T. SHIPLEY.

GAS COMPRESSOR.

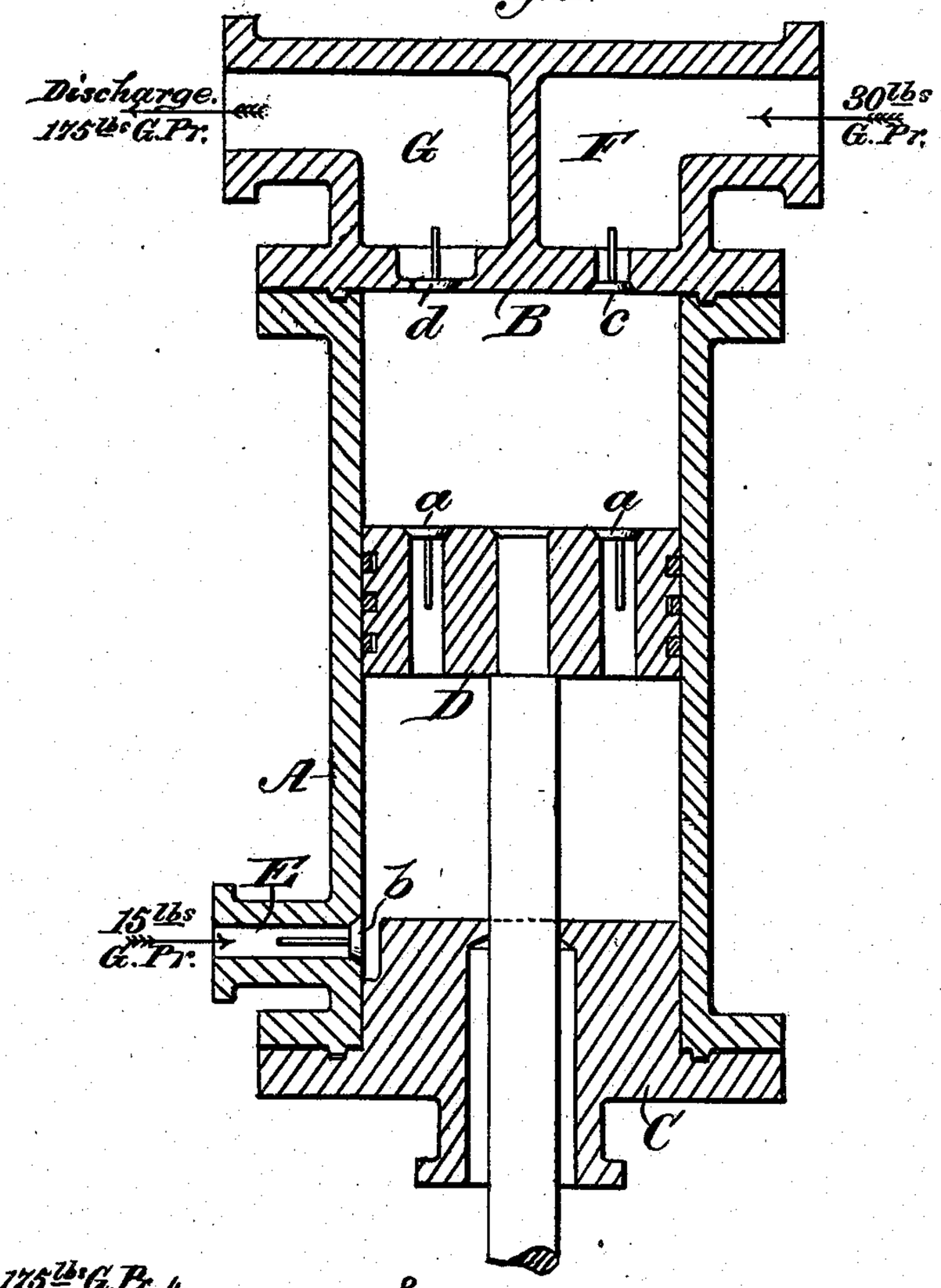
APPLICATION FILED APR. 26, 1909.

930,567.

Patented Aug. 10, 1909.

2 SHEETS—SHEET 1.

Fig. 1.



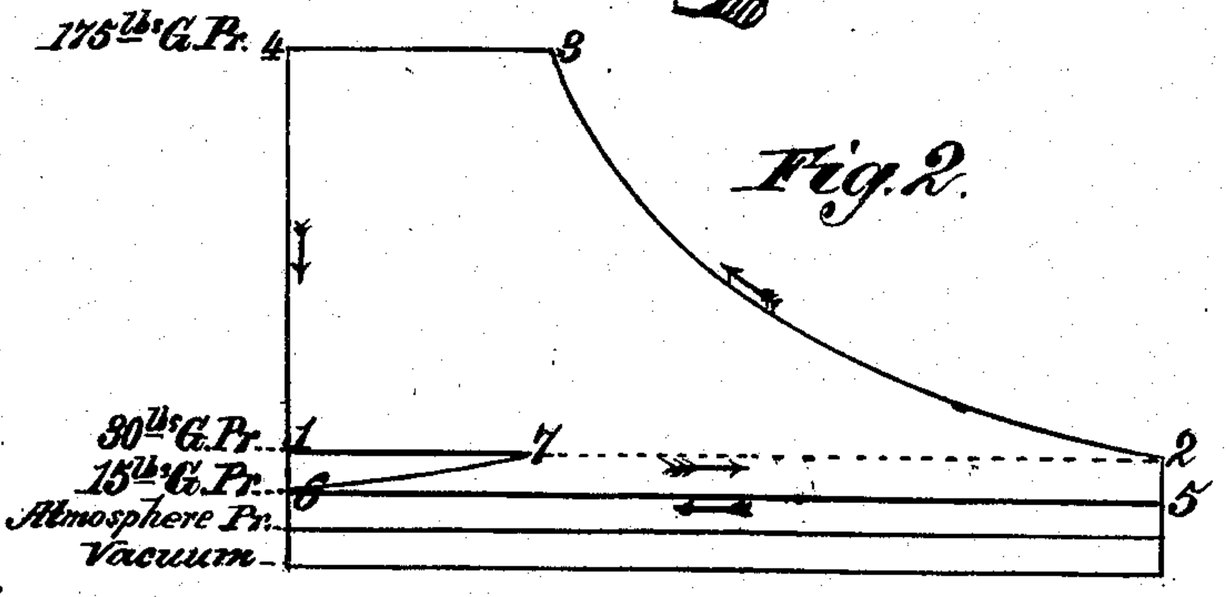


Fig. 2.

Witnesses.
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2 SHEETS—SHEET 2.

Fig. 3.

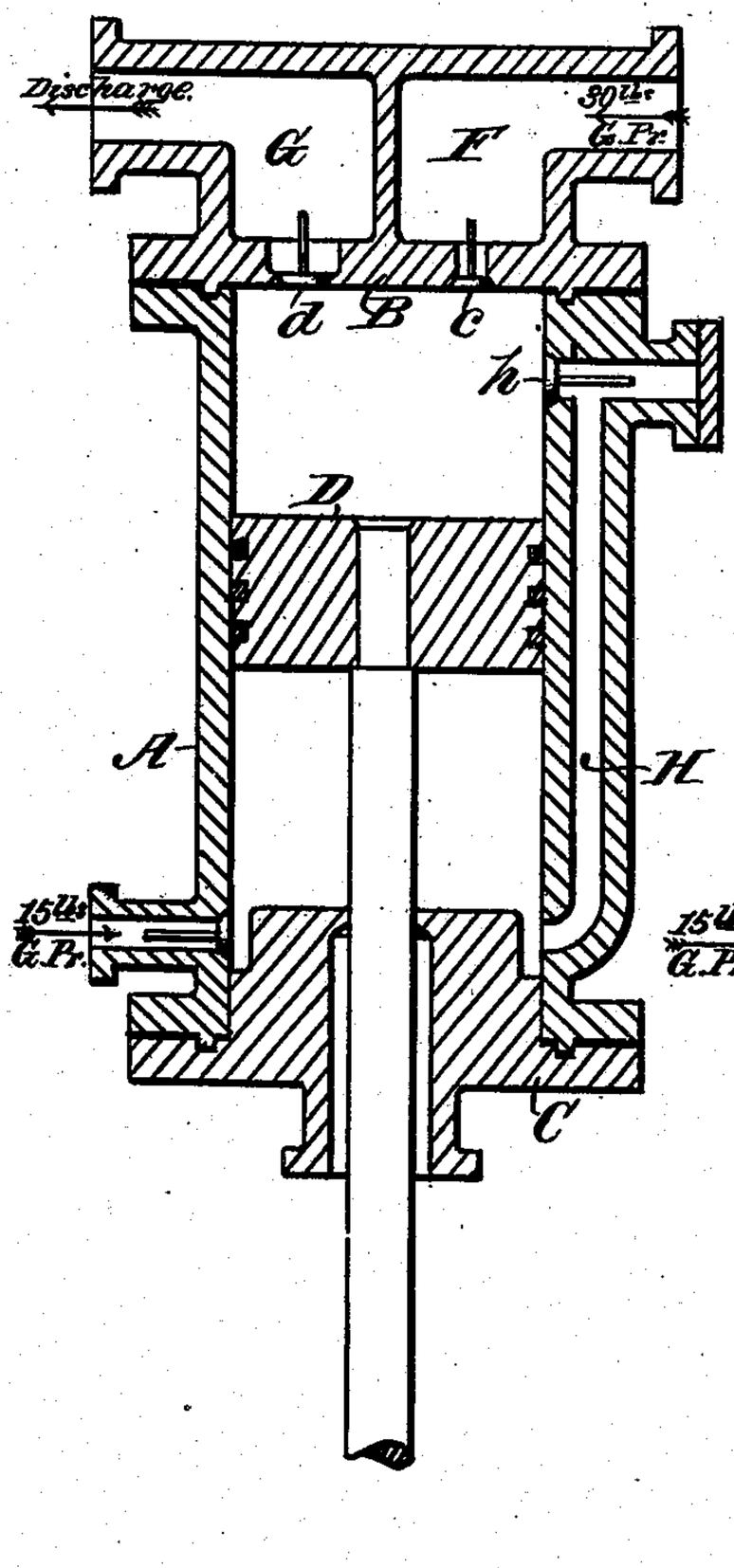
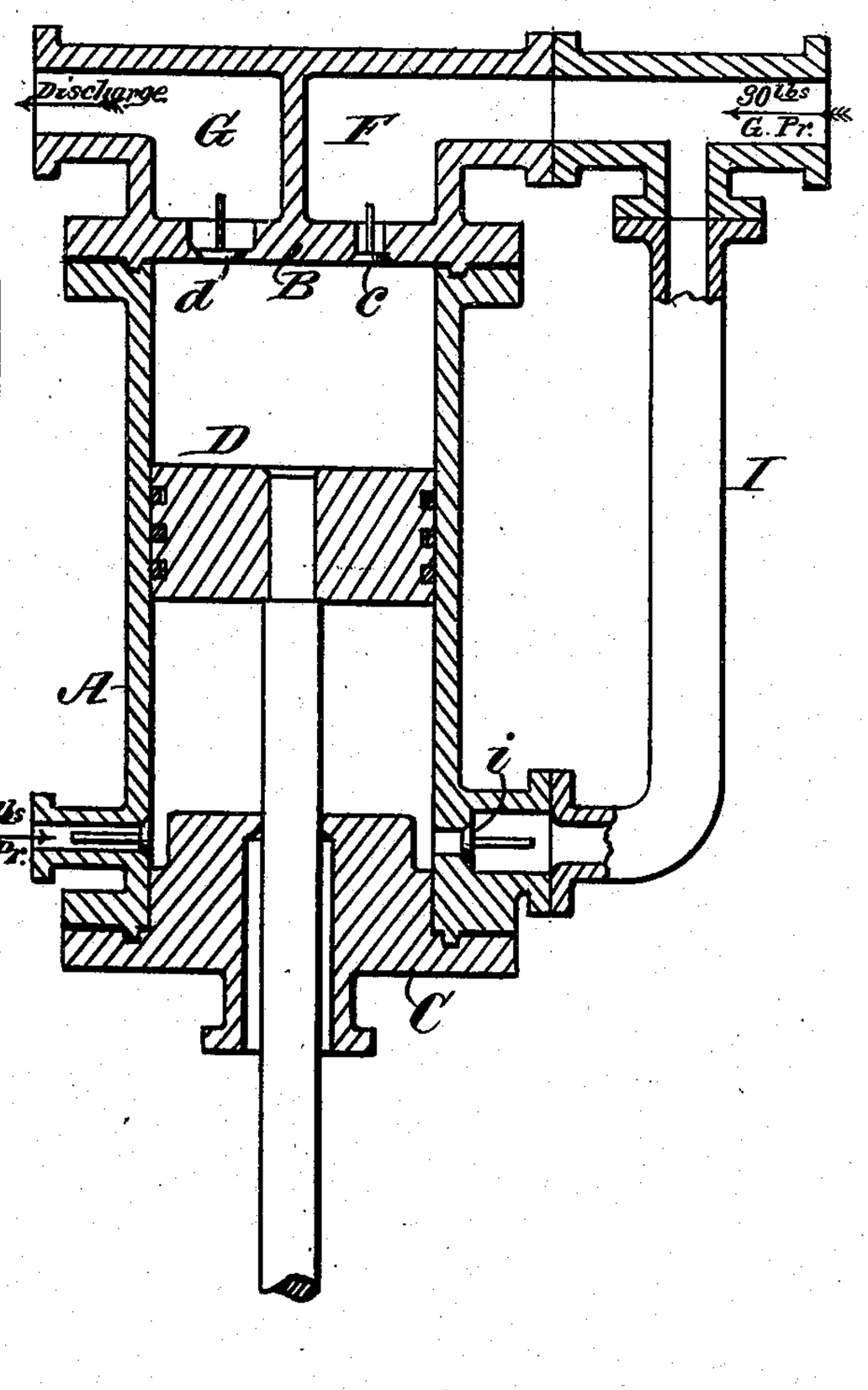


Fig. 4.



Witnesses.
Robt Govett,
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Inventor.
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UNITED STATES PATENT OFFICE.

THOMAS SHIPLEY, OF YORK, PENNSYLVANIA.

GAS-COMPRESSOR.

No. 930,567. Specification of Letters Patent. Patented Aug. 10, 1909.

Application filed April 26, 1909. Serial No. 492,131.

To all whom it may concern:

Be it known that I, THOMAS SHIPLEY, of York, in the county of York and State of Pennsylvania, have invented a new and useful Improvement in Gas-Compressors, of which the following is a specification.

My invention relates to compressors for ammonia and other gases, for use more particularly in refrigerating plants wherein more than one temperature is employed. In operating these plants it is necessary to reduce the pressure at which the refrigerant evaporates when a reduction of temperature is desired. This makes it necessary to have more than one pressure where more than one temperature is required for the work.

Under my invention the separate bodies of gas, each at a pressure different from the other, are received and taken care of in one and the same compressor cylinder wherein they are brought to the same pressure and mingled, and wherefrom they are finally discharged through a common outlet. This I am aware is not broadly new with me.

My invention resides in certain features relating principally to the manner of introducing the gases into the cylinder, and of equalizing their pressures and mingling them—the main characteristic of the improvement being that the low pressure gas enters the cylinder on the side of the piston opposite that on which the higher pressure gas enters; that the low pressure gas fills the cylinder during the discharge stroke of the piston (the discharge outlet being on the same side with the higher pressure gas inlet) and that this low pressure gas, by and during the return or suction stroke of the piston, is compressed until it forces its way through one or more valve controlled passages leading mediately or immediately into the space on the other side of the piston which is entered by the higher pressure gas during the suction stroke, so that by the time the suction stroke is completed, the cylinder is filled with gas at the entering pressure of the higher pressure gas, the whole of the charge on the low pressure inlet side of the piston having passed over to the other side thereof. A compressor having this mode of operation is capable of handling more ammonia per unit of power than any other design of compressor known to me.

The nature of my improvement and the manner in which the same is or may be carried into effect will readily be understood by reference to the accompanying drawing in which—

Figure 1 is an axial section (largely diagrammatic) of so much of a compressor cylinder and its piston and connections as is needed for the purpose of explanation. Fig. 2 is an indicator card illustrative of the action of the compressor. Figs. 3 and 4 are sectional views similar to Fig. 1 of modifications hereinafter more particularly referred to.

A is the cylinder casting proper having heads B, C, and piston D. The lower head C has a stuffing box through which the piston rod passes. The upper head B has in it a suction or inlet chamber F which communicates on the one hand with the external source (not shown) from which the supply of higher pressure gas is drawn, and on the other hand with the cylinder A through a passage controlled by an inwardly opening puppet valve *c*; and it also has in it a discharge chamber G which communicates on the one hand with the condenser or other external receiver in which the highly compressed gas is stored, and on the other hand with the interior of the cylinder A through a passage controlled by an outwardly opening puppet valve *d*. It will be noted that the discharge valve *d* and the higher pressure gas inlet or suction valve *c* are at the same end of the cylinder. At the other end of the cylinder A, is a nozzle or passage E which communicates on the one hand with the extraneous source (not shown) from which the supply of low pressure gas is drawn, and on the other hand with the interior of the cylinder A, this latter communication being controlled by an inwardly opening puppet valve *b*.

As hereinbefore stated, provision should be made whereby at certain times and under certain conditions communication may be established mediately or immediately between the chambers in the cylinder on opposite sides of the piston. I prefer to avail of the piston itself for this purpose. To this end I form in it one or more passages—two in this instance—through which direct, or immediate, communication may be established between the chambers in the cylinder on opposite sides of the piston, these passages being controlled by puppet valves *a a*, which open only upward, or in response to superior pressure from the low pressure inlet side of the piston.

It is assumed that the higher pressure gas enters at F at a pressure of 30 lbs. above atmosphere (or 45 lbs. absolute); that the low pressure gas enters at E at a pressure of 15 lbs. above atmosphere; and that the compressed gas leaves the compressor through the discharge G at a pressure of 175 lbs. above atmosphere.

The operation under these conditions is as follows: When the piston on its up stroke has reached the upper cylinder head B, after having discharged at *d* all the compressed gas, the cylinder space below the piston will be filled with gas at 15 lbs. pressure, drawn in through the suction nozzle E during the rise of the piston. As soon as the piston begins its down stroke, the suction valve *c* of chamber F opens, thus allowing gas at 30 lbs. pressure to enter and fill the cylinder space above the piston. This gas being at 30 lbs. pressure, holds valves *a a* in the piston closed until by the downward movement of the piston the gas below the latter has been compressed to a pressure above 30 lbs. As soon as this happens, the valves *a a* will lift and allow the gas to pass from below to above the piston; and this gas being at a higher pressure than 30 lbs. will cause the suction valve *c* to close. Thereafter during the down stroke of the piston the gas pressure on both sides of the piston will be equalized and consequently as the piston descends the gas will be merely displaced from the under to the upper side of the piston without further compression. When the piston has reached the end of its down stroke the cylinder will be full of gas at 30 lbs. pressure; and the succeeding up stroke of the piston will first compress this charge of gas until it attains a pressure superior to that in the discharge chamber G and will then discharge it through that chamber into the condenser, or whatever other receiver chamber G is connected with. The full cylinder of gas at 30 lbs. pressure which is thus discharged is made up of one cylinder full of gas at 15 lbs. pressure, which has entered through the low pressure nozzle E, and about one third of a cylinder full of gas at 30 lbs. pressure, which has entered from chamber F. The amount of gas taken from chamber F is determined by the distance from the head B the piston must travel on its down stroke before the gas below the piston is compressed to the pressure at which it will lift the valves *a* against the pressure of the gas in chamber above. The distance will be about 30% for 30 lbs. pressure, as shown in the indicator card, Fig. 2. In this theoretical card 1—2 is the 30 lbs. pressure line; 5—6 is the 15 lbs. pressure line; 3—4 is the 175 lbs. pressure line.

The card for pressures of the gas above the piston during one reciprocation of the latter, is seen at 1, 2, 3, 4. Starting at 2, where the piston is at the extreme of its down stroke, and the cylinder above the piston is full of gas at 30 lbs. pressure, as the piston rises the gas is gradually compressed, indicated by the curve 2—3, until at the point 3, a pressure of 175 lbs. (condenser pressure) is reached and thereafter until the completion of the up stroke of the piston, represented by the line 3—4, the gas at that pressure is discharged into the condenser or other receiver with which the discharge chamber G may be connected. The moment the piston starts on its down stroke, the tendency to vacuum above the piston thus created opens the higher pressure gas inlet valve *c*, and gas at 30 lbs. pressure enters the cylinder from that source, the pressure above the piston dropping to 30 lbs., as indicated by line 4—1, and continuing at that pressure until the completion of the down stroke, as indicated by line 1—2.

The card 5, 6, 7, 2 indicates the pressures of the gas below the piston during the same cycle of movement of the latter. Starting from the point 5, the cylinder below the piston is, as the piston rises, supplied with the low pressure gas entering through inlet E at 15 lbs. pressure, so that by the time the piston has completed its up stroke the cylinder below the piston will be full of gas at 15 lbs. pressure—this being indicated by the line 5—6. On the down stroke of the piston this charge of gas is gradually compressed, the increase of pressure being indicated by the inclined line 6—7, until by the time the point 7 is reached, the pressure will have been raised to the 30 lbs. pressure line of the gas above the piston, and thereafter the pressures above and below the piston, until the completion of the down stroke of the latter, are equalized and are one and the same, as indicated by line 7—2. The moment the piston again commences to rise, the tendency to vacuum thus created will open the low pressure inlet valve *b*, and the pressure in the cylinder below the piston will drop to 15 lbs., as indicated by line 2—5.

The higher the ratio, or in other words the greater the relative difference, between the absolute pressure in chamber F and the absolute pressure at nozzle E, the greater will be the relative amount of gas taken from chamber F during each cycle of movement.

I have used herein the terms "up stroke" and "down stroke" of the piston merely for convenience of description, and because the compressor cylinder happens to be shown in the drawing in a position which makes such terms applicable. By "up stroke" of course is intended the discharge stroke—that is to say the stroke by which the piston discharges the compressed gas; and by "down stroke" is intended the return or so-called suction stroke of the piston. Similarly "above" and "below" when used to designate the cylinder spaces on each side of the piston; refer the

one to the space on the discharge side of the piston, and the other to the space on the side of the piston opposite thereto.

It will be understood that in case it be desired to take care of gases of more than two pressures, additional suction inlets or ports with mechanically operated controlling valves can be provided in the chamber on the discharge side of the piston, one for each different higher pressure, connected each to its own source of gas supply and arranged to open successively during the suction stroke of the piston, the lower pressure first and so on up to the highest, as has before been proposed in compressors of this general kind.

In the modification illustrated in Fig. 3, the communication between the two chambers on opposite sides of the piston is direct, or immediate, as in Fig. 1, but the valve controlled passages, for this purpose, through the piston are dispensed with, and in lieu thereof I make use of a by-pass connection H, leading from the lower part to the upper part of the cylinder and having at its upper mouth or port an inwardly opening puppet valve *h*, as shown—this valve *h* having the same purpose and function as the valves *a* in the piston (Fig. 1) as will be understood without further explanation.

In the modification illustrated in Fig. 4, the communication between the low pressure and high pressure chambers is not direct as in Figs. 1 and 3, but is indirect and through the intermediary of the connections through which the higher pressure gas is supplied through the valve controlled inlet *c*. In this arrangement there is a by-pass I which at its lower end opens into the bottom of the cylinder and at its upper end discharges into the connection which feeds chamber F with the higher pressure gas. The lower end of the by-pass I is provided with an outwardly opening puppet valve *i* which (like the valves *a* in Fig. 1) opens when the low pressure gas during the down stroke of the piston has reached a predetermined compression, and permits the thus compressed gas to pass through the by-pass I to chamber F and thence through the suction valve *c*, to the discharge side of the piston. Under this arrangement in case of two or more higher back pressure inlets on the discharge side of the piston, the by-pass I would discharge into the connections supplying the highest back pressure used.

Having described my invention and the best way now known to me of carrying the same into practical effect, I state in conclusion that I do not restrict myself to the structural details hereinbefore shown and set forth in illustration of my invention, since manifestly the same can be widely varied without departure from the principle of my invention, but

What I claim herein as new and desire to secure by Letters Patent is as follows:

1. In a gas compressor, a compressor cylinder; a reciprocatory piston therein; a valve controlled suction port at one end of the cylinder communicating with a source of low pressure gas; a valve controlled port at the opposite end of the cylinder for discharge of the compressed gas; a valve controlled suction port at the same end of the cylinder with the discharge port, communicating with a source of gas at higher pressure than that supplied through the low-pressure port; and valve controlled communications between the chambers in the cylinder on opposite sides of the piston whereby the low pressure gas which enters the cylinder during the discharge stroke of the piston and is subsequently compressed during the return stroke of the latter, may, when it has reached a predetermined degree of compression, pass over, thus compressed, to the chamber on the opposite side of the piston, substantially as and for the purposes hereinbefore set forth.

2. In a gas compressor, a compressor cylinder; a reciprocating piston therein; a valve controlled suction port at one end of the cylinder, communicating with a source of low-pressure gas; a valve controlled port at the opposite end of the cylinder for discharge of the compressed gas; a valve-controlled suction port at the same end of the cylinder with the discharge port, communicating with a source of gas at higher pressure than that supplied through the low-pressure port; a passage in the piston communicating with the chambers in the cylinder on opposite sides of said piston; and a valve controlling said communicating passage and adapted to open when the low pressure gas which enters the cylinder during the discharge stroke of the piston and is subsequently compressed during the return stroke of the latter, has, during such return stroke, reached a predetermined degree of compression, substantially as and for the purposes hereinbefore set forth.

In testimony whereof I affix my signature in presence of two witnesses.

THOMAS SHIPLEY.

Witnesses:
A. B. STRICKLER,
T. A. STEBBINS.