No. 663,909. Patented Dec. 18, 1900.

F. M. LEAVITT.

STEAM PUMPING ENGINE.

(Application filed Oct. 19, 1898.)

(No Model.) 4 Sheets—Sheet 1.

FIG. 1.

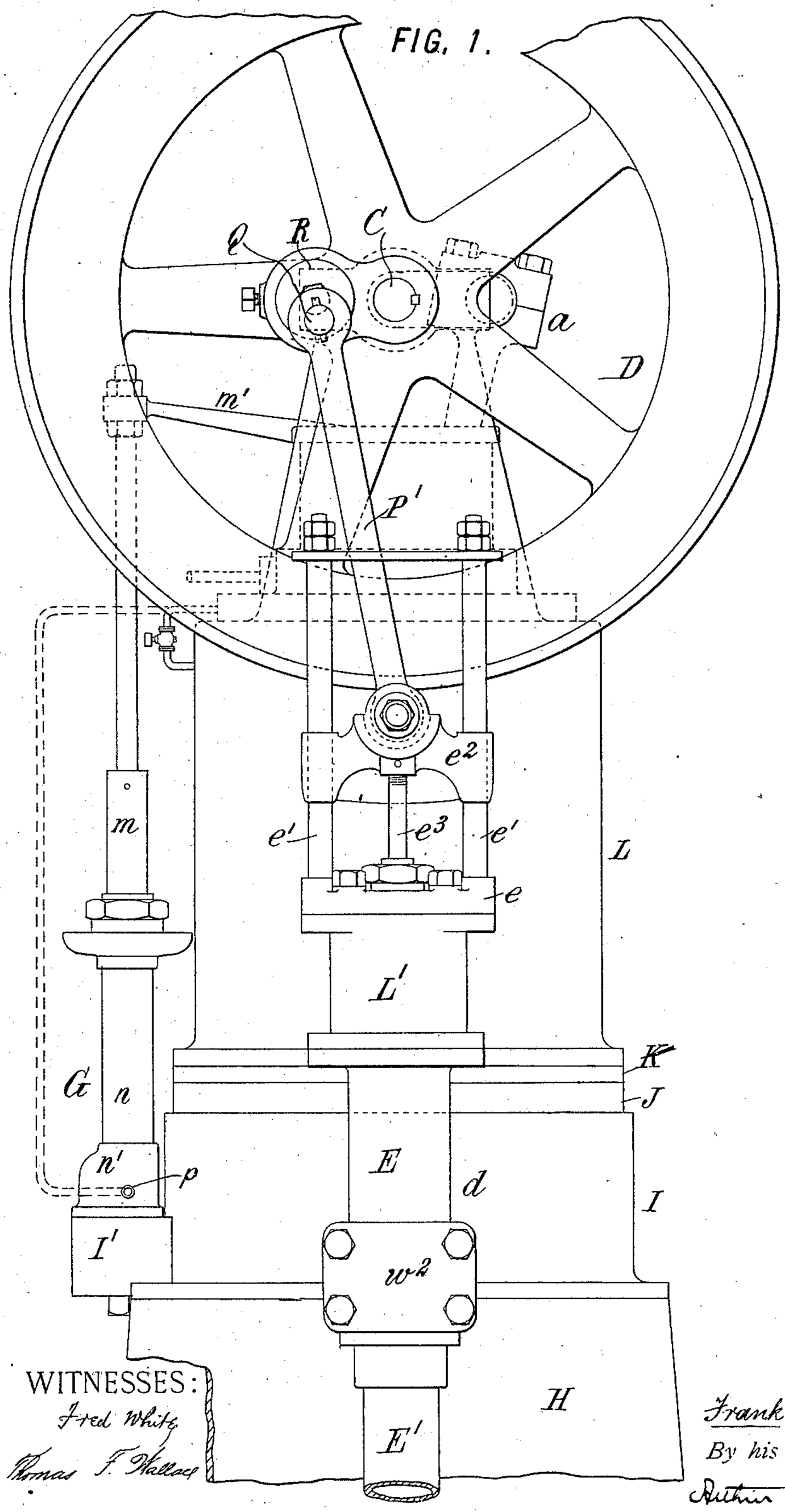

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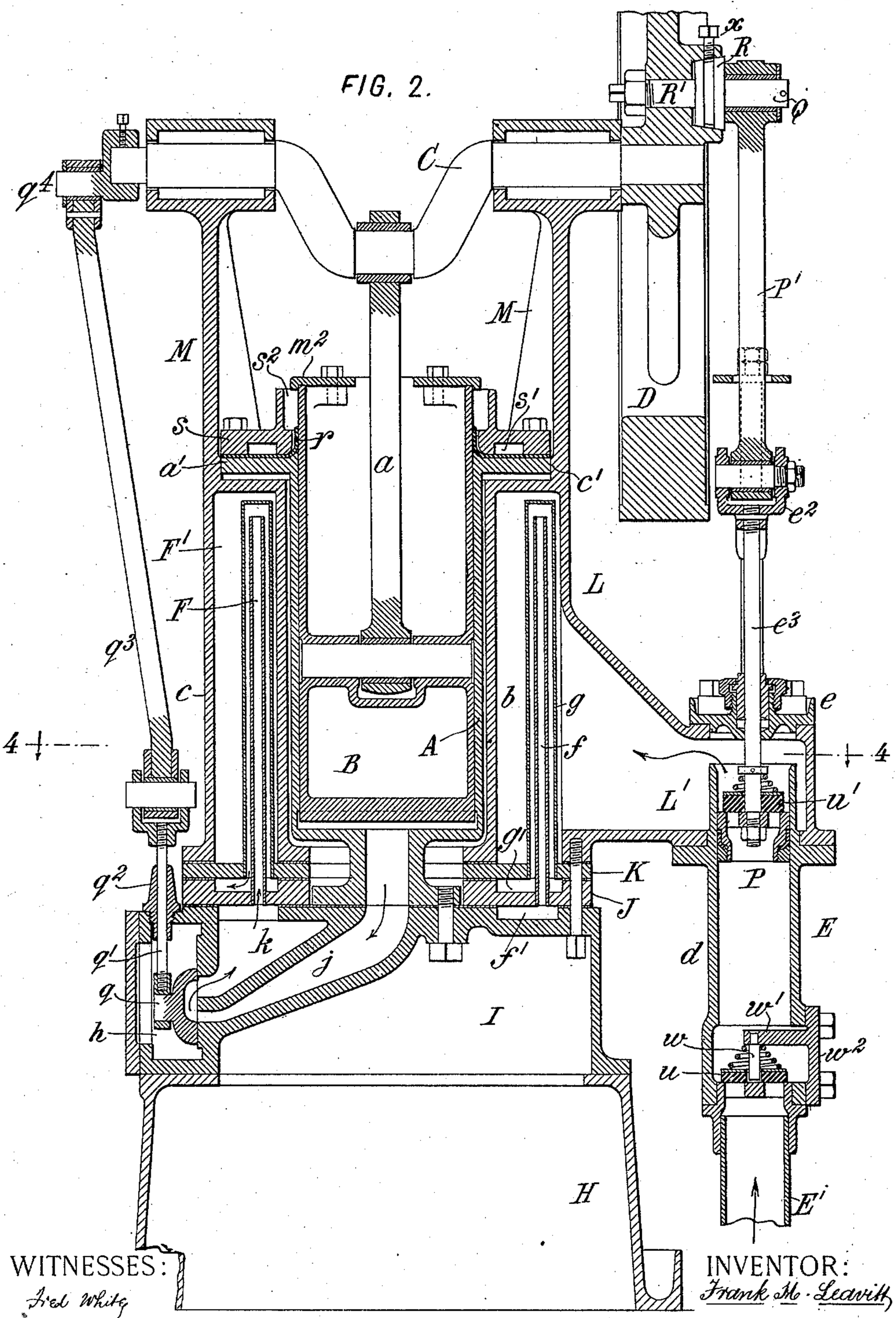
FIG. 2.



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(No Model.) 4 Sheets—Sheet 3.

FIG. 3.

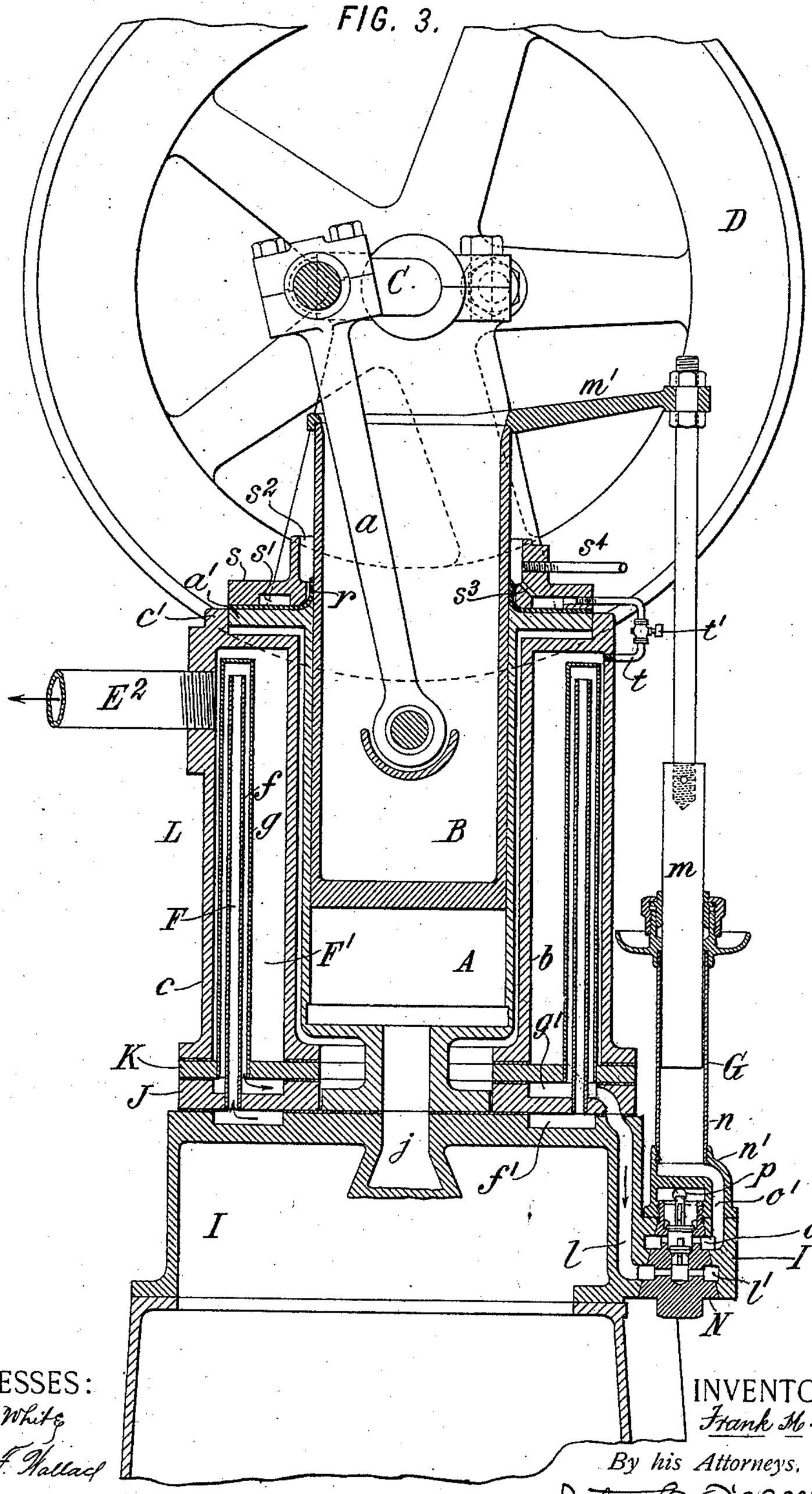

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FIG. 4.

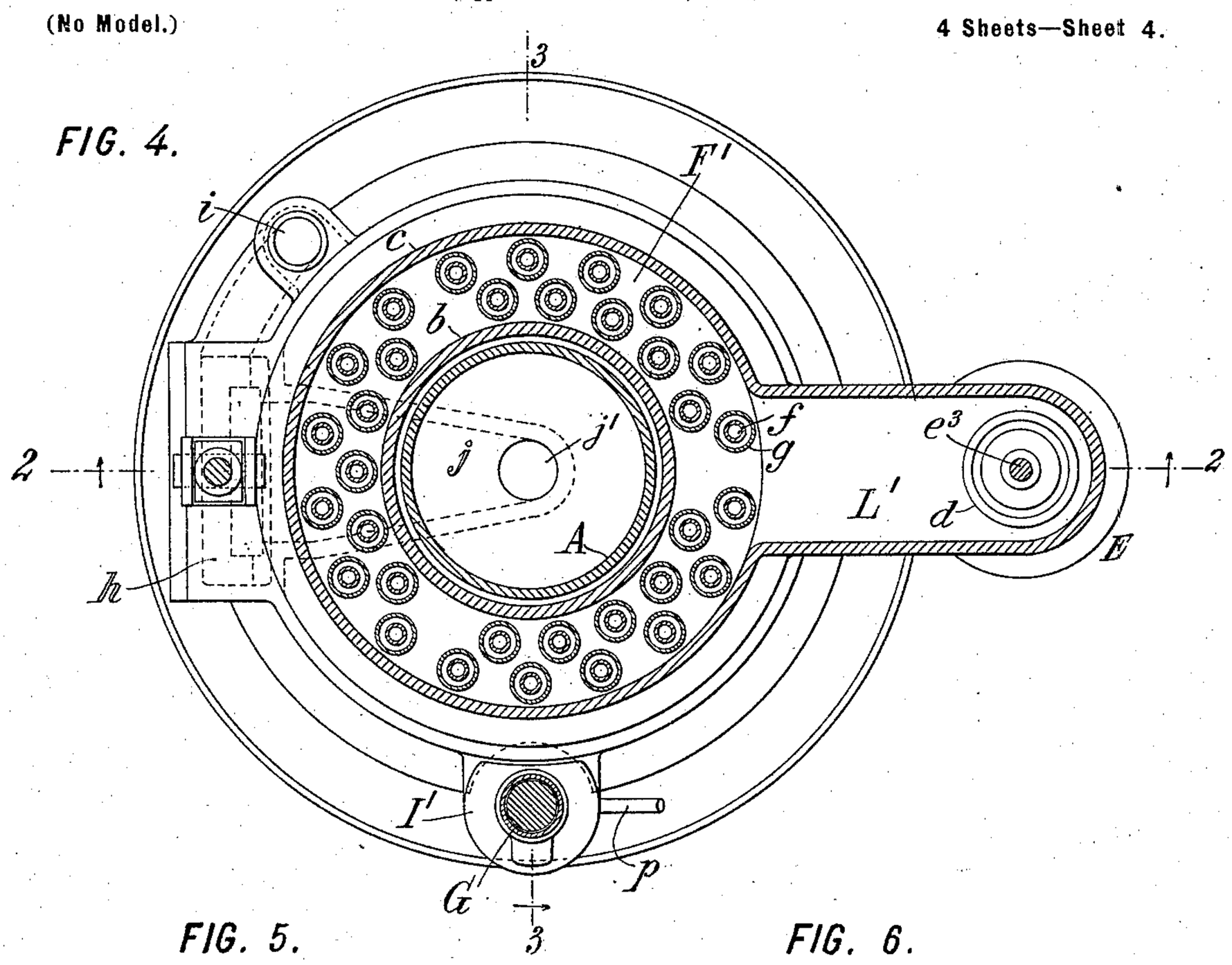
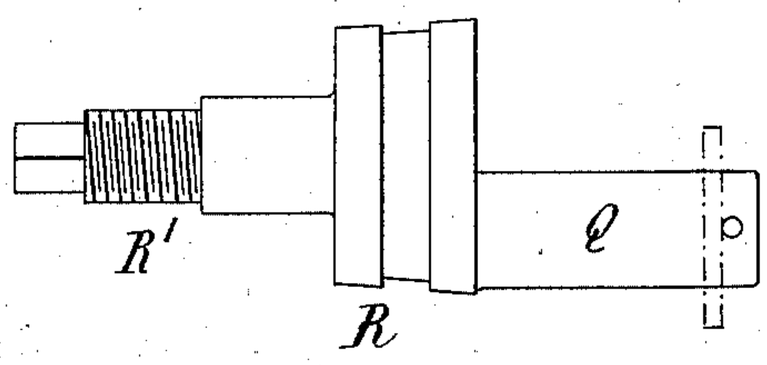
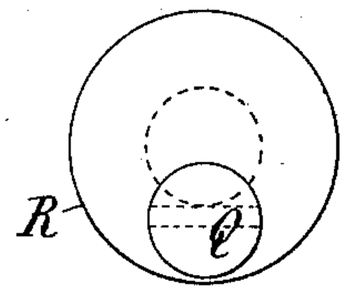


FIG. 5. FIG. 6.





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UNITED STATES PATENT OFFICE.

FRANK M. LEAVITT, OF NEW YORK, N. Y., ASSIGNOR TO THE E. W. BLISS COMPANY, OF SAME PLACE.

STEAM PUMPING-ENGINE.

SPECIFICATION forming part of Letters Patent No. 663,909, dated December 18, 1900.

Application filed October 19, 1898. Serial No. 693,978. (No model.)

To all whom it may concern:

Be it known that I, FRANK M. LEAVITT, a citizen of the United States, residing in New York, (Brooklyn,) in the county of Kings and State of New York, have invented certain new and useful Improvements in Steam Pumping-Engines, of which the following is a specification.

This invention relates chiefly to atmospheric or vacuum engines employed for small power purposes, such as pumping water for domestic establishments and for railway-tanks, shops, &c., or for driving of small light machinery. As engines for such purposes are commonly operated where there is no licensed engineer, it is important for safety that the steam-pressure in the boiler be practically *nil* or only sufficient to cause a circulation of steam through the engine in starting. Hence such engines are operated entirely or almost entirely by atmospheric pressure due to the condensation of the steam admitted to the cylinder. My invention aims to provide an improved construction of engine of this character and introduces the novel features hereinafter set forth and claimed.

The accompanying drawings show the preferred construction of engine embodying my present invention, wherein—

Figure 1 is an elevation. Fig. 2 is a vertical mid-section on the line 2 2 in Fig. 4 looking from the left in Fig. 1. Fig. 3 is a vertical transverse section on the line 3 3 in Fig. 4 looking oppositely to Fig. 1. Fig. 4 is a horizontal section on the line 4 4 in Fig. 2. Fig. 5 is an enlarged elevation of the pump-driving crank-stud detached. Fig. 6 is an end elevation thereof.

The engine thus illustrated is a single-acting vacuum steam-engine combined with a surface condenser, a single-acting water-pump, and a single-acting air or vacuum pump. The engine is designed to be supplied with steam at approximately atmospheric pressure—say, for example, at a maximum pressure of one to two pounds above the atmosphere.

In the practical construction of engines of this character serious difficulty is encountered in maintaining the vacuum which is essential to sustain the power of the engine owing to the liability of leakage of air past the piston-packing into the cylinder. If such leakage is considerable, it may exceed the capacity of the air-pump, which in an engine of this character is necessarily limited. To avoid this leakage is one important object of my invention.

Referring to the drawings, let A designate the engine-cylinder; B, the piston, which is of the bucket-plunger variety; *a*, the pitman, connecting the piston to the crank formed on the crank-shaft C; D, the fly-wheel, fixed on this shaft; E, the water-pump; F, the condenser, and G the air or vacuum pump.

In constructing the engine it is built up of a series of shells or sections in manner following: Upon any suitable supporting-base H is mounted a shell I, conforming with the steam and condensation-water passages and the valve-chests. On this are superposed two plates J and K, and above these is mounted the main shell or frame L. The latter is formed with the uprights M M, carrying the crank-shaft bearings, and is shaped to receive within it the steam-cylinder A. The shell L constitutes also the casing for the condenser F, which for convenience is arranged, as heretofore in engines of this class, concentrically around the steam-cylinder. This is constituted by forming the shell L with inner and outer concentric walls *b* and *c*, respectively, between which is the annular space or chamber F′, through which flows the water from the pump E, which surrounds the tubes of the condenser. The shell L is also formed with an offset or trunk L′ on one side, which forms the supporting-base of the pump E and the interior chamber of which receives the discharge from the pump and forms a passage conducting said discharge into the annular chamber F′. The pump-cylinder *d* is bolted to the lower side of the trunk L′, its upper part projecting up thereinto, while the pump-cylinder head *e* is applied over an opening in the upper side of the trunk L′. There is a clear space left between the top of cylinder *d* and the cylinder-head for the outflow of water from the pump into the trunk. This construction facilitates and cheapens the connection of the pump to the chamber inclosing the condenser and reduces the number of

pieces and joints to the minimum. The discharge-pipe from the pump enters the shell L near the upper part of the chamber F′, as shown at E² in Fig. 3.

The condenser F is a surface condenser and is constructed, according to a well-known system, with inner and outer copper tubes *f g*, respectively, so arranged that the steam passes through the inner tubes to the closed ends of the outer tubes and returns through the latter, in which it is condensed. The inner tubes *f f* are united at their lower ends to the plate J. The outer tubes *g g* are similarly united to the plate K. The tubes are arranged in concentric circular order, as shown in Fig. 4, and their open lower ends communicate with annular passages *f′* and *g′*, respectively, the former being formed as a groove or depression in the top of the shell I and the latter as a similar groove in the top of the plate J. This construction has the advantages of facilitating the assembling and dismounting of the engine, simplifying the construction of the steam-passages, and insuring against leakage in the condenser due to unequal expansion and contraction.

The section of shell I has formed integrally with it the valve-chamber *h*, the steam-inlet passage *i*, Fig. 4, the cylinder-port *j*, leading from the chamber *h* upward to the center for communicating with the base of the cylinder, and the exhaust-passage *k*, arranged above the cylinder-port and communicating with the annular space or groove *f′* already referred to. The shell I is also formed on one side with a projecting boss I′, which forms the base for the air-pump G, and with a condensation-port *l*, Fig. 3, which communicates with the annular channel *g′* already referred to and leads downward to the admission-valve of the pump.

The air-pump G is a plunger-pump, its plunger *m* being connected by a rod to an arm *m′*, projecting from the cap-plate *m²*, which is fastened on top of the piston B. The pump-cylinder is preferably formed of a tube *n*, screwed into a footpiece *n′*, which rests upon the boss I′, as shown in Fig. 3, and is fastened down thereon by means of a conical plug N, which passes through a conical bore in the base, at the upper end of which it is parallel and screw-threaded and screws into the footpiece *n′*. The conical plug N forms the valve-chamber of the pump, being bored into from above to three diameters, with conical valve-seats between them for receiving the suction and discharge valves of the pump. The plug, which is ground to a tight fit with the conical bore in the base, is formed with an exterior groove *l′*, which communicates with the port *l* and from which lateral bores enter beneath the suction-valve at the bottom, while above this valve lateral bores communicate with an external groove *o*, from which a port *o′* is formed in the base I′ and footpiece *n′*, leading to the lower end of the pump-cylinder. The footpiece is formed above the discharge-valve of the pump with a chamber, from which leads the discharge-pipe *p*.

The valve-gear consists simply of the slide-valve *q*, the rod *q′* of which passes out of the chamber *h* through a bushing *q²* (which need not be a gland, because the steam-pressure is practically *nil*) and to which motion is imparted through a connecting-rod *q³* from a crank *q⁴*, (or it may be an eccentric,) fixed on the end of the shaft C.

The course of the steam is as follows: Entering from the boiler at *i*, Fig. 4, it passes into the valve-chest *h*, and thence when the valve is raised is admitted through port *j* into the cylinder, which it fills as the piston rises. The valve then shifts to the position shown, connecting the cylinder-port to the exhaust-port, in which there may be a vacuum of approximately twelve pounds, whereby is afforded the power for drawing the piston downward. The exhaust-steam passes around in the annular channel *f′*, thence up through the inner tubes *f* of the condenser, and down through the outer tubes *g* thereof, which are surrounded by cold water, and being condensed the condensation-water drains into the annular passage *g′*, from which it flows (see Fig. 3) down through port *l* to the vacuum-pump G. In this pump during the suction-stroke the condensation-water and air enter through port *l′*, raising the lower or suction valve, and being drawn through ports *o o′* enter the cylinder, while during the return stroke they are expelled through the same ports *o′ o* and, lifting the upper or discharge valve, pass out from the chamber above it through the discharge-pipe *p*.

The engine-cylinder A is entirely distinct from the shell L, and preferably out of contact therewith to form a non-heat-conducting space between them, as shown. Its lower end is extended downward through openings in the plates J and K, and its foot rests upon the top of the shell I, to which it is directly bolted. The upper end of the cylinder has a flange *a′*, which extends over the top of the condenser-chamber F′ and is peripherally guided within an annular wall or rim *c′*, formed on the shell L, as an upward extension of the outer wall *c*, Fig. 3. Thus the cylinder is unattached at its upper end and free to expand or contract from the base I and independently of the shell L, through which the cold water is circulating.

The piston is packed, as heretofore, by an upturned cupped leather packing *r* surrounding it, the cupped leather being clamped between the flange *a′* and a packing-ring *s*, which is bolted down upon said flange. This packing-ring has an annular chamber or passage formed, as a groove *s′*, on its under face, through which water or oil may be circulated in direct contact with the packing-leather, so as to keep it moist and supple. The packing-ring has also an upturned flange forming

a chamber or pocket s^2, surrounding the piston above the free edge of the cupped leather, which chamber can be kept supplied with water, oil, or other liquid for not only moistening the cupped leather, but also for preventing access of air to the packed joint. As before stated, the effective maintenance of a vacuum in an engine of this character is one of the most serious problems, since air is liable to leak in through the piston-packing and since the maintenance of the efficiency of the engine is dependent upon the ability to suppress such leakage. A leakage of water instead of air would be insignificant, since the air-pump has ample capacity for drawing off all the water that can possibly leak in. Hence I provide for keeping the chamber s^2 constantly filled with some suitable liquid, and preferably with water, to a level sufficiently above the upper edge of the packing-leather to seal the packing and prevent access of air thereto, so that if any leakage occurs water will be drawn in instead of air. There are numerous ways of providing such supply of liquid; but I prefer to admit liquid to the annular chamber s' and let it flow thence through a duct s^3, Fig. 3, into the chamber s^2, and from the latter to escape by an overflow-pipe s^4. There are two convenient ways in connection with this engine of affording the supply of water. Of these the first is to take it from the discharge side of the pump E through any suitable pipe controlled by a cock, the simplest arrangement being that shown in Fig. 3, where t is a pipe connecting from the condenser-chamber F' to the packing-ring s, the flow being controlled by a cock or faucet t'. The other way is to lead the discharge-pipe p from the air-pump G up, as shown in dotted lines in Fig. 1, and cause it to enter the packing-ring s. This latter plan might be adopted in addition to or in lieu of that shown in Fig. 3. By either means an ample flow of water is maintained around the packing-ring so as to keep the leather entirely immersed, and consequently to keep it soft and supple, and thereby in as nearly as possible leak-tight condition, while if any leak should occur some of the surplus water in the seal would be drawn in to the exclusion of air.

The water-pump E is in general of ordinary construction. The suction-pipe E' enters the base of the pump-cylinder d beneath the suction-valve u. The discharge-valve u' is carried by the pump-piston P. The pump-cylinder head e carries upright parallel guide-rods e' e' for guiding the cross-head e^2 of the piston-rod e^3. This cross-head is connected by a pitman P' to a crank-stud Q, carried by the fly-wheel D, or otherwise connected to the shaft C. The valves u u' are ordinary disk tappet-valves pressed down by springs. Access is gained to the upper valve on the piston by lifting off the cylinder-head e. The central guiding-pin w of the lower valve is united to an arm w', projecting inward from a hand-hole plate w^2, as shown in Fig. 2. By detaching this plate and removing it the pin is taken away laterally with it, and hence drags the valve u laterally out through the hand-hole, giving complete and ready access to all the parts.

The crank-pin Q is formed eccentrically upon a conical disk or plug R, which on its opposite side has a concentric screw-threaded stud R'. The fly-wheel hub is formed with a socket for receiving the plug R and a bore concentric therewith, through which its stud R' passes and is fastened fixedly in any position by a nut screwed thereon. Thus by turning the plug R in its socket the crank can be brought to varying distances from the center and the stroke of the pump adjusted in accordance with the load under which the engine is working. The object of constructing the disk R as a conical plug is to facilitate clamping it in place, since drawing up the clamping-nut draws it into the conical socket and makes a tight frictional joint. As an additional precaution a set-screw x, Fig. 2, may be employed engaging the periphery of the plug. By this means the stroke of the pump can be varied to an extent equal to four times the eccentricity of the stud Q with relation to the plug R.

The novel construction of air-pump G herein described with reference to the conical plug N, which serves both for attaching the pump-cylinder to its base and for a valve-chamber for both valves, is made the subject of a separate application for patent filed October 19, 1898, Serial No. 693,979, and hence is not of itself claimed in the present application.

My invention may be variously modified without departing from its essential features. For example, the annular passages f' g' are not necessarily formed in the parts I and J, respectively, but may be otherwise formed, so as to be in communication with the joints between the parts I J K, respectively, so as to be accessible at these joints upon taking the sections apart.

I claim as my invention the following-defined novel features, substantially as hereinbefore specified, namely:

1. In a vacuum-engine, the combination with the cylinder and piston of a cupped packing for preventing leakage of air into the cylinder, and means for maintaining a water seal submerging said packing to a predetermined level, whereby if leakage occurs the suction due to the vacuum acts to cause water to enter the cylinder instead of air.

2. In a vacuum-engine, the combination with a plunger-piston, of a cylinder having an upturned cupped packing against said piston, an annular chamber inclosing the cupped packing, and means for feeding water to said chamber to form a seal submerging said packing, whereby if any leakage occurs

the suction due to the vacuum acts to cause water to enter the cylinder instead of air.

3. The combination with plunger-piston B and cylinder A, the latter having an upturned cupped packing against the piston, of a packing-ring *s* for confining said packing formed with an annular channel *s'* against said packing, and an annular chamber s^2 surrounding the upturned portion thereof, with a duct communicating between said channel and chamber, a pipe admitting liquid to the channel, and an overflow-pipe from said chamber.

4. The combination of cylinder A, base-shell I to which the lower end of the cylinder is fastened, and upper shell L, the latter having a wall *b* inclosing the body of the cylinder, with an intervening space, and having an upper guiding-wall *c'*, and the cylinder having an outwardly-projecting flange *a'* engaged by said guiding-wall, whereby differences in expansion and contraction of said cylinder and shell L are provided for.

5. The combination of shell L having outer and inner walls *c b* forming between them a condenser-chamber F' closed at the top, condenser-tubes arranged in said chamber, a base-shell I beneath, a cylinder A within said inner wall *b* and connected at its bottom to said shell I, said cylinder formed with a flange *a'* projecting over the top of said condenser-chamber and having a packing-ring *s* between which and said flange the cupped packing *r* is clamped.

6. The combination of shell L having outer and inner walls *c b* forming between them an annular condenser-chamber F' closed at the top and forming a circular well for the engine-cylinder, a base-shell I beneath, condenser-tube plates J and K clamped between said shells, inner and outer condenser-tubes *f* and *g* projecting upward from the respective plates into said chamber F', the engine-cylinder, an exhaust-passage leading therefrom into communication with the tubes *f*, a suction-pump, and a passage leading from the tubes *g* to such pump.

7. The combination of shell L having outer and inner walls *c b* forming between them an annular condenser-chamber F' closed at the top and forming a circular well for the engine-cylinder, a base-shell I beneath, condenser-tube plates J and K clamped between said shells, inner and outer condenser-tubes *f* and *g* projecting upward from the respective plates into said chamber F', said parts being formed with annular passages *f'* and *g'*, the former communicating with the lower ends of the tubes *f*, and the latter communicating with the lower ends of the tubes *g*.

8. The combination of shell L having outer and inner walls *c b* forming between them a condenser-chamber F' closed at the top, a base-shell I beneath, condenser-tube plates J and K clamped between said shells, inner and outer condenser-tubes *f* and *g* projecting upward from the respective plates into said chamber F', said parts formed with an annular passage *f'* communicating with the lower ends of the tubes *f*, and with an annular passage *g'* communicating with the lower ends of the tubes *g*, a vacuum-pump, and said base-shell I formed with an exhaust-passage *k* leading to said passage *f'*, and with a passage *l* leading from said passage *g'* to said pump.

9. The combination of cylinder A, annular shell L surrounding it, condenser-tube plates J and K with their condenser-tubes, base-shell I on which said parts are mounted formed with a steam-admission port *i*, valve-chest *h*, cylinder-port *j*, exhaust-port *k* leading to the condenser, and a projecting base I' for the attachment of a suction-pump, and with a suction-passage *l* leading from the condenser to such base for communication with such pump.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

FRANK M. LEAVITT.

Witnesses:

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FRANK C. B. PAGE.