No. 774,433. PATENTED NOV. 8, 1904.

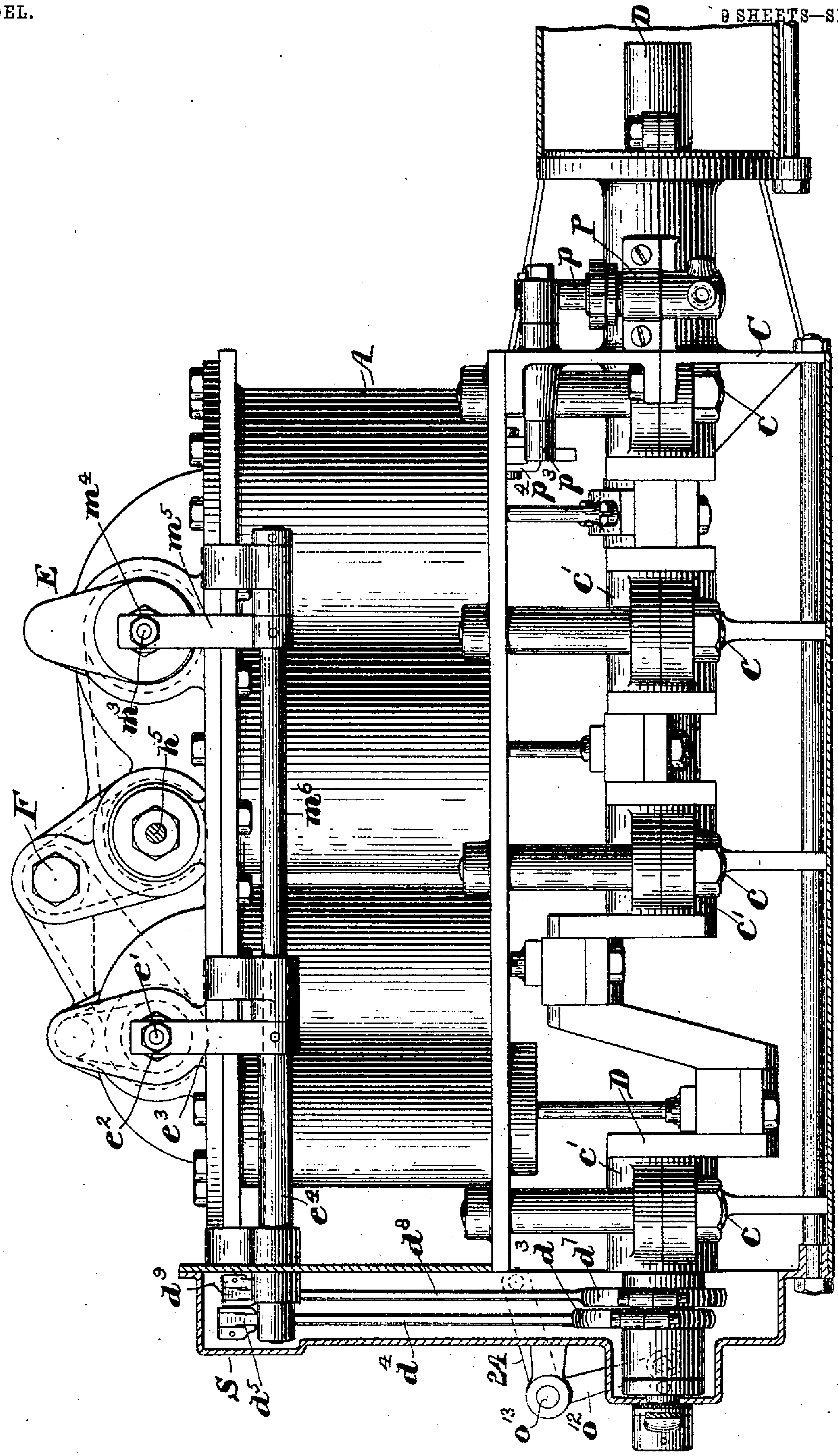
D. E. JOHNSON.

STEAM ENGINE.

APPLICATION FILED AUG. 4, 1902.

NO MODEL. 9 SHEETS—SHEET 1.

Fig. 1.



Witnesses:
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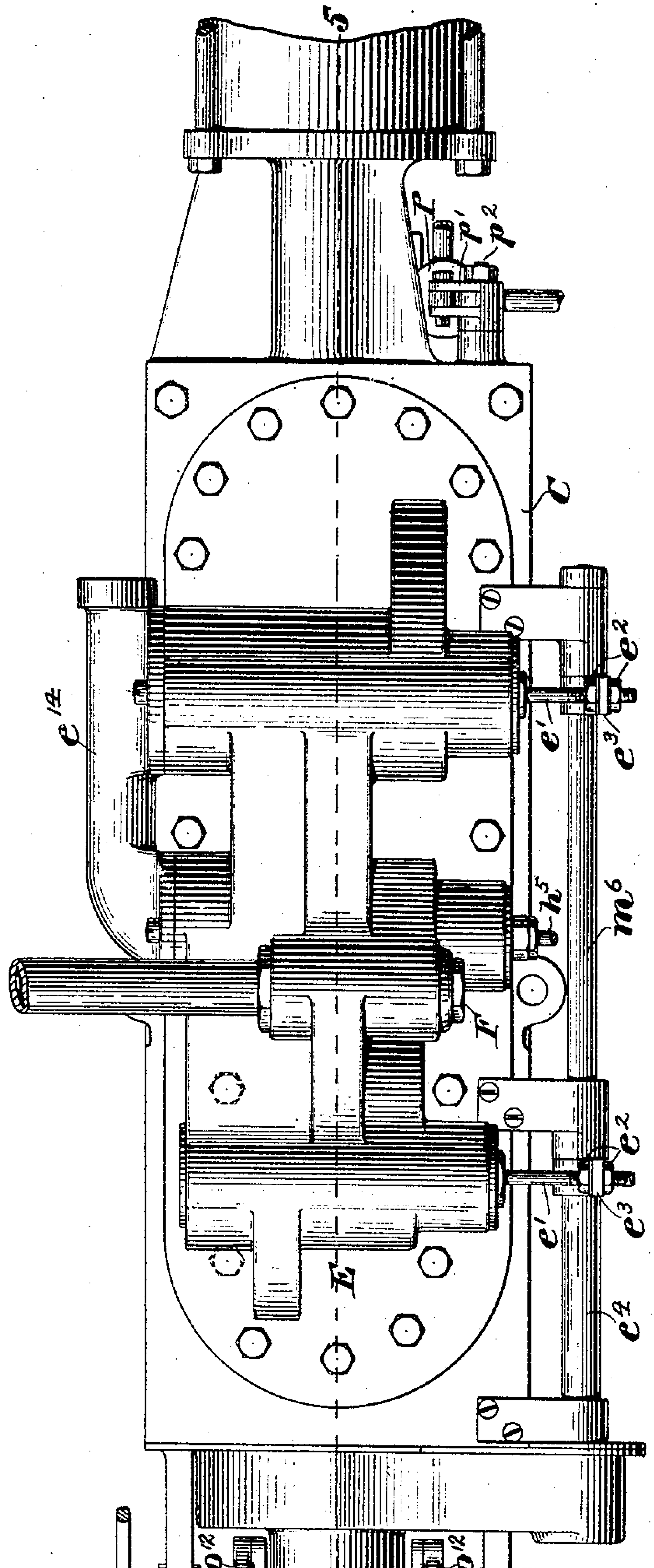
NO MODEL. 9 SHEETS—SHEET 2.

Fig. 2.



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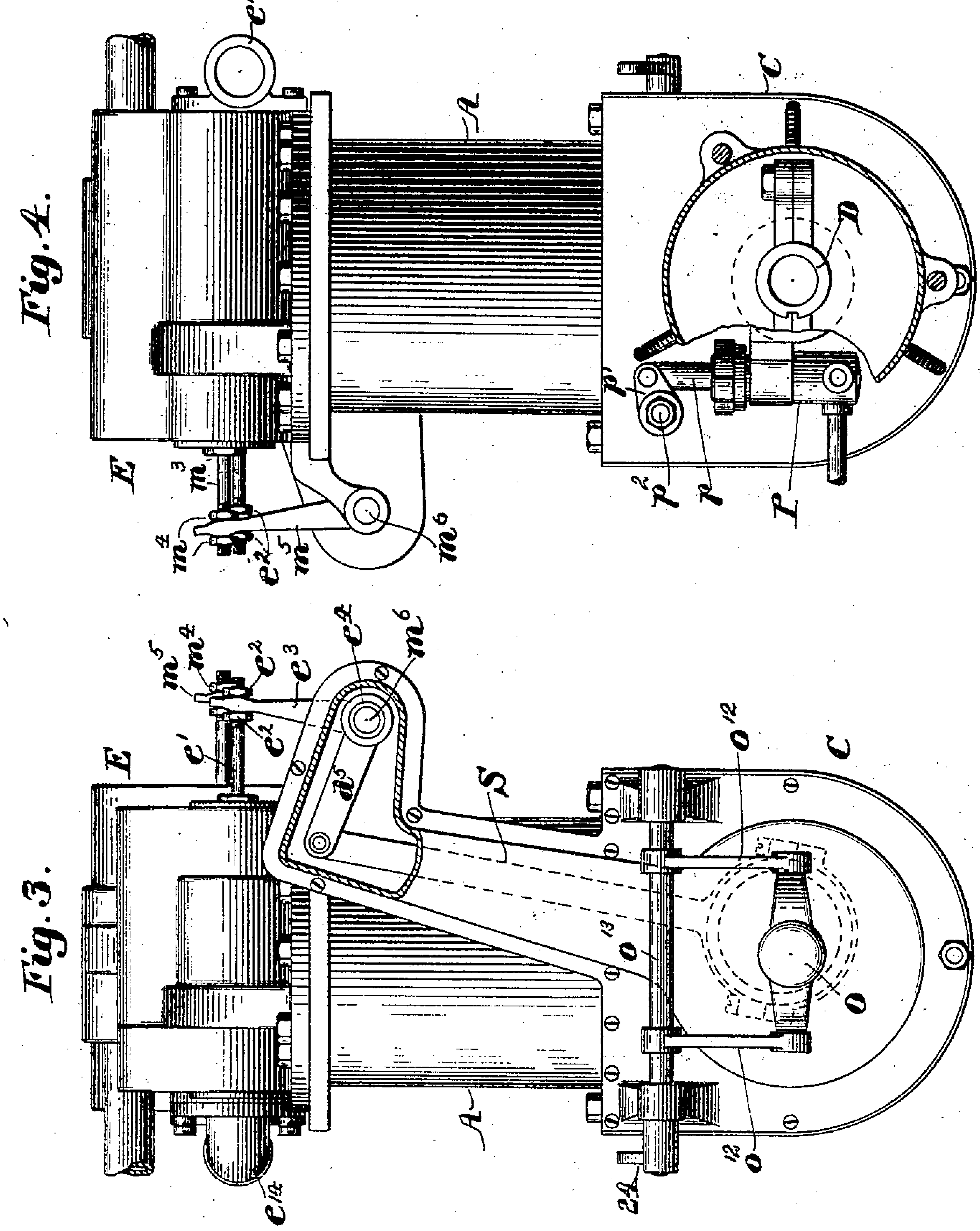
NO MODEL. 9 SHEETS—SHEET 3.



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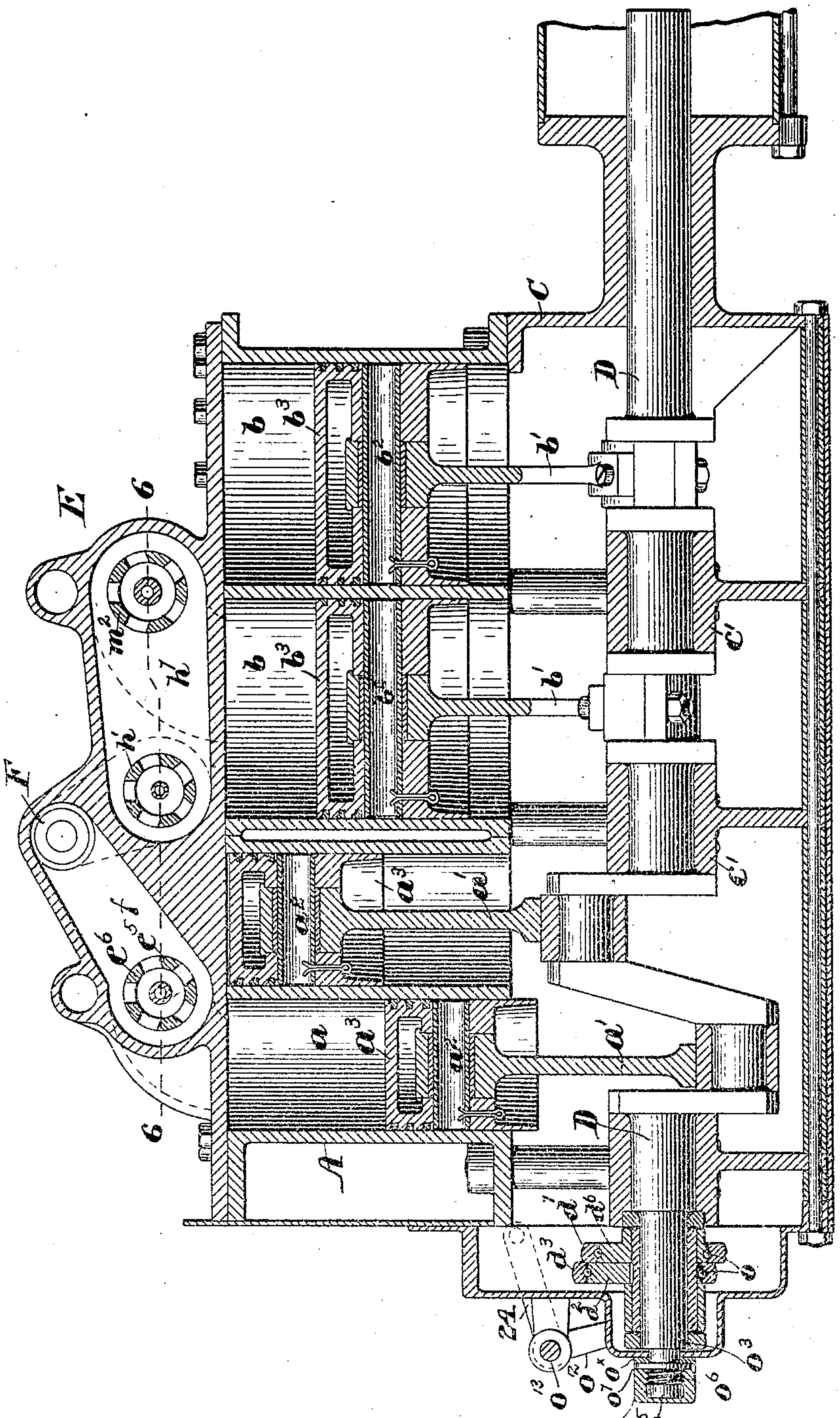
NO MODEL. 9 SHEETS—SHEET 4.

Fig. 5.



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NO MODEL. 9 SHEETS—SHEET 5.

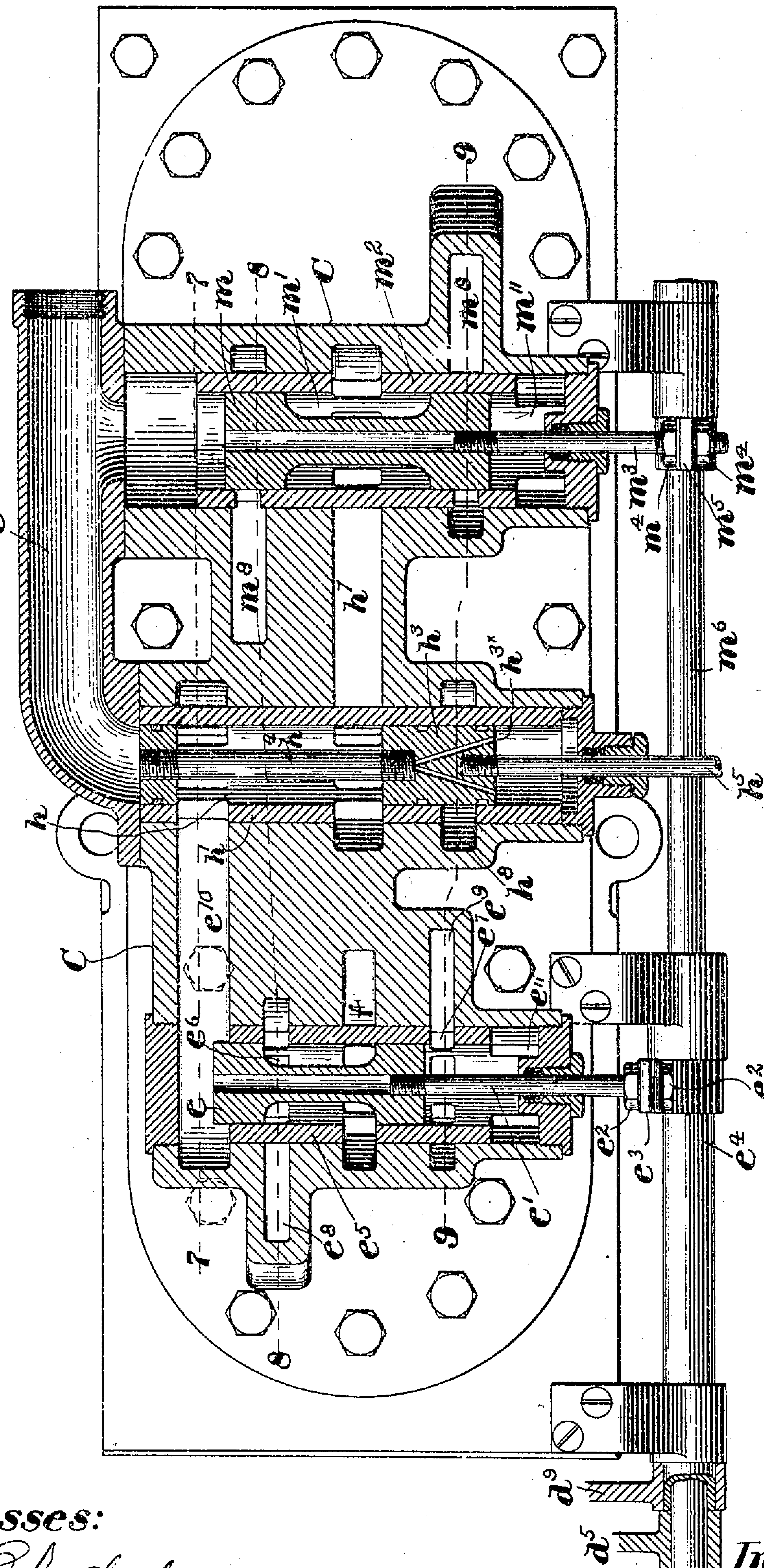

Fig. 6.

Witnesses:

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NO MODEL. 9 SHEETS—SHEET 6.

Fig. 7.

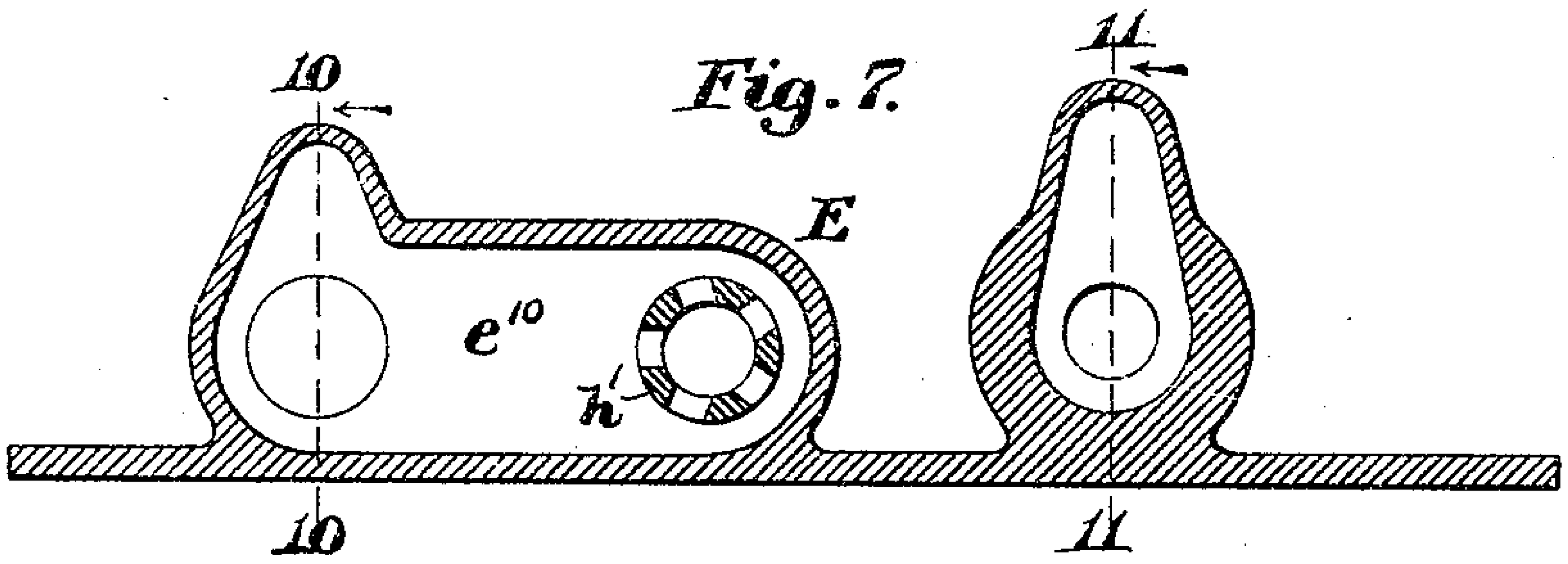


Fig. 8.

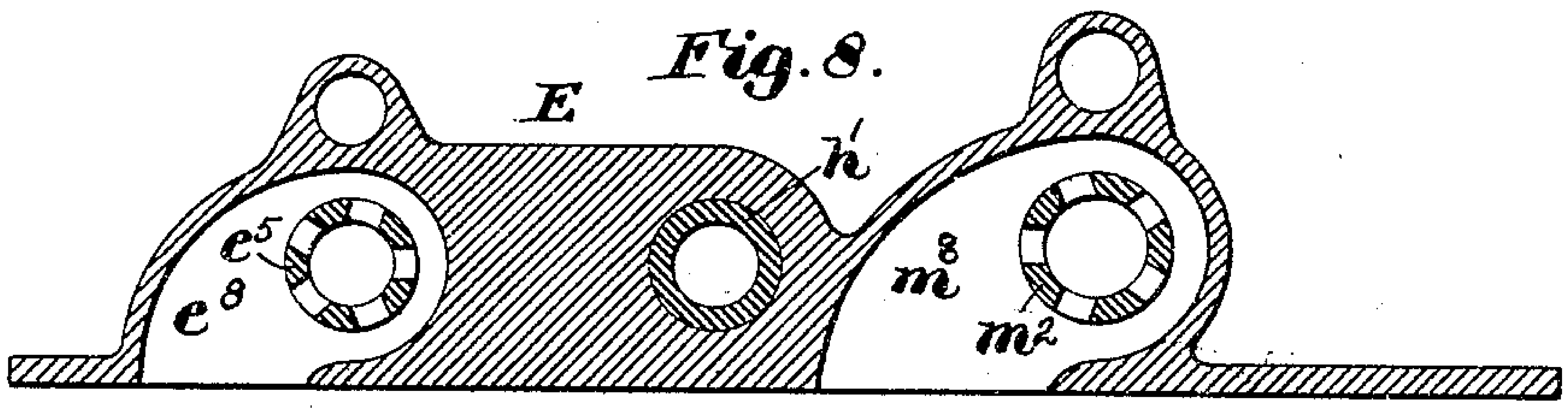


Fig. 9.

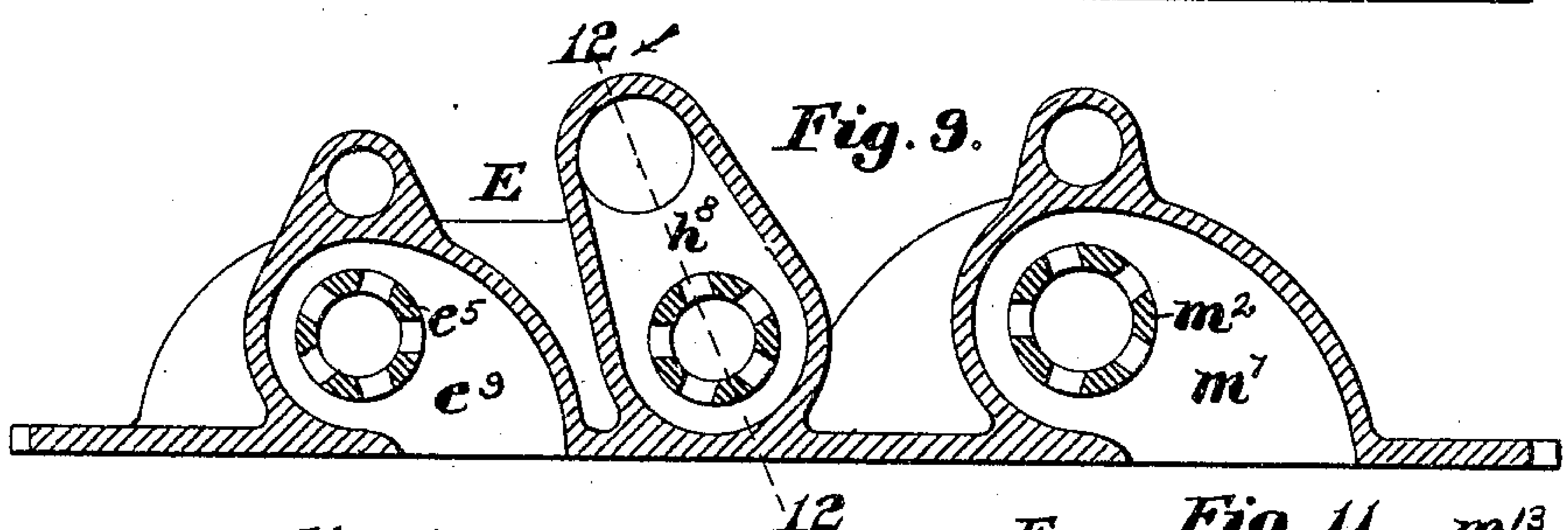


Fig. 10

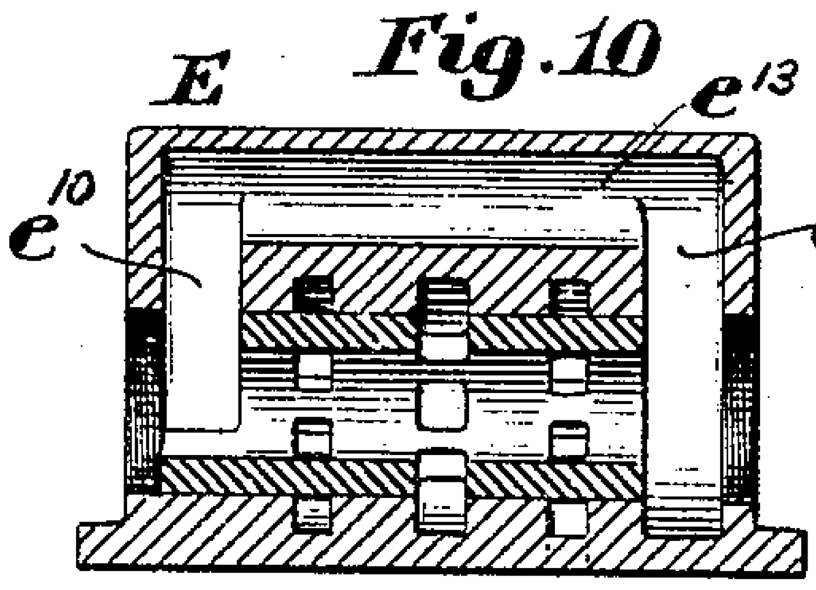


Fig. 11

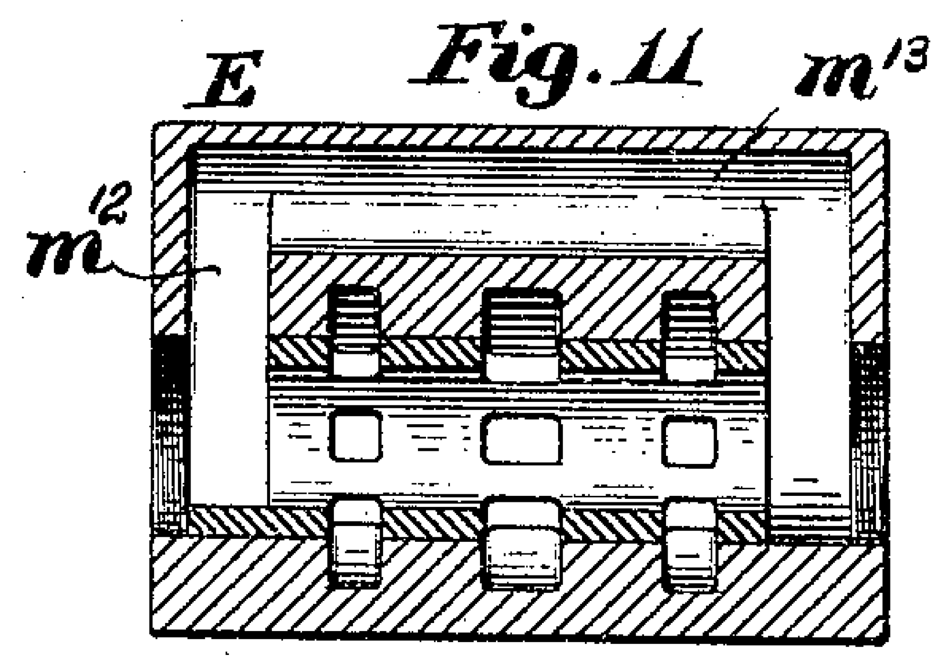
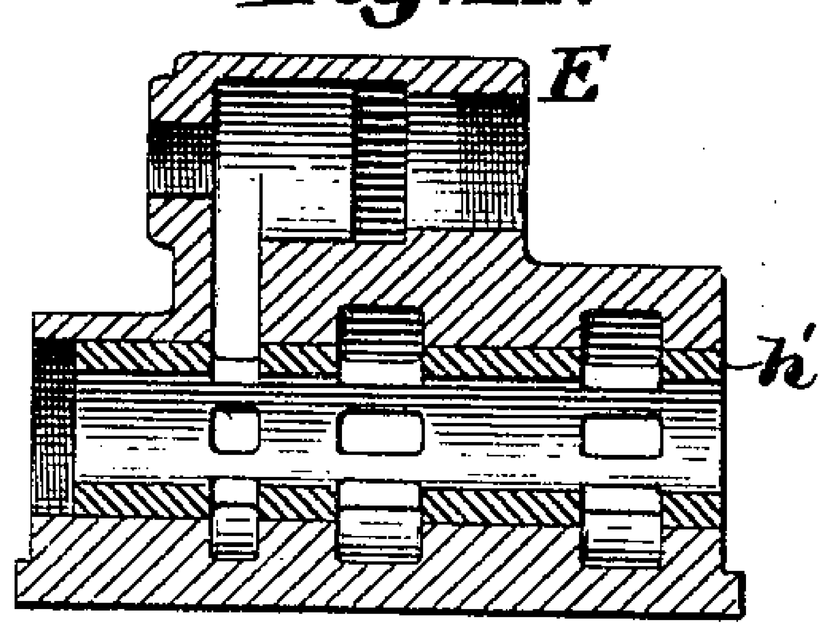


Fig. 12.



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NO MODEL. 9 SHEETS—SHEET 7.

Fig. 13.

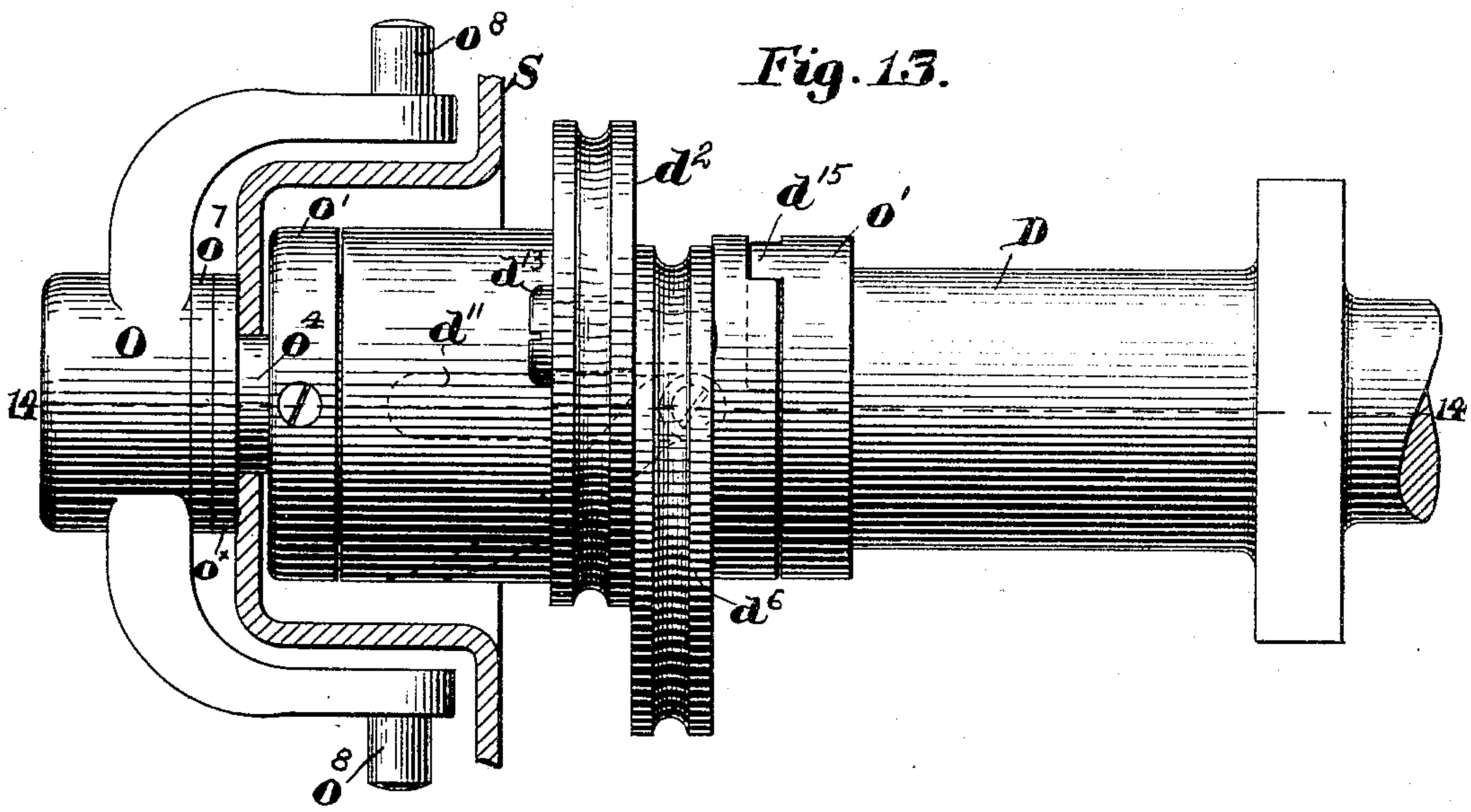
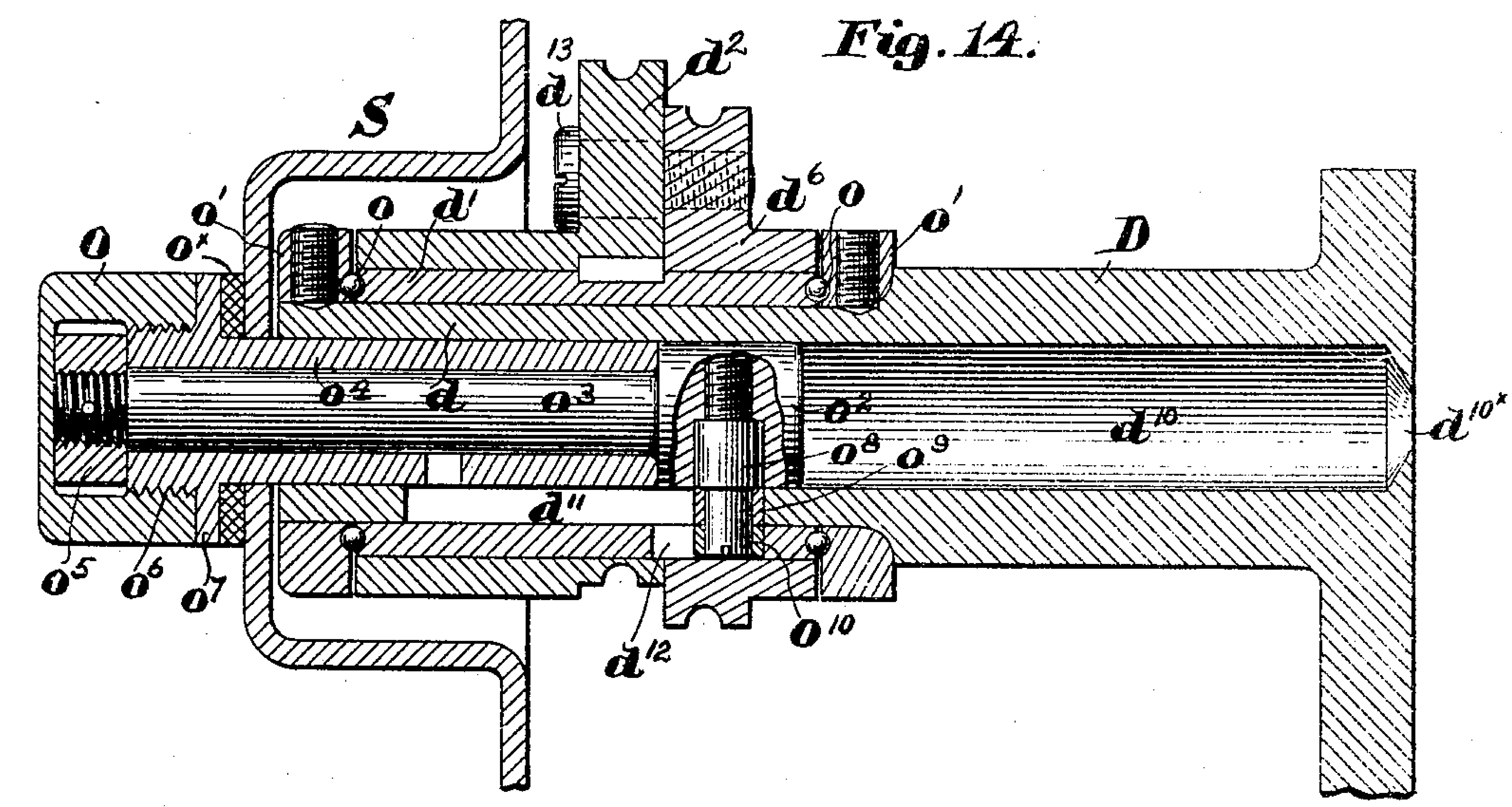


Fig. 14.



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NO MODEL. 9 SHEETS—SHEET 8.

Fig. 15.

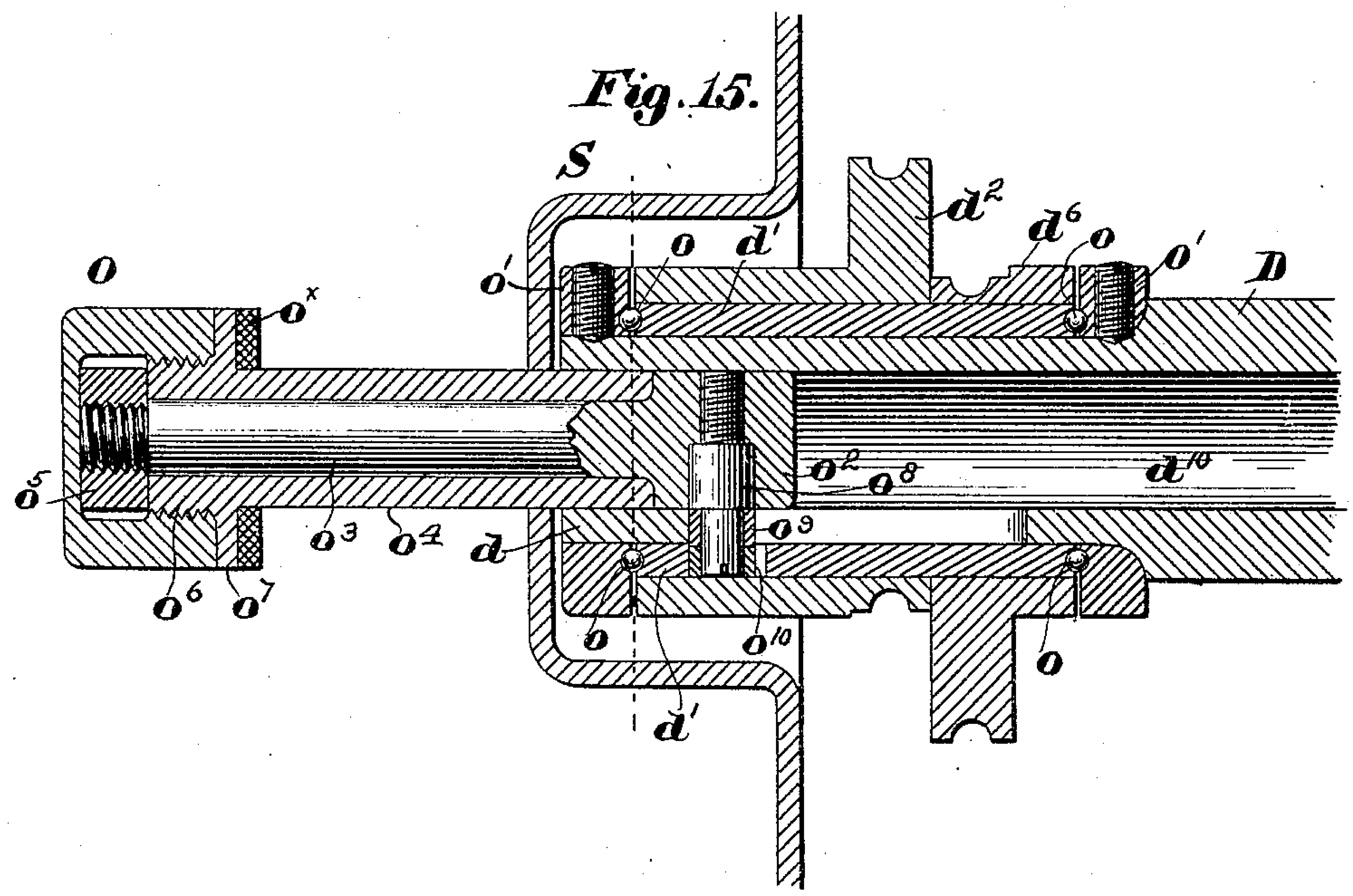
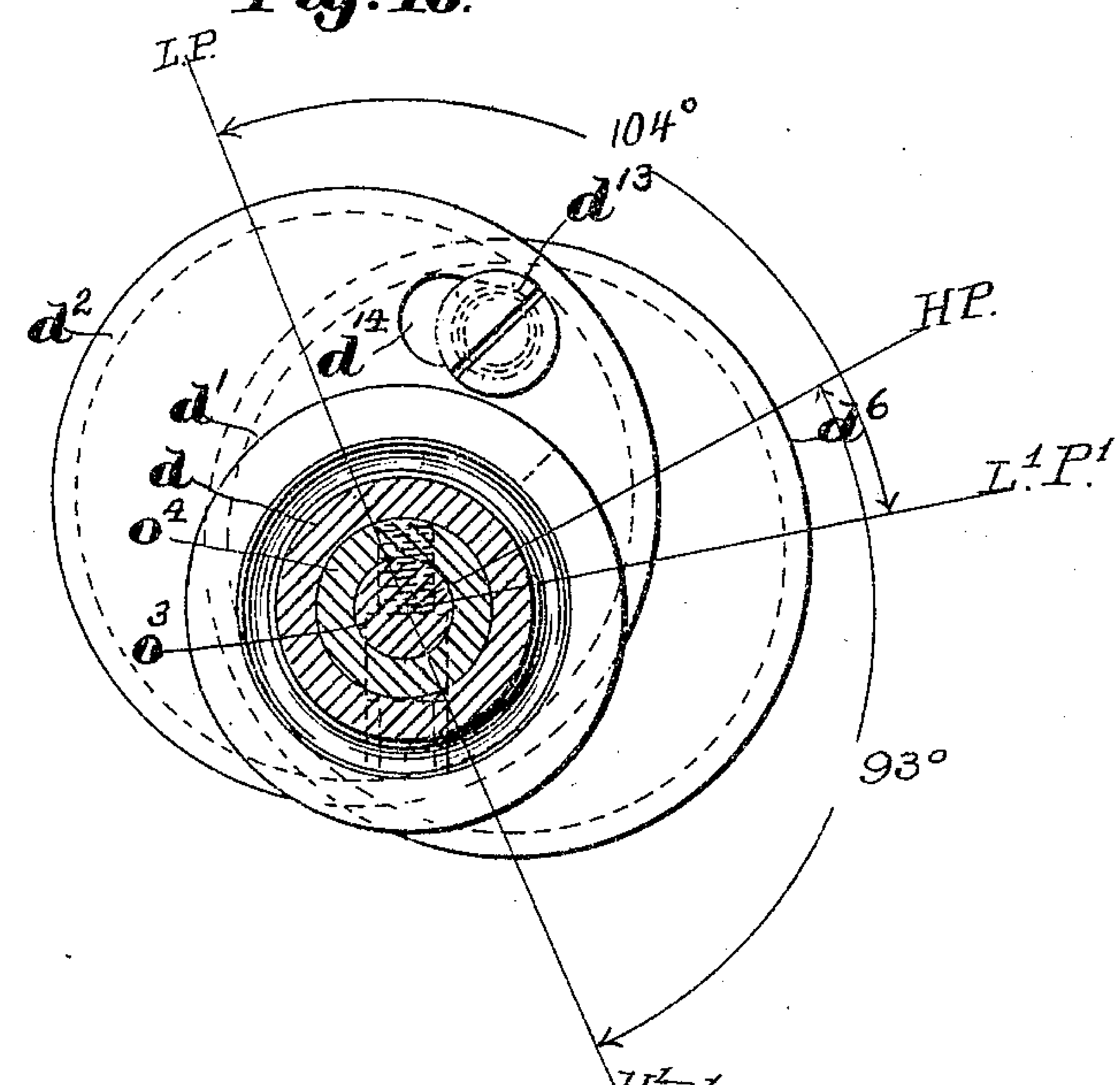


Fig. 16.



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STEAM ENGINE.

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NO MODEL. 9 SHEETS—SHEET 9.

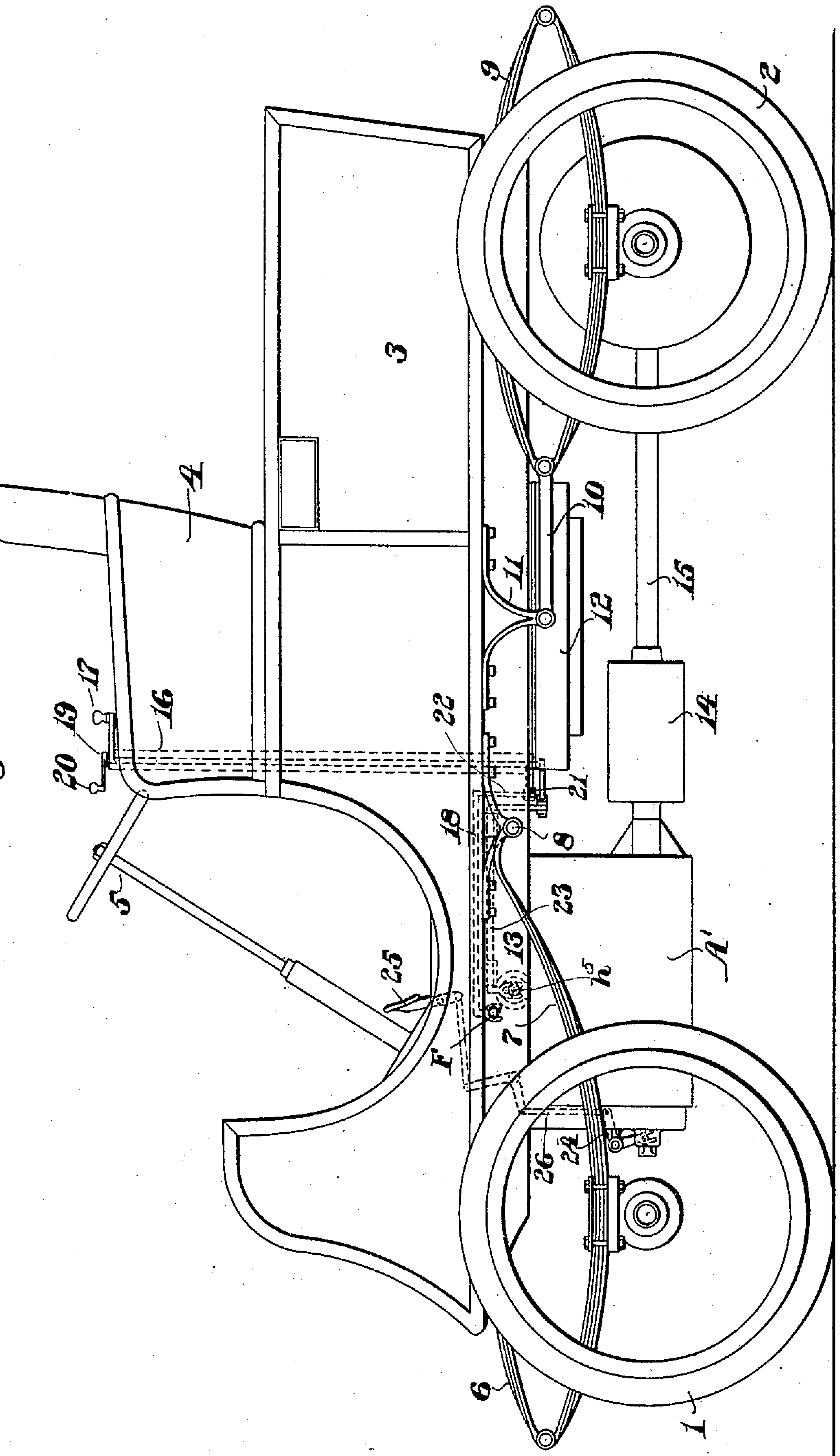

Fig. 17.

Witnesses:

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No. 774,433. Patented November 8, 1904.

UNITED STATES PATENT OFFICE.

DANIEL E. JOHNSON, OF HARTFORD, CONNECTICUT, ASSIGNOR TO FREDERIC C. BILLINGS, OF HARTFORD, CONNECTICUT.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 774,433, dated November 8, 1904.

Application filed August 4, 1902. Serial No. 118,256. (No model.)

To all whom it may concern:

Be it known that I, DANIEL E. JOHNSON, a citizen of the United States, residing at Hartford, in the county of Hartford and State of Connecticut, have invented an Improvement in Steam-Engines, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

This invention aims to provide a novel and improved steam-engine.

The invention is particularly adapted, though not exclusively, to single-acting, simple, or compound engines, and I have selected a single-acting compound engine as an illustration of my invention herein, it being understood, however, that my invention is not restricted to the particular embodiment thereof so shown.

In the drawings, Figure 1 in side elevation, partially broken away, shows an engine illustrating my invention. Fig. 2 is a top or plan of Fig. 1; Figs. 3 and 4, left and right hand elevations, respectively, of the engine, both figures being partly broken away for illustration of some of the parts. Fig. 5 is a vertical longitudinal section on the dotted line 5 5, Fig. 2; Fig. 6, an enlarged horizontal section on the dotted line 6 6, Fig. 5, showing the various valves and other parts in section; Fig. 7, a vertical sectional detail on the dotted line 7 7, Fig. 6; Fig. 8, a similar section on the dotted line 8 8, Fig. 6; Fig. 9, a similar section on the dotted line 9 9, Fig. 6; Fig. 10, a vertical section on the dotted line 10 10, Fig. 7; Fig. 11, a vertical section on the dotted line 11 11, Fig. 7; Fig. 12, an inclined section on the dotted line 12 12, Fig. 9; Fig. 13, an enlarged detail looking down upon the reversing mechanism of the engine illustrated; Fig. 14, a vertical longitudinal section on the dotted line 14 14 of the parts shown in Fig. 13; Fig. 15, a view similar to Fig. 14, showing the parts in reversing position; Fig. 16, a diagram illustrating the relative locations of the two eccentrics and showing the lost motion between the same, and Fig. 17 a side elevation showing a motor-vehicle equipped with my improved engine.

In the particular embodiment of my invention selected for illustration herein and shown in the drawings, referring first to Figs. 1 and 5, the cylinders of the engine, here shown as four in number—two high-pressure *a a* and two low-pressure *b b*—are shown as formed within a single casting A, mounted upon and secured to the hollow two-part well-like bottom casting C. The several cylinders are arranged in alinement with the crank-shaft, the two high-pressure cylinders being together and the two low-pressure cylinders together.

The two-part bottom or well casting C is divided horizontally, preferably in the plane of the crank-shaft, its two parts being suitably connected, as by bolts *c c*, Fig. 1, they having formed between them the bearings c' for the crank-shaft D. The crank-shaft is provided with four cranks arranged in pairs, the cranks of each pair being arranged opposite each other—that is, one hundred and eighty degrees apart—the cranks of the two being arranged on the quarter—that is, ninety degrees apart.

Referring to Fig. 5, the two cranks for the high-pressure cylinders *a a* are actuated by the connecting rods or pitmen a' a', connected at their upper ends to the hollow wrist-pins a^2, carried in and by the cup-shaped single-acting high-pressure pistons a^3. These pistons are of sufficient length, together with the length of the cylinders, to serve as guides for the pistons in their movements, as is common with single-acting engines.

The two cranks for the low-pressure cylinders are similarly actuated by the connecting rods or pitmen b' b', connected at their upper ends to the wrist-pins b^2, carried in and by the low-pressure pistons b^3. Thus the two high-pressure pistons and their cranks balance each other, and also the two low-pressure pistons and cranks.

The upper ends of the several cylinders are closed by a cap-casting E, secured to the cylinder-casting A and containing the several inlet and exhaust ports and valves. The several valves as here shown are of the piston type, hence balanced, the high-pressure valve being shown at *e*, Figs. 5 and 6, it comprising two connected piston-heads mounted upon the end of a valve-stem e', threaded at its outer end to receive the two nuts $e^2 e^2$, which receive between them the upper end of the actuating-arm e^3 on the tubular shaft e^4, actuated by mechanism to be described.

The high-pressure valve e is reciprocated in a valve-chamber formed by a bushing e^5, arranged in the cap-casting E, and provided near its ends with exit or port openings $e^6 e^7$, which communicate, respectively, with the ports e^8 e^9, leading to the two high-pressure cylinders a a. The port e^8 is shown in full lines in the section Fig. 8 and the port e^9 is shown in full lines in the section Fig. 9. The high-pressure-valve chamber is open at both ends, the rear end thereof communicating directly with the exhaust-passage e^{10}, Fig. 6, while at its opposite or front end said chamber communicates, through ports e^{11} in the front end of the bushing e^5, with a vertical passage e^{12}, (shown best in Fig. 10,) which communicates with an upper horizontal passage e^{13} above the valve-chamber and opening at its rear end into the exhaust-passage e^6, referred to, so that exhaust from either end of the valve or valve-chamber eventually reaches the exhaust-passage e^{10}.

Referring to Fig. 6, with the valve in its position there shown, live steam entering through the intermediate live-steam port f (see also Fig. 5) between the pistons of the valve e passes directly to the port e^8 for the left-hand high-pressure cylinder, Fig. 5, to move the piston therein, while the exhaust from in front of the ascending piston in the other high-pressure cylinder escapes through its port e^9, Fig. 6, through the bushing-ports e^7, into the valve-chamber, thence outward through the bushing-ports e^{11}, into the exhaust-passages e^{12} e^{13}, (see Fig. 10,) into the exhaust-passage e^{10}. The pistons having reached the ends of their respective strokes, the valve is moved into its opposite or dotted position, Fig. 6, to cause steam from the live-steam port f to flow through the port e^9 into the right-hand high-pressure cylinder, Fig. 5, to move the piston therein, the exhaust from the ascending piston in the other high-pressure cylinder escaping through its port e^8, Fig. 6, past the end of the valve and directly into the exhaust-passage e^{10}. The live steam first enters the live-steam inlet F, Figs. 1, 5, and 2, under the control of a suitable throttle-valve, (not shown,) passing thence through the said port f to the cylinders. The exhaust-passage e^{10} enters an intermediate controlling-valve chamber h, arranged parallel with the other valve-chambers and formed within a bushing h', let into the cap-casting C. This chamber contains a controlling-valve H, comprising two heads or pistons h^2 h^3, connected by a reduced portion or stem h^4, the same being provided also with an operating-stem h^5, extended through a suitable packing-box to the outside, where it may be reached for moving the valve when necessary. When the said controlling-valve is in its position Fig. 6, with the head h^2 closing communication from the exhaust-passage e^{10} to the main exhaust-pipe or conduit e^{14}, the exhaust-steam from the passage e^{10} will enter the controlling-valve chamber h, passing therefrom through the intermediate port h^6 into the passage h^7, which communicates with the interior of the low-pressure-valve chamber m', formed within the bushing m^2, let into the cap-casting C. To balance the controlling-valve, the stem h^4 thereof is made tubular, and its end adjacent the valve-stem h^5 communicates with two divergent passages $h^{3\times}$, whereby exhaust-steam from the passage e^{14} may enter the controlling-valve chamber in front of the piston h^3 of the said valve, thereby to balance the valve in either of its positions and prevent any possible accidental movement of the valve due to unbalanced pressure at either end thereof. This low-pressure-valve chamber m' contains a piston-valve m, similar in construction to the high-pressure valve e, the same comprising, as shown, two connected heads or pistons mounted upon a valve-stem m^3, which projects outward through suitable packing means and carries upon its threaded end two nuts m^4, between which is received the end of an arm m^5 on the low-pressure rock-shaft m^6, which telescopes within the high-pressure tubular shaft e^4, which operates the high-pressure valve.

The controlling-valve chamber h, with its connected passages e^{10} and h^7, constitutes a receiver between the high and low pressure cylinders, from which steam entering the low-pressure-valve chamber m' may pass through either of the low-pressure-cylinder ports m^8 m^9, Fig. 6, to the respective low-pressure cylinders b b, according to the position of the low-pressure valve m therein. The exhaust from the low-pressure cylinder in each case escapes past the end of the low-pressure valve m, the exhaust from the port m^8 escaping from the low-pressure-valve chamber directly into the exhaust-pipe e^{14}, while the exhaust from the other port, m^9, escapes through the port m^{11} in the low-pressure-valve-chamber bushing into a vertical passage m^{12}, (see Fig. 11,) thence through a horizontal passage m^{13}, over the top of the low-pressure-valve chamber, and entering the low-pressure-valve chamber at its end adjacent the exhaust-pipe e^{14}. Thus the exhaust from both ends of the high-pressure valve e first enters the receiver e^{10} h^7, passing thence to the low-pressure-valve chamber, from which it is admitted to the low-pressure cylinders, exhausting from the latter past the ends of the low-pressure valve m into the exhaust-pipe e^{14}.

The arrangement of the high and low pressure cranks, respectively, upon the quarter necessitates the use of a receiver, which would be unnecessary were the said cranks set opposite, or one hundred and eighty degrees apart. Since the high and low pressure cranks are set on the quarter, the high and low pressure valves are necessarily set approximately one (a quarter of a revolution) in advance of the other. Consequently when the high-pressure valve *e*, Fig. 6, is in position admitting steam to one and exhausting it from the other of the high-pressure cylinders the low-pressure valve is in an intermediate position covering both cylinder-ports, its pistons being approximately at the ends of their strokes. Hence about the time the high-pressure valve moves to cut off admission the low-pressure valve moves to admit steam to its cylinders.

With the controlling-valve in its position Fig. 6 the engine will operate as a compound engine in the manner described. To operate the engine as a simple engine, as when starting or when working under heavy loads, live steam must be admitted direct to both high and low pressure valve chambers. This is accomplished by moving the controlling-valve H from its full-line position, Fig. 6, into its dotted position, Fig. 6, which places the exhaust-passage e^{10} in direct communication with the exhaust-pipe e^{14}, so that the exhaust from the high-pressure cylinders passes directly to the exhaust-pipe e^{14} without going to the low-pressure cylinders. Such movement of the controlling-valve also moves its piston h^3 past and uncovering the live-steam port h^8, Fig. 6, (see also Figs. 9 and 12,) from the live-steam inlet F, and thus admits live steam direct to the controlling-chamber between the pistons of the controlling-valve therein, from whence it may pass through the receiving-passage h^7 direct to the low-pressure-valve chamber and low-pressure cylinders. Consequently so long as the controlling-valve is in its abnormal dotted position, Fig. 6, the engine will operate as a four-cylinder simple engine.

Having described the valve movements, I will now describe the valve-actuating mechanism.

Referring to Figs. 5, 13, and 14, the crank-shaft D has a reduced end portion *d*, upon which is arranged a sleeve *d'*, to which is keyed the eccentric for actuating the low-pressure valve. Said eccentric is embraced by a suitable eccentric-strap d^3, Figs. 1 and 3, the rod d^4 of which is jointed to an arm d^5, fast on the end of the low-pressure-valve rock-shaft m^6. Loosely surrounding the sleeve *d'* is a second eccentric d^6, connected with and to operate the high-pressure valve, said eccentric having its strap d^7, Fig. 1, provided with an eccentric-rod d^8, jointed at its upper end to an arm d^9, fast on the end of the tubular high-pressure rock-shaft e^4. Thus rotation of the sleeve carrying the said eccentrics will cause the said valve-actuating rock-shafts m^6 and e^4 to be rocked, thereby to reciprocate the valves, as described. The sleeve *d* is arranged to have partial rotation about and upon the reduced end of the crank-shaft, said sleeve being provided with end-thrust ball-bearings *o* between its ends and the collars *o'*, fast on the said shaft. The end of the crank-shaft is made tubular, as at d^{10}, to receive a sliding plug o^2 on the end of a stem o^3, which extends outward and has mounted upon its end a yoke O. Surrounding the stem o^3 of the plug o^2 is a bushing o^4, secured by a nut o^5, screwed upon the end of the stem. The outer end of the said bushing is threaded at o^6, and the yoke O is screwed thereupon and against the shoulder o^7 thereof. This axially-movable plug o^2 has a stud o^8, which projects radially through a straight longitudinal slot d^{11} in the end of the crank-shaft D and enters a spiral slot d^{12} in the partially-rotatable sleeve *d*. Preferably the said stud o^8 will have rollers o^9 o^{10} to engage, respectively, the walls of the said slots. Thus with the crank-shaft in a given rotative position if the yoke O be moved to draw the plug o^2 outward the straight slot d^{11} in the said shaft will enforce perfectly-straight longitudinal and non-rotative movement of the said stud, and this non-rotative movement of the stud, acting in the spiral slot d^{12} of the sleeve *d'*, will cause partial rotation of the said sleeve through a distance determined by the pitch of the slot and which is sufficient to reverse the positions of the valves and reverse the engine. As the sleeve rotates it carries with it the two eccentrics d^2 and d^6, shifting the latter on and relative to the crank-shaft through a sufficient distance to shift the valves and reverse the engine, it being well understood by those conversant with the art that if a steam-engine be stopped after having run in one direction and its eccentrics be rotated in the proper direction through approximately ninety degrees to one hundred degrees the engine when again started will run in an opposite direction.

The point of cut-off for the low-pressure valve for the best results should be later than that of the high-pressure valve. Consequently in reversing the low-pressure valve from a given point of cut-off in one direction to a corresponding cut-off in a reverse direction the low-pressure eccentric is required to move through a greater distance than the high-pressure eccentric. I have found with the engine here shown that for the best results the low-pressure eccentric should be shifted through approximately one hundred and four degrees, while the high-pressure eccentric should be shifted through not more than ninety-three degrees, and since both eccentrics are shifted by one and the same sleeve *d'*, which of course must move a sufficient distance to shift the eccentric requiring the greatest movement, it becomes necessary to provide a lost motion between such sleeve and the low-pressure eccentric having the least shifting movement. This I have accomplished by mounting the high-pressure eccentric loosely upon the sleeve

d', as described, instead of keying it thereto, as is the low-pressure eccentric. The high-pressure eccentric is further provided with a laterally-extended stud d^{13}, (see Figs. 14 and 16,) which stud is extended through a slot d^{14} in the low-pressure eccentric d^2. When, now, the eccentrics are to be shifted for reversing, the sleeve d' and low-pressure eccentric d^2 will move for a distance approximately eleven degrees before the end of its wall d^{14} will meet the stud d^{13}, after which, acting through said stud, the two eccentrics will move in unison. Conversely, upon return movement of the low-pressure eccentric for again changing the direction of the engine such eccentric will move through the same distance—viz., eleven degrees—to and in an opposite direction before the other end wall of said slot will meet the said stud and carry with it the high-pressure eccentric.

The shifting movement of the high-pressure eccentric d^6 is limited in both directions by a stop d^{15}, Fig. 13, on the collar o', which stop is accurately positioned to permit the said eccentric to shift through the required distance for reversing its valve. Consequently when shifting in either direction against this stop the said eccentric is held tightly clamped or positioned between said stop, on the one hand, and the end wall of the slot in the low-pressure eccentric acting upon the stud d^{13}, on the other hand, thus guarding against any possible looseness, the low-pressure eccentric itself being held firmly in either of its positions by the coöperating slots d^{11} and d^{12}.

The yoke O (see Fig. 13) has its arms provided with studs o^8, which are engaged by the depending arms o^{12} (see Figs. 1, 3, and 5) on the reversing-shaft o^{13}.

A water-pump P, Figs. 1 and 4, arranged upon the outside of the well-casting C, has its plunger p actuated by an arm p' on a short shaft p^2, entering the well-casting through the end wall thereof and having its bearings therein, said shaft within said casting being provided with an arm p^3, connected by a rod p^4 with the piston of the adjacent low-pressure cylinder. Thus the pump is retained exterior to the engine-casting for convenience of access, yet it is connected with the operating parts within the pump without the necessity for any packing, thereby simplifying the construction and reducing oversight and attention to a minimum. At the same time practically all the working parts are arranged within the well-casting to be freely lubricated by the oil carried in quantity in the well-casting and which is thrown in all directions to and over all bearings by the rapid rotation or movement of the parts therein. The eccentrics, rods, and connections likewise are arranged in a housing S, the only protruding part being the end of the bushing o^4, which surrounds the plug-stem o^3 and which has no rotative movement whatsoever, but merely out-and-in movement, requiring little lubrication and admitting little or no dirt. Since the principal movements of the engine will be in a forward direction, I have so arranged the parts that the plug occupies an inward position to produce forward motion of the engine and have provided a packing-washer $o^{\times}$ at the inner side of the bushing-flange o^7, which during forward motion of the engine is brought close against the protecting-housing S, further to guard against possible entrance of dirt to the interior thereof.

The reduced end of the crank-shaft from the face of the nearest crank to its end is made tubular, as shown in Fig. 14, with a conical entrance terminating in a sharp edge $d^{10\times}$. This sharp edge picks off any oil flowing or moving across the face of the crank and directs it into the interior of the crank-shaft, from which it works through all the various bearings accessible therefrom, thereby to lubricate the same.

Referring now to Fig. 17, I have illustrated a typical motor-vehicle comprising the leading or steering wheels 1, rear or driving wheels 2, the spring-supported body 3, provided with a seat 4, and a steering-wheel 5. As herein shown, the springs 6, supporting the leading end of the vehicle, are of the French type, the lower members 7 thereof extending rearward and upward to the body, to which they are connected at 8, forming a strut-like connection between the body and front axle to aid in maintaining the latter in proper relative position. The rear springs 9 are full elliptic springs and have jointed to their leading ends the distance members or struts 10, in turn jointed to brackets 11, depending from the body. The burner is indicated at 12, the same being arranged beneath a usual steam-generator, (not shown,) and the engine is indicated at A', the same being suspended from a pivot or trunnion at 13 to permit it to maintain its alinement notwithstanding the spring-supported movements of the body. The crank-shaft of the engine is connected by a slip-joint at 14 with a driving-shaft 15, geared in suitable manner to the driving-wheels of the axle thereof. The throttle at F, Figs. 1, 5, and 6, may be operated in suitable manner from the seat, I having herein shown a vertical tubular shaft 16, provided with a horizontal swinging throttle-handle 17, the throttle-valve being connected to the bottom of said shaft 16 by a rod 18, whereby rotation of the latter by its throttle-handle will cause said throttle to be opened and closed, as desired. Within this tubular throttle-shaft 16 I have arranged a starting-shaft 19, provided with a starting-handle 20 and connected at its lower end by a rod 21 with a bell-crank 22, in turn connected by a rod 23 with the starting or controlling valve stem h^5, Fig. 6, whereby said valve may be moved from its full-line position, Fig. 6, into its dotted position for starting and for heavy duty and returned again to its full-line position to enable the engine to operate as a compound. A reversing-lever at 25, Fig. 17, herein shown as foot-operated, is connected in a suitable manner, as by the horizontally-connected rod and bell-crank, with the rod 26, the latter being in turn connected with the arm 24 on the reversing-shaft o^{13}, Fig. 3, whereby to rock said shaft and for shifting the eccentrics to reverse the engine.

My invention is not limited to the particular embodiment thereof here shown and described, but may be varied without departing from the spirit and scope of the invention.

I claim—

1. A single-acting four-cylinder compound engine provided with two valves, one of the valves controlling admission to and exhaust from the two high-pressure cylinders, the other controlling admission to and exhaust from the low-pressure cylinders, and an intermediate controlling-valve for exhausting the high-pressure cylinders independently of the low-pressure cylinders and admitting live steam to the latter for operating the engine as a simple engine.

2. A single-acting four-cylinder compound engine, the same having its high-pressure cylinders arranged together and its low-pressure cylinders arranged together, with a single high-pressure valve controlling both high-pressure cylinders, a single low-pressure valve controlling both low-pressure cylinders, an engine crank-shaft, an eccentric operatively connected to each of said valves and means to impart differential rotative movement to the said eccentrics one by and from the other.

3. A single-acting four-cylinder compound engine, the same having its high-pressure cylinders arranged together and its low-pressure cylinders arranged together with a single high-pressure valve controlling both high-pressure cylinders and a single low-pressure valve controlling both low-pressure cylinders, means to operate said valves and means to permit the continued operation of said engine as a four-cylinder simple engine.

4. A single-acting four-cylinder compound engine provided with a single high-pressure valve for the high-pressure cylinders and a single low-pressure valve for the low-pressure cylinders, means to operate said valves and a single controlling-valve to simultaneously permit the passage of the high-pressure exhaust to the engine exhaust-pipe and the passage of live steam to the low-pressure cylinders, permitting the engine to be operated as a simple engine.

5. An inclosed single-acting engine comprising a plurality of cylinders, pistons therein, a crank-shaft operated thereby, valve-operating shifting eccentrics on said crank-shaft, all of said parts being inclosed and exteriorly accessible means for shifting said eccentrics to reverse the engine.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

DANIEL E. JOHNSON.

Witnesses:

FREDERICK L. EMERY,
E. H. STOCKER.