2 Sheets--Sheet 1.

P. M. CONOLLY.
Pneumatic-Engine.

No. 164,809. Patented June 22, 1875.

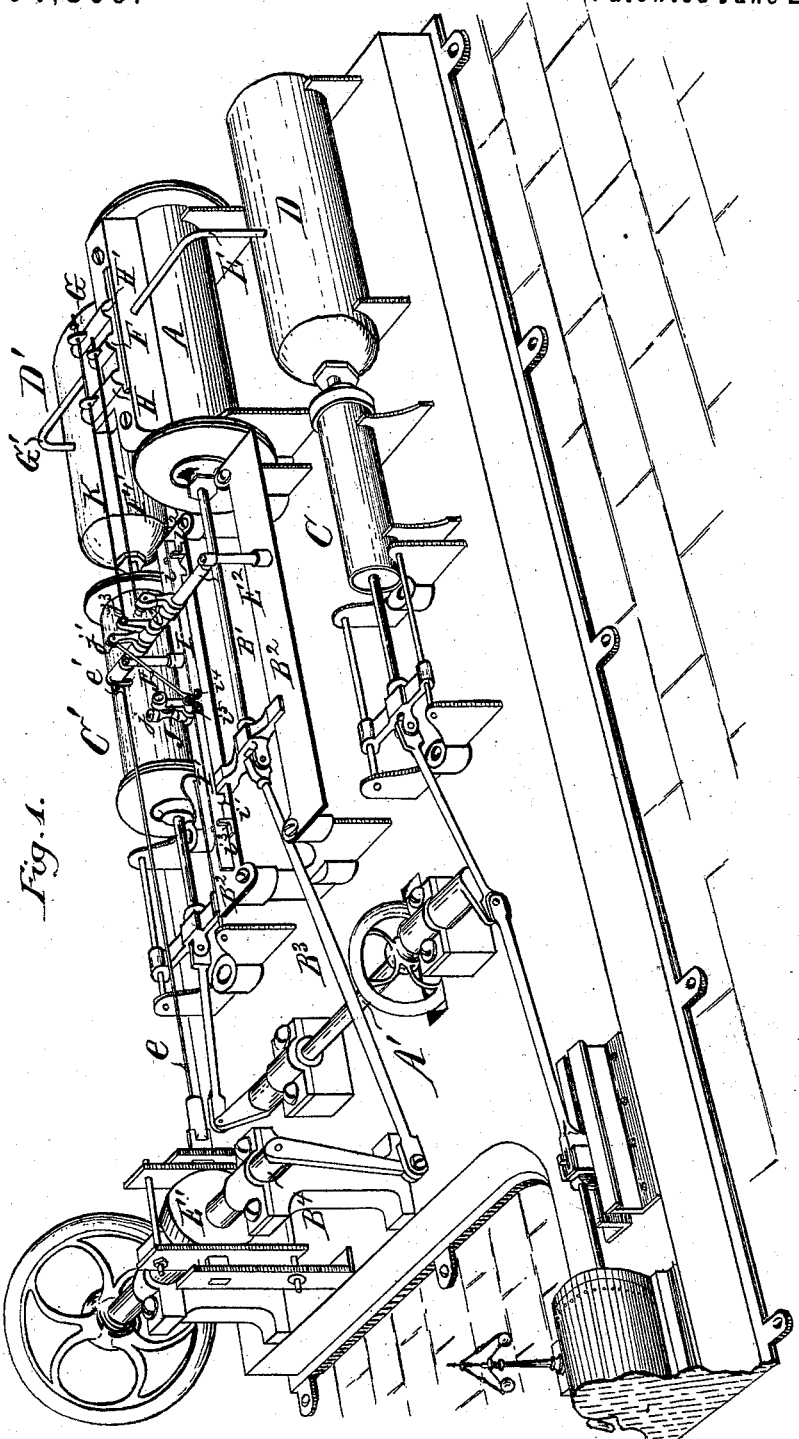

Fig. 1.

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2 Sheets--Sheet 2.

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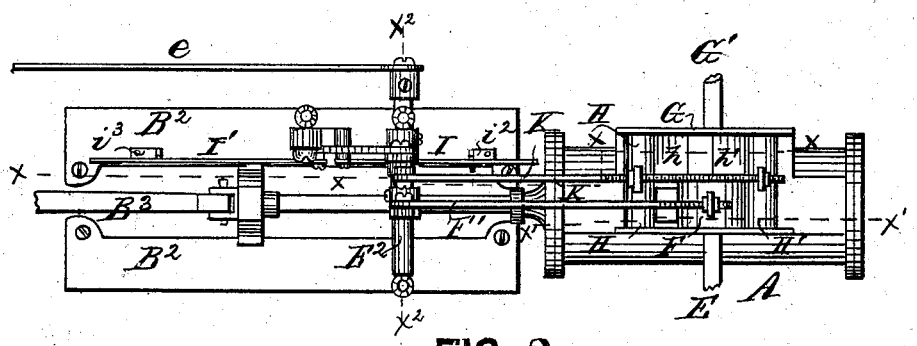

FIG. 2.

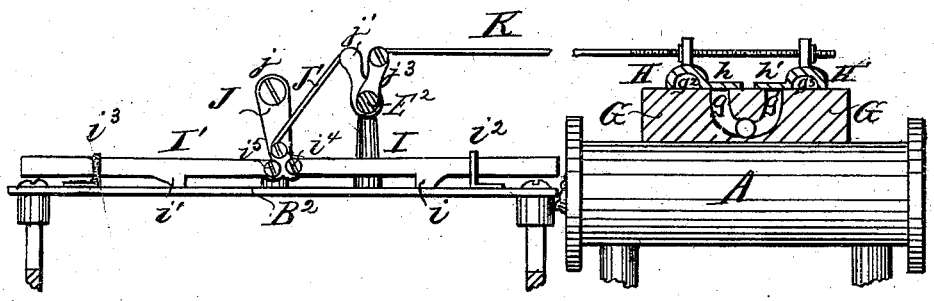

FIG. 3.

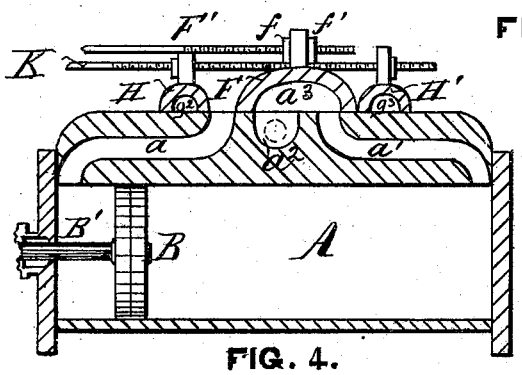

FIG. 4.

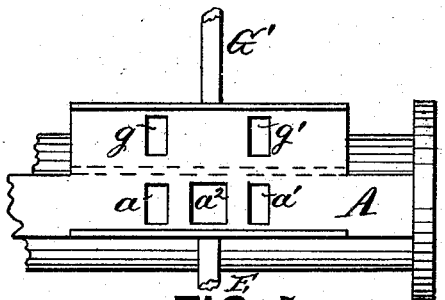

FIG. 5.

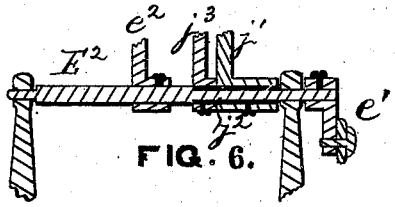

FIG. 6.

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UNITED STATES PATENT OFFICE.

PETER M. CONOLLY, OF ST. LOUIS, MISSOURI.

IMPROVEMENT IN PNEUMATIC ENGINES.

Specification forming part of Letters Patent No. **164,809**, dated June 22, 1875; application filed February 6, 1873.

To all whom it may concern:

Be it known that I, PETER M. CONOLLY, of the city and county of St. Louis, and State of Missouri, have invented a certain Improved Pneumatic Engine, of which the following is a specification:

The general object of this invention is the formation of an improved pneumatic engine, which can be profitably employed in the propulsion of marine vessels, or as a general impeller of stationary machinery. To accomplish this invention atmospheric air is utilized as its common motor, by virtue of its natural force, to destroy or supply a vacuum or void.

This invention consists in the combination of the parts with the engine, by means whereof the power of atmospheric air is applied as a motor, by the indirect operation of an auxiliary well-known power, and all of which will now more fully appear.

Of the drawings, Figure 1, Sheet 1, is a perspective view of the engine, showing it in its entirety and operative condition. Fig. 2, Sheet 2, is a top plan of engine without the adjuncts of air-vessels, pumps, crank, and cam-connections. Fig. 3 is a sectional elevation with line x x of Fig. 2, but showing exhaust-chamber in section. Fig. 4 is a section through cylinder on line x^1 x^1 of Fig. 2. Fig. 5 is a detail plan of valve-seats. Fig. 6 is a detail transverse section on line x^2 x^2 of Fig. 2.

The general constructive design of this invention is similar to that of the ordinary steam-engine.

A is the cylinder; B, the piston; B^1, the piston-rod. The piston-rod connects, by T-head operating on the slides B^2, with a pitman, B^3, which operates the crank of the main driving-shaft B^4, as ordinary.

As an auxiliary power a small steam-engine is used to operate air-pumps. The steam-engine is properly connected to a crank-shaft, A′, which in turn operates the respective air-pumps C C′, and these in turn are directly connected to chambers or vessels D D′, as illustrated in Fig. 1. The design of the pump C is to create and maintain a vacuum in the vessel D, and hence said vessel is termed hereafter "vacuum-vessel." The design of the pump C′ is to exhaust the vessel D′, and this will hereafter be termed "exhaust-vessel." It must not be understood that the air in the engine, and when exhausted from it, passes into the vacuum-vessel D. On the contrary, the exhaust is made into the exhaust-vessel D′ by connections from it to cylinder and valves controlling said connections, as will hereafter appear. In order, therefore, to establish connections from cylinder with the vacuum-vessel D, this I do as follows: The cylinder is provided with the air-ports a a^1 to, admit air to either end thereof, said ports, therefore, communicating from cylinder-space to valve-seat. (See Fig. 4.) Also, the cylinder is provided with a vacuum-port, a^2. (See Fig. 4.) In connection with said port a pipe, E, connects to vacuum-vessel D. Further, a valve and its operating parts are provided to establish and control said connection with cylinder. Therefore, F represents this valve. This, by its cored hollow, covers two ports—viz, vacuum-port a^2 and one of the air-ports—forming a passage, a^3, between. (See Fig. 4.)

The vacuum-valve F is operated by a full-stroke cam, E^1, connected by a cam-rod, e, to an arm, e^1, on the end of the rock-shaft E^2. (See Fig. 1.) A further arm, e^2, on rock-shaft connects with the valve-rod F′, to the end of which the vacuum-valve F is properly secured by nuts f f'. When, therefore, by the action of the cam E^1, the vacuum-valve F is operated to cover either of the air ports a a^1, a connection is established from engine with the vacuum-vessel D. It is necessary to first exhaust the air from either end of cylinder before the connection aforesaid with the vacuum-vessel D is made. Hence the parts in connection with the air-pumps C′ and exhaust-vessel D′, before described, to produce exhaust from cylinder, are as follows:

The cylinder A is provided with a side-exhaust chamber, G, Fig. 3. This chamber G has exhaust-ports g g^1, each communicating from valve-seat, and being positioned in direct line with air-ports a a^1. (See Fig. 3.) Further, an exhaust-pipe, G′, communicating with both exhaust-ports g g^1, connects with the exhaust-vessel D′.

To control the exhaust-ports, the following valve-gear and rigging is provided and arranged: To control the air-port a and exhaust-port g, an air-valve, H, is provided; similarly,

to control the air-port a^1 and exhaust-port g^1, an air-valve, H′, is provided. The valves H H′ are of the slide-valve variety, having their bodies hollowed, but constructed each to have a tail, h h', forming said valves L-shaped. (See Fig. 2.) Each of the valves H H′ have imparted to them their required shifting-movement by the forward and return sliding action of the T-head of piston. Hence two levers, I I′, are arranged, each formed with a stationary or adjustable catch and inclined plane, as at i i^1, against which the T-head acts until its passage releases and drops said levers. The levers I I′ are guided in action by the respective brackets i^2 i^3 near each end of the slides, and, further, said brackets serve to unship, by their plane, said levers after their performed motions. The levers I I′ have their center of motion in the middle of stroke of engine, being, therefore, pivoted at i^4 i^5 to a movable arm, J, which in turn is pivoted at j to a proper standard. The movable arm J is also operated by a connecting-rod, J′, which in turn connects with a socket-arm, j^1. The socket-arm j^1 is adjustably secured to a sleeve or female-shaft, j^2, which turns independently on the rock-shaft E^2. (See Fig. 6.) A further socket-arm, j^3, attached to the female-shaft j^2, (see Fig. 6,) connects by valve-rod K to the valves H H′. The valves H H′ are loosely secured by nuts to the threaded end of valve-rod K, so as to allow said valve the play of the distance of an air-port, and thus avoid all jar or undue operation of said valves.

Having described the valve-gear and rigring controlling the action of the air-valves H H′, the operation of said parts is as follows: When the piston arrives near end of its forward stroke, the action of the T-head engaging the catch i of the lever I throws same sufficiently forward, which movement is imparted to the valve H, so that same is shifted to close the open port a. The valve H thus covering air-port a and exhaust-port g a connection is established, by virtue of the passage g^2 between and through said exhaust-port, with exhaust-vessel D′, and thus the air in cylinder is allowed freely to be exhausted by the action of the air-pump C. At the same time the bracket i^2 unships the lever I—the same being raised by the passing T-head on the plane of said bracket. On the return stroke of piston this operation of valve-rigging and opposite air-valve H′ is similarly effected, viz: The action of the T-head against the catch i^2 of the lever I′ throws same sufficiently back, which movement is imparted to the valve H′, so that same is shifted to close the open port a'. The valve H′ in this position covering ports a^1 and exhaust g^1, a communication is made by the passage g^3, between and through said exhaust-port, with exhaust air-vessel D′, and thus the air in opposite end of cylinder is exhausted. At the same time the lever I′ is unshipped to allow the necessary escapement to take place. The air from either end of engine that has been used is sufficiently exhausted into exhaust-vessel; and said exhaust, being thus cut off from returning into engine, a vacuum or void results in either end of cylinder, which permits me to establish from cylinder the vacuum connection with vacuum-vessel without danger of destroying the vacuity. This being the case, the vacuity in either end of cylinder, together with the already-existing vacuum in the vacuum-vessel, forms the essential basis of the power of my air-engine. Further, it will be noted that the vacuum-vessel D, in consequence of the air giving the power being excluded from it, the air-pump C exhausting it can be small, and, in comparison to that of the cylinder, say one-sixth the area and one-third of its stroke. The exhaust-vessel D′ receiving the air used, and in consequence of all communication being cut off between the cylinder for seven-eighths of the stroke, the air-pump C′ can also be small—say one-third the area of cylinder and one-third of its stroke. Further, as the pump can be run rapidly to exhaust by the use of a small steam-engine, (indicated in Fig. 1,) both combined, their areas being fifty per cent. under that of the air-engine, and their stroke one-third, the vacuum in cylinder being strong and uniform, the air in the exhaust-chamber at first, after exhaustion from cylinder, nearly balancing that of the external air, little power is therefore required to move the piston of the pump discharging it.

Thus constructed, and its parts arranged as described and shown, the combined operation of my improved engine is as follows: The steam-engine being set in motion to work the pumps, and the necessary vacuum and exhaust having taken place, thenceforward the engine proper works automatically. Now, supposing the engine or its piston being at half-stroke in its forward motion, the air-port a is open to admit air, and the vacuum-valve F covers the vacuum-port a^2, and air-port a^1 having established vacuum connection with the forward end of cylinder, Fig. 4. Thus there exists on one side of piston-head a void or vacuum which the admitted air, in its tendency to establish an equilibrium in vacuum vessel, and, by its power to destroy the said vacuum, causes the piston to travel its required forward stroke. At the same time the exhausted air in exhaust-vessel D′ is prevented from returning by the fact that the valves H H′ have their tails h h' covering exhaust-ports g g^1. Near the completion of the forward stroke of piston, by the motion derived from the action of the T-head, the air-valve H is shifted up against the vacuum-valve F, so as to close the open ports a and establish closed connections with the exhaust-port g, from thence with exhaust-vessel D′, into which sufficient air from the cylinder is exhausted. The vacuum-valve F remains unmoved, so as to keep outside air from entering into and destroying the vacuity in vacuum-vessel D. At the period of piston beginning its return-stroke, (the valve H having been unshipped,) and by the mo-

tion derived from the action of the cam, the vacuum-valve F displaces the air-valve H, so that its tail *h* covers the exhaust-port *g*, the tail *h'* of H' remaining over port g^1, thus shutting out the exhaust. At the same time the vacuum-valve F covers air-port *a*, and vacuum-port a^2 establishes vacuum communication with vessel D, and in doing so uncovers the air-port a^1 to outside air, which, by its power, propels the piston to make its full back-stroke. When the piston has traveled near its full back-stroke by the motion derived from T-head acting against the lever I', the air-valve H' is shifted to close the open port a^1, and establishes closed connections from said port through exhaust-port g^1 with the exhaust-vessel. Thus sufficient exhaust from other end of cylinder is effected. The vacuum-valve F here again remains stationary to prevent air from outside destroying the created vacuum. The exhaust effected, and the valve H being unshipped at the period for the reversal of piston, and by the motion derived from the action of the cam, the vacuum-valve F displaces said valve H', so that its tail *h'* covers the exhaust-port g^1, the tail *h* of valve H remaining in position, thus again excluding the return of exhaust.

At the same time the vacuum-valve F covers air-port a^1 and vacuum-port a^2, to establish communication with vessel D, and, in doing so, uncovers the air-port *a* to outside air, which by its power produces the same result accomplished at the other end of cylinder.

By the aforesaid combined operation of all parts there is practically achieved, first, the immediate establishment of a vacuum or void alternately in cylinder ends, at the same time that the outside air is admitted, which, by its power, propels the piston to travel its respective strokes, thus imparting to same a continuous motion like unto the use of steam; secondly, the conveyance of the exhaust-air out of either end of cylinder alternately into an exhaust-vessel, and the prevention of return of said exhaust; thirdly, a simplified arrangement of valve-gear and rigging to effect a perfect distribution of air in the engine, admitting, exhausting, shutting off, and closing at the proper period; fourthly, the reverse operation here achieved to that of steam-power, the power in this engine being introduced at a period in which it would escape if it was a steam-engine, and further working under valves instead of top, and requiring no inclosure around or over the valve-seat, as the power of the atmosphere sufficiently retains said valves in their seat or position; lastly, the manifold advantages of this invention are readily apparent.

What I claim is—

1. An improved pneumatic engine, consisting of the cylinder A, having ports *a* a^1 a^2 *g* g^1, valves F H H', operated in the manner herein shown and described.

2. The vacuum-vessel D, exhaust-vessel D', pumps C C', in combination with an auxiliary motor, substantially as and for the purpose set forth.

In testimony whereof I have hereunto set my hand.

PETER M. CONOLLY.

Witnesses:

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