject to intercooler pressure until the unloading device for the low pressure cylinder has operated.

7. In a multi-stage compressor, the combination of cylinders and inlet and discharge valves, intercoolers and a receiver, a plurality of clearance chambers and unloading valves for each cylinder for step by step unloading and loading, means automatically responsive to rise in receiver pressure for unloading the low pressure cylinder, unloading means for each of the other cylinders automatically responsive to drop in the intercooler pressures respectively, and means for automatically and successively preventing the operation of each of the unloading devices for the intermediate and high pressure cylinders until the next preceding unloading device has operated.

In testimony whereof I have signed this specification.

FREDERICK van DUZER LONGACRE.