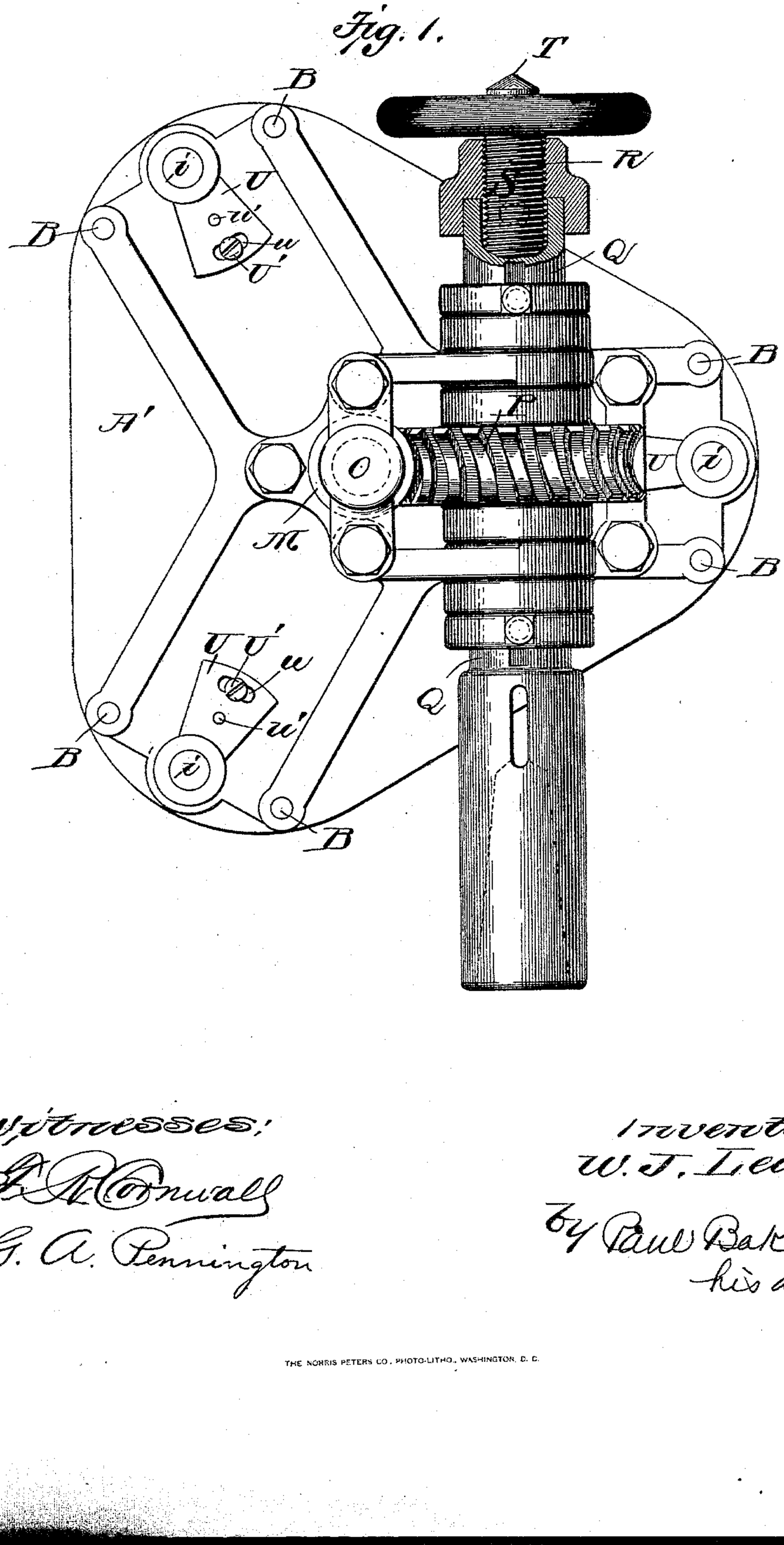
(No Model.) 2 Sheets—Sheet 1.

W. J. LEWIS.

DIRECT ACTING ENGINE.

No. 598,154. Patented Feb. 1, 1898.

Fig. 1.



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Inventor,
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(No Model.) 2 Sheets—Sheet 2.

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Fig. 2.

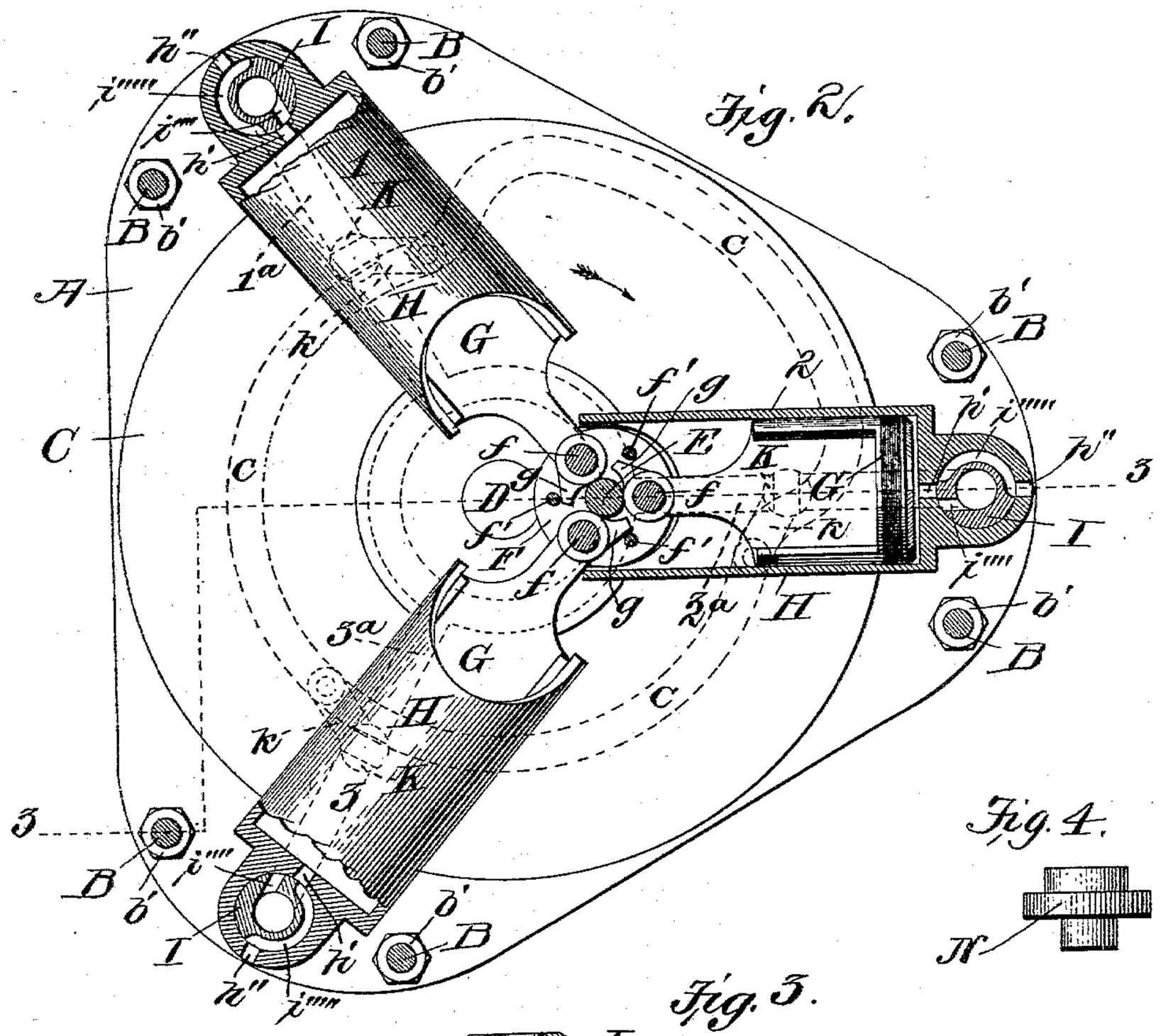
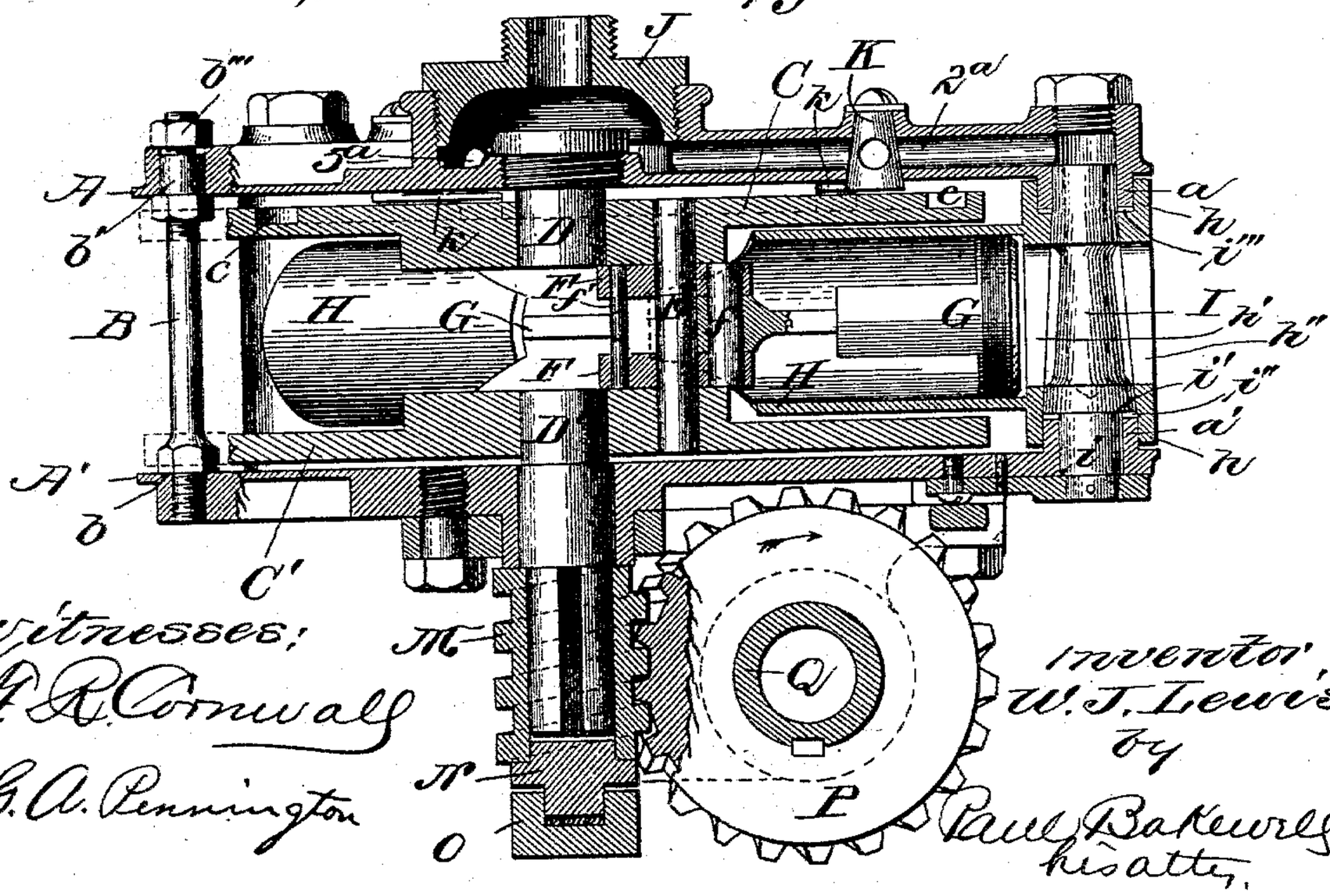


Fig. 4.

Fig. 3.



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UNITED STATES PATENT OFFICE.

WALLACE J. LEWIS, OF ST. LOUIS, MISSOURI.

DIRECT-ACTING ENGINE.

SPECIFICATION forming part of Letters Patent No. 598,154, dated February 1, 1898.

Application filed March 27, 1897. Serial No. 629,473. (No model.)

To all whom it may concern:

Be it known that I, WALLACE J. LEWIS, a citizen of the United States, residing in the city of St. Louis, State of Missouri, have invented a certain new and useful Improvement in Direct-Acting Engines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification, in which—

Figure 1 is a side elevational view of my improved engine. Fig. 2 is an elevational view, the near frame-plate being removed and one of the cylinders and the valve-stems being shown in section. Fig. 3 is a sectional view on line 3 3, Fig. 2. Fig. 4 is a detail view of the block for taking up the end thrust of the worms.

This invention relates to a new and useful improvement in direct-acting engines and is designed to be run by compressed air as a motive fluid. The type of engine illustrated in the drawings embodies in its construction three oscillating cylinders whose piston-rods are nested or grouped in a cage mounted on a wrist-pin.

I have shown my improved engine as applied to a drill; but it is obvious that there are other uses to which it could as advantageously be put. I have also shown the engine as being specially adapted for portability; but it is obvious that a suitable base for the frame-plate could be used when the engine is to be stationarily mounted.

The special features of my improved engine reside in the cylinders pivotally mounted on a valve-stem, whereby the oscillations of the cylinders admit and exhaust pressure to the piston, in the arrangement of the valve-gearing for cutting off pressure from the pistons when said pistons are in certain positions relative to their cylinders, in the construction and arrangement of the cage on the wrist-pin for nesting the ends of the piston-rods, and in the novel construction of the adjustable posts between the frame-plates; and, finally, the invention consists in the construction, arrangement, and combination of the several parts, all as will hereinafter be described, and afterward pointed out in the claims.

In the drawings, A and A′ indicate the side frame-plates, which are secured together by adjustable posts B. These posts, as shown in Fig. 3, have one end threaded into one of the plates, as A′, a shoulder *b* on the post abutting against the inner face of the plate. The other end of the post is threaded and has arranged upon it a sleeve *b*′, said sleeve having a shoulder at its inner end, which is adapted to abut against the plate A when the sleeve is introduced into an opening in said plate.

b‴ indicates a nut on the outer end of the post for coöperating with the outer face of the frame-plate A.

It will be obvious from the above description that when the frame-plates are assembled, the post B being screwed home into the frame-plate A′, the plate A can be adjusted laterally relative to the plate A′ by the manipulation of the jam-nuts coöperating against the inner and outer faces of the plate A.

C and C′ indicate fly-wheels mounted upon stub-shafts D and D′ in the plates A and A′, respectively. These fly-wheels are preferably formed with hub extensions on their inner faces to give a more extended bearing for the shafts on which they are mounted.

E indicates a wrist-pin mounted in the fly-wheels.

F indicates two heads of a cage, which heads are loosely mounted on the wrist-pin E.

f indicates spindles mounted in the heads of the cage, to which spindles the piston-rods are pivotally connected.

f′ indicates pins mounted in the heads of the cage and alternating with the spindles *f*.

G indicates the pistons whose inner ends terminate in bearings or eyes which embrace the spindles *f* of the cage.

g indicates noses formed on the piston-bearings and disposed in a like direction relatively around the wrist-pin E. These noses operate between the wrist-pin and the pins *f*′ of the cage and prevent the cage from so rotating on the wrist-pin that the pistons would not have a direct end thrust thereagainst. In other words, these noses on the piston-bearings limit the rotary movement of the cage by contacting with their respective pins *f*′ in certain of their positions, as shown in Fig. 2, and preserve the relation of the

pistons to each other and the relation of the pistons to the cage and the wrist-pin on which said cage is mounted.

H indicates the cylinders whose inner ends are open and whose outer ends are closed and suitably bored for the reception of valves I, which valves act as pivotal bearings for the piston, or, in other words, are axially disposed to the axis of oscillation of the piston, because, as a matter of fact, the cylinders are not entirely supported by the valves in their oscillation.

Valves I are provided with a stem *i*, which fits in a suitable bossed opening in the frame-plate A'. The valve inside of this frame-plate is formed with a shoulder *i'*, between which shoulder and the boss on the frame-plate is arranged a washer *i''*, made either of lead or rubber. The main body of the valve is tapered, as shown in Fig. 3, one side of the valve being radially reduced to form an exhaust-port, while the valve is bored out in its center to form an inlet-port. The smaller end of the valve fits into a bossed opening in the frame-plate A.

a and *a'* indicate the bosses on the plates A and A', respectively, said bosses being around the valve-opening, as before described.

The heads of the cylinders H, as before stated, are bored to receive the valves I, and in order to relieve the valves I of the strain of the cylinders I extend the cylinder-heads laterally, as at *h*, to form pockets which receive the bosses *a* and *a'*. Between the boss *a* and the bottom of its coöperating pocket I introduce a metal or rubber washer *i'''*.

The parts being assembled as above described, when wear occurs between the valve and its seat in the cylinder-head the posts, which are arranged one on each side of the valves I, are adjusted so as to draw the frame-plates close together at that point. When the frame-plates are so drawn together, the plate A operates against the cylinder-head to more firmly and tightly seat the valve therein, said valve being held in a fixed position relative to the frame-plate A' by reason of the shoulder *i'*. It will of course be understood that in this adjustment the flanges *h* of the cylinder-head will be filed off corresponding to the adjustment required. When the cylinder oscillates, the strain which is in an outward direction by reason of the pressure between the piston-head and closed end of the cylinder will be distributed between the bosses *a* and *a'* and the valve I, which is seated in said bosses.

J indicates a suitable cap mounted on the plate A and provided with a threaded extension, to which is adapted to be secured a coupling which connects a pipe leading from a source of compressed-air supply to the chamber within the cap.

I will now describe the manner in which the pressure is admitted to and exhausted from the several cylinders, and in order to render my explanation as clear as possible I will refer to the cylinders as 1, 2, and 3. Pressure entering cap J will be distributed to the three valves through radially-disposed conduits 1^a, 2^a, and 3^a, which we will assume for the purposes of this description are uninterruptedly open to their respective valves. As shown in Fig. 2, the pressure is entering through the valve I, port *i''''*, which is now registering with a single port *h'*, opening into the outer end of cylinder H. This cylinder receiving the live air, being the active one at this period, I have marked 1 on the drawings. Ports *i''''* and *h'* will continue to register and admit air behind the piston until the pivotal point of the piston on the cage will be in line with and on the far side of the axis of the fly-wheel, at which time the port *h'* will have become blinded, a corresponding position to which is shown to the right of Fig. 2. When the cylinder is oscillated so that the pivotal point of connection between its piston and the cage is carried on the other side or below the axis of rotation of the fly-wheel, the exhaust-space *i'''''* will open or register with the port *h'* and exhaust the spent motive fluid from this cylinder, said exhaust escaping into the atmosphere through the opening *h''* in the head of the cylinder. When cylinder 1 is in the position shown in Fig. 2 and is the active cylinder, the second cylinder is inactive, but ready to admit pressure behind the piston upon a continued downward movement of the piston to register the port *h'* with the inlet-port of the valve I. The third cylinder is exhausting the spent motive fluid from behind its piston and will not become active until it has passed beyond dead-center.

From the above description it will be seen that one cylinder is effective at all times and for a short time two cylinders are effective while the other is idle.

As the pressure behind the piston and the exhaust thereof is dependent upon the oscillation of the cylinder and as this change from admission or exhaust, or vice versa, occurs only when the piston is on a dead-central position, it will be obvious that the live motive fluid entering the cylinder just before the change occurs is practically useless, in that it exerts a dead pressure almost in line with the dead-center of the piston. It is well known that a piston is most powerful when the wrist-pin to which the piston is connected is at right angles relatively to the axis of rotation of said pin and that pressure of the piston in approaching or leaving this position is not entirely effective. For this reason I deem it desirable to cut off the motive fluid from the piston at about the time the piston gets in its most effective position, the remaining portion of the effective stroke being the result of expansion. Not only is the engine where three cylinders are employed as powerful by this arrangement, but great saving results in the amount of fluid-

pressure consumed by the engine. In order to accomplish this result, I arrange, preferably at some point in the length of the pressure-supply ducts 1^a, 2^a, and 3^a, suitable valves and provide mechanism for opening these valves, so that pressure is admitted to the piston only when the piston is making the first half of its stroke, said pressure being cut off when the piston acts most powerfully against the wrist-pin, the remaining half of the stroke being under the influence of expanding pressure.

In the drawings I have shown ordinary plug-valves K to control the passage of motive fluid through the individual supply-ducts; but it is obvious that other forms of valves could as advantageously be employed. To operate these valves at the proper time, I provide an extension *k* upon their inner ends, on the outer end of which extension is mounted a roller running in a cam-groove in the fly-wheel C. In Fig. 2 it will be seen that the valve admitting pressure to the first cylinder has just been closed, the roller on the end of the valve-arm having just been moved from the greater radial position of the cam-groove to the smaller radial position. The valve for the second cylinder is shown as closed, the roller on the end of its arm being in position where it will leave the smaller radius of the cam and go to the larger radius of the cam-groove to open the supply-duct. The valve in the duct leading to the third cylinder is closed and will so remain until actuated by the fluctuation in the cam-groove.

It is obvious from the above description that the shaft of fly-wheel C′ could have mounted upon it a driving-pulley, or said shaft could be directly coupled to anything which the engine was designed to drive.

In this present application I have shown the engine as a power medium for imparting motion to a drill, and I will now describe how this is accomplished.

The outer end of the shaft D′ is formed with a key-seat and receives a worm M, which is somewhat longer than the shaft, or, in other words, the shaft D′ does not extend entirely through the worm.

N indicates an antifriction-block which is introduced into the outer end of the worm, said block having a bearing in a yoke O, secured to the framing of the machine. This block N is made of suitable metal to resist wear and is loosely fitted in position, so that if it revolves at all it will be by friction. The object in placing this hardened antifriction-block in the outer end of the worm is to absorb the end thrust of the worm and reduce the wear to a minimum.

Worm M meshes with a worm-wheel P, arranged in a suitable frame bolted to the side of the frame-plate A′. This worm-wheel is keyed to a hollow shaft Q, forming the shank of a drill-stock, into which stock the chisel is to be inserted, as is usual. Being keyed to the stock, it is obvious that any rotation imparted to the worm-wheel will also rotate the stock. In order to feed the stock, I mount an interiorly-threaded cap R on its upper end, which is fixed relative to the stock. Through this cap R is introduced a threaded rod S, having a hand-wheel at its upper end, by which it may be turned. A bearing-point T, axially coincident with the threaded rod S, is arranged above the hand-wheel. In drilling the bearing-point T is fixed against a suitable support and, presenting such a small surface, but little friction results, and rotation imparted to the worm-wheel will rotate all of its associate parts. When it is desired to feed the drill, the hand-wheel is turned in the proper direction, and the threaded connection of its rod with the cap forces the entire machine toward the work.

I have found it desirable in practice to provide means for the adjustment of the valve I in testing machines, so that said valves will coöperate properly with their respective cylinders. To do this, I mount a slotted segment on the outer end of the valve-stem and pass an ordinary screw through the slot, so that the valve can be adjusted and locked in its adjusted position to note the effect of the different rotatory positions of the valve. When the proper position has been determined, I bore through the segment and casing and rivet the parts together, after which the adjusting-screw may be removed, if desired. In the drawings, U indicates the segment, *u* the adjusting-slot, U′ the adjusting-screw, and *u′* the permanent rivet, said parts being mentioned in the above description.

I am aware that many minor changes in the construction, arrangement, and combination of the several parts of my device can be made and substituted for those herein shown and described without in the least departing from the nature and principle of my invention.

I am not the first to arrange a cage on a wrist-pin, to which are connected a plurality of piston-rods, but I believe I am the first to provide means on said cage and piston-rods coöperating with each other to prevent the cage from unduly turning under a thrust from any one of said piston-rods. In the known construction of cages such as illustrated in the patent to Smith and Scott, No. 565,641, of August 11, 1896, the cage has a free movement on the wrist-pin and in operation is apt to oscillate or rotate backward and forward under thrusts from different piston-rods. I have found by experience that such a construction will break the piston-rods close to their point of connection with the cage, and, moreover, the lost motion of the piston-rods in so unnecessarily moving the cage around the wrist-pin renders the engine less efficient than when the parts are provided with means to prevent such undue movement, as I have shown and described. By providing means to preserve the proper rotation of the piston-rods to each other, in which the proper relation between the piston-

rods and the cage and wrist-pin is also maintained, I get the full benefit of the thrust, thereby making the engine more efficient and less liable to breakage.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a direct-acting engine, the combination with suitable frame-plates, of oscillating cylinders mounted therebetween, valves for admitting and exhausting the pressure to said cylinders, said valves being axially coincident with the axis of oscillation of the cylinders, and means for adjusting the frame-plates relative to each other, to take up wear of the valves, substantially as described.

2. In a direct-acting engine, the combination with suitable frame-plates, of valves fixed in one of said frame-plates, oscillating cylinders mounted upon the valves, said valves being tapered, the base of the taper being nearest the plate in which the valves are fixed, and means for adjusting the plates relative to each other, to force the tapered valves more snugly in their seats in the cylinders, substantially as described.

3. In a direct-acting engine, the combination with suitable frame-plates formed with bosses on their inner faces, valves mounted in said bosses, a washer between a shoulder on the valve and one of said bosses, a cylinder having a valve-seat formed on its head, said valve-seat embracing said bosses on the frame-plate, and a washer interposed between the boss on one of the frame-plates and the cylinder-head, substantially as described.

4. In a direct-acting engine, the combination with suitable frame-plates, of fly-wheels mounted therein, cylinders arranged between said fly-wheels, and supported by the frame-plates, a wrist-pin mounted in the fly-wheel, pistons in the cylinders which are nested or grouped around said wrist-pin and means for preserving the relation of the pivotal ends of the pistons relative to each other, substantially as described.

5. In a direct-acting engine, the combination with suitable frame-plates, of fly-wheels mounted therebetween, oscillating cylinders mounted on the frame-plates and arranged between said fly-wheels, a wrist-pin mounted in the fly-wheels, a cage on said wrist-pin, pistons in the cylinders whose inner ends are pivotally mounted in the cage and means on the pivotal ends of all of said pistons for preserving the proper relations between the pistons to each other and to the cage, substantially as described.

6. In a direct-acting engine, the combination with suitable frame-plates, of fly-wheels mounted between said frame-plates, a wrist-pin carried by said fly-wheels, oscillating cylinders mounted in the frame-plates and extending inwardly between the fly-wheels, a cage pivotally mounted on the wrist-pin, pistons in the cylinders whose inner ends are mounted on spindles forming part of the cage, noses on the inner ends of the pistons, and cage-bars with which said noses coöperate, substantially as described.

7. In a direct-acting engine, the combination with oscillating cylinders, of a pivotally-mounted cage, pistons in said cylinders whose inner ends are grouped together in said cage, and means in said cage for coöperating with the ends of the pistons for preventing the cage from turning on the wrist-pin so as to render the force of the pistons ineffective, substantially as described.

8. In a direct-acting engine, the combination with oscillating cylinders, of pistons therein, a cage in which said pistons are grouped, noses on said pistons, and pins or bars in the cage for coöperating with said noses to limit the rotary movement of the cage relative to the pivotal points of connection of the piston-rods, substantially as described.

9. In a direct-acting engine, the combination with a single crank-pin, of a cage mounted thereon for preserving the proper relation between the piston-rods and said crank-pin, a plurality of pistons connected with said cage, oscillating cylinders for said pistons, individual valves for each cylinder, each valve being axially coincident with the axis of oscillation of its respective cylinder, and upon which said cylinders are mounted, pressure-supply ducts formed in said valves, and exhaust-passages in said valves, said supply-ducts and exhaust-passages coöperating with proper ports in the ends of the cylinders, which ports are registered with the supply or exhaust passages by the oscillation of the cylinder; substantially as described.

10. In a direct-acting engine, the combination with a single crank-pin, of a cage mounted thereon for preserving the proper relation between the piston-rods and said crank-pin, a plurality of pistons connected with said cage, oscillating cylinders for said pistons, individual valves for each cylinder, and upon which said cylinders are mounted, a projection on each valve-stem, means coöperating with said projection for temporarily adjusting the position of each individual valve, and means for permanently securing each individual valve in its adjusted position; substantially as described.

11. In a direct-acting engine, the combination with two or more cylinders and their respective pistons, of individual supply-ducts for the pressure fluid leading to said cylinders, valves in these individual supply-ducts, and means for opening these valves so that pressure will be admitted to the pistons only when the pistons are making the first half of their stroke, said pressure being cut off when the pistons are in their most effective position the remaining half of the stroke in the same direction being carried on by the expansion of the live pressure, said pistons being con-

nected so as to move together, whereby, each dead-piston is returned by a live piston or pistons substantially as described.

12. In a direct-acting engine, the combination with two or more cylinders and their respective pistons, frame-plates in which said cylinders are mounted, fly-wheels arranged between said plates, individual supply-ducts in one of said frame-plates, said supply-ducts leading to the cylinders, valves in said frame-plate for controlling the individual supply-ducts, arms on the inner ends of the valves, rollers on the ends of the arms, and a cam-groove in the adjacent fly-wheel in which said rollers are received, substantially as described.

In testimony whereof I hereunto affix my signature, in presence of two witnesses, this 18th day of March, 1897.

WALLACE J. LEWIS.

Witnesses:
HUGH K. WAGNER,
F. R. CORNWALL.