

No. 811,378.

PATENTED JAN. 30, 1906.

H. E. CLIFFORD.  
AIR COMPRESSING ENGINE.

APPLICATION FILED APR. 17, 1905.

4 SHEETS—SHEET 1.

Fig. 1.

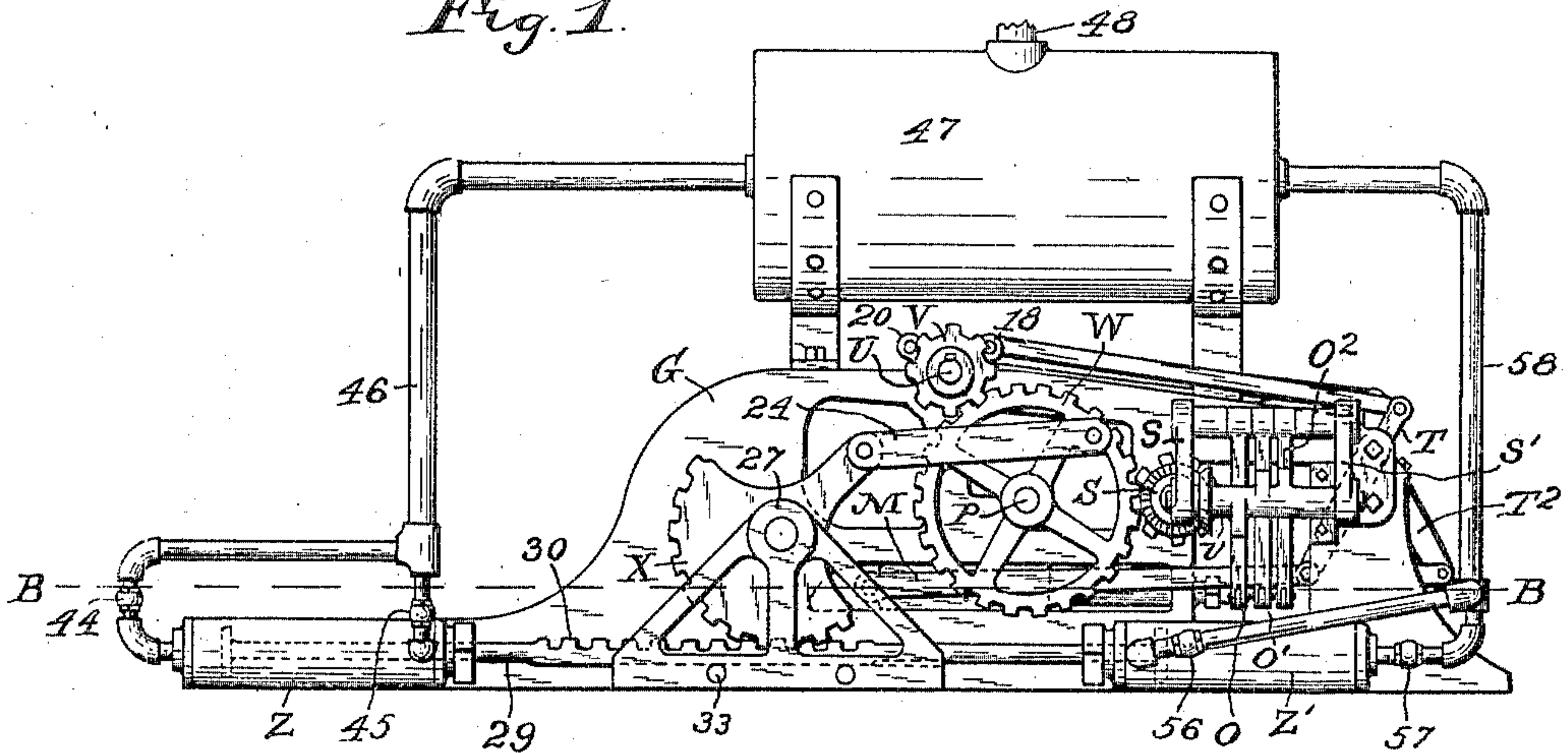


Fig. 2.

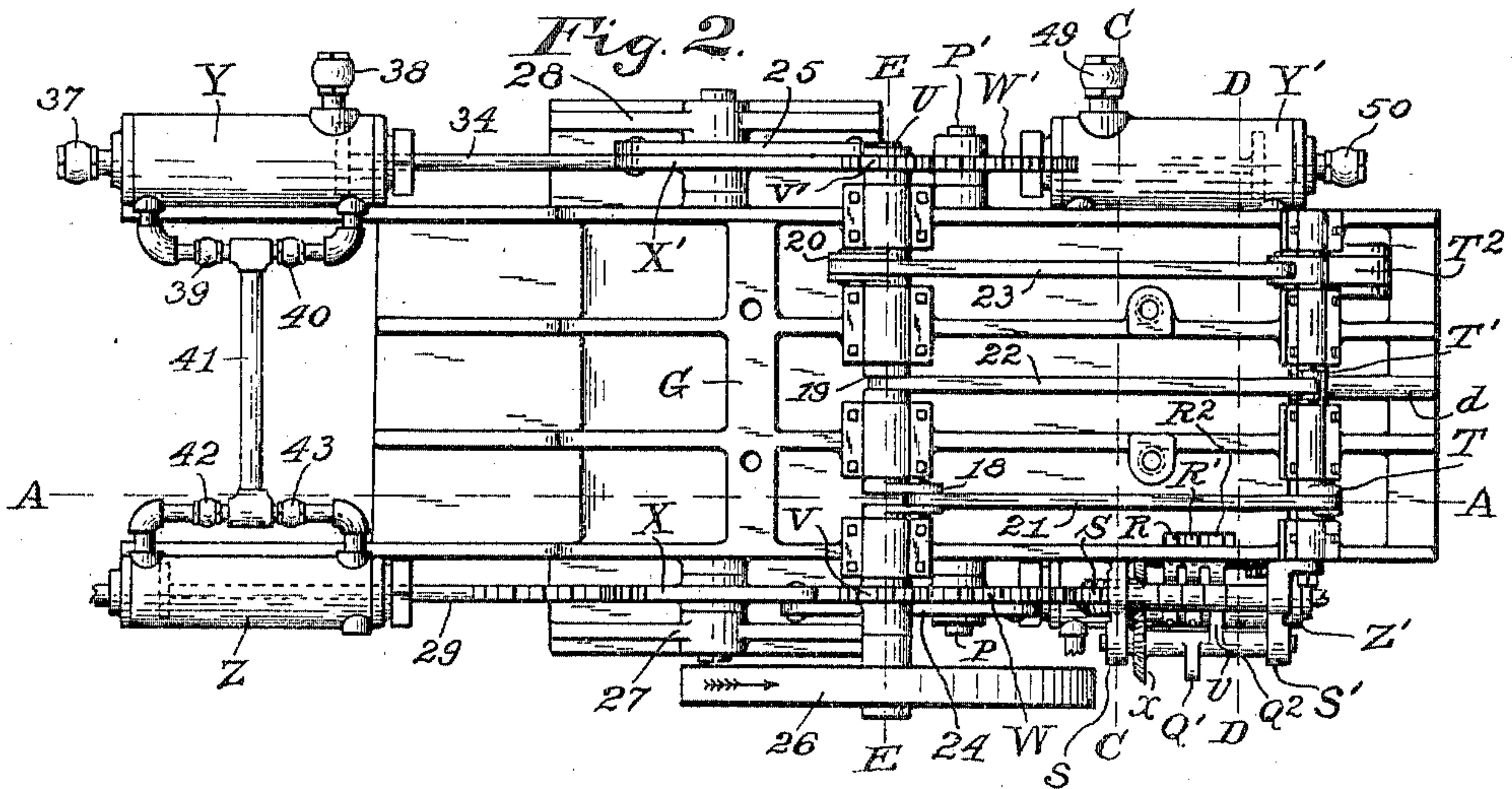
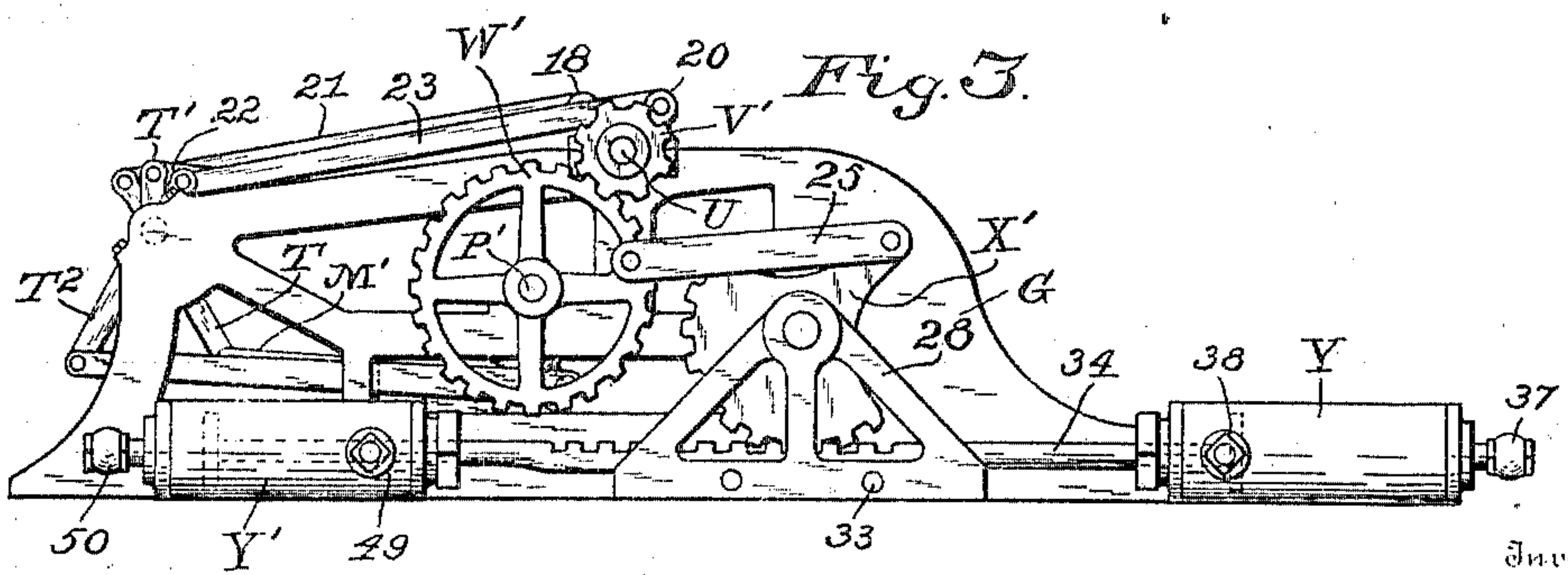


Fig. 3.



Witnesses:

Wm H Payne.  
Stella Snider.

Inventor:  
Hobbs E. Clifford.  
by  
E. J. Silvius.  
Attorney.

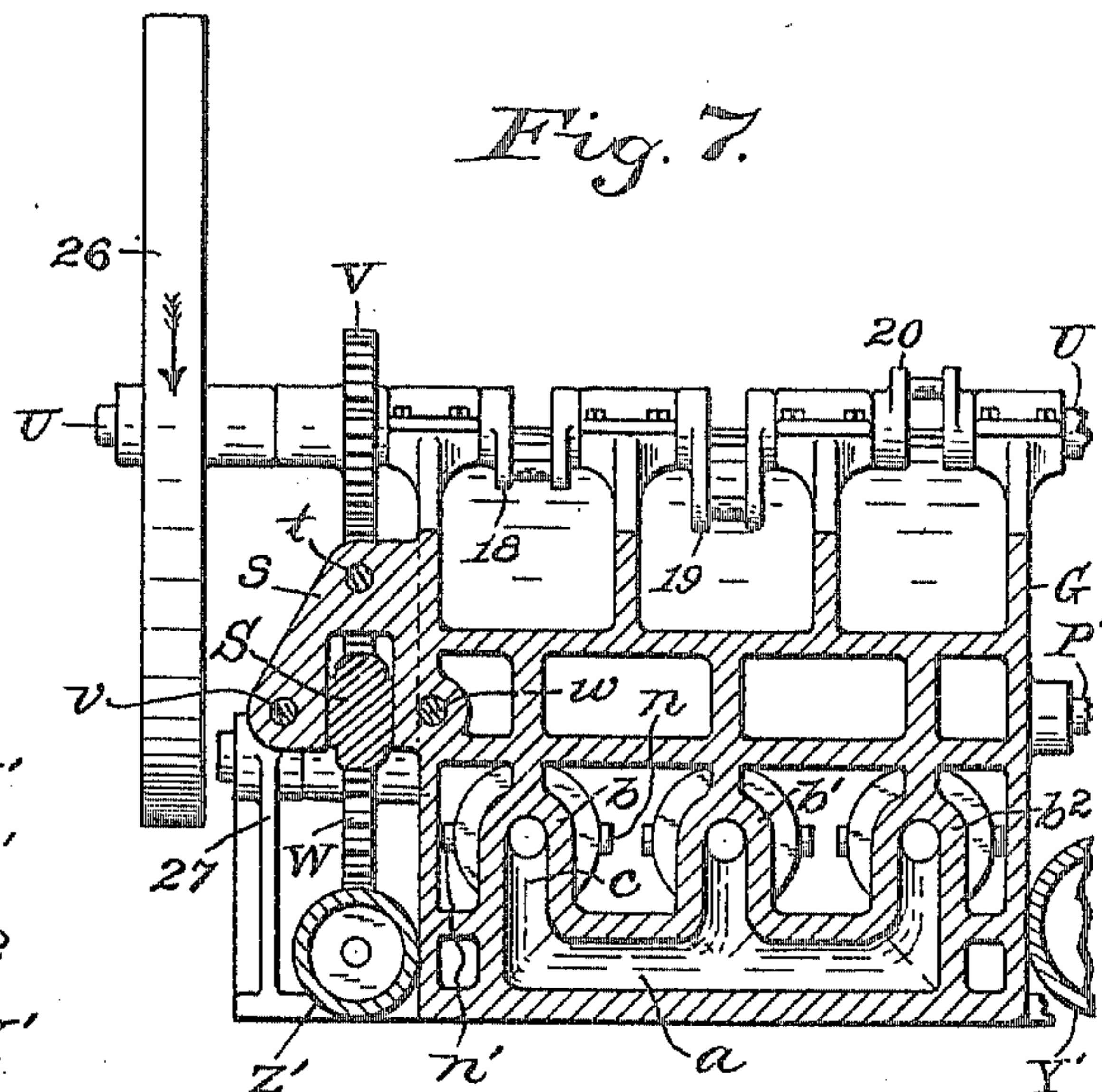
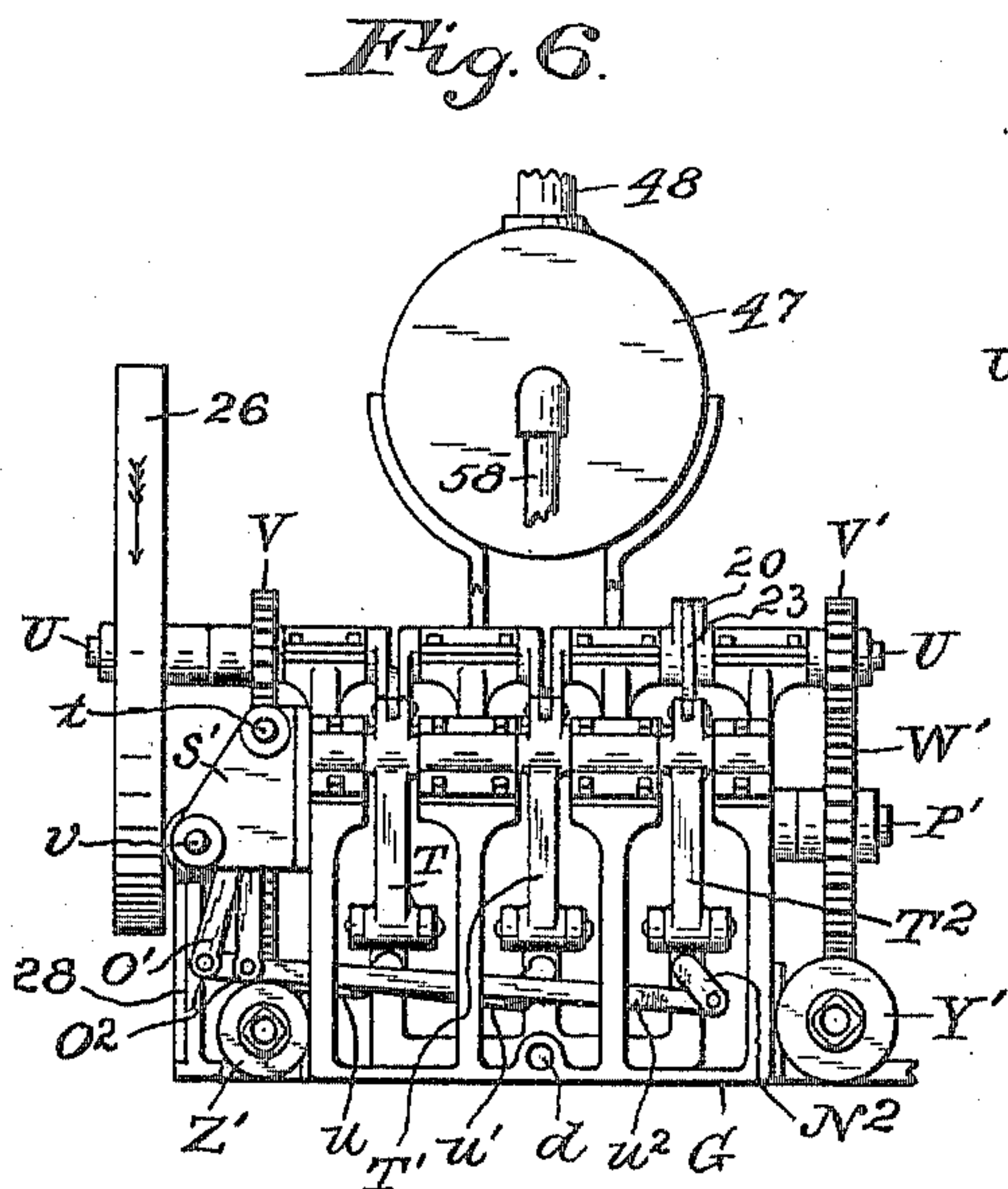
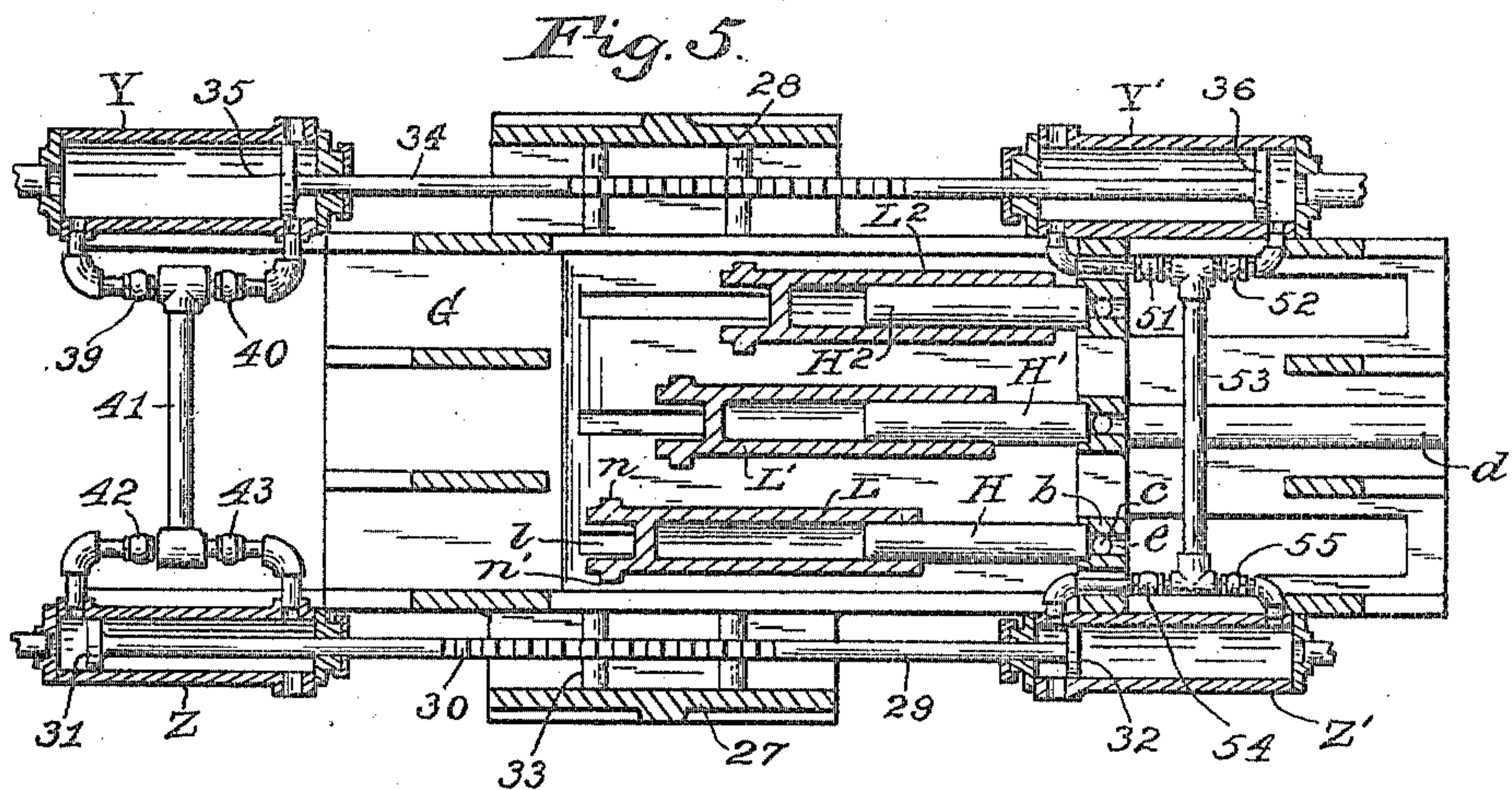
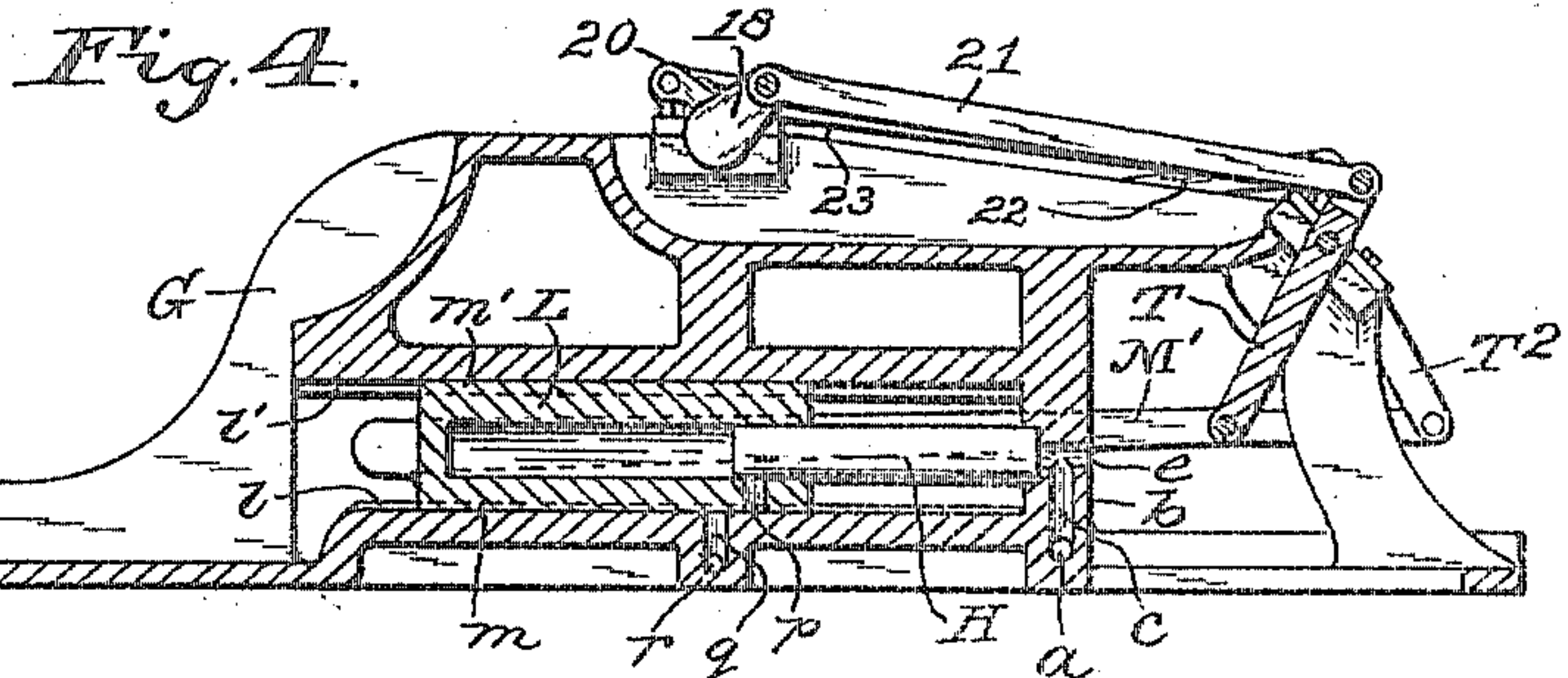


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4 SHEETS—SHEET 2.



Inventor:

Hobbs E. Clifford,

by

E. J. Silvius.

Attorney.

Witnesses:

Wm. H. Payne.  
Stella Snider.



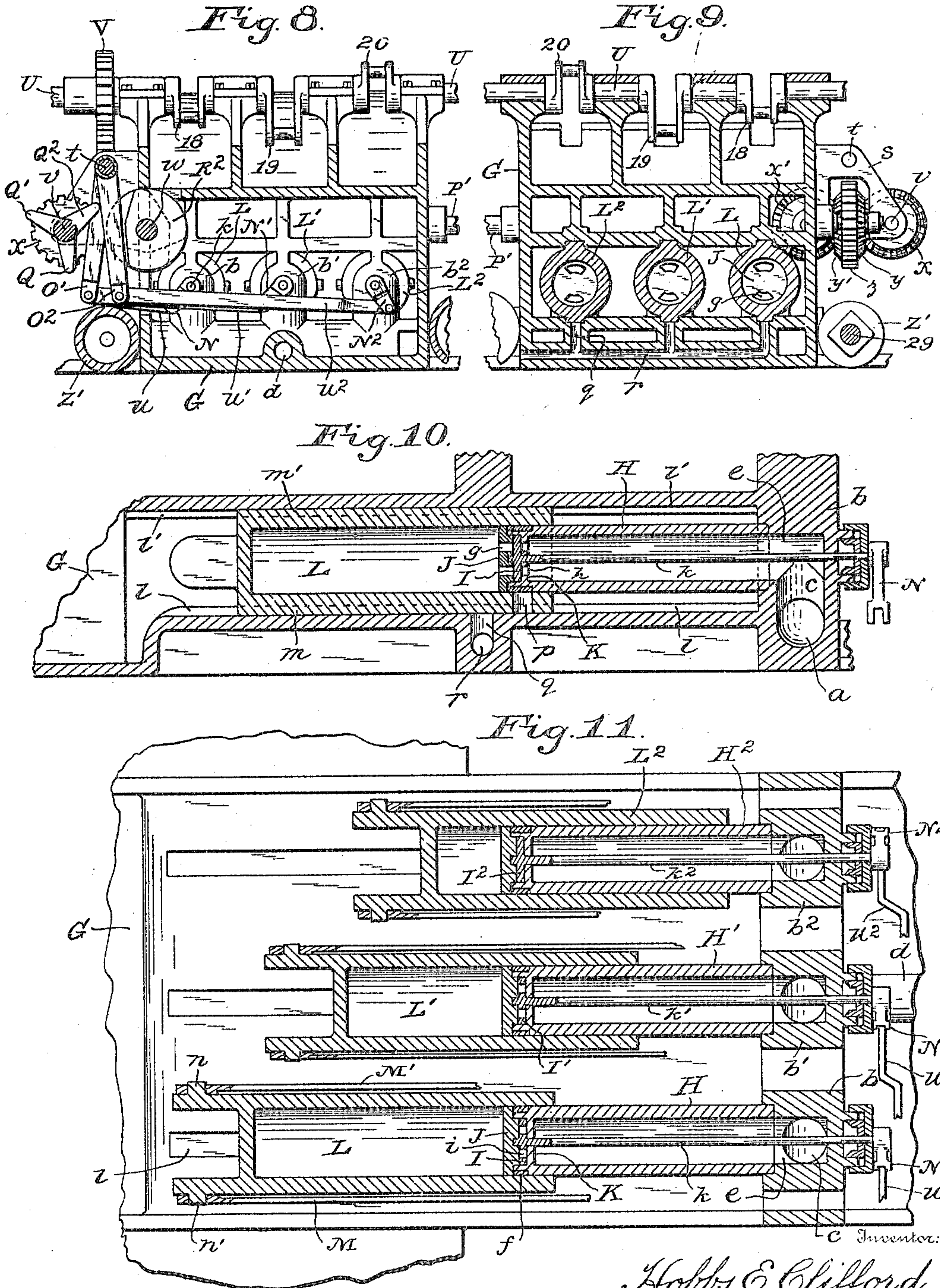
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4 SHEETS—SHEET 3.



Witnesses:

Wm. H. Payne.  
Stella Snider

Hobbs E. Clifford,  
by  
E. J. Silvers.

Attorney.



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4 SHEETS—SHEET 4.

Fig. 12.

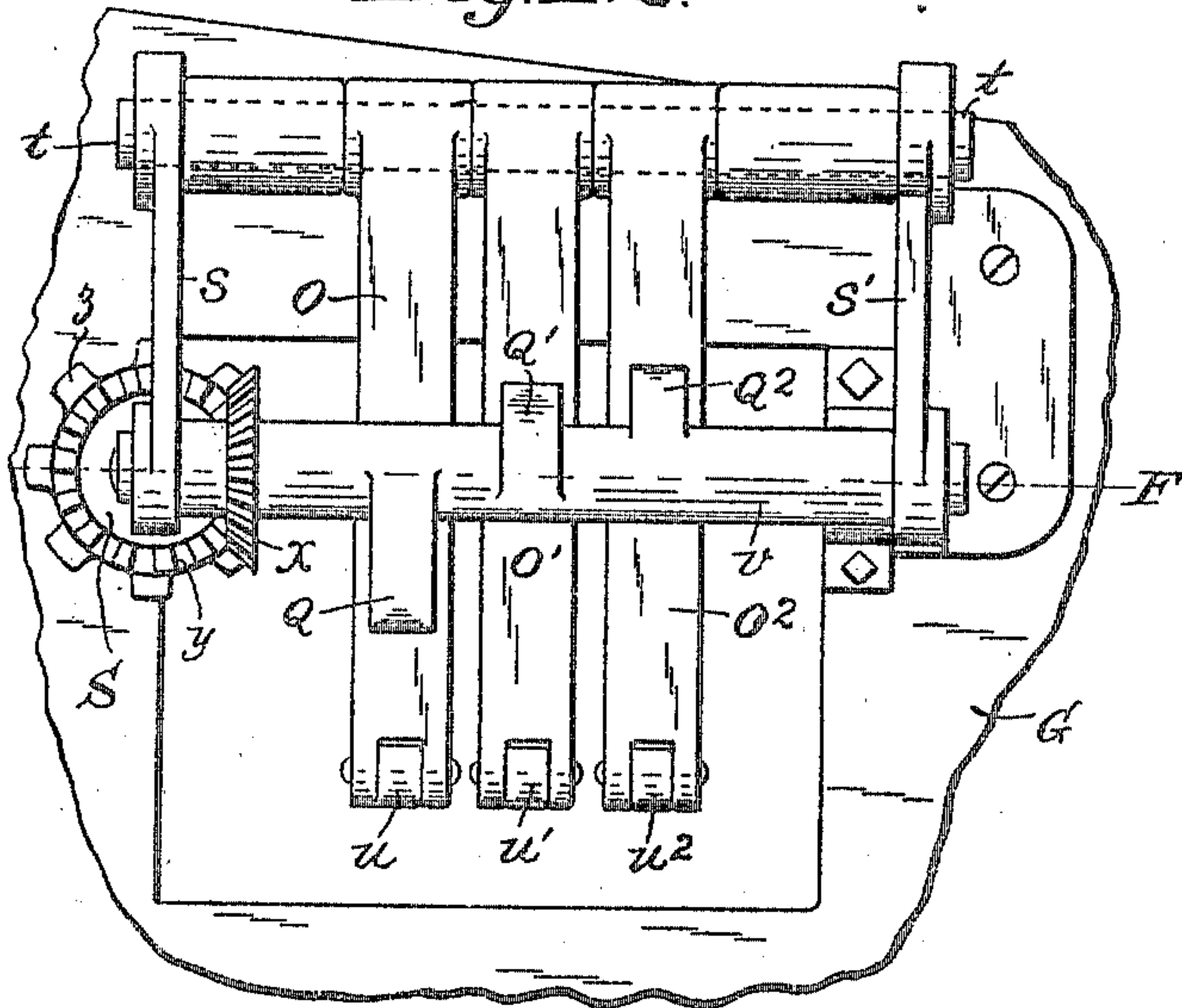


Fig. 14.

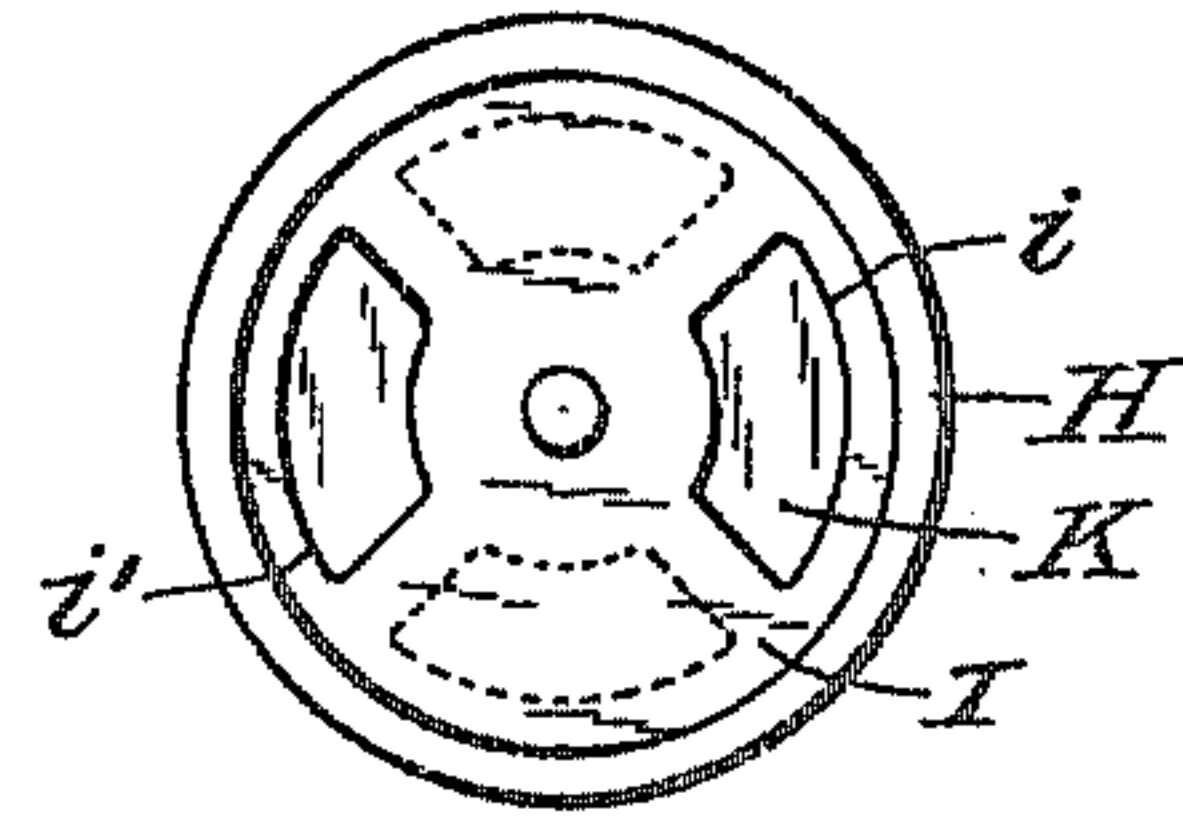


Fig. 15.

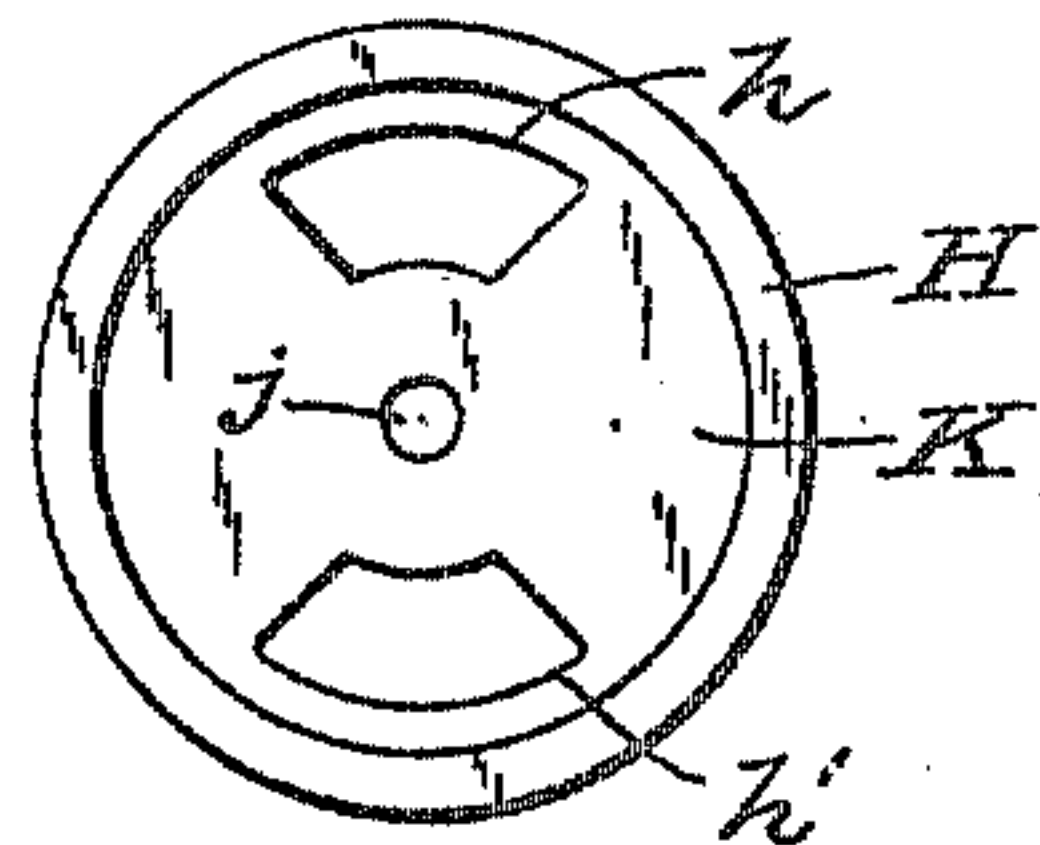


Fig. 13.

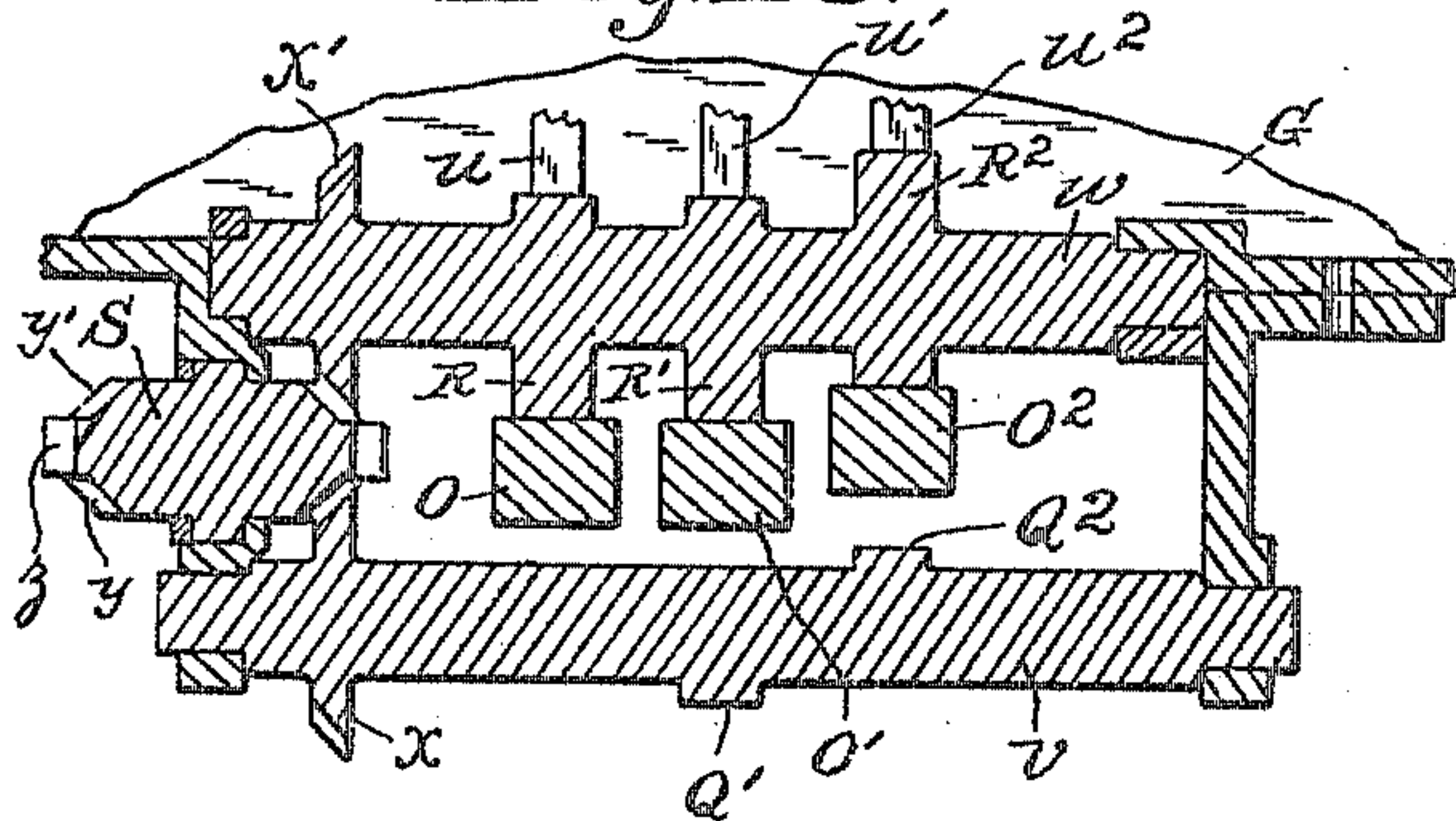


Fig. 16.

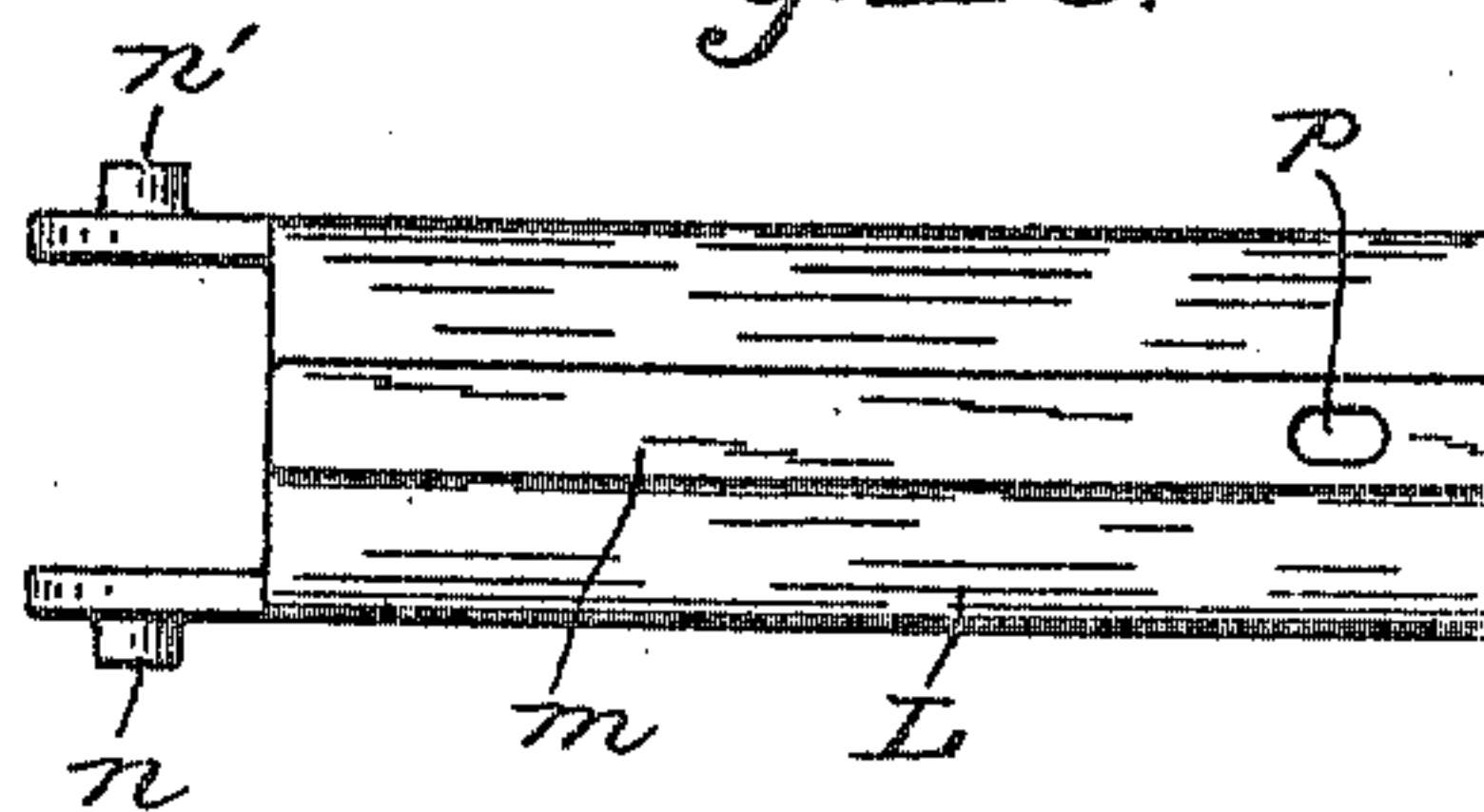
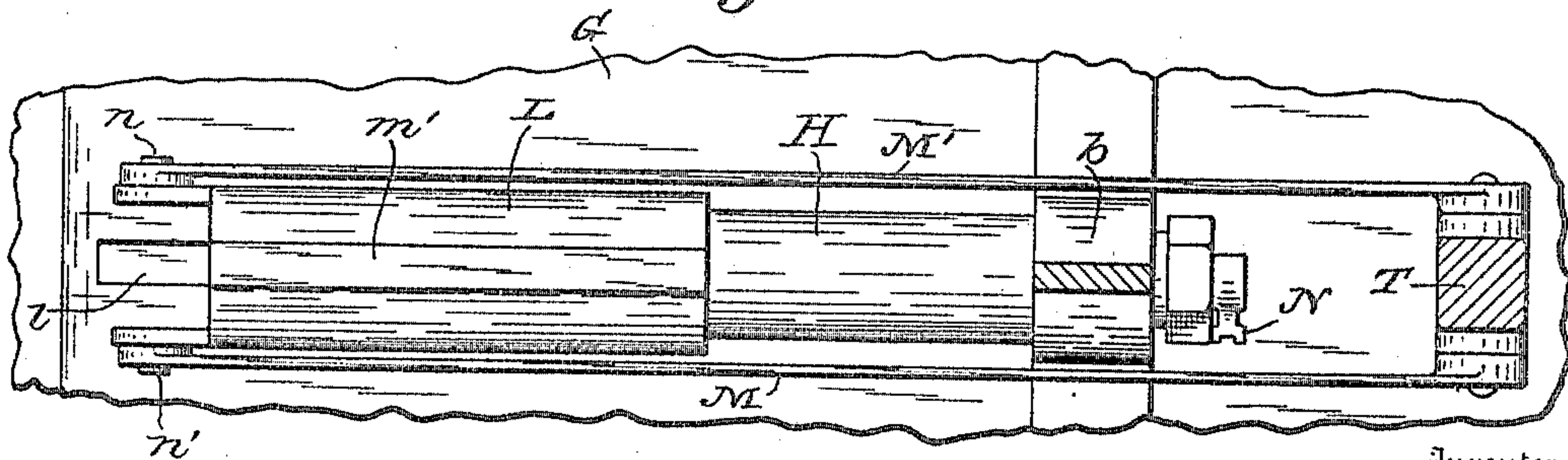


Fig. 17.



Witnesses:

Wm. H. Payne.  
Stella Snyder

Inventor:  
Hobbs C. Clifford,  
by  
E. J. Silvers,  
Attorney.



# UNITED STATES PATENT OFFICE.

HOBBS E. CLIFFORD, OF LAFONTAINE, INDIANA.

## AIR-COMPRESSING ENGINE.

No. 811,378.

Specification of Letters Patent.

Patented Jan. 30, 1906.

Application filed April 17, 1905. Serial No. 255,926.

*To all whom it may concern:*

Be it known that I, HOBBS E. CLIFFORD, a citizen of the United States, residing at Lafontaine, in the county of Wabash and State of Indiana, have invented new and useful Improvements in Air-Compressing Engines; and I do declare the following to be a full, clear, and exact description of the invention, reference being had to the accompanying drawings, and to the letters and figures of reference marked thereon, which form a part of this specification.

This invention relates to reciprocatory fluid-pressure engines and air-compressors, for it has reference particularly to the means whereby the fluid-pressure may be utilized for developing and transmitting the power for compressing the air and for other purposes.

The object of the invention is to provide an air-compressing engine adapted to be operated economically by fluid-pressure, particularly by either compressed air or by steam, which engine may be adapted to be modified so as to be operated by gas-explosion impulses; and a further object is to improve the construction and arrangement of air-compressing mechanism with respect to the power-generating mechanism.

With the above-mentioned and minor objects in view the invention consists in certain novel features of construction and arrangement of elements comprised in air-compressing engines and in the specific parts and the combinations and arrangements thereof, as hereinafter particularly described and claimed.

Referring to the drawings, Figure 1 is a side elevation representing the complete machine, omitting the balance-wheel; Fig. 2, a top plan of the complete machine, omitting the air-receiver and parts of the air-pipes; Fig. 3, an elevation of the side of the machine opposite to that shown in Fig. 1; Fig. 4, a fragmentary vertical longitudinal sectional view approximately on the line A A in Fig. 2; Fig. 5, a fragmentary horizontal sectional view approximately on and below the line B B in Fig. 1, the plane of the section being at the axes of all of the cylinders; Fig. 6, an end elevation of the machine; Fig. 7, a fragmentary transverse vertical sectional view on the line C C in Fig. 2; Fig. 8, a fragmentary transverse vertical sectional view on the line D D in Fig. 2; Fig. 9, a fragmentary transverse vertical sectional view on the line E E

in Fig. 2; Fig. 10, a fragmentary vertical sectional detail view on the line A A in Fig. 2; Fig. 11, a fragmentary horizontal sectional detail view on the line B B in Fig. 1; Fig. 12, a fragmentary front elevation of the main valve-gear reproduced from Fig. 1; Fig. 13, a horizontal sectional view on the line F in Fig. 12; Fig. 14, an end view of one of the main valves of the engine and its chamber; Fig. 15, an end view of the valve-chamber and the valve-seat therein; Fig. 16, a plan view of an inverted cylinder of the engine; and Fig. 17, a top plan of the cylinder and its connecting-rods coupled to a working beam, the beam and a portion of the engine-frame being shown in section on a plane near the line B B in Fig. 1.

Similar reference characters in the several figures of the drawings designate corresponding elements or features.

In construction a suitable main frame G is provided, which supports the whole apparatus of the engine proper and the compressing-pumps and also a reservoir for the compressed air. While the engine may be operated by other than steam-pressure, for the sake of convenience the parts thereof will be herein described as referring to a steam-engine.

In the lower part of the frame G is a steam-passage *a*, extending transversely therein, and above the passage are three upright hollow pillars *b b' b''*, forming parts of the frame, and in each pillar is a passage *c*, communicating with the passage *a*, the latter being connected by a supply-pipe *d*. At the top of each passage *c* is a steam-chamber *e*. Three hollow cylindrical abutments H, H', and H'', formed alike, are rigidly secured in horizontal positions to the pillars above described, each abutment being supported at an end thereof by a pillar and forming an extension of the chamber *e*, the other end of the abutment serving as a valve-chamber and while the steam is operating expansively as an abutment, together with a main valve therein, there being a rotary valve in the end of each abutment, as I, I', and I'', either valve being arranged between two seats J and K and having openings *i i'* therein, the seat J having openings *g* and the seat K having openings *h h'* opposite to the openings *g*, corresponding to the openings *i* in the valve. The seats are disk-like in form and secured suitably to the shell of the abutment, and the valve is similar in form and adapted to make steam-tight connections with either one of the seats.



The ends of the abutments are provided with external packing-rings  $f$ . The main valves are provided with valve-rods, as  $k$   $k'$   $k^2$ , for their operation, which extend through openings  $j$  in the seats  $K$  and through the steam-chambers of the abutments and project beyond the pillars, as  $b$ , where the rods are suitably packed.

Guides  $l$   $l'$  are provided, that are arranged in planes above and below the abutments in pairs, and hollow steam-cylinders  $L$   $L'$   $L^2$  are mounted movably on the abutments, there being a cylinder for each abutment and having each a pair of guide-bars  $m$   $m'$  at the top and bottom thereof in connection with the above-mentioned guides. Each cylinder is provided with a pair of wrist-pins  $n$  and  $n'$ , one at either side thereof, to which are connected a pair of coupling-rods  $M$   $M'$ , designed for draft purposes, that extend at opposite sides of a pillar, as  $b$ . Each cylinder is closed by a head at one end thereof, and near its opposite end in its under side is an exhaust-port  $p$ .

The ends of the valve-rods are provided with rocking arms  $N$   $N'$   $N^2$  for rocking the rods, and thereby the main valves, the packing of the rods serving as journal-bearings for the ends of the rods.

In the main-frame base are exhaust-ports  $q$ , a port for each cylinder, to receive the exhaust-steam from the port  $p$  thereof, all of the ports  $q$  communicating with a transverse port  $r$ , extending to a side of the main frame, from which point it may be extended elsewhere.

At a side of the main frame near an end thereof a pair of brackets  $s$   $s'$  are attached thereto and support a pivot-rod  $t$ , on which three swinging arms  $O$   $O'$   $O^2$  are pivoted and depending from the rod, the free ends of the arms being connected by coupling-rods  $u$   $u'$   $u^2$  to the rocking arms  $N$   $N'$   $N^2$ . Below the plane of the rod  $t$  a pair of shafts  $v$  and  $w$  are journaled rotatively. On the shaft  $v$  are cams  $Q$   $Q'$   $Q^2$ , adapted to move the swinging arms toward the main frame or inwardly, and on the shaft  $w$  are cams  $R$   $R'$   $R^2$ , adapted to move the arms outwardly. In the bracket  $s$  is journaled a gear-wheel  $S$ , constructed as a triple wheel, having bevel-wheel teeth  $y$  at one side thereof in engagement with a bevel-wheel  $x$  on the shaft  $v$ , bevel-wheel teeth  $y'$  at the opposite side thereof in engagement with a bevel-wheel  $x'$  on the shaft  $w$  and spur-teeth  $z$  on the middle portion thereof. The cams are shown as being integral with their supporting and driving shafts, but obviously may be formed separately and secured adjustably to the shafts.

On the top of an end of the main frame working beams  $T$   $T'$   $T^2$  are pivoted between their ends thereon, there being a working beam for each cylinder and arranged on hori-

zontal axes, each working beam with an end thereof opposite a pillar, as  $b$ , and to such end the rods  $M$   $M'$  are connected.

A main shaft  $U$  is journaled on the top of the main frame and has cranks 18 19 20, to which are connected pitmen 21 22 23, which are connected to the upper ends of the working beams  $T$   $T'$   $T^2$ . The main shaft is arranged somewhat above the cylinders and extends transversely thereof in a plane approximately at the ends of the abutments, the cranks of the shaft being above the cylinders in the same vertical planes therewith. A gear-wheel  $V$  is secured to the shaft at one side of the main frame, and a gear-wheel  $V'$  is also secured to the shaft at the opposite side of the frame.

The front side of the frame is provided with a stud  $P$ , on which is journaled a gear-wheel  $W$ , that meshes with the wheel  $V$  and the spur-teeth  $z$  of the wheel  $S$ , communicating motion from the main shaft to the valve-gears. The rear side of the frame is provided with a stud  $P'$ , on which is journaled a gear-wheel  $W'$ , that is driven by the wheel  $V'$ . A coupling-rod 24 is pivoted to the wheel  $W$ , and a like rod 25 is pivoted to the wheel  $W'$ .

A balance-wheel 26 is secured to the main shaft  $U$ , and obviously other similar wheels and pulleys may also be secured to the shaft, so that machinery could thereby be driven.

At the front side of the frame a gear-wheel segment  $X$  is pivotally mounted and supported partly by the frame and partly by a stand 27, that is attached to the frame, and at the rear side of the frame a similar segment  $X'$  is mounted and supported similarly partly by the frame and partly by a stand 28, one segment having an arm pivotally connected to the rod 24 and the other segment having an arm connected pivotally to the rod 25.

At the rear side of the frame, as illustrating the purpose of the engine, are two low-pressure pump-cylinders  $Y$  and  $Y'$  at opposite ends of the frame, and at the front side of the frame are two high-pressure cylinders  $Z$  and  $Z'$  at opposite ends of the frame, all of the cylinders being secured horizontally to the frame and formed substantially alike, except that the high-pressure cylinders have less diameter than the others. A piston-rod 29 extends into both of the cylinders  $Z$  and  $Z'$ , and the middle portion of the rod is formed as a gear-rack 30, that is engaged by the segment  $X$ . Pistons 31 and 32 are attached to the ends of the rod in the cylinders. Suitable roller-bearings 33 are provided for the rack part of the rod. At the opposite side of the frame a similar piston-rod and rack 34 is arranged in engagement with the segment  $X'$ , and pistons 35 and 36 are attached to the rod in the cylinders  $Y$  and  $Y'$ , into which the rod extends. The cylinder  $Y$  is provided at the ends thereof



with inlet-valves 37 and 38 and also outlet-valves 39 and 40, between which is connected a discharge-pipe 41. The cylinder Z is provided at the ends thereof with inlet-valves 42 and 43, between which the pipe 41 is connected therewith, and the cylinder is also provided with outlet-valves 44 and 45, with which is connected a discharge-pipe 46, leading to a reservoir 47, having an outlet-pipe 48 and mounted upon the main frame of the engine. The ends of the cylinder Y' are provided with inlet-valves 49 and 50 and also with outlet-valves 51 and 52, between which a discharge-pipe 53 is connected therewith. The inlet-valves 37, 38, 49, and 50 may all be connected with a suitable single intake-pipe, as is obvious. The cylinder Z' is provided at its ends with inlet-valves 54 and 55, between which the pipe 53 is connected therewith, and the cylinder is also provided with outlet-valves 56 and 57, with which is connected a discharge-pipe 58, leading to the reservoir 47. Obviously the pipes 46 and 58 may be connected together and to a single pipe leading to the reservoir. Also the pipes 41 and 53 may be connected together, if desired.

Although an advantageously - arranged three-cylinder engine is described, it will be obvious that the machine may be constructed as a two-cylinder or a four-cylinder engine, or any suitable number of cylinders and necessary coöperating parts therefor may be provided. Any suitable types of valves for the air-cylinders may be employed and may obviously be arranged in the heads of the cylinders. Various other modifications may also be made within the scope of the invention.

In practical use the steam is to be admitted to the supply-pipe *d* and will flow through the passages to the chambers in the abutments H H' H<sup>2</sup> always conveniently disposed to be promptly admitted to the cylinders by the main valves. It may be assumed that the engine is starting from the position illustrated in the direction of the arrow on the balance-wheel when steam is cut off from cylinder L, which after moving outwardly somewhat the steam would be exhausted therefrom, and the cylinder would be returned empty by the crank 18 and the intermediate connections. In cylinder L' the steam has been cut off by the main valve and is expansively exerting its force, presumably while cylinder L<sup>2</sup> is in position to receive full-pressure steam to move it outwardly, this cylinder being the one relied upon to start the engine from its illustrated position. By the time cylinder L<sup>2</sup> moves to the end of its stroke live steam will have been admitted to cylinder L', which will drive the crank-shaft U until cylinder L has been returned to its proper position to receive live steam. Therefore the engine may be started from any position in which the cylinders may be left standing.

The main valves will be operated by the to-and-fro motions of the arms O O' O<sup>2</sup>, imparted to them by the valve-cams at opposite sides thereof, which will be operated by means of the wheel V and intermediate connections. The wheels W W' will rock the segments X X', and thereby imparting reciprocating motions to the piston-rods 29 and 34. Air will be drawn into the low-pressure cylinders by the pistons therein and forced under moderate pressure into the pipes 41 and 53, from which the air will flow into the high-pressure cylinders to be compressed and discharged into the reservoir 47 and therein further compressed as the inflowing air continues.

Having thus described the invention, what is claimed as new is—

1. An engine including a support having a chamber therein, a hollow cylindrical abutment secured fixedly at an end thereof to the support in communication with the chamber thereof and provided at the opposite end thereof with a valve-seat, a valve operative on the valve-seat and having an operating-rod extending through the chamber of the support, a hollow cylinder movable on the abutment, a rotative shaft having a crank, operative connections between the hollow cylinder and the crank of the shaft, and connections between the rotative shaft and the operating-rod of the valve.

2. An engine including a frame, a support having a chamber therein, a hollow cylindrical abutment secured fixedly at an end thereof to the support in communication with the chamber thereof and provided at the opposite end thereof with a valve-seat, a valve operative on the valve-seat and having an operating-rod extending through the chamber of the support, means for controlling the operating-rod, a hollow cylinder movable on the abutment, a reciprocating rod mounted on the frame and having gear-teeth thereon, a gear-segment pivoted to the frame and engaging the gear-teeth of the reciprocating rod, and operative connections between the hollow cylinder and the gear-segment.

3. An engine including a frame, a support having a chamber therein, a hollow cylindrical abutment secured fixedly at an end thereof to the support in communication with the chamber thereof and provided at the opposite end thereof with a valve-seat, a valve operative on the valve-seat and having an operating-rod extending through the chamber of the support, a hollow cylinder movable on the abutment and provided with an exhaust-port, a rotative shaft having a crank and mounted on the frame, operative connections between the hollow cylinder and the crank of the rotative shaft, means for controlling the operating-rod of the valve, a pinion secured to the rotative shaft, a gear-wheel mounted on the frame in engagement with the pinion,



a reciprocating rod mounted on the frame and having gear-teeth thereon, a gear-segment pivoted to the frame and engaging the gear-teeth of the reciprocating rod, and a coupling-rod pivoted to the gear-wheel and also to the gear-segment.

4. An engine including a support having a chamber therein, a hollow cylindrical abutment secured fixedly at an end thereof to the support in communication with the chamber thereof and provided at the opposite end thereof with a valve-seat, a valve operating on the valve-seat and having an operating-rod extending through the chamber of the support, a hollow cylinder movable on the abutment and having an exhaust-port therein, a working beam, a pair of connecting-rods pivoted to the cylinder and also to the working beam, a crank-shaft, a pitman connected to the crank of the shaft and also to the working beam, a balance-wheel on the crank-shaft, a rocking arm attached to the valve-operating rod, and connections between the crank-shaft and the rocking arm.

5. An engine including stationary hollow abutments provided with valves having operating-rods extending through ends thereof, rocking arms secured to the operating-rods of the valves, hollow cylinders movable on the abutments and provided with exhaust-ports, pivoted working beams, connecting-rods pivoted to the cylinders and also to the working beams, guides for the cylinders, a main shaft having cranks, connecting-rods pivoted to the cranks and also to the working beams, a pair of rotative shafts provided with cams, gearing between the rotative shafts and the main shaft, swinging arms movable between and by the cams of the pair of rotative shafts, and connecting-rods pivoted to the swinging arms and also to the rocking arms.

6. An air-compressing engine including a frame, a plurality of pairs of parallel guides supported by the frame, a plurality of hollow cylinders movable in the pairs of guides and having each a closed end and an open end, a plurality of working beams pivoted on the frame, a plurality of connecting-rods pivoted to the cylinders in pairs and also to the working beams, a plurality of hollow abutments supported by the frame and extending therefrom into the movable cylinders and pro-

vided each with two parallel apertured valve-seats, main apertured valves movable between the seats and having operating-rods extending through the abutments, a main shaft having a plurality of cranks mounted on the frame, and connecting-rods pivoted to the cranks and also to the working beams.

7. An air-compressing engine including a frame, a plurality of cylinders mounted movably in the frame, a plurality of abutments serving as fluid-chambers supported at ends thereof by the frame and extending into the cylinders, main valves mounted in the ends of the abutments within the cylinders and having operating-rods extending through the abutments, rocking arms secured to the operating-rods, a plurality of working beams pivoted on the frame, a main crank-shaft journaled on the frame, coupling-rods pivoted in pairs to the cylinders and also to the working beams, coupling-rods pivoted to the cranks of the main shaft and also to the working beams, reciprocating rods mounted on the frame and having gear-teeth thereon, gear-segments pivoted to the frame and engaging the gear-teeth of the reciprocating rods, operating-gearing between the gear-segments and the main shaft, and operating mechanism between the main shaft and the rocking arms of the valve-rods.

8. In an engine, the combination of a frame, a pair of guides in the frame, a cylinder closed at one end thereof mounted movably between the guides and having an exhaust-port near the opposite end thereof, a chambered pillar attached to the frame, a hollow cylindrical abutment attached to the pillar and extending into the cylinder, a main valve movably mounted in the end of the abutment that is in the cylinder, a packing between the end of the abutment and the cylinder, a working beam mounted on the frame, a pair of parallel connecting-rods pivoted to the cylinder and extending at opposite sides of the pillar to the working beam and pivoted thereto, and means for operating the main valve.

In testimony whereof I affix my signature in presence of two witnesses.

HOBBS E. CLIFFORD.

Witnesses:

WM. H. PAYNE,  
E. T. SILVIUS.