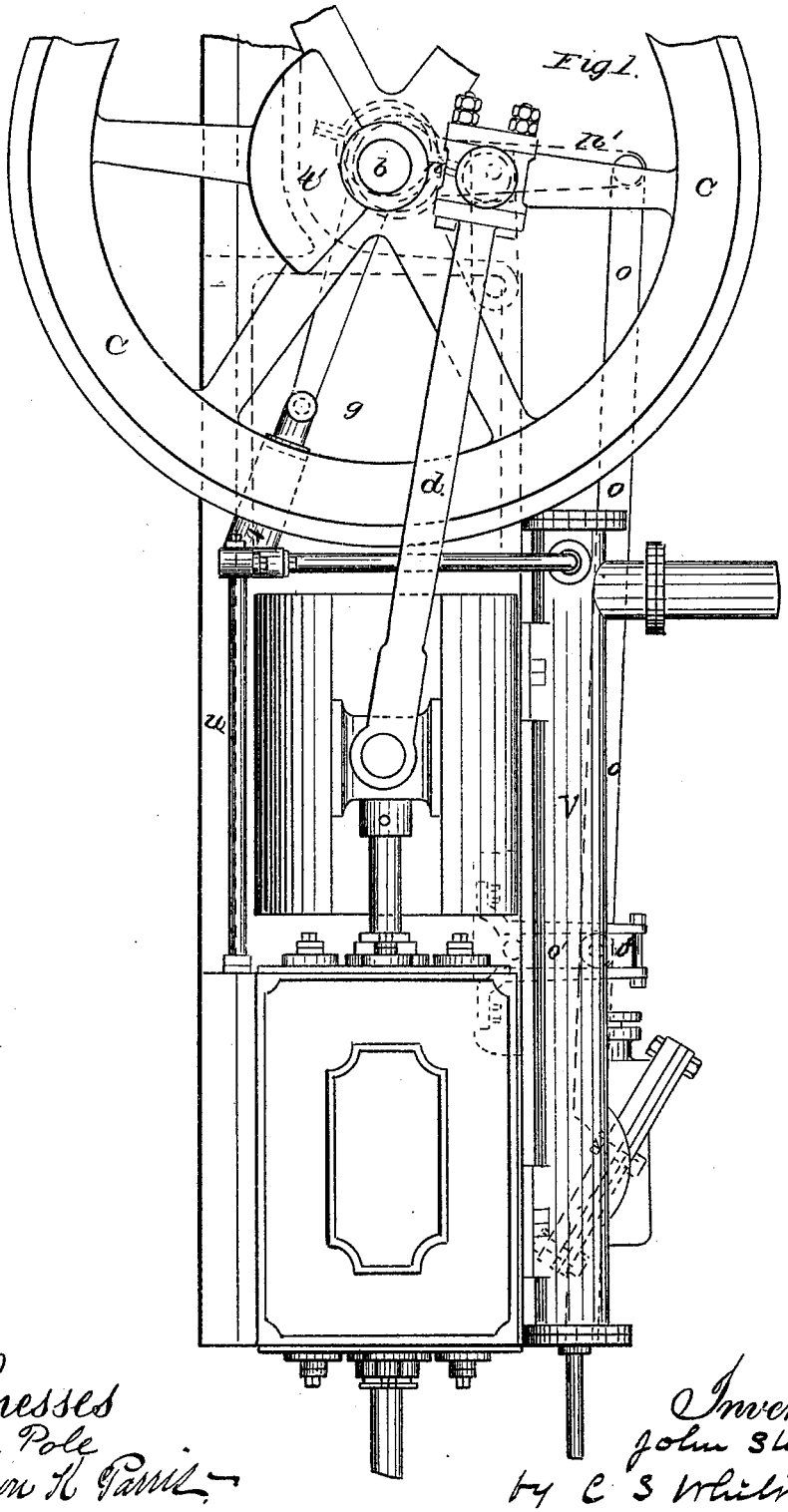
5 Sheets—Sheet 1.

J. STURGEON.

AIR-COMPRESSING MACHINE.

No. 180,958. Patented Aug. 8, 1876.

Fig 1.



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AIR-COMPRESSING MACHINE.

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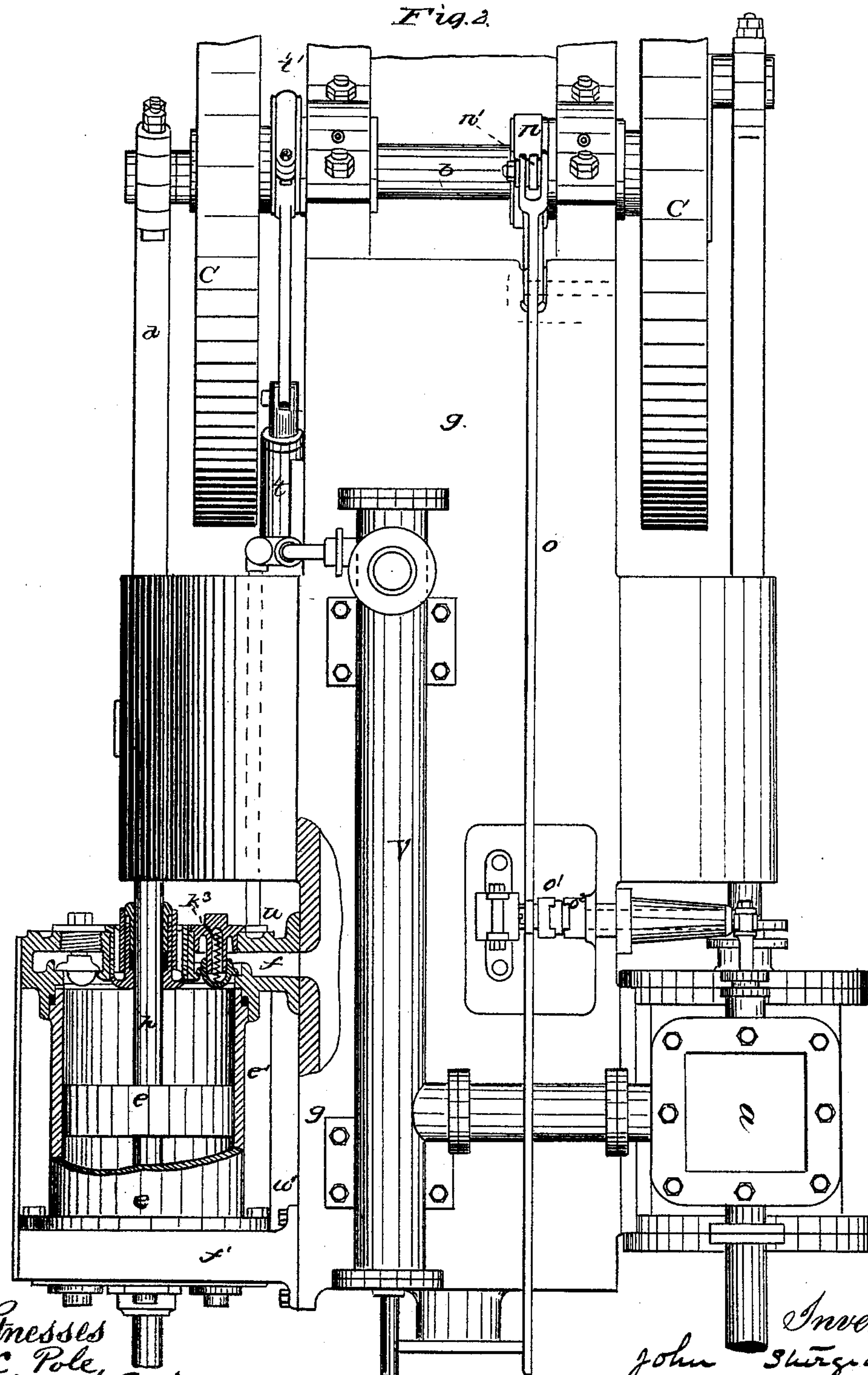
Fig. 2.



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5 Sheets—Sheet 3.

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AIR-COMPRESSING MACHINE.

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Fig. 4.

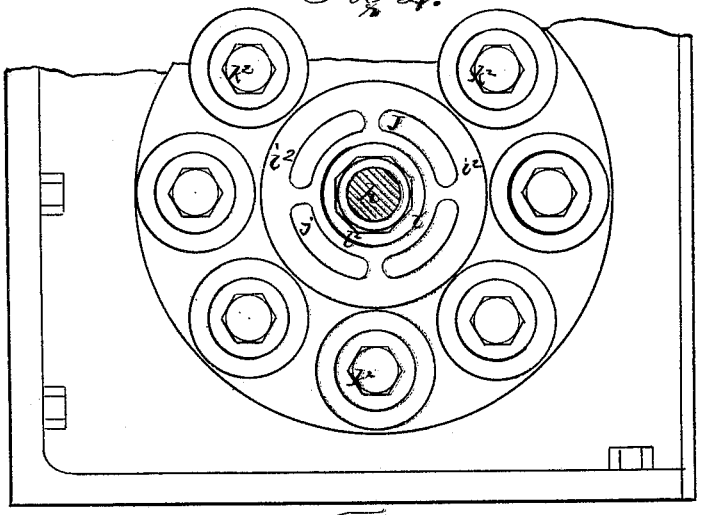
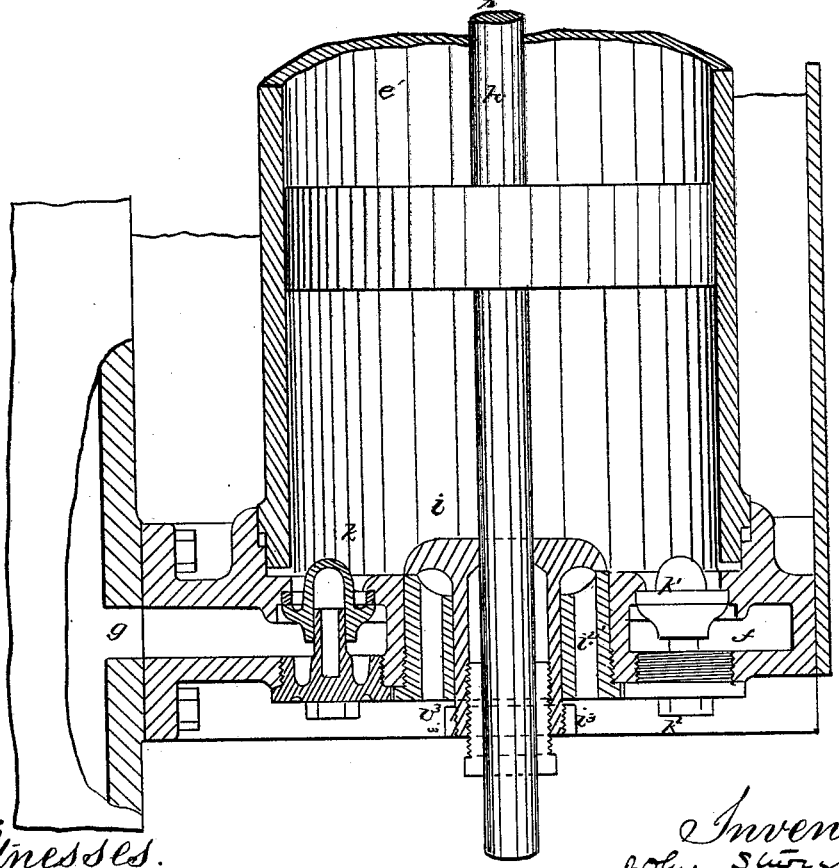


Fig. 3.



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5 Sheets—Sheet 4.

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AIR-COMPRESSING MACHINE.

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Fig. 5.

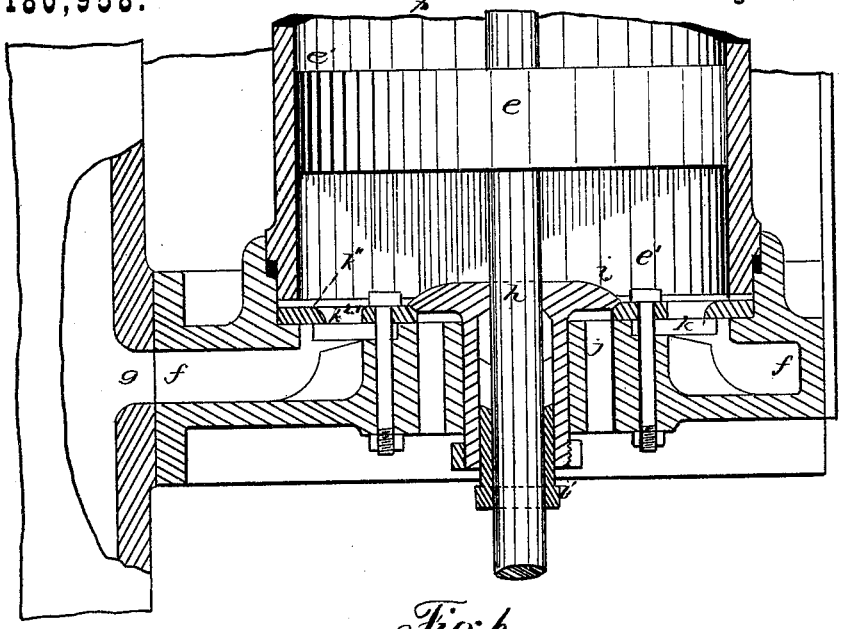
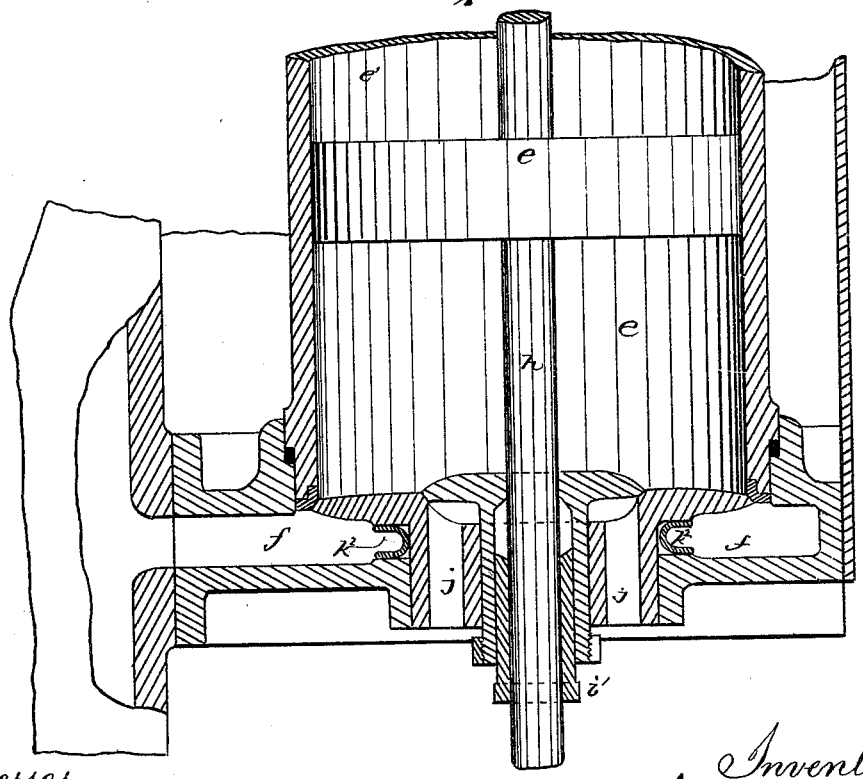


Fig. 6.



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5 Sheets—Sheet 5.

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AIR-COMPRESSING MACHINE.

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Fig. 7.

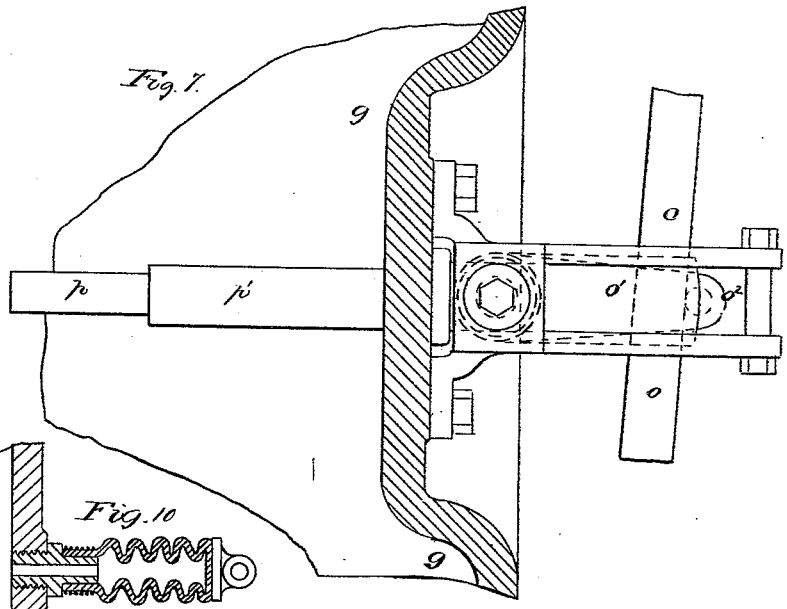


Fig. 10

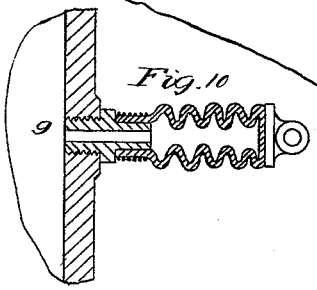


Fig. 8

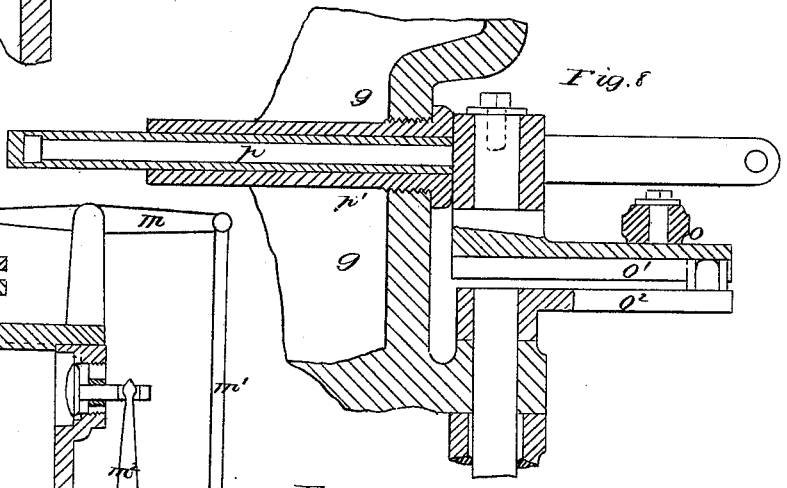


Fig. 11

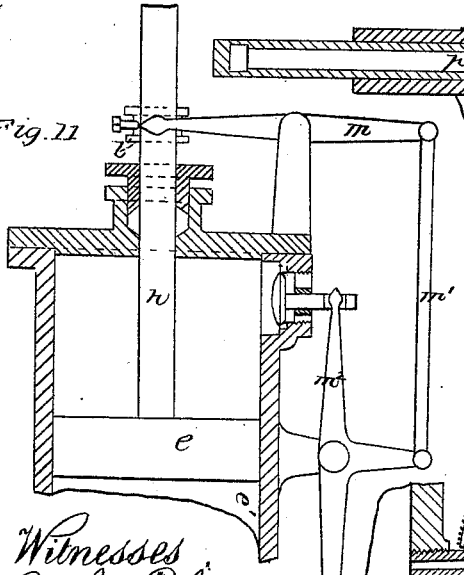
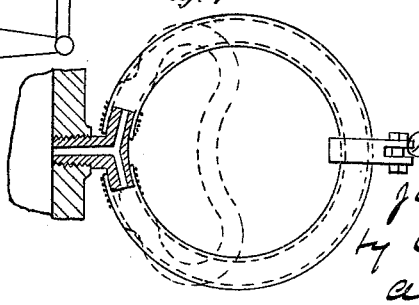


Fig. 9



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UNITED STATES PATENT OFFICE.

JOHN STURGEON, OF BOLTON-LE-MOORS, GREAT BRITAIN.

IMPROVEMENT IN AIR-COMPRESSING MACHINES.

Specification forming part of Letters Patent No. **180,958**, dated August 8, 1876; application filed January 15, 1875.

To all whom it may concern:

Be it known that I, JOHN STURGEON, of Bolton-le-Moors, in the county Palatine of Lancaster, in the Kingdon of Great Britain, have invented Improvements in Machinery for Compressing Air, partly applicable to pumping fluids.

The following description, taken in connection with the accompanying plates of drawings hereinafter referred to, forms a full and exact specification, wherein are set forth the nature and principles of the invention, by which the same may be distinguished from others of a similar class, together with such parts thereof as are claimed as new and are desired to be secured by Letters Patent of the United States.

My invention has for its object improvements in machinery for compressing air, partly applicable to pumping fluids; and consists, in the first place, in certain improvements in the valves and valve mechanism of pumps used for compressing air or pumping fluids, which I shall describe as applied to compressing air, the same being applicable, with slight modifications, to pumping generally.

Heretofore the induction or inlet valves of air-compressors have been generally made to open for the admission of air into the cylinder by the formation of a vacuum in the cylinder by the receding movement of the piston; but this mode of actuating the valves has been found in practice to be defective and uncertain in its action, more particularly at high speeds, and is attended with considerable waste of power, owing to the compressed air left in the valve-passages and the clearance-space after each stroke of the piston. Various plans have been from time to time proposed to overcome these difficulties, but hitherto without success.

According to my invention, I place the inlet-valve in the center of the cylinder-cover of the compressor, having its boss fitting closely round the piston-rod, the latter being free to slide through it, but the friction between the two being sufficient to draw the valve open as the piston begins to move away from it, and push it shut as the piston begins to move toward it. By this arrangement the valve is made to open and shut regularly at the commencement of each stroke of the piston, no matter at what speed the piston may be driven.

In order to enable the friction between the valve and the piston-rod to be adjusted to the requisite degree, I place a stuffing-box in the boss of the valve, by means of which the amount of friction may be so regulated that it cannot draw the valve open until the pressure of the air left in the cylinder acting against it is relieved by the receding movement of the piston, while at the same time it is sufficient to close immediately the valve toward which the piston is moving, there being in that case no opposing pressure to be overcome. By this means the power which has been taken up in compressing the air left in the clearance-space and valve-passages is not thrown away, as the elastic force of the air so left is in reality then assisting to propel the piston in its return-stroke, thereby relieving the driving-engine.

The principle of action above described may be briefly stated to consist in actuating the inlet-valves by friction from some reciprocating part of the machine. The inlet-valves may be actuated on this principle, although they may be situated otherwise than as above described. For instance, they may be actuated by means of suitable frictional mechanism from the rod of the compressor or driving-engine through suitable intermediate gear, the action being substantially the same as above described; or they may be actuated in a similar manner by means of a rod or rods moved to and fro by the engine, and carrying the frictional mechanism for actuating the valves, or acting direct on the valves, substantially as above described; or in some cases—as, for instance, in single-acting engines—they may be applied to the piston, being arranged to fit the cylinder, and receive the requisite motion by their frictional contact therewith. I also place the delivery-valves in the cylinder-cover, arranging them in an outer circle around the central inlet-valve, when the latter is placed in the center as above described; and I make the cylinder-cover hollow, so as to form an air-chamber, into which the delivery-valves open direct when the pressure in the cylinder is sufficient to overcome the resistance against them. The delivery-valves being thus placed directly op-

posite the direction of movement of the piston offer less resistance to the passage of the air than in any other position, and I further lessen that resistance by making the passages into the valves as near as possible of the form of the "*vena contracta*." By these means the heating of the air in compressing will be greatly reduced. I also arrange the inlet and delivery valves in the cover of the air-cylinder in the following manner: I make the delivery-valve of nearly the same diameter as the air-cylinder, and set concentrically therewith. This valve may be either a metallic valve or a circular flap-valve. If the former, I provide it with a boss passing through a stuffing-box in the cylinder-cover. If the latter, the stuffing-box is not required. The inlet-valve fits round the piston-rod, as above described, its boss passing through the center of the boss of the delivery-valve, leaving a space between the two for the inlet of the air, and having its seating formed in front of, or on the face of, the delivery-valve inside the cylinder, so that one valve (the inlet) is, in fact, within the other, (the delivery,) and concentric therewith, the cylinder-cover being also made hollow, as in the former case above described.

My invention consists, in the next place, in making the bed or frame, to which the compressor is attached, of a hollow section, so as to serve as a receiver for the compressed air, thereby dispensing with the necessity of a separate receiver and the intermediate piping.

It is usual in machines for compressing air to surround the air-cylinder with water, in order to prevent the overheating of the metal by the heat generated in compressing the air.

In order that the heat thus imparted to the water may not be entirely lost, I propose to feed the boiler which drives the compressing-engine with the water thus used to cool the air-cylinder, a fresh supply of cold water being regularly fed into the tank surrounding the air cylinder to supply the place of that drawn out to feed the boiler. I thus keep up a continual renewal of cold water round the air-cylinder, and a large proportion of the heat generated in compressing the air is returned to the boiler.

My invention consists, in the next place, in an improved arrangement of mechanism, whereby the driving-engine is enabled to regulate its speed automatically, according to the quantity of compressed air required. For this purpose I apply to the receiver a piston, or other equivalent contrivance, in such a manner that when the pressure in the receiver rises it imparts a movement in one direction to the piston, which, through suitable intermediate gear, acts upon the valve of the driving-engine, so as to shorten its stroke, and thereby reduce its speed or stop it altogether, and as the pressure lowers the contrary action takes place, and the stroke of the valve increases, giving a greater speed to the engine, so as to keep up the pressure in the receiver.

Figure 1, Sheet 1, is a side elevation, and Fig. 2, Sheet 2, a plan of a horizontal double-acting air-compressor constructed according to my invention, and driven by a steam-engine fixed to the same bed as the compressor. *a*, Fig. 2, is the cylinder of the steam-engine, which transmits motion through the shaft *b*, fly-wheels *c*, and connecting-rod *d*, to the piston *e* working in the air-cylinder *e'*, the covers of which, *f f'*, are made hollow to receive the air as discharged from the air-cylinder, and are bolted direct onto the bed of the machine *g g*. This bed is made of a hollow or box section, so as to serve the purpose of a receiver or air-vessel, into which the air, compressed by the movement of the piston, passes through the hollow covers *f f'*.

The arrangement of the valves is shown on an enlarged scale in Fig. 3, Sheet 3, which is a section through, and Fig. 4, which is an end view of, the air-cylinder. *e'* is the air-cylinder; *e*, the piston, and *h* the piston-rod, the same letters being used to denote the same or corresponding parts in each figure. *i* is the inlet-valve, fitting close round the piston-rod *h*, and carrying the stuffing-box and gland i^1, and seated on front of the bush i^2 inside the cylinder. This bush contains openings *j j*, through which the outer air passes into the cylinder, as soon as the backward movement of the rod has drawn the valve open, by means of its frictional hold upon it, the amount of opening being determined by the position of the collar i^3, which serves the purpose of a stop. *k* k^1 are a number of small delivery-valves, which are placed in the hollow cover *f*, in a circle surrounding the central inlet-valve *i*, and are closed in by the covers and guides k^2, &c., which are screwed in at the front of the cover. These valves may be held against their seatings by springs, as at k^3, where needful, (but when in a vertical position the springs will not be required,) and are opened by the pressure of air produced in the cylinder by the forward movement of the piston *e*. The surfaces of the valves and the valve-passages on the inside, facing the piston, are curved off so as to approach as near as possible to the form of the *vena contracta*, and thereby lessen the resistance to the passage of the air from the cylinder to the receiver.

From the above description, the modified arrangements shown in Figs. 5 and 6, Sheet 4, will be readily understood. In Fig. 5, *k* is the delivery-valve of nearly the full diameter of the cylinder and seated in front thereof, and is provided with a boss passing through the center of the cylinder-cover, and an india-rubber packing-ring of the form shown at k^2, which serves the double purpose of a packing to prevent the escape of air, and a spring to keep the valve up to its seating. *i* is the inlet-valve, fitting round the rod *h*, passing through the boss of the delivery-valve *k*, and seated on front thereof. In Fig. 6, *k* is again the delivery-valve, consisting of an india-rubber ring, or it may consist of a series of india-rubber or metallic flaps radiating from the

center, and k^1 is the seating containing a series of openings, k^2, covered by the valve or valves. The inlet-valve i is the same as described in reference to Fig. 5.

In applying that part of my invention which relates to the actuating of the inlet-valves of air-compressors, by means of frictional action from some reciprocating part of the machine to air-compressors already in existence, or of different construction to those above described, it is obvious that the details may be variously modified to suit the required conditions without departing from the principle of my invention. Thus, when the inlet-valves are at the top or side of the cylinder, as at l, Fig. 11, Sheet 5, the valves may be actuated from the friction-collar l', fitting on the piston-rod of the engine or compressor, or an auxiliary rod applied for that purpose, through a system of levers and rods, as at m m', &c.

If required to compress gas, or other fluid, which must be kept separate from the outer air, or for exhausting, or for pumping, fluids, a bonnet may be applied over the inlet-passages, having an opening communicating with the place or vessel from which the gas or other fluid has to be drawn.

In Figs. 1 and 2, Sheets 1 and 2, t is the pump for feeding the boiler, worked by the eccentric t', and u is the suction-pipe communicating with the water-space w' surrounding the air-cylinder e'. The heated water surrounding the air-cylinder is thus drawn into the feed-pump t to feed the boiler, and may be still further heated by being passed through the exhaust-pipe V on its way to the boiler.

A convenient mode of arranging the mechanism for regulating the speed of the engine automatically, according to the rate at which the compressed air has to be supplied, is shown in Figs. 1 and 2, and, on an enlarged scale, in Figs. 7 and 8, Sheet 5. n is the eccentric which imparts a rocking motion to the lever n', which transmits the requisite movement to the valve through the rod o, and the levers o^1 o^2, &c. The upright arm of the lever o^1 has a slot formed in it, in which a pin on the end of the lever o^2 is free to work, as the lever o^1 moves up or down. It is obvious that, as the lever o^1 rises up, the lever o^2 will have its stroke shortened, thereby giving less opening to the valve, and causing the engine to run slower, and as it lowers and approaches nearer to the common center, the lever o^2 will have its stroke lengthened, consequently increasing the opening of the valve, and causing the engine to run quicker, and when the lever o^1 is at the top, so that its axis is in line with the center of the pin of the lever o^2, the latter will remain stationary, the valve covering both ports, and bringing the engine to a stand still.

The rising and falling of the air-pressure in the receiver is caused to impart the requisite up-and-down movement in the slot, by acting upon the plunger-piston p, working in the small cylinder p^1, as shown on an enlarged scale in Figs. 7 and 8, Sheet 5, in which g g shows a portion of the hollow bed.

Instead of the piston or plunger, a flexible or expanding pipe of india-rubber, or other suitable material, may be used, as shown in Figs. 9 and 10. These pipes lengthen or collapse as the pressure increases or diminishes, thereby shortening or lengthening the stroke of the valve.

Having thus described my invention, I claim and desire to secure by Letters Patent of the United States—

1. The combination of the piston-rod h, inlet-valve i, carrying the stuffing-box i^1, bush i^2, containing openings j j, through which the outer air passes into the cylinder, and the collar i^3.

2. The spring delivery-valves k k^1, placed in the hollow f in a circle surrounding the central inlet-valve i, in combination with the guides k^2.

In testimony that I claim the foregoing I have hereunto set my hand this 21st day of July, 1874.

JOHN STURGEON.

Witnesses:

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WILLIAM GEORGE WHITE.