No. 637,516. Patented Nov. 21, 1899.

H. E. LUDWIG.

PUMP FOR COMPRESSING AIR OR GAS.

(Application filed June 10, 1898.)

(No Model.)

Fig. 1.

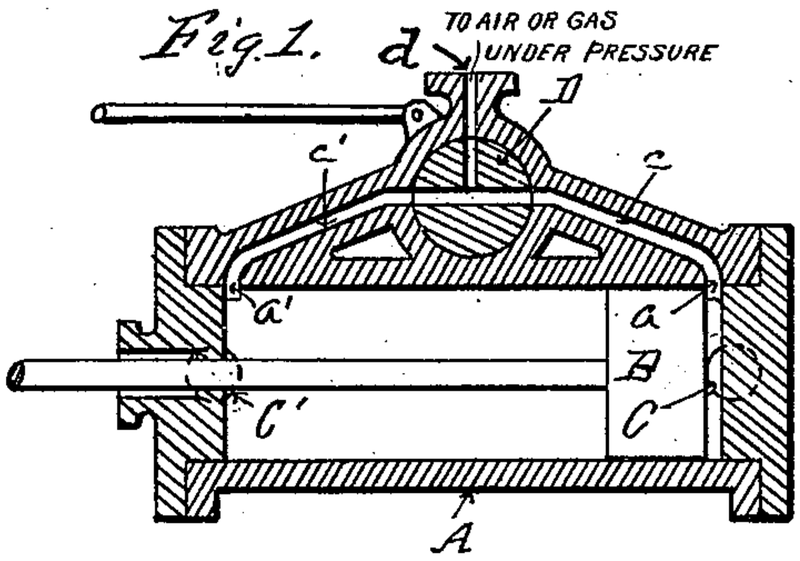


Fig. 2.

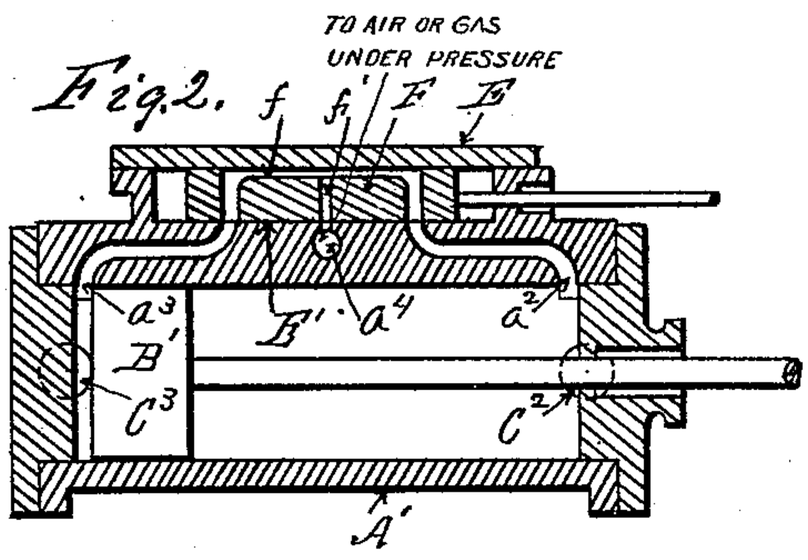


Fig. 4.

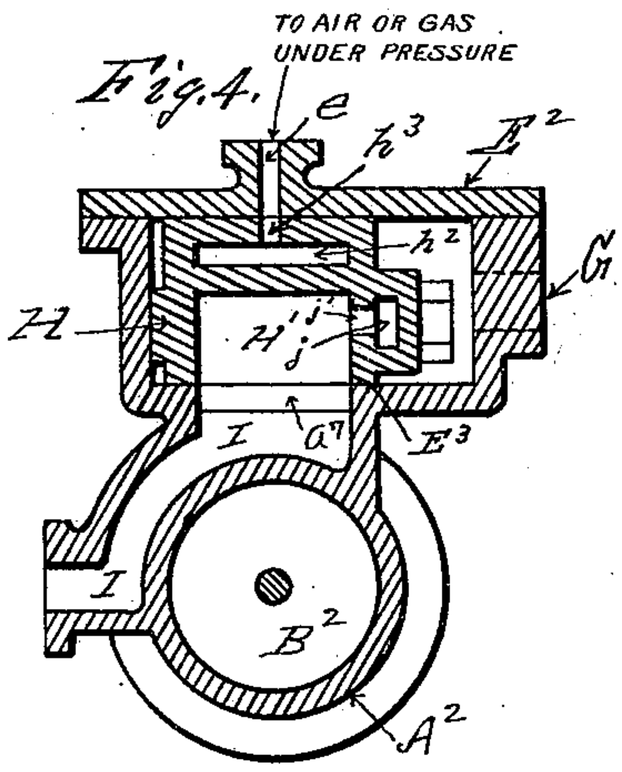


Fig. 7.

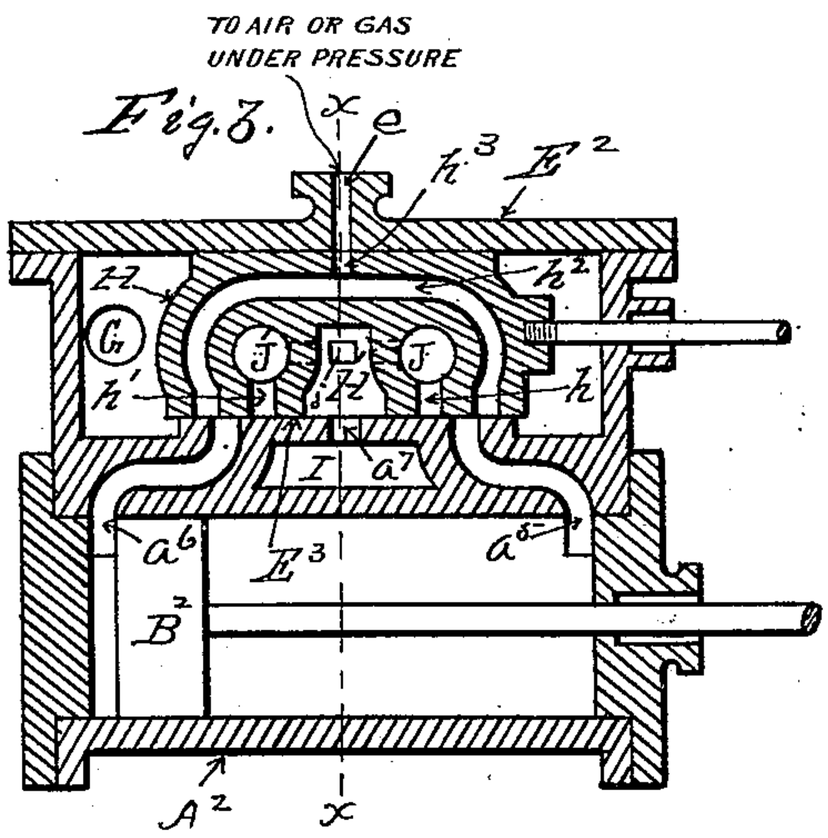


Fig. 6.

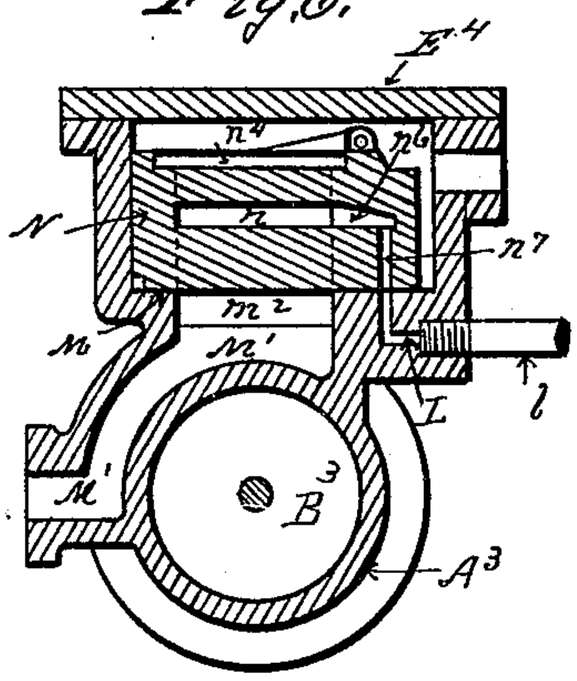
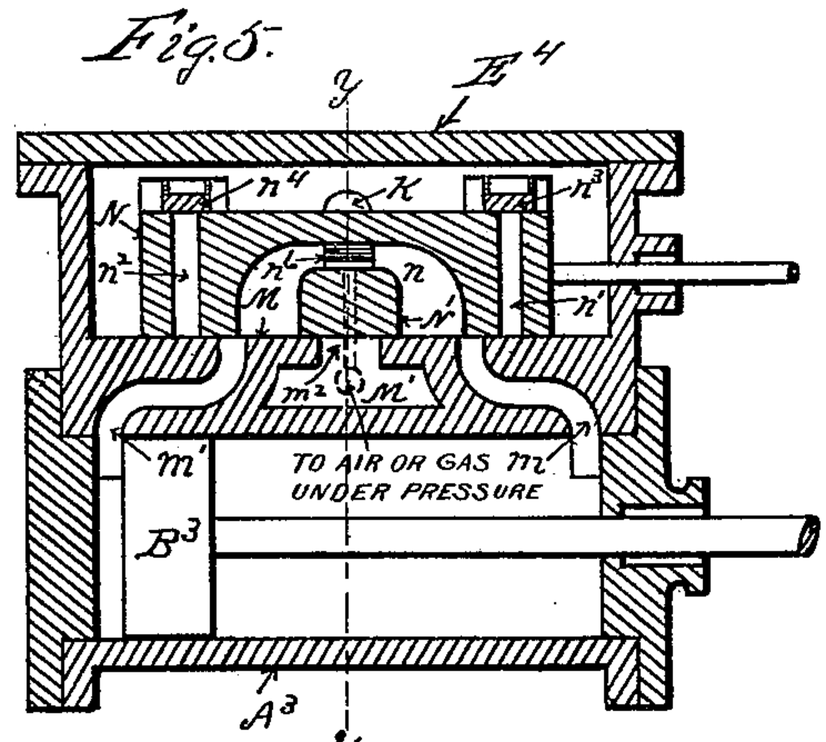


Fig. 5.



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HENRY E. LUDWIG, OF ERIE, PENNSYLVANIA.

PUMP FOR COMPRESSING AIR OR GAS.

SPECIFICATION forming part of Letters Patent No. 637,516, dated November 21, 1899.

Application filed June 10, 1898. Serial No. 683,074. (No model.)

To all whom it may concern:

Be it known that I, HENRY E. LUDWIG, a citizen of Switzerland, residing at Erie, in the county of Erie and State of Pennsylvania, have invented certain new and useful Improvements in Pumps for Compressing Air or Gases; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, forming part of this specification.

This invention relates to pumps for compressing air or gases—such as ammonia, ether, carbon dioxid, &c.—in the manner and for purposes well understood by those familiar with air compressing and refrigerating machinery.

In compressing air or other gas it is well known that considerable heat is generated, which seriously affects the cylinder, piston, and valves of the pump.

The object of this invention is to provide means for reducing the heat so generated in the cylinder and the valve mechanism thereof, so as to minimize its effects thereon, and to accomplish this result I provide means for cooling the same by injecting a small quantity of compressed or liquefied air or gas into a passage opened between the ends of the cylinder for equalizing the pressure therein at or near the beginning of the return stroke of the piston, whereby the compressed air or fluid so injected is carried with the compressed air or gas passing toward the opposite end of the cylinder, meanwhile rapidly expanding both in the passage and in the cylinder and serves to rapidly cool the heated air or gas passing over therewith and prevent its unduly heating the valve mechanism and cylinder. I accomplish this result in several ways—for example, when ordinary puppet-valves are used in the compressor I make a passage between the ends of the cylinder provided with a three-way valve, operated by eccentric mechanism in the usual manner, or I can use a slide-valve provided with a passage for establishing communication between the ends of the cylinder at or near the beginning of the return stroke of the piston and a passage in the valve to said passage, whereby a small quantity of the compressed or liquefied air or gas is admitted to said passage just as it opens communication with the two ends of the cylinder, whereby the heated air or gas is met in its passage by the compressed or liquefied air or gas so admitted, the rapid expansion of which cools the air or gas as it passes over to the opposite end of the cylinder to equalize the pressure therein, thereby minimizing the heating effects thereof and incidentally counteracting the effects of the clearance, and thereby increasing the efficiency of the compressor.

This invention is hereinafter fully described and illustrated in the accompanying drawings, in which—

Figure 1 shows a longitudinal section of a puppet-valved compressor-cylinder and piston with a passage between the ends of the cylinder and a three-way valve therein embodying my invention. Fig. 2 shows a longitudinal section of a puppet-valved compressor-cylinder and piston with a slide-valve having a passage and an inlet for admitting compressed or liquefied air or gas thereto embodying my invention. Fig. 3 is a longitudinal section of a slide-valved compressor-cylinder and piston comprising a slide-valve mechanism consisting of a central discharge-port, puppet-valves, a passage, and an inlet for admitting compressed or liquefied air or gas thereto embodying my invention. Fig. 4 is a transverse section of the same on the line $x\ x$ in Fig. 3. Fig. 5 is a longitudinal section of a slide-valved compressor-cylinder and piston comprising another form of slide-valve mechanism having a passage and an inlet for admitting compressed or liquefied air or gas thereto embodying my invention. Fig. 6 is a transverse section of the same on the line $y\ y$ in Fig. 5.

In the drawings illustrating my invention, as shown in Fig. 1, A is the cylinder, B the piston, and C C′ puppet-valves, all of which are of ordinary construction. On one side of the cylinder A there is a passage $c\ c'$, communicating with ports $a\ a'$ at the ends of the cylinder A, adapted to connect the ports $a\ a'$. There is also a passage d leading to the central part of the passage $c\ c'$ and adapted to be connected by a suitable connection with a con-

denser or other receptacle, (not shown,) in which compressed or liquefied air or gas is stored, and at the junction of the passages *c* *c'* and *d* there is a three-way plug-valve adapted to be operated by an eccentric or other suitable mechanism, so as to connect the passages *c c'* and open the passage *d* into the passages *c c'* at or near the beginning of the return stroke of the piston B, at each end of its traverse, for a brief period, until the pressure in the two ends of the cylinder *a* is equalized, or nearly so, and then close said passages until the piston B has completed its traverse in the opposite direction and starts on its return traverse, whereby the highly compressed and heated air or gas occupying the clearances at the ends of the cylinder is permitted to pass over to the opposite ends of the cylinder and is cooled by the expansion of the compressed or liquefied air or gas entering through the passage *d* and passing on with it into the opposite end of the cylinder.

In Fig. 2 the cylinder A', the piston B', and the puppet-valves C^2 C^3 are constructed the same as hereinbefore described, except that the cylinder A' is provided on one side with a valve-chest E, in which a slide-valve F operates on a valve-seat E'. The valve-seat E' is provided with two outside ports a^2 and a^3, which communicate with the ends of the cylinder, and a central port a^4, which is adapted to be connected with a condenser or other suitable receptacle, (not shown,) in which compressed or liquefied air or gas is stored, and in the valve F there is a passage *f* and a central passage *f'*, leading into the central port of said passage, which passage is adapted to connect the ports a^2 and a^3 simultaneously with the connection of the central passage *f'* and the central port a^4, the valves F being operated by an eccentric or other suitable mechanism, (not shown,) so that this action takes place at or near the beginning of the return stroke of the piston B', at each end of its traverse, for a brief period, until the pressure in the two ends of the cylinder A is equalized, or nearly so, whereby the highly compressed and heated air or gas occupying the clearances at the ends of the cylinder is permitted to pass over to the opposite ends of the cylinder and is cooled by the expansion of the compressed or liquefied air or gas entering through the central port a^4 and passage *f'* and passing over with it into the opposite end of the cylinder, as hereinbefore described.

In Figs. 3 and 4 the cylinder A^2 and the piston B^2 are constructed in the usual manner. In this construction, however, the entire valve mechanism is within a valve-chest E^2, provided with a suction-opening G, and is secured to one side of the cylinder A^2 in the usual manner. The cylinder A^2 is provided with valve-seat E^3 and end ports a^5 and a^6 and a central or discharge port a^7, opening into a discharge-opening I, which ports open through valve-seat E^3 in the usual manner. In the valve-chest E^2 there is a slide-valve H, operating on the valve-seat E^3 and provided with a central chamber H', which covers the central port a^7, and at each end of this central chamber H' there are ports *h* and *h'*, in each of which are check-valves J and J', from which a longitudinal passage *j* leads through a lateral passage *j'* (shown in Fig. 4) to the chamber H', so that as the air or gas being compressed is forced out of the cylinder A^2 through the ports a^5 and a^6 and up through the ports *h* and *h'* in the valve until the check-valves J and J' are raised so as to allow it to pass on into the central chamber H' and out through the central port a^7 and discharge-passage I. In the valve H outside of the central chamber H' there is a passage h^2, which operates to equalize the pressure in the ends of the cylinder at or near the commencing of the backward stroke of the piston, and also operates as the open ends thereof pass off of the ends of the valve-seat E^3 as suction-ports in the valve for the cylinder-ports a^5 and a^6. Through the top of the valve-chest E^2 there is a passage *e*, adapted to be connected with a condenser or other receptacle, (not shown,) in which compressed or liquefied air or gas is stored, and from the central part of the passage h^2 there is a passage h^3, extending up through the top of the valve H, adapted to coincide with the passage *e* through the top of the valve-chest at the time the ends of the passage h^2 in the valve coincide with the ports a^5 and a^6 in the valve-seat, which position of the valve H is attained at or near the beginning of the return stroke of the piston B^2 at each end of its traverse, whereby the pressure in the two ends of the cylinder A^2 is equalized, or nearly so, and as the highly compressed and heated air or gas passes over to the opposite end of the cylinder the compressed or liquefied gas entering the passage h^2 through the passages *e* and h^3 is taken up thereby and expands in said passage h^2, the ports a^5 and a^6, and in the cylinder as the heated air or gas is passing over, as herein described, and cools it as well as the valve and cylinder into which it passes.

In Figs. 5 and 6 the cylinder A^3 and the piston B^3 are constructed in the usual manner. In this construction, however, as in Figs. 3 and 4, the entire valve mechanism is within a valve-chest E^4, provided with an outlet K, and is secured to the cylinder in the usual manner. The cylinder A^3 is provided with a valve-seat M, with end ports *m m'* opening through the same into the ends of the cylinder A^3 and a central port m^2 opening into a central or suction passage M' in the usual manner. In the valve-chest E^4 there is a slide-valve N, operating on the valve-seat M and provided with a central bridge N', adapted to close the central port m^2 in the valve-seat M. Extending over and around this bridge N' there is a passage *n*, which operates as a passage through the valve for alternately connecting the ports *m* and *m'* with the central or suction port m^2. This passage *n* also serves

to connect the ports m and m' just at or near the commencement of the return stroke of the piston B^3 for the purpose of equalizing the pressure in the ends of the cylinder A^3. In the ends of the valve N there are vertical ports n' n^2, adapted to alternately connect with the ports m and m' in the valve-seat and serve as discharge-ports therefor, the upper ends of these ports n' n^2 being closed by puppet-valves n^3 and n^4 against the return of the compressed material passing outward. In one side of the central portion of the bottom of the valve-chest E^4, I make a passage L, (see Fig. 6,) which extends up through the valve-seat M, the outer end of which passage is adapted to be connected by means of a pipe l or other suitable means with a condenser or other receptacle, (not shown,) in which compressed or liquefied air or gas is stored, and from the central portion of the passage n in the valve there is a lateral passage n^6, from which there is a downward passage n^7, adapted to coincide with the passage L in the valve-seat when the passage n in the valve coincides with and connects the ports m and m', so that as the pressure between the ends of the cylinder is being equalized compressed or liquefied air or gas enters through the passages L, n^7, and n^6 and is taken up by the heated air or gas passing over and, expanding, serves to cool not only the valve mechanism, but the cylinder, as hereinbefore stated.

I have thus described my invention as applied to several types of compressor-cylinder mechanism, so as to enable others skilled in the art to construct and operate the same; but I do not, however, confine myself to the forms of construction thereof herein shown and described, as I am aware that the same may be modified in many respects without departing from the spirit of my invention. Therefore,

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The combination in an air or gas compressor having a passage adapted to connect the ends of the compressing-cylinder, of a valve controlling said passage and adapted to open said passage at or near the commencement of the return stroke of the piston in said cylinder for equalizing the pressure in the ends thereof, and means for admitting liquefied air or gas into said passage, substantially as and for the purpose set forth.

2. The combination in an air or gas compressor, of a cylinder and a piston operating therein, valve mechanism for controlling the air or gas being compressed and having a passage or passages therein adapted to connect with the ports at both ends of the cylinder at or near the commencement of each return stroke of the piston therein for equalizing the pressure in the ends of the cylinder, and means for admitting liquefied air or gas into said passage, substantially as and for the purpose set forth.

3. The combination in an air or gas compressor, of a cylinder and a piston operating therein, a valve-chest and valve operating therein for controlling the air or gas being compressed in said cylinder, and having a passage or passages therein adapted to connect the ports at both ends of the cylinder at or near the commencement of each return stroke of the piston therein for equalizing the pressure in the ends of the cylinder, and means for admitting liquefied air or gas into said passage or passages in the valve, substantially as and for the purpose set forth.

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

HENRY E. LUDWIG.

Witnesses:
B. A. STURGEON,
H. J. CURTZE.