No. 692,071. Patented Jan. 28, 1902.

W. J. PUGH.

EXPLOSIVE ENGINE.

(Application filed Mar. 5, 1901.)

(No Model.) 3 Sheets—Sheet 1.

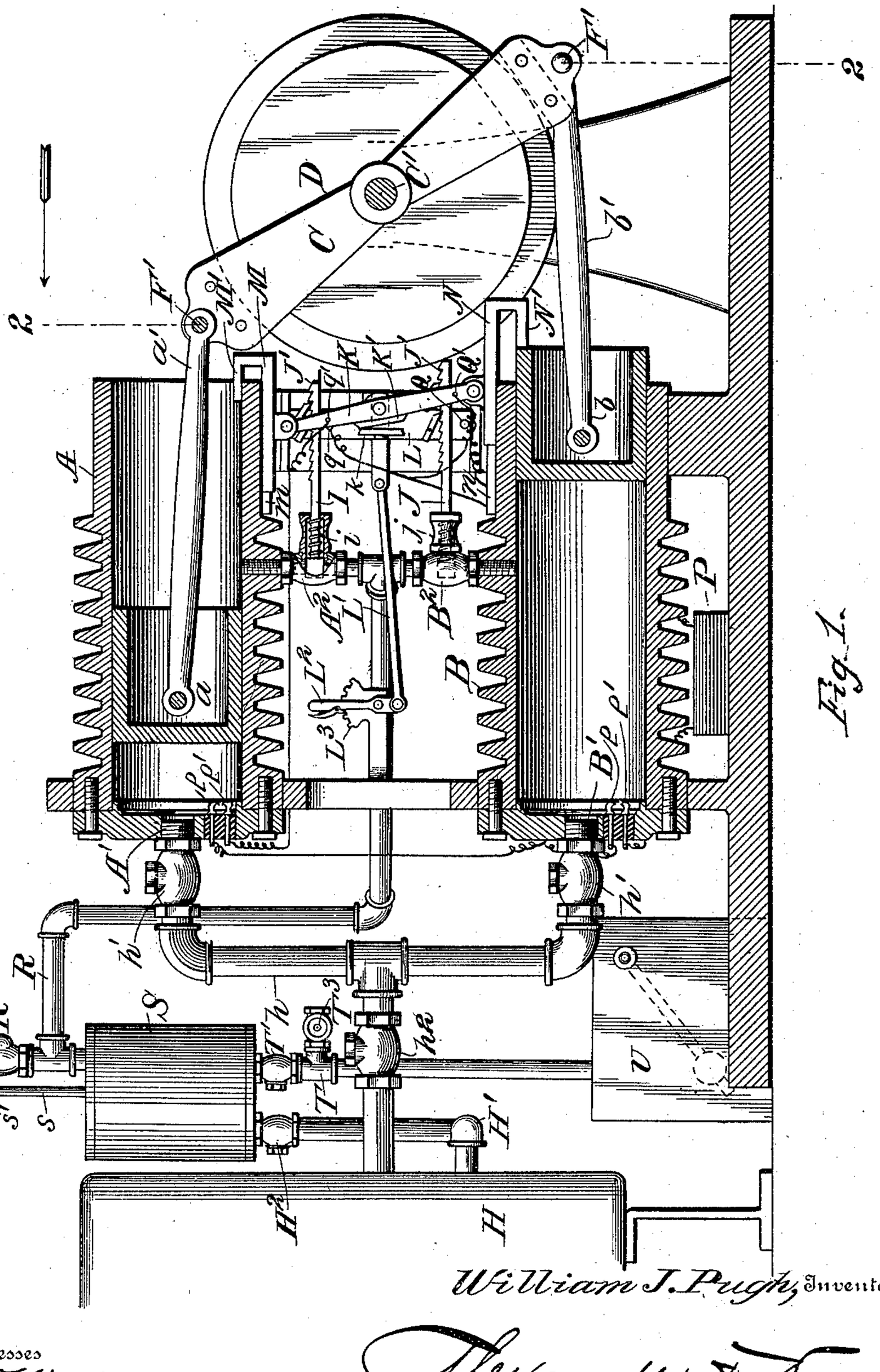

Fig. 1.

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Fig. 2.

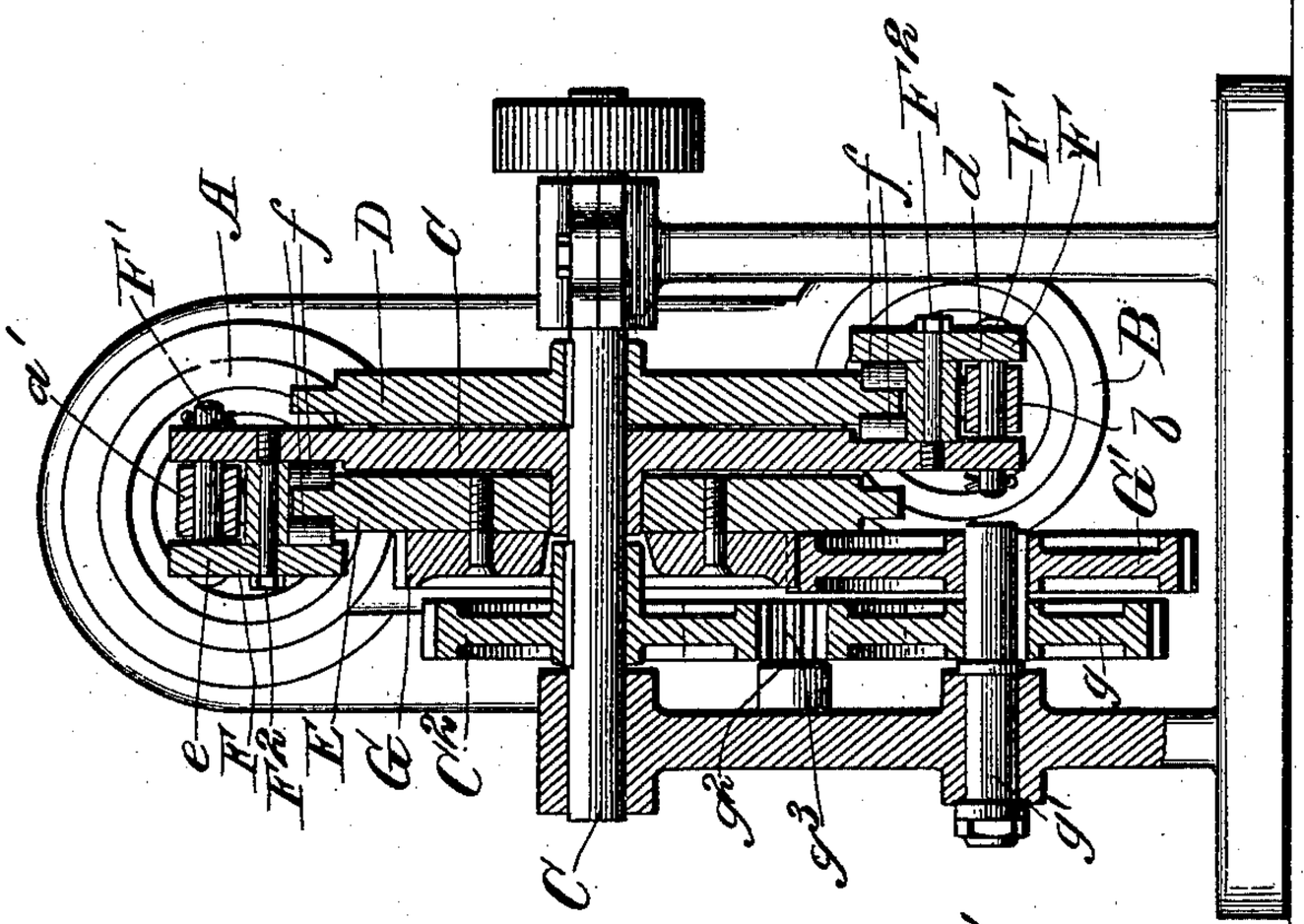


Fig. 5.

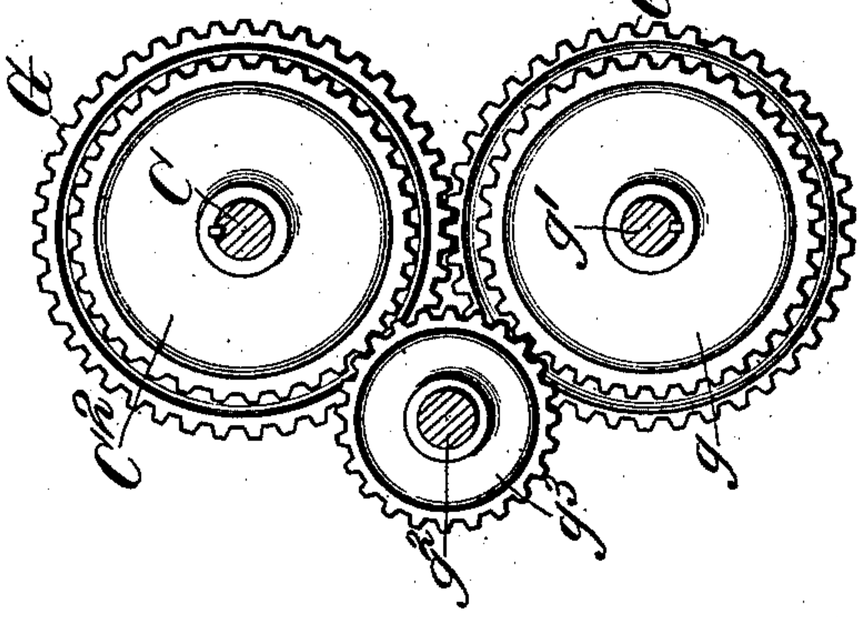


Fig. 3.

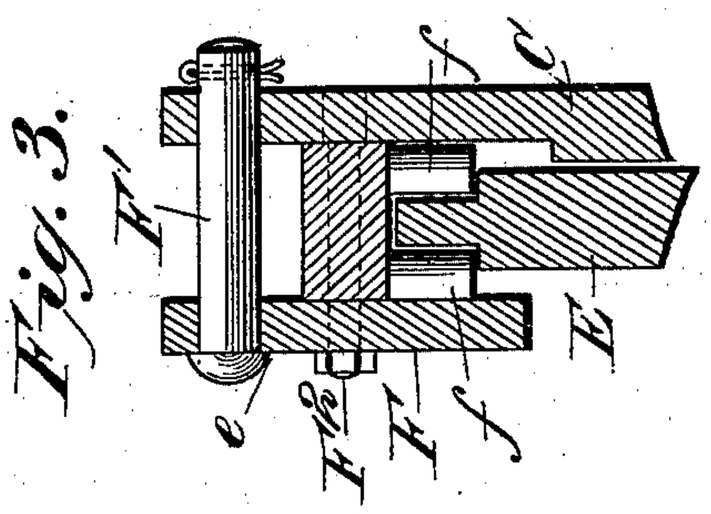
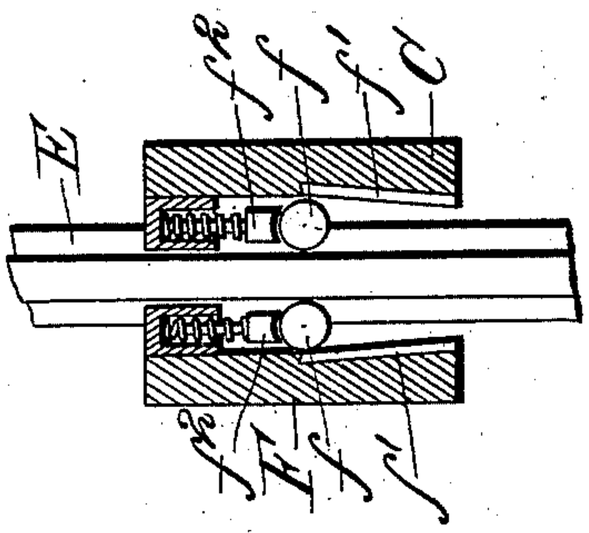


Fig. 4.



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(No Model.) 3 Sheets—Sheet 3.

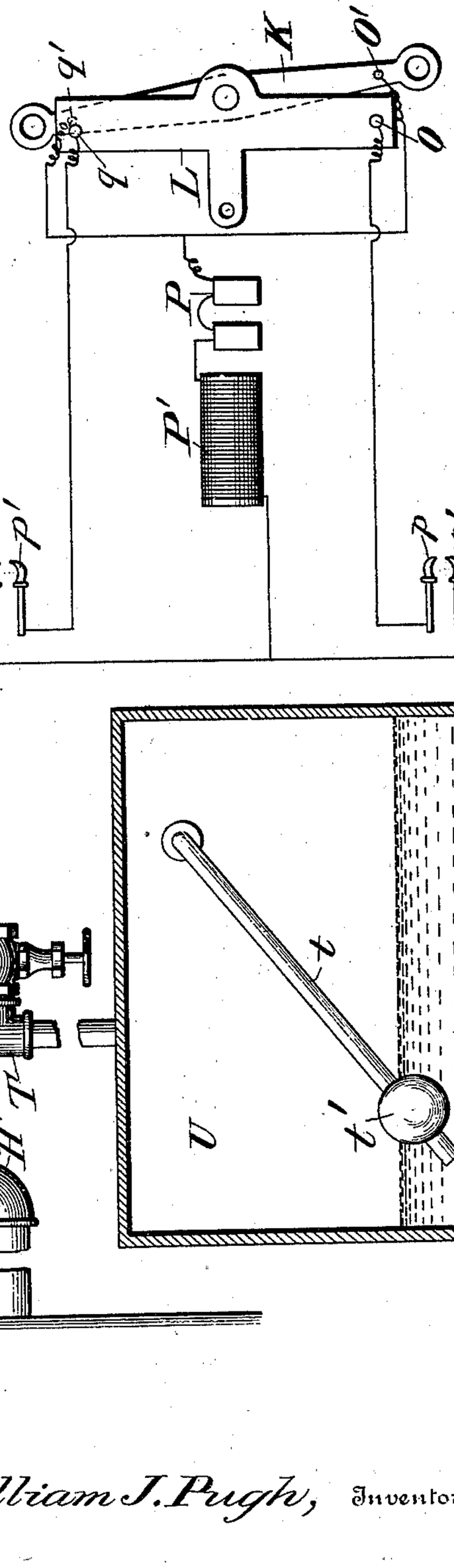

Fig. 9.

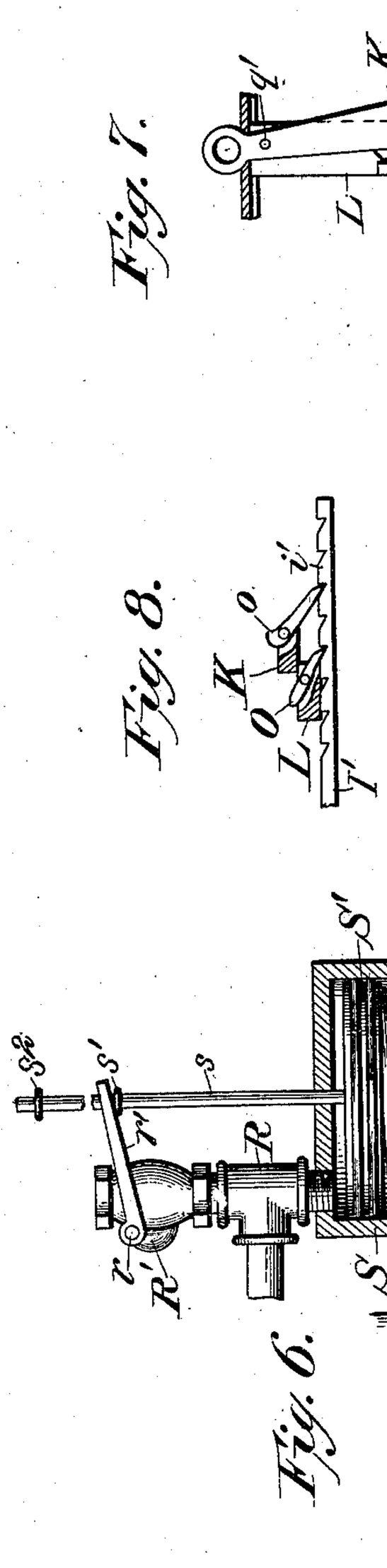

Fig. 8.

Fig. 6.

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UNITED STATES PATENT OFFICE.

WILLIAM J. PUGH, OF DAVENPORT, IOWA, ASSIGNOR OF ONE-HALF TO THOMAS R. LEVIS, OF ROCHESTER, NEW YORK.

EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 692,071, dated January 28, 1902.

Application filed March 5, 1901. Serial No. 49,865. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM J. PUGH, of Davenport, in the county of Scott and State of Iowa, have invented certain new and useful Improvements in Explosive-Engines; and I hereby declare that the following is a full, clear, and exact description thereof, reference being had to the accompanying drawings, which form part of this specification.

This invention is an improvement in explosive-engines; and its object is to produce a simple and efficient form of such engine wherein the power transmitted or developed may be regulated by varying the working strokes of the pistons; and it consists in the novel construction and combinations of parts, as hereinafter claimed, and fully described with reference to the accompanying drawings, in which—

Figure 1 is a longitudinal sectional elevation of the engine. Fig. 2 is a vertical section on line 2 2, Fig. 1. Figs. 3 and 4 are detail top and sectional views of the disk-clutching devices. Fig. 5 is a detail illustrating the driving-gears. Fig. 6 is a detail section of the vapor-compressing devices. Figs. 7 and 8 are detail views of the valve-controlling devices, and Fig. 9 a detail view of the sparking devices.

Referring to the drawings, A B designate a pair of cylinders, within which are pistons *a b*, directly connected by pitmen *a' b'* to the opposite ends of an oscillating lever C, loosely mounted on a shaft C', and on this shaft at opposite sides of lever C are similar disks D E, the peripheries of which are respectively adapted to be engaged by clutch devices *d e* on opposite ends of lever C. Disk D is keyed to shaft C', while disk E is loosely mounted thereon or on the hub of lever C, as shown. The clutches *d e* are adapted to engage their respective disks only during the outstroke of the respective pistons, clutch *d* being positively actuated while locked to disk D on the outstroke of piston *b*, and clutch *e* being positively actuated while locked to disk E by the outstroke of piston *a*. The return idle strokes of the piston are due to the oscillations of lever C. The clutches *d e* are alike and may be of any suitable construction. As shown in Figs. 3 and 4, each clutch comprises rollers *f*, mounted in tapered guideways *f'*, formed in the opposed faces of lever C, and a plate F, attached to the end of the lever by bolts F' F', the periphery of the disk E (or D) being embraced between said plate and lever, and the rollers *f* being on both sides of the disk, as shown. During the positive outstroke of the clutch the rollers *f* grip the disk and cause it to move. On the return stroke the rollers move to the wider part of the guideways *f'* and release the disk. Spring-controlled plungers f^2 may be used to facilitate the engagement of the clutch-rollers and disk on the outstroke.

As the disks D E are positively actuated in opposite directions, suitable gearing is used to utilize the disk E for driving shaft C'. As shown, a gear G is fastened to the outer face of disk E and meshes with a gear G', keyed on a counter-shaft *g'*, on which is keyed another gear *g*, meshing with a gear g^3, keyed on a stub-shaft g^2, affixed to the framework, and meshing with a gear C^2, keyed on shaft C'. By means of this gearing the positive impulses of both disks D E are utilized to rotate shaft C' in the same direction.

The inlet-ports A' B' of cylinders A B are connected with a vapor-supply tank H by means of a branched pipe *h*, in which at the ports are placed ordinary check-valves *h'* to prevent back pressure or firing. An additional check-valve h^2 may be placed in the pipe *h* at its junction with the cylinder, if desired. The outlet-ports A^2 B^2 of the cylinders are provided with valves I J, which are constructed alike, having rods J', that are adapted to be actuated alternately by an oscillating lever K, pivoted on a slide L, mounted in suitable supports between the cylinders A B, and the position of this slide L may be adjusted by a link L', connected to a hand-lever L^2, provided with a latch to engage a segment L^3, as shown. The lever K is pivotally connected at its ends to slides M N, mounted in guides *m n* on the sides of the cylinders, said slides having extensions M' N', that are to project into the open ends of the cylinders in position to be struck by the pistons *a b* as they near the outer ends of their strokes. Thus the pistons, through slides M N and lever K, actuate the valves I J alternately, and by

adjusting plate L the time when the pistons will operate said valves can be regulated and the exhaust-valves be opened earlier or later in the stroke of the pistons *a b*, thus regulating the length of the piston-strokes. One piston on its outstroke forces the other piston in, and the inwardly-moving piston begins to compress after it passes the outlet-port. Consequently when the outlet-port of the outwardly-moving cylinder is opened the stroke is shortened, both by the cessation or lessening of the expansive force of the exploded gases in one cylinder and by the increasing resistance of the compressing gases in the other cylinder. As no cranks are employed, the pistons do not have to make any certain length of stroke, it only being necessary for them to move sufficiently to pass and repass the exhaust-ports, and by adjusting plate L the strokes can be varied from minimum to maximum. With shorter strokes less motion is imparted to shaft C'. With longer strokes greater motion is imparted. The valves I J are seated by springs *i j*, as shown, and as the bar K would not ordinarily hold the valves open sufficiently long to admit proper exhaust the devices indicated in Fig. 8 may be employed. This figure shows the device applied only to the rod I' of valve I; but like devices would be also used in connection with rod J'. As shown, the valve-rods are notched, as at *i'*, and these notches are engaged by a pawl O on plate L and a pawl *o* on lever K. As pawl *o* is moved outward by the swing of the lever K it engages a notch *i'* in the rod and pulls the rod I' outward, unseating the valve and opening the exhaust, while the pawl O on plate L drops into one of the notches *i'* and holds the valve open until lever K swings backward so far that it will strike the heel of pawl O and disengage it from rod I', whereupon the spring *i* will close the valve and cut off the exhaust. It will be observed that in the construction shown pawl *o* will be unseated by riding up on the edge of plate L about the time that lever K unseats pawl O, thus permitting the spring to close the valve. The exhaust is thus kept open sufficiently long to substantially reduce the pressure in the cylinder to zero, and the explosive gases in cylinder H are under sufficient compression to cause them to automatically flow into and charge the cylinders after the burned gases are sufficiently exhausted therefrom, and the admission of explosive gases is cut off when the back stroke of the pistons compresses the gases in the cylinders beyond the pressure in the reservoir H, the excess of pressure in the cylinders automatically closing check-valves *h'*, and these remain closed after the explosion until the pressure of the burned gases in the cylinders falls as low or lower than the pressure in reservoir H.

The working charges in the cylinders may be ignited in any convenient way. As shown, I have indicated an electrical spark-igniter comprising a battery P, spark-coil P', and spark-terminals *p p'* in each cylinder, connected in usual electrical manner. The circuits are closed at the proper times by the meeting of the contacts Q Q' or *q q'*, the contacts Q *q* being mounted on opposite ends of lever K, and contacts Q' *q'* being mounted on plate L in position to close the circuit at the proper times, as indicated in Fig. 9.

When the pistons are at centers of strokes, the slides M N would be free to move and if unchecked might shift lever K improperly and close contacts at wrong time. To prevent such occurrences, lever K has a flat central bearing-surface K', against which the head of a presser-plate *k* is adapted to impinge, said presser-plate being mounted on plate L and pressed toward lever K by a spring *k'*, and when the slides M N are free from the pistons this device will hold lever K parallel with plate L and prevent the closing of circuit through either igniter until the slides M N are positively shifted.

To maintain the supply of explosive mixture in reservoir H by the means indicated in Fig. 6, the exhaust-gases may be led through suitable pipes R to a pump-cylinder S, above a piston S' therein, which is normally raised by spring S^2. The exhaust-gases force the piston S down, thereby compressing a mixture of air and gas into the reservoir H through pipe H', which is provided with check-valve H^2 to prevent backflow into the pump. The pipe R has an outlet R', normally closed by a valve *r*, provided by an operating-lever *r'*, which projects beside a piston-rod *s*, attached to piston S, and is adapted to be engaged alternately by tappets *s' s²* on the rod. When the piston S' is elevated by spring S^2, tappet *s'* will engage lever *r'* and close valve *r*. As the piston descends, tappet s^2 engages lever *r'* and opens the valve *r*, allowing the exhaust-gases to escape into the atmosphere. Air and oil-vapor are sucked into the pump-chamber, when piston S^2 rises, through a pipe T, provided with a check-valve T'. This pipe draws air through a carbureter U of any suitable construction. As shown, it is a tank adapted to contain oil or gasolene. Air is admitted into this tank through a pipe *t*, provided with a float *t'*, so that the air will be enriched by passing through the oil. If the mixture be too rich, air may be admitted directly into pipe T between the carbureter and pump through a regulating-valve T^3, as shown.

Having thus described my invention, what I therefore claim as new, and desire to secure by Letters Patent thereon, is--

1. The combination in an engine, of an oscillating lever and means for imparting motion therefrom to a rotating shaft; with a pair of cylinders, and pistons therein connected to opposite ends of said lever.

2. In an engine, the combination of a pair of cylinders, pistons therein, a main shaft, an oscillating lever mounted on said shaft connected at its ends to the opposite pistons, and clutch mechanism for transmitting continu-

ous motion to said shaft from said lever, substantially as described.

3. In an engine, the combination of a main shaft, an oscillating lever, a pair of oppositely-rotating disks on the shaft beside the lever, clutches for locking said lever alternately to the opposite disks, and gearing for transmitting motion from both said disks to drive the shaft in one direction.

4. In an engine, the combination of a pair of cylinders, pistons therein, a main shaft, oppositely-rotating disks geared to said shaft, an oscillating lever mounted on said shaft, connected at its ends to the opposite pistons, and clutches on said lever adapted to engage the respective disks, substantially as described.

5. In an engine, the combination of a pair of cylinders, main shaft, an oscillating lever mounted on the shaft connected at its opposite ends to the pistons in the respective cylinders, a pair of oppositely-rotating disks on the shaft beside the lever, clutches for locking the opposite ends of said lever alternately to the opposite disks, and gearing for transmitting motion from both said disks to the shaft in one direction, substantially as described.

6. In an engine, the combination of a main shaft, an oscillating lever, a pair of oppositely-rotating disks on the shaft beside the lever, clutches on the opposite ends of said lever respectively adapted to engage one of said disks, and gearing for converting the opposite rotations of the disks into continuous rotation of the main shaft.

7. In an engine, the combination of a main shaft, an oscillating lever, a pair of oppositely-movable disks on the shaft beside the lever, clutches on the opposite ends of said lever respectively adapted to engage one of said disks, and gearing for converting the opposite rotations of the disks into continuous rotation of the main shaft; with a pair of cylinders, pistons therein and pitmen connecting the respective pistons to opposite ends of said lever, substantially as described.

8. The combination of the oscillating lever, and means for operating same, the oppositely-rotatable disks beside the lever one fast and one loose on a common shaft, clutches for locking opposite ends of said lever to the respective disks during opposite movements of the lever, and a train of gearing for converting the rotary movement of the loose disk into the desired rotation of the shaft, substantially as described.

9. In a gas-engine, the combination of a pair of similarly-facing open-ended cylinders, pistons therein, a main shaft, an oscillating lever thereon connected to the pistons, clutch mechanisms for converting the oscillatory motion of the lever into rotary motion of the shaft; slides adapted to be contacted by the pistons, an oscillating valve-actuating lever connecting the slides, and exhaust-valve mechanisms operated by said valve-actuating lever, substantially as described.

In testimony that I claim the foregoing as my own I affix my signature in presence of two witnesses.

WILLIAM J. PUGH.

Witnesses:
C. P. BROWN,
G. I. YOUNG.