2 Sheets--Sheet 1.

J. ERICSSON.

Air-Compressing Apparatus.

No. 146,055. Patented Dec. 30, 1873.

Fig: 1

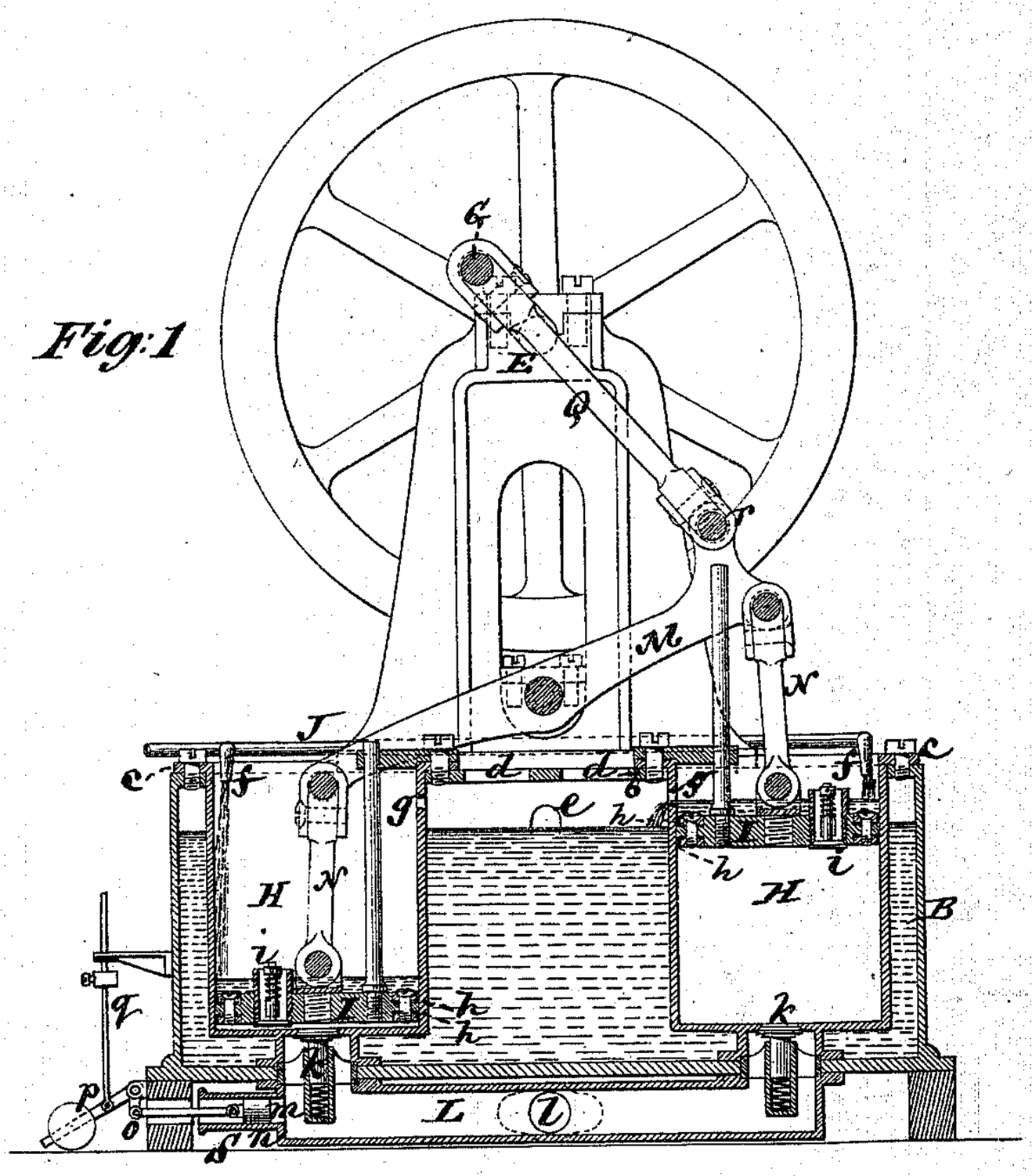
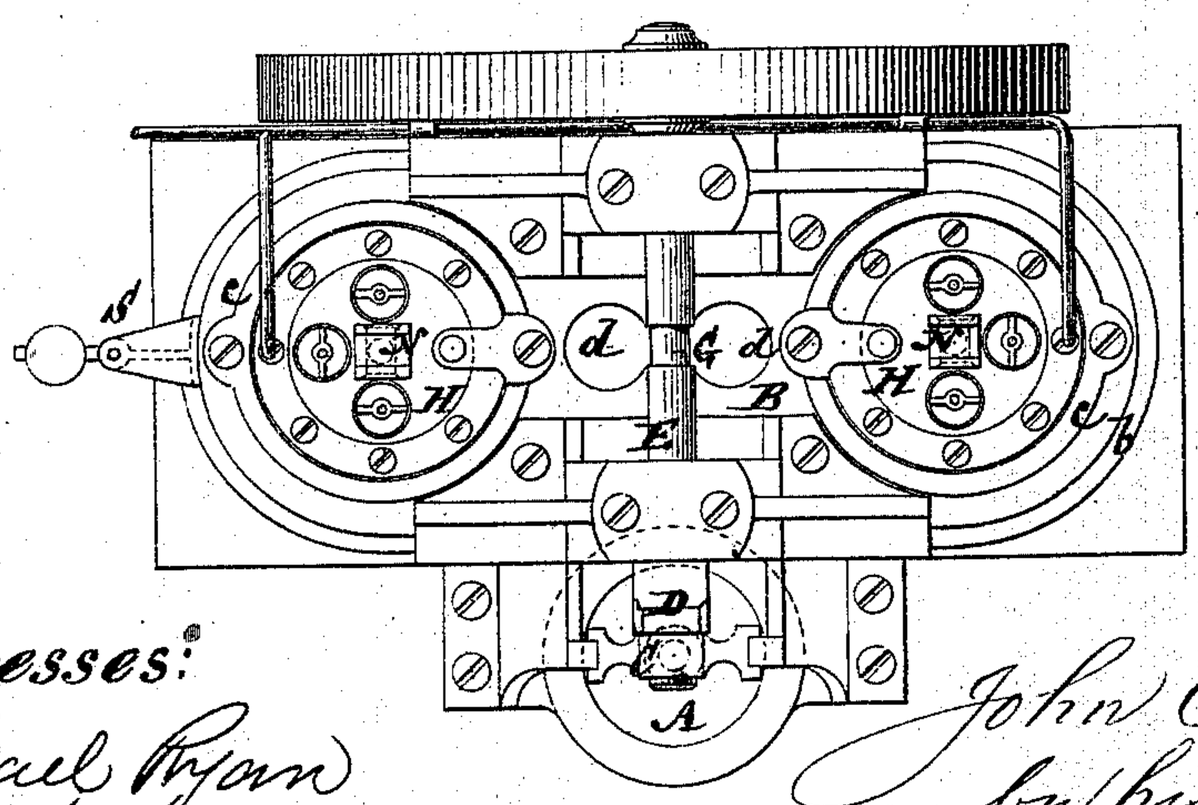


Fig: 2



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2 Sheets--Sheet 2.

J. ERICSSON.

Air-Compressing Apparatus.

No. 146,055. Patented Dec. 30, 1873.

Fig: 3

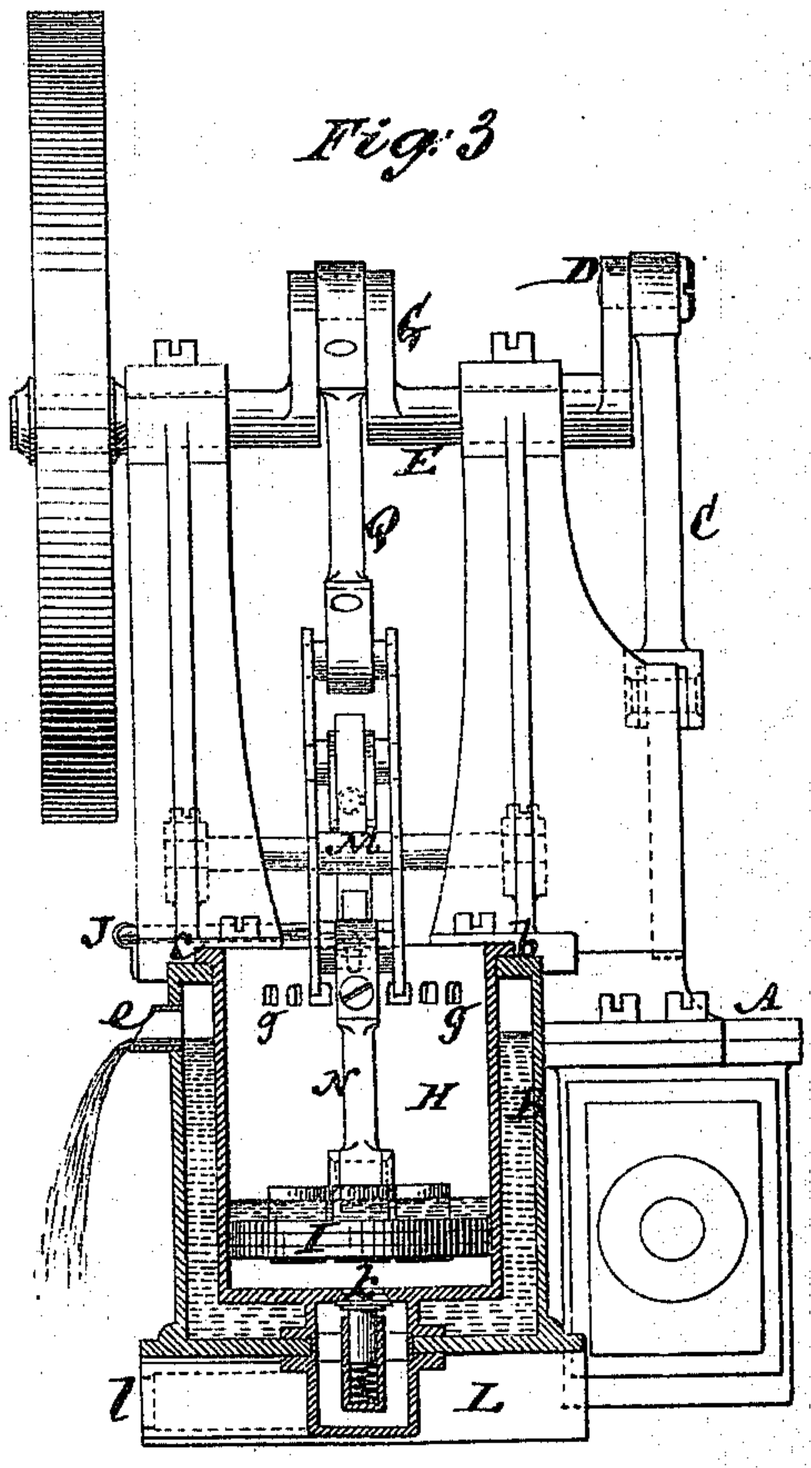
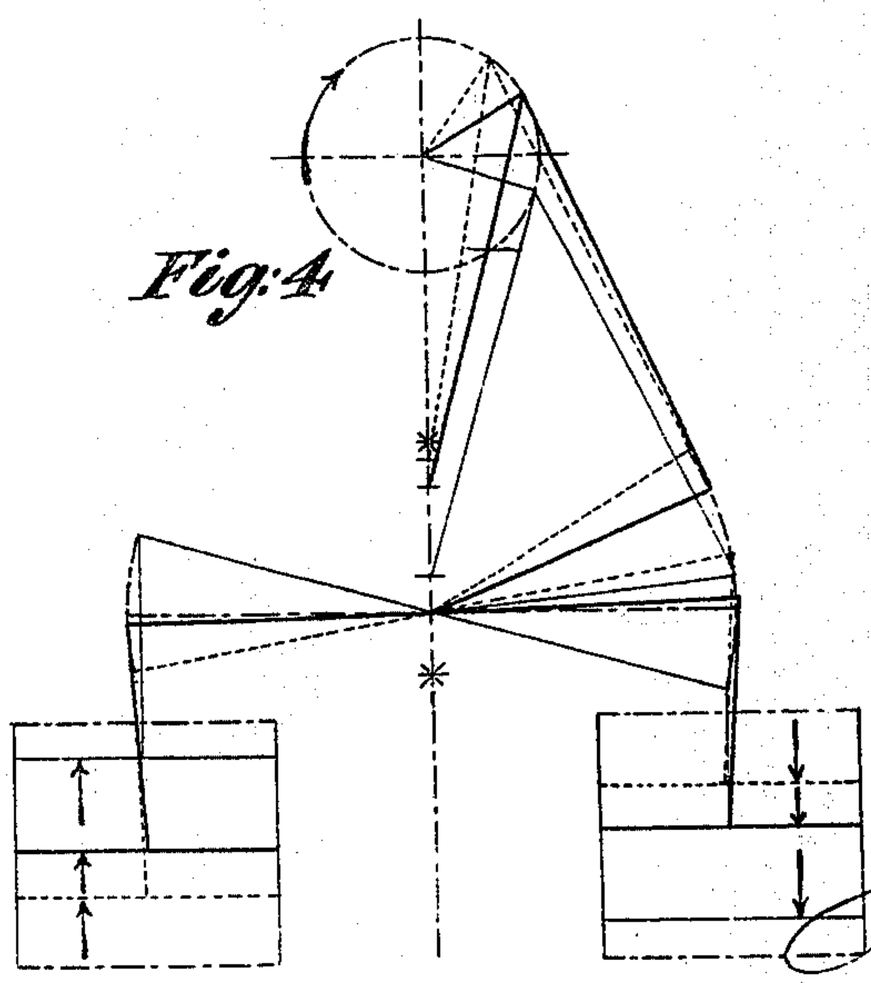


Fig: 4



Witnesses:
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UNITED STATES PATENT OFFICE.

JOHN ERICSSON, OF NEW YORK, N. Y., ASSIGNOR TO CORNELIUS H. DELAMATER AND GEORGE H. ROBINSON, OF SAME PLACE.

IMPROVEMENT IN AIR-COMPRESSING APPARATUS.

Specification forming part of Letters Patent No. **146,055**, dated December 30, 1873; application filed September 12, 1873.

To all whom it may concern:

Be it known that I, JOHN ERICSSON, of the city, county, and State of New York, have invented certain Improvements in Apparatus for Compressing Air and other aeriform fluids or gases, of which the following is a specification:

This invention consists in certain novelties of construction and combination or arrangements of parts in apparatus mainly designed for the compression of air by steam or other motive power, whereby numerous advantages are obtained, including a very effective cooling of the cylinder and piston of each single-acting air-compressing pump in a series of pumps; also cooling the air in these pumps without saturating it by spray. The cooling is effected by washing the interior of the pump-cylinders with cooling water introduced above the pistons, and either discharged over the tops of the cylinders or through upper overflow-openings in their sides, or the water first introduced into a water-pedestal, within which the pump-cylinders are immersed, and, after cooling the exterior of the cylinders, allowed to overflow into the cylinders on top of the pistons, and ultimately to escape from the cylinders in any convenient way. Another advantage is in the application of the power of the engine to the air-compressing pumps by a novel arrangement of air-compressing cylinders in parallel axial relation with each other; the engine-cylinder; a beam for operating the pistons of said cylinders; and a certain oblique connection of such beam relatively with the engine-shaft or connection from the engine-piston and pump and engine-cranks, coincident with each other, whereby and consequent on the different angles simultaneously assumed by the cranks to their respective connections the power of the engine is more advantageously applied to meet the varying resistance encountered. Still another advantageous feature of the invention is in the application of an automatic governor, operated by the pressure in the compressed air-receiver, to regulate the speed of the engine to the draft made upon said receiver.

It should be particularly noticed that the fly-wheel of the steam-engine is at the same time a band-wheel, admitting of operating the air-pumps by water-power. Thus, during the dry season, when water-power fails, the steam-engine will be applied, while at the other seasons the main connecting-rod of the steam-engine will be detached, and the water-power employed by means of ordinary gearing and a band applied to the fly-wheel of the engine.

In the accompanying drawing, which forms part of this specification, Figure 1 represents a vertical longitudinal section of the apparatus taken centrally through the pump-cylinders. Fig. 2 is a plan of the same; Fig. 3, a vertical transverse section through one of the pump-cylinders; and Fig. 4 is a diagram in illustration of the application of the driving power to the pumps.

Similar letters of reference indicate corresponding parts.

A is the cylinder of a direct-acting steam-engine, having a water-pedestal, B, and serving to rotate by a connecting-rod, C, and crank D, a main shaft, E, arranged overhead. This shaft is constructed to form a double or second crank, G, by which motion is communicated to the pumps. These cranks D and G are coincident as regards set or pitch, one with the other. The water-pedestal B is made of a suitable depth to receive down within it on opposite sides, as it were, of the shaft E, cylinders H H of two single-acting air-compressing pumps, said cylinders, which have their longitudinal axes parallel with each other, and are vertical, resting on and being bolted to the top plate *b* of the water-pedestal, through or by means of flanges *c* on the upper open ends of the cylinders, the air being compressed alternately below the pistons I of said pump-cylinders. In this way the cylinders H, that have only a valvular opening at their bottoms, serve, in conjunction with the top plate *b* of the water-pedestal, to close, or approximately close, the upper surface of said pedestal, which, however, should be provided with one or more air-inlets, *d*, to establish an atmospheric equilibrium on the water in the pedestal to provide for its free escape by an upper overflow, *e*. Moreover, the cylinders H, by this arrangement, are wholly immersed, or nearly so, in the body of water within the pedestal or tank B, in distinction to merely being surrounded by a water-jacket each; and by a circulation

which is kept up in the tank, as hereinafter described, the bottoms and outsides of the cylinders H are very thoroughly cooled. But the main cooling of said cylinders and their pistons I is effected by the continuous, or preferably continuous, washing of the interior of the cylinders by the introduction of cold water, as by a pipe, J, provided with outlets or nozzles *f* onto the tops of the pistons, both during their up and down strokes, thereby leaving or forming a thin film of water on the insides of the cylinders, and supply of cold water on the tops of the pistons, such water as it accumulates being allowed to overflow the tops of the cylinders, or through a number of overflow-apertures, *g*, at the close of the upper stroke of each piston into the tank or water-pedestal B, from whence surplus water passes off by the outlet *e*. The water thus introduced into the tank B from the cylinders H also serves to keep up a circulation of the water in the tank about the cylinders, while the constant or frequent introduction of fresh cold water into the interior of the cylinders on top of the pistons most effectually cools the latter and the cylinders, thus adding to the working efficiency of the pumps, as regards their packings and valves, and cooling the whole volume of air in the cylinders without objectionably saturating the same.

If desired, the water may first be introduced into the pedestal B, and, after cooling the exterior of the pump-cylinders, be allowed to overflow into the cylinders on top of the pistons, and ultimately to escape in any convenient way.

The pistons I are each fitted with upper and lower cup-packing, *h h*, and the arrangement, as described, is such that the upper one of these duplicate packings to each piston is relieved of all pressure dependent upon compression of the air, and is only required to prevent leakage of water past the pistons. Other kinds of packing, such as hard rubber, may be employed.

Air to be compressed is introduced through the pistons I by inlet-valves *i*, and discharged, as compressed by each piston alternately in its down stroke, through delivery-valves *k*, into a compressed air-receiver or passage, L, from whence it passes off, to be utilized, by an outlet, *l*. This compressed air-receiver or passage is provided with an automatic governor, S, which is controlled by the pressure of the air in the receiver, to regulate the speed of the engine to the draft made upon said receiver, so that when the drain on the compressed air in the receiver temporarily ceases or slackens, instead of the engine continuing to run at its regular speed and waste steam by freely pumping air as before, into the receiver, and providing for the escape of such additional supply through the safety-valve of the receiver, the steam is more or less throttled or cut off from the engine by the governor S, and its supply to the engine re-established or increased as the drain on the receiver L is restored or augmented. This compressed air-governor S is represented as composed of a piston, *m*, arranged within an open-ended cylinder, *n*, which is connected with the receiver L, said piston being attached to a crank, O, the shaft of which carries a weighted lever, *p*, that has a rod, *q*, attached to it for operating the throttle-valve of the engine, the weight on the lever *p* preferably being adjustable, and serving as a counterpoise to the pressure of the compressed air in the receiver on the inner face of the piston *m*, whereby the governor S operates to automatically control the speed of the engine, as described. It is desirable, to produce a more efficient action of said governor, that the lever *p* should be arranged to form an acute angle with the crank O, and so that as air accumulates in the receiver the increased pressure in forcing out the piston will find an increasing resistance till the weight of the lever passes a horizontal position, and the crank O will have a diminishing efficiency during such action by reason of change in its angle from a right-angled position relatively with the axial line of the piston to a less effective one.

The vertically-arranged air-compressing pumps are disposed at a suitable distance apart to admit of their operation in like directions alternately by or from opposite ends of a rocking beam, M, which is connected with the pistons I by rods N. This rocking beam is actuated by the crank G through a connecting rod, Q, attached by joint *r* to the one end of the beam, above the joint by which the rod N of the one pump is connected with the beam.

The engine-shaft E, it will be observed, has a central overhead position between the pumps, so that the rod Q occupies an oblique position across the center of the shaft when the pump-piston connected with the same end of the beam is at its top stroke, and always maintains a varying oblique position with the connection between said shaft and the piston of the engine. This arrangement, in connection with the cranks D and G, being coincident, is important, as by it the power of the engine is more advantageously applied to meet the varying resistance encountered by reason of the angular efficiency of the engine-crank increasing as the angular efficiency of the pump-crank diminishes—that is, relatively to their respective connections or rods—thus giving an increased power to the pump-pistons as they approach the ends of their compressing strokes, and proportioning, in a measure at least, the velocity of said pistons to the varying resistance they encounter. This is a consequence of the hereinbefore-described arrangement of the pump-cylinders, the beam, the engine-shaft, the engine and pump cranks, and their connections, the diagram in Fig. 4 being illustrative of such action.

I claim as my invention and desire to secure by Letters Patent—

1. The combination of the water-pedestal

B, the cylinders H H of the single-acting air-pump, the pistons I I, a duct for conveying cold water to the interior of the pump-cylinders on top of the pistons, and one or more upper overflows or outlets from said cylinders to the pedestal, substantially as and for the purposes specified.

2. The combination, with the engine and one or more air-pumps operated thereby, of a compressed air-governor, S, organized substantially as herein described, to control the steam-supply to the engine, and whereby the motion of the engine is regulated by the draft made upon the air as compressed by the pump or pumps, essentially as herein set forth.

3. The combination, substantially as herein described, of the air-compressing cylinders H H and their single-acting pistons I I, the engine-piston A, the beam M, the cranks D G, the engine-shaft E, and the connection Q, whereby the power of the engine throughout its stroke is approximately equalized to meet the varying resistance encountered by the pistons of the pumps, as specified.

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Witnesses:
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