(No Model.) 3 Sheets—Sheet 1.

E. HILL.

AIR COMPRESSOR.

No. 454,590. Patented June 23, 1891.

Fig. 1

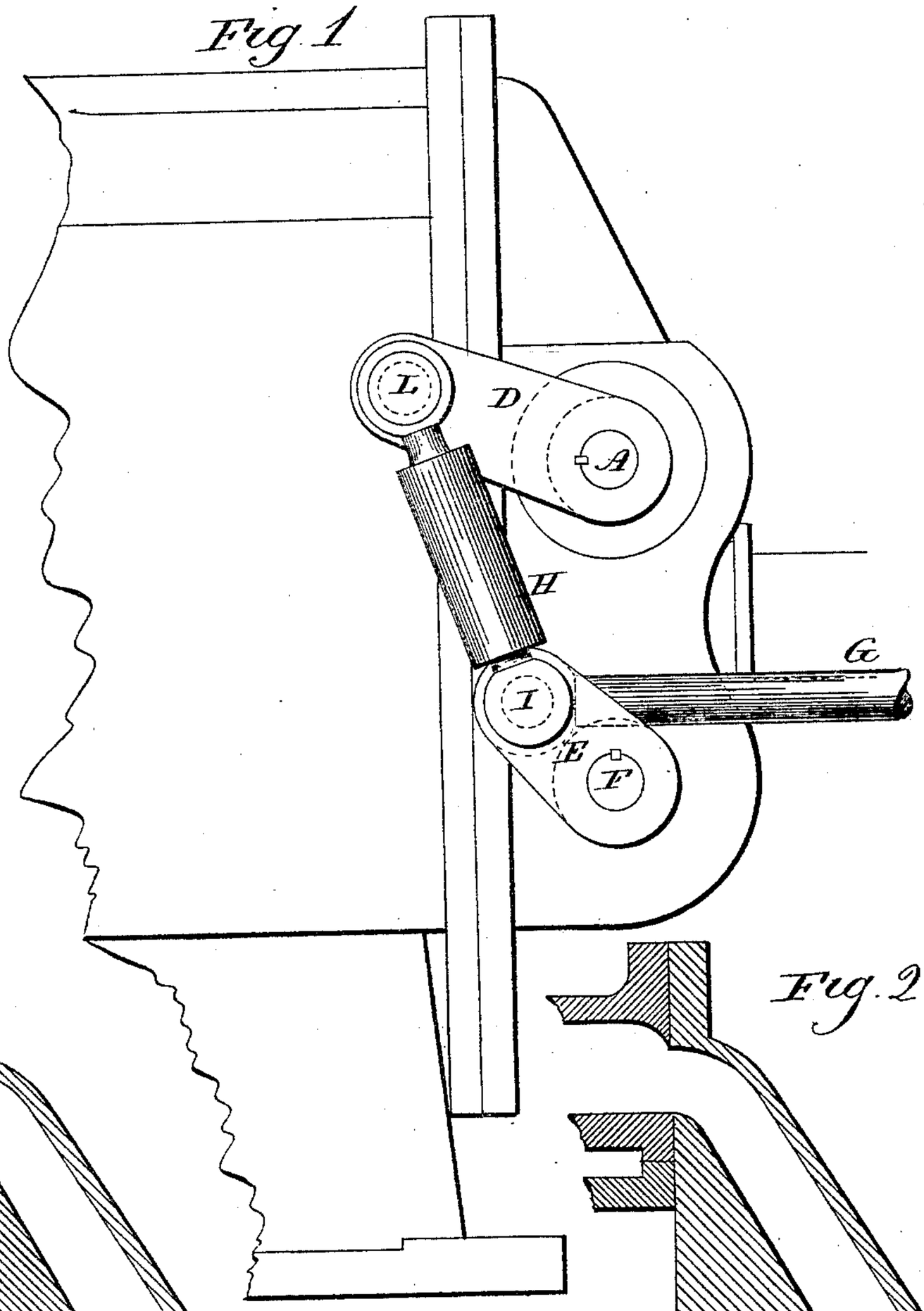


Fig. 3

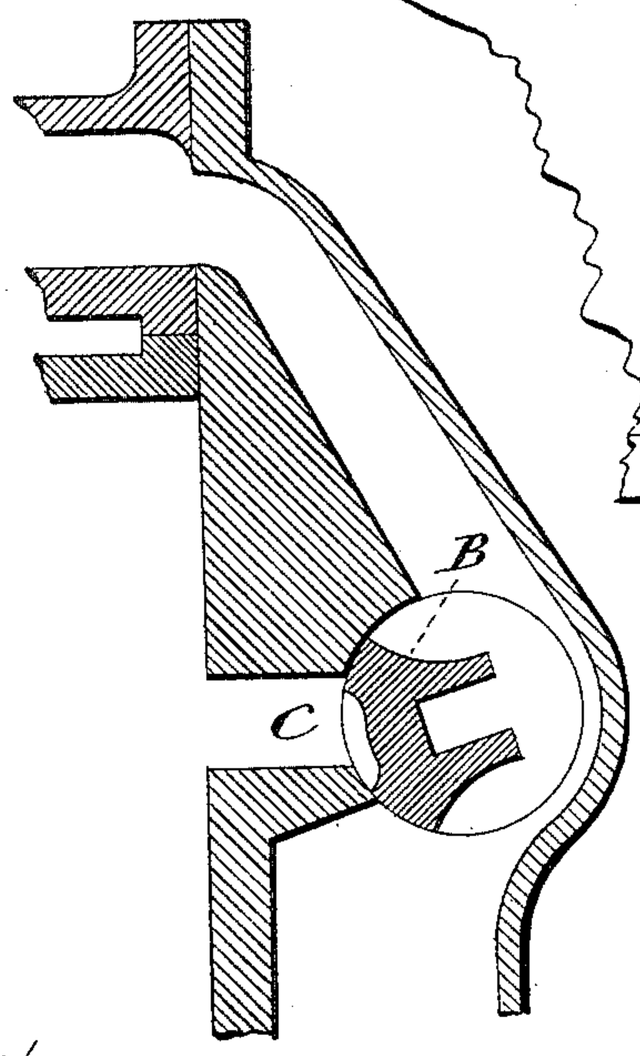
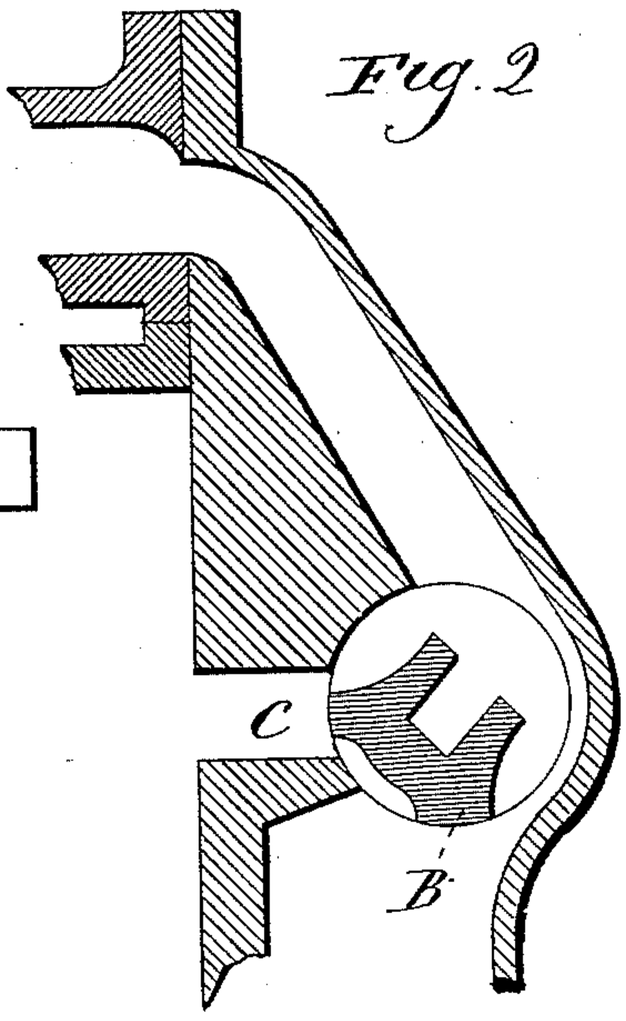


Fig. 2



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(No Model.) 3 Sheets—Sheet 2.

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AIR COMPRESSOR.

No. 454,590. Patented June 23, 1891.

Fig. 4

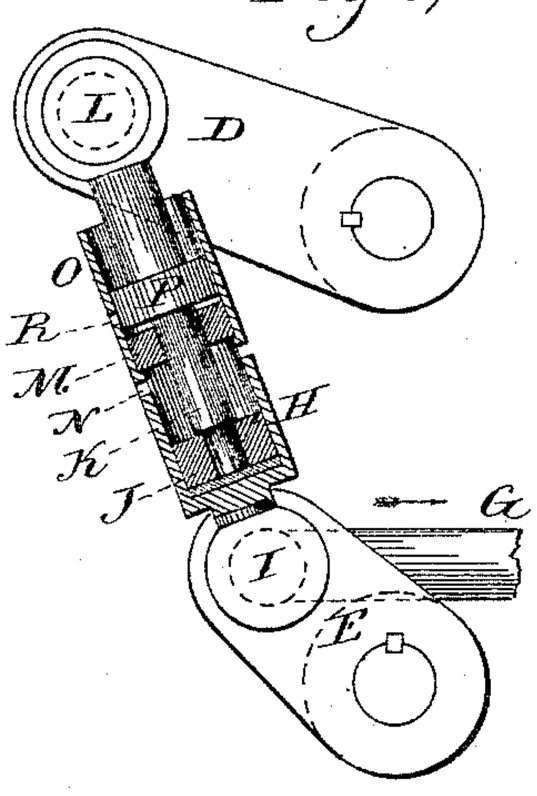


Fig. 5

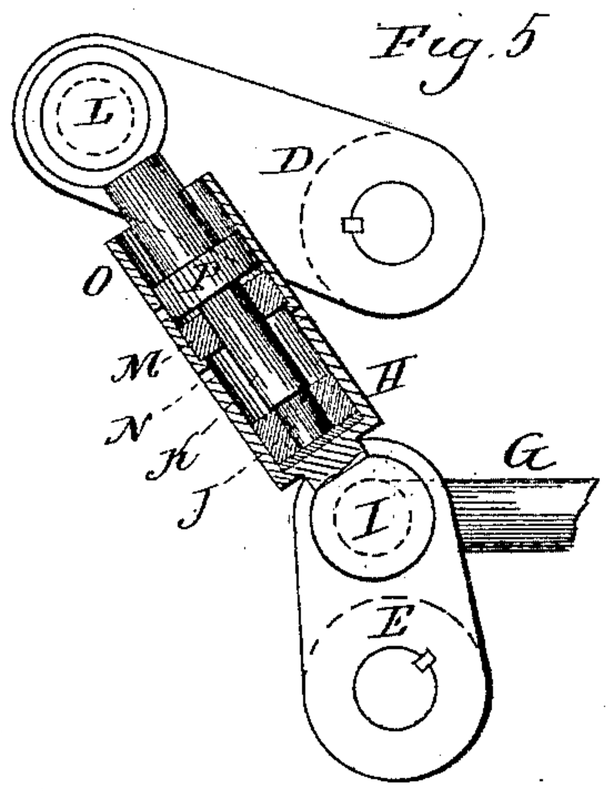


Fig. 6

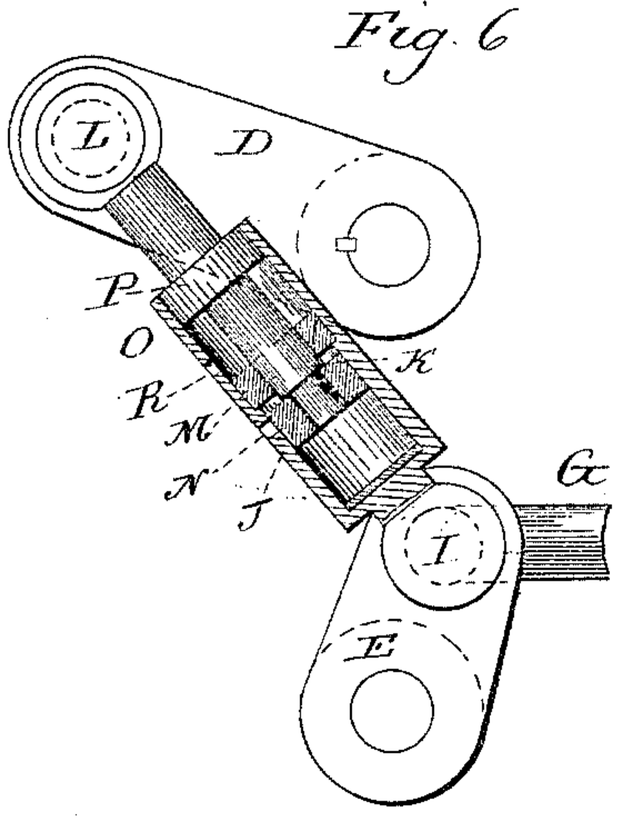
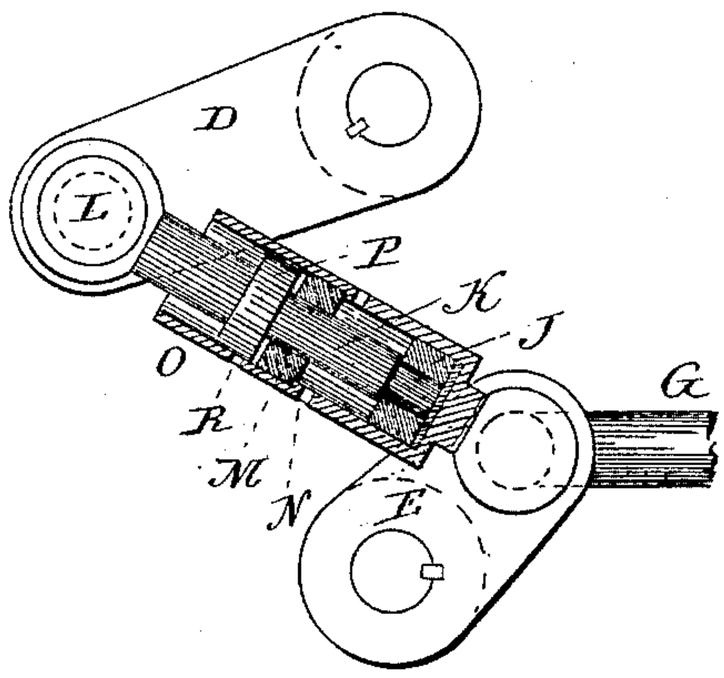


Fig. 7



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(No Model.) 3 Sheets—Sheet 3.

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AIR COMPRESSOR.

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Fig 8

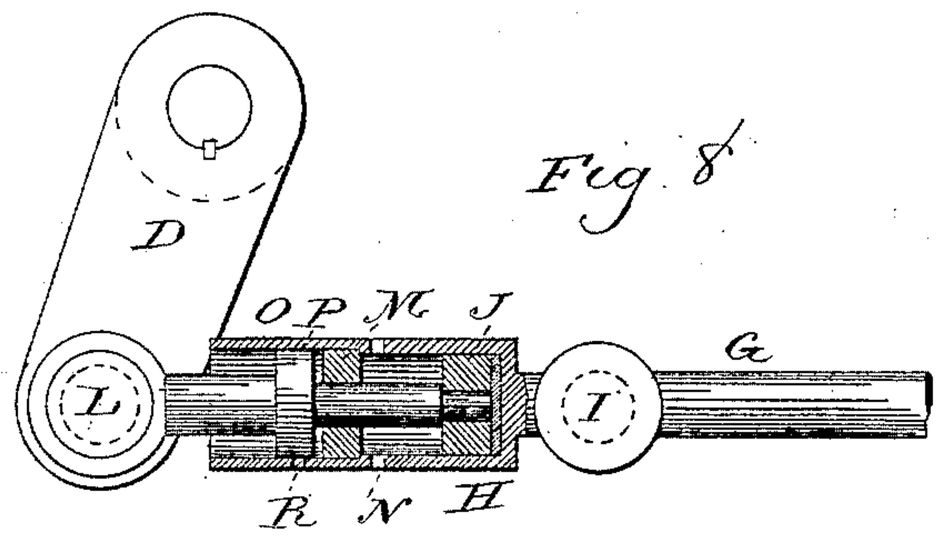


Fig 9

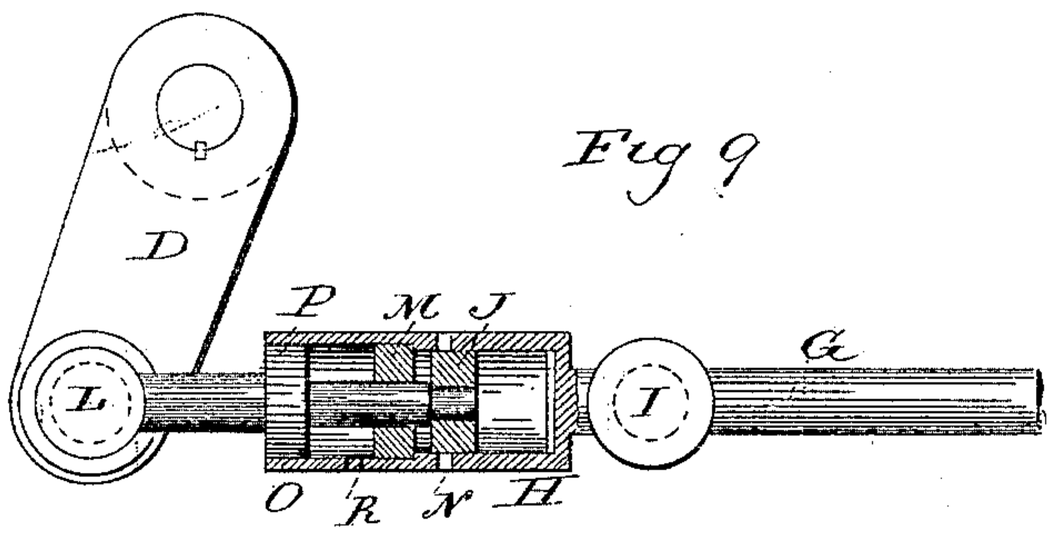


Fig. 10

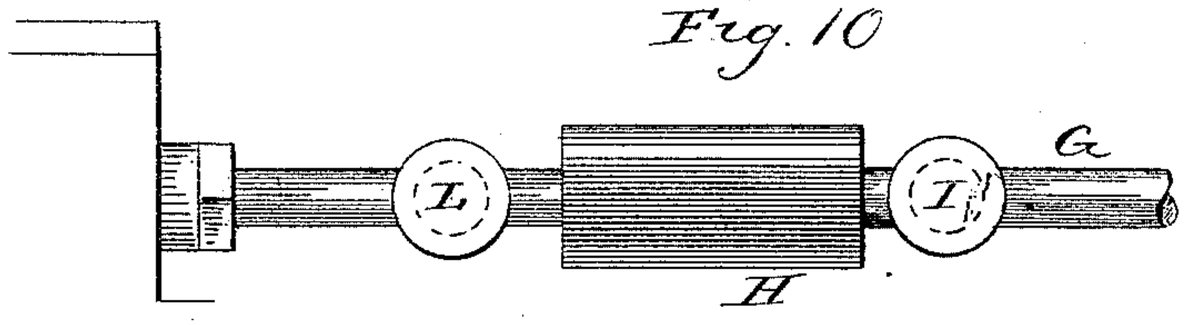


Fig. 12

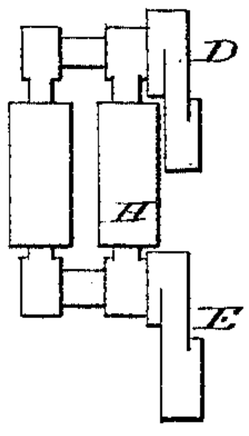
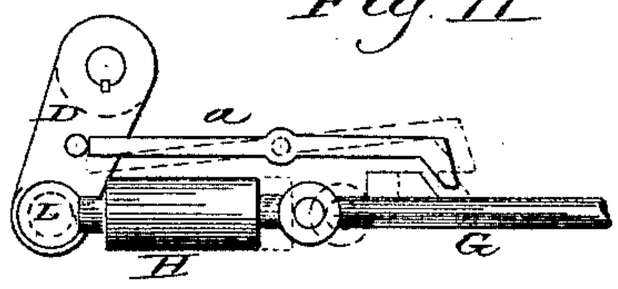


Fig. 11



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UNITED STATES PATENT OFFICE.

EBENEZER HILL, OF SOUTH NORWALK, CONNECTICUT.

AIR-COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 454,590, dated June 23, 1891.

Application filed May 24, 1889. Serial No. 311,993. (No model.)

To all whom it may concern:

Be it known that I, EBENEZER HILL, of South Norwalk, in the county of Fairfield and State of Connecticut, have invented a new Improvement in Air-Compressors; and I do hereby declare the following, when taken in connection with accompanying drawings and the letters of reference marked thereon, to be a full, clear, and exact description of the same, and which said drawings constitute part of this specification, and represent, in—

Figure 1, a side view of so much of the cylinder as necessary to illustrate the valve-gear for one outlet-valve; Fig. 2, a vertical section cutting through the outlet-valve at right angles, showing the valve in the open position; Fig. 3, the same as Fig. 2, showing the valve in the closed position; Figs. 4, 5, 6, and 7, detached views of the valve and eccentric crank-arms, showing the connecting-cylinder in vertical central section and in different positions to illustrate the operation; Figs. 8, 9, 10 and 11, modifications in the adaptation of the vacuum cylinder and piston; Fig. 12, a modification in the adaptation of the air-cushion.

This invention relates to an improvement in that class of air-compressors in which the valves are mechanically operated for the escape of compressed air from the cylinder. Under the more general construction of this class of air-compressors the valves are set so as to open at a predetermined point in the movement of the piston, and this point is intended to be when the pressure in the cylinder shall have reached the pressure in the receiver. For illustration, suppose the pressure outside the valve in the receiver, or whatever it may be, is fifteen pounds, that pressure under ordinary circumstances will be attained in the cylinder when the piston has reached its half-stroke in the cylinder. Now if under this positive arrangement of the valves with relation to the piston it be desired to reduce the pressure in the receiver or outside the valve—say to ten pounds—the continued action of the machine will still compress the air to the same extent in the cylinder and discharge it under a pressure of fifteen pounds, because the valve would not ordinarily open until the time when that pressure of fifteen pounds in the cylinder had been attained. On the contrary, if it be desired to increase the pressure in the receiver, the valve will open before the receiver-pressure has been reached in the cylinder. In the first case the valve is opened too late and in the latter case opened too early. The results of thus opening the valve are too well known to require particular description. Hence when such change in the pressure is desired a corresponding resetting of the valve is necessary to a perfect working of the machine.

In another application, Serial No. 304,622, I have described improvements in valve-operating mechanism to overcome the difficulties referred to, and which invention consists in providing an overmotion of the parts with which the outlet-valves are mechanically engaged and through which the power is applied to the said valves, during which overmotion the outlet-valves are independent of the power combined with means independent of such power, which during such overmotion may operate upon the outlet-valves to automatically open the same when they are brought to an equilibrium by the pressure in the cylinder, on the cylinder side of the valve, substantially equaling the pressure on the out or receiver side of the valves, the valves being held to their seats by the pressure of the air in the receiver or on the back of the valve. In that invention the outlet-valves are positively closed by the action of the eccentric; but on the return operation of the eccentric the valve is left free and independent of the eccentric until a predetermined pressure shall have been attained within the cylinder, when an auxiliary power is automatically applied to the valve to throw it instantly to its wide-open position, and this irrespective of what may be the position of the piston in the cylinder. The auxiliary power described in that application as the means for thus opening the valve is a spring or a weight.

The object of my present invention is to employ a vacuum as the means for bringing atmospheric pressure to operate as the said auxiliary power.

As the outlet-valve necessarily remains stationary after it is closed at the end of the advancing stroke of the piston until the piston has returned to the opposite end of the cylinder and again advanced toward that valve

until the equilibrium pressure has been produced the time of rest is so great that if an ordinary stationary vacuum dash-pot be used to operate the valve the vacuum would necessarily be produced as the valve reached its closed position, and that vacuum must be held through the long space of time mentioned. To hold the vacuum active for this long time would be difficult, because of the liability of air to leak into the vacuum-cylinder and destroy its efficiency.

By my present invention I am enabled to produce the vacuum by which atmospheric pressure is brought to bear as the power to open the outlet-valve and immediately before the time of opening of the valve occurs; and the invention consists in combining with the valve which is arranged to open and close the outlet-passage from the compressing-cylinder a cylinder and piston interposed between the said valve and the motor by which the valve is positively closed, and so that the piston will be drawn from the cylinder by the said motor when returning from the closing movement to produce a vacuum in said cylinder, which vacuum will at the proper time permit the atmospheric pressure thereby produced to operate as the power to move the valve from the closed to the open position, and as more fully hereinafter described.

In illustrating the invention I represent it as applied to rotary or oscillating valves.

A represents the outlet-valve spindle. B, Figs. 2 and 3, represents the outlet-valve; C, the port leading from the cylinder to the outlet-valve, the position of the valve in Fig. 2 being open and the position in Fig. 3 being closed. The valve thus illustrated is the same as that in the application before referred to.

To the valve-spindle A a crank-arm D is made fast, by which the oscillating movement may be imparted to the spindle to give to the valve its opening and closing movement.

E is a second crank-arm hung upon an axis F, and with which arm the eccentric-rod G is connected, so that through the operation of the eccentric a vibratory movement will be imparted to the crank-arm E, the crank-arms D and E being arranged in substantially the same plane. Connection is made between the crank-arms D and E, so that vibratory movement imparted to the crank-arm E may under certain circumstances be communicated to the crank-arm D. The connection between the crank-arms D and E is a cylinder H closed at one end, and hung by that end to one of the arms, as E, upon a crank-pin I, combined with a piston J, the rod K of which extends through the other end of the cylinder, and is hung upon a crank-pin L on the other crank-arm D. (See Fig. 4.) The piston is free to move in the cylinder. The closed end of the cylinder is tight, and so that if the piston be withdrawn from the closed end of the cylinder it will create a vacuum therein, which vacuum causes a corresponding atmospheric pressure upon the opposite side of the piston, and which pressure, if free to operate, will cause the piston to return to the closed end of the cylinder.

The position of the outlet-valve crank-arm D in Fig. 4 is as when the valve is in its closed position and at the closing extreme throw of the eccentric. From this point the movement of the eccentric crank-arm E is in the direction indicated by the arrow, Fig. 4. The crank-pin I of the eccentric-rod E, it will be observed, is out of line with the crank-pin of the valve-arm and the axis upon which the eccentric crank-arm turns. As the eccentric moves as indicated by the arrow, Fig. 4, it will take the crank-pin of the eccentric-arm across and to the other side of the line between the crank-pin of the valve crank-arm and the axis upon which the eccentric-crank turns to the position seen in Fig. 5. In this part of the movement of the eccentric-arm no substantial movement has been imparted to the valve crank-arm. The outlet-valve therefore still remains closed, and this position is attained when the piston has arrived at the end of its stroke opposite this valve. The piston now returns, the eccentric continuing its movement; but from this point, Fig. 5, the movement of the crank-pin of the eccentric-arm is away from the crank-pin of the valve-arm, so that the valve being held to its seat by the pressure upon its back the cylinder will be drawn from the position seen in Fig. 5 to that seen in Fig. 6, the piston being held by the pressure upon the valve. This will accordingly lengthen the connection between the two crank-pins to the extent of the movement of the cylinder, and in so drawing the cylinder from the piston a vacuum will have been created in the cylinder with a corresponding atmospheric pressure upon the reverse side of the piston, the tendency of which is to force the piston into the cylinder. This vacuum and consequent atmospheric pressure will continue in force until the pressure within the cylinder upon the face of the valve substantially counterbalances the pressure upon the back of the valve. Then the said atmospheric pressure comes into operation and acts upon the piston to return it into the cylinder, as seen in Fig. 7, and give to the valve crank-arm the opening movement required for the outlet-valve. The piston now stands in its normal position, and the eccentric has reached its opposite extreme throw, and on the return throw of the eccentric the piston and cylinder will act as a positive connection between the two crank-arms, so that they will move together to the other extreme, as seen in Fig. 4, when the valve will have reached its extreme closed position, and thus have made one complete opening and closing movement. It will thus be seen that the vacuum is not created until the time it is actually required, and being employed substantially as soon as it is created there is no opportunity to destroy or reduce that vacuum

by the leakage of air into the vacuum, as is unavoidably the case in a vacuum dash-pot.

As the valve when in equilibrium, as I have described, will require but a slight power to move it, there would naturally be a "thump" as the piston returns into the cylinder under the action of the said atmospheric pressure. To avoid this thumping or jar, I provide a cushion, and this I do by extending the cylinder toward the arm to which the piston-rod is connected and introducing a stationary head M into the cylinder distant from the closed head sufficient to permit the vacuum-piston to operate. The piston-rod works through this head M, and the vacuum-cylinder is constructed with air-openings N near the head M to permit the escape of air as the piston is drawn away from the closed end of the cylinder. Into the extension of the cylinder, as at O, a second piston P is formed upon or attached to the piston-rod, which fits close into its cylinder and moves with the piston-rod and the vacuum-piston, and so that as the piston and cylinder separate, as seen in Fig. 6, the piston P will be drawn from its head M and will take air into the cylinder through a small aperture R provided for the purpose, and the air thus taken in will form a cushion upon which the piston P will strike as it returns with the vacuum-piston J, the air of the cushion gradually escaping, so as to permit the vacuum-piston to reach its normal position without thump or jar.

Instead of employing the crank-arm E between the cylinder and the eccentric-rod, the connection may be made directly to the eccentric-rod, as represented in Figs. 8 and 9, Fig. 8 representing the position of the parts when the valve is closed and substantially the same as Fig. 4, before referred to. In this case the cylinder is represented as hung directly to the eccentric-rod, and so as to move with it, while the piston-rod is connected to the valve-crank, as in the first illustration. The dead-point in the movement of the eccentric gives substantially the same rest after the valve has reached its closed position, as I have described in the first illustration. Fig. 9 represents the same parts as Fig. 8 in the same relative position as that represented in Fig. 6—that is, when the vacuum has been substantially formed and so that as the eccentric completes its stroke the vacuum will be brought into action and produce the opening movement of the valve, as before described.

The moving vacuum-cylinder may be employed with a slide-valve, as represented in Fig. 10, the cylinder being connected directly to the eccentric-rod, and the piston-rod to the valve-rod, as indicated in that figure, and so that the operation of the eccentric upon the cylinder and piston to form the vacuum will be the same as that described with reference to Figs. 8 and 9.

In some cases it may be desirable to mechanically hold the valve in the closed position and give to it the quick opening action which will necessarily follow the operation of the atmospheric pressure. In such case a latch may be provided to catch the valve-arm when in the closed position, as represented in Fig. 11, in which *a* represents a latch which will engage the crank-arm of the valve when it has reached its closed position, and this latch will be tripped at the proper time by any suitable means, as by engaging a projection on the rod, as seen in broken lines, Fig. 11, and so that at a predetermined point after the vacuum is formed the valve will be released. While therefore preferring the arrangement of the cylinder and piston as first described, I do not wish to be understood as limiting the invention to any particular arrangement of the vacuum piston and cylinder further than that they shall be so arranged that the vacuum is produced by the movement of the valve-motor immediately before the opening movement of the valve is required.

I have represented the piston as hung to the valve-arm and the cylinder as hung to the eccentric-arm; but it will be understood that this order may be reversed without change in the result or departure from this invention.

While I prefer to make the air-cushion as a part of the vacuum-cylinder and a piston on the same rod as the vacuum-piston, the combination of the air-cushion with the vacuum may be otherwise arranged. For illustration, the air-cushion cylinder may be a separate and independent cylinder with corresponding independent piston, as represented in Fig. 12, the same letters as heretofore used indicating corresponding parts in this figure.

It will be understood that the term "eccentric" as applied to the motor by which the valve is operated is to be used in the general sense as including any motor by which the valve is operated.

I do not in this application claim, broadly, the outlet-valve held solely by friction until the equilibrium pressure is produced thereon with an auxiliary power to operate the valve, as that is the subject of another application, Serial No. 304,622.

I claim—

1. In an air-compressor having a valve arranged to open and close the outlet-passage from the compressing-cylinder and a motor operating to close the valve, the combination therewith of a cylinder and a piston in said cylinder, said cylinder and piston being interposed between the said valve and the said motor, substantially as described, and whereby as the motor returns after the closing of the valve the return movement will draw the piston from the cylinder and produce a vacuum with corresponding atmospheric pressure which will operate to impart to the valve its opening movement.

2. In an air-compressor having a valve arranged to open and close the outlet-passage

from the compressing-cylinder and a motor operating to close the valve, the combination therewith of a cylinder and a piston in said cylinder, said cylinder and piston being interposed between the said valve and the said motor, and an air-cushion, composed of a cylinder and piston, also interposed between the valve and its motor, substantially as and for the purpose described.

3. In an air-compressor having a valve arranged to open and close the outlet-passage from the compressing-cylinder and a motor operating to close the valve, the combination therewith of a cylinder and a piston in said cylinder, said cylinder and piston being interposed between the said valve and the said motor, the said cylinder being extended toward the point of its piston connection and the piston-rod provided with a second piston in said extension and the cylinder being constructed with a stationary head between the said two pistons, the said extension and its piston forming an air-cushion, substantially as and for the purpose described.

4. In an air-compressor having a valve arranged to open and close the outlet-passage from the compressing-cylinder, the back of the valve exposed to the pressure of the air in the receiver and the face of the valve being exposed to the pressure from the cylinder, and whereby the said valve will be frictionally held substantially stationary upon its seat by the said pressure upon its back until the pressure upon the face of the valve substantially equals the pressure upon the back of the valve, a vibrating crank-arm in connection with said valve and by which it is operated, a second vibrating crank-arm in connection with the motor, a cylinder closed at one end, hung by said closed end to one of said crank-arms, a piston in said cylinder, the piston-rod extending from the piston and hung to the other crank-arm, and so that as the said crank-arms separate the piston will be drawn from the cylinder and produce a vacuum therein, substantially as and for the purpose described.

5. In an air-compressor having a valve arranged to open and close the outlet-passage from the compressing-cylinder, the back of the valve exposed to the pressure of the air in the receiver and the face of the valve being exposed to the pressure from the cylinder, and whereby the said valve will be frictionally held substantially stationary upon its seat by the said pressure upon its back until the pressure upon the face of the valve substantially equals the pressure upon the back of the valve, a vibrating crank-arm in connection with said valve and by which it is operated, a second vibrating crank-arm in connection with the motor, a cylinder closed at one end, hung by said closed end to one of said crank-arms, a piston in said cylinder, the piston-rod extending from the piston and hung to the other crank-arm and so that as the said crank-arms separate the piston will be drawn from the cylinder and produce a vacuum therein, the said cylinder extended toward the arm to which the piston is connected and the piston-rod being provided with a second piston in the said extension of the cylinder, the said cylinder constructed with a stationary head between the said two pistons, the said extension and its piston forming an air-cushion, substantially as and for the purpose described.

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