(No Model.)

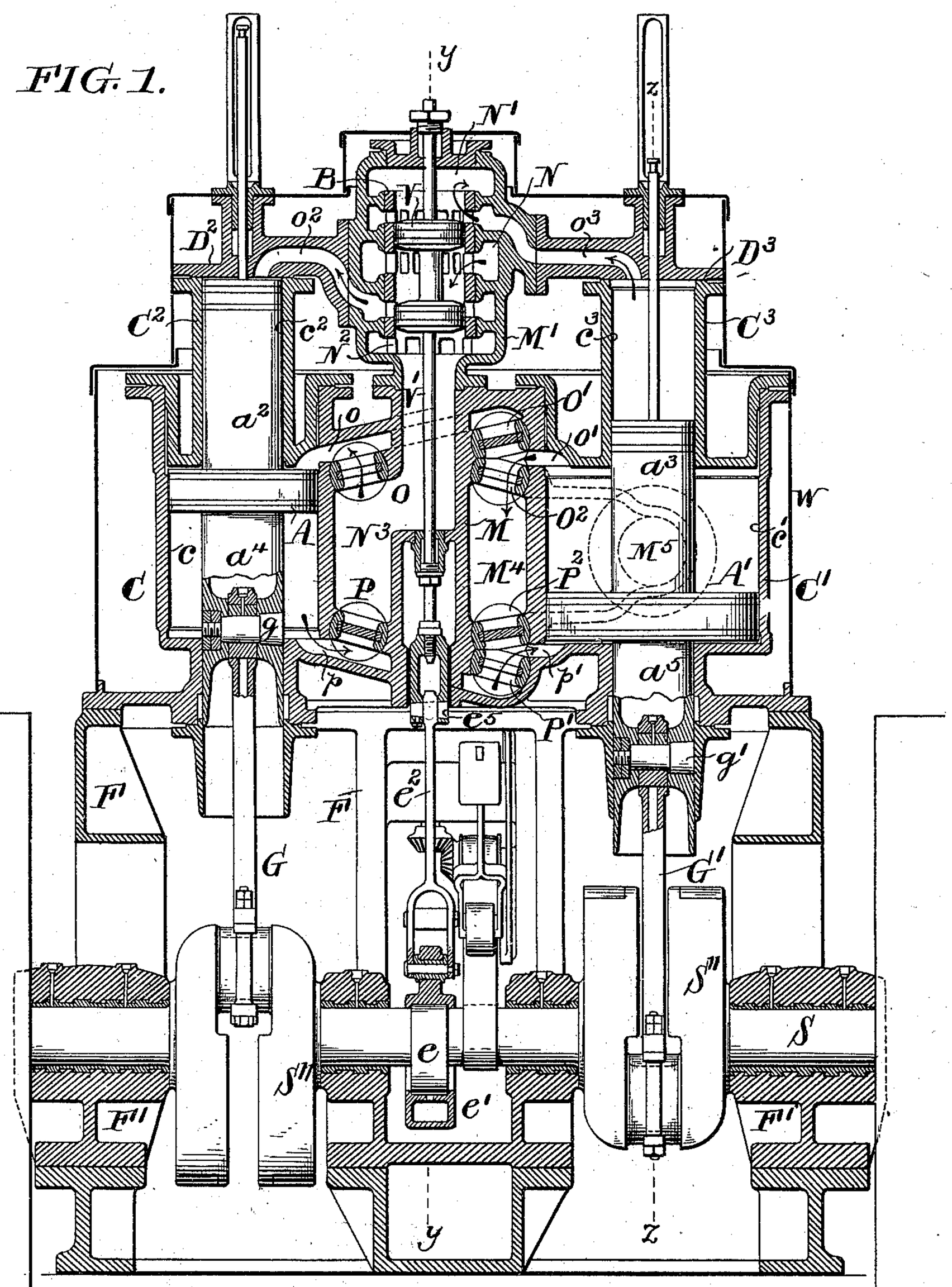
5 Sheets—Sheet 1.

G. S. STRONG.

STEAM ENGINE.

No. 559,501. Patented May 5, 1896.

FIG. 1.



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(No Model.)

5 Sheets—Sheet 2.

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STEAM ENGINE.

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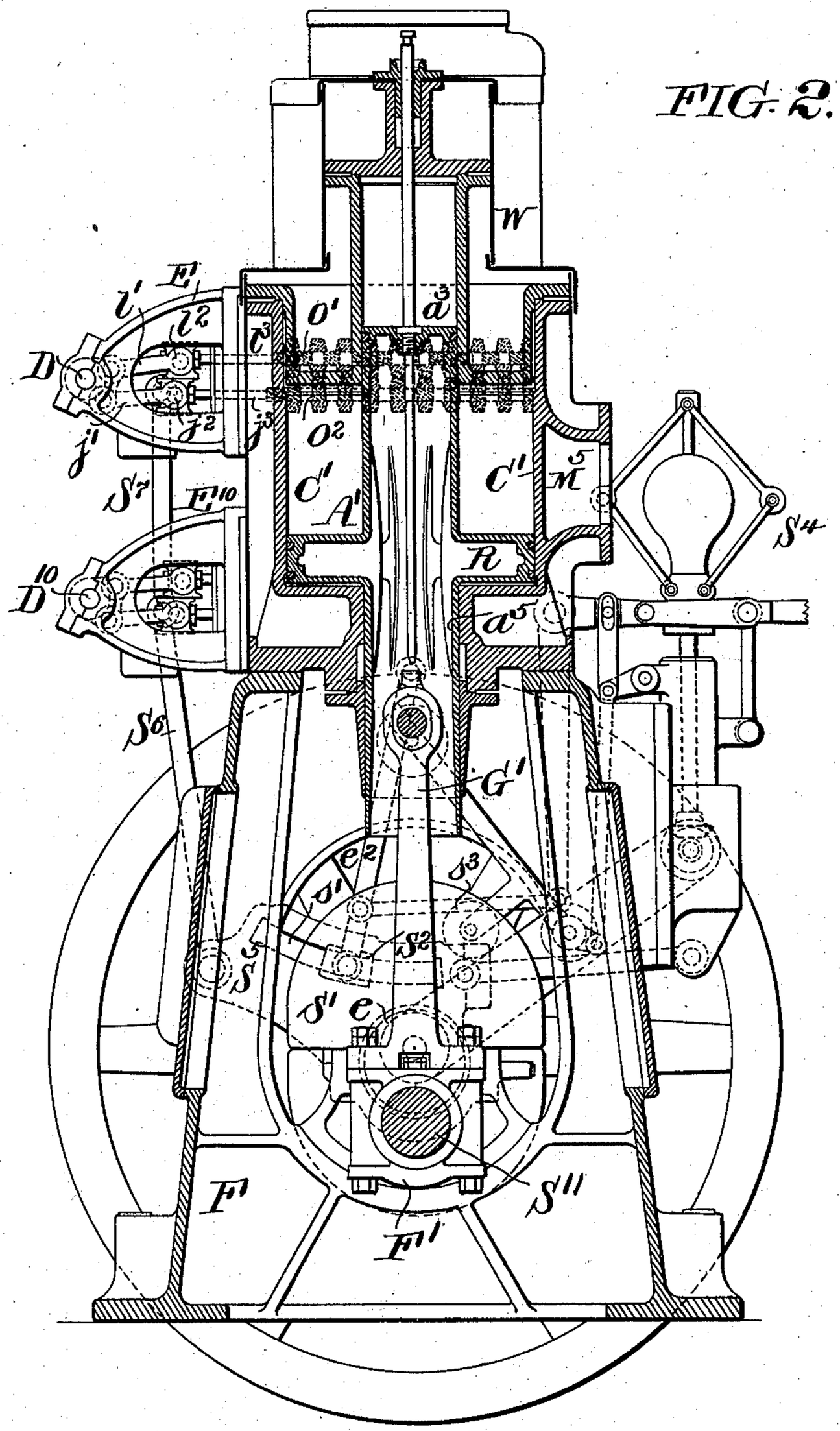
FIG. 2.



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STEAM ENGINE.

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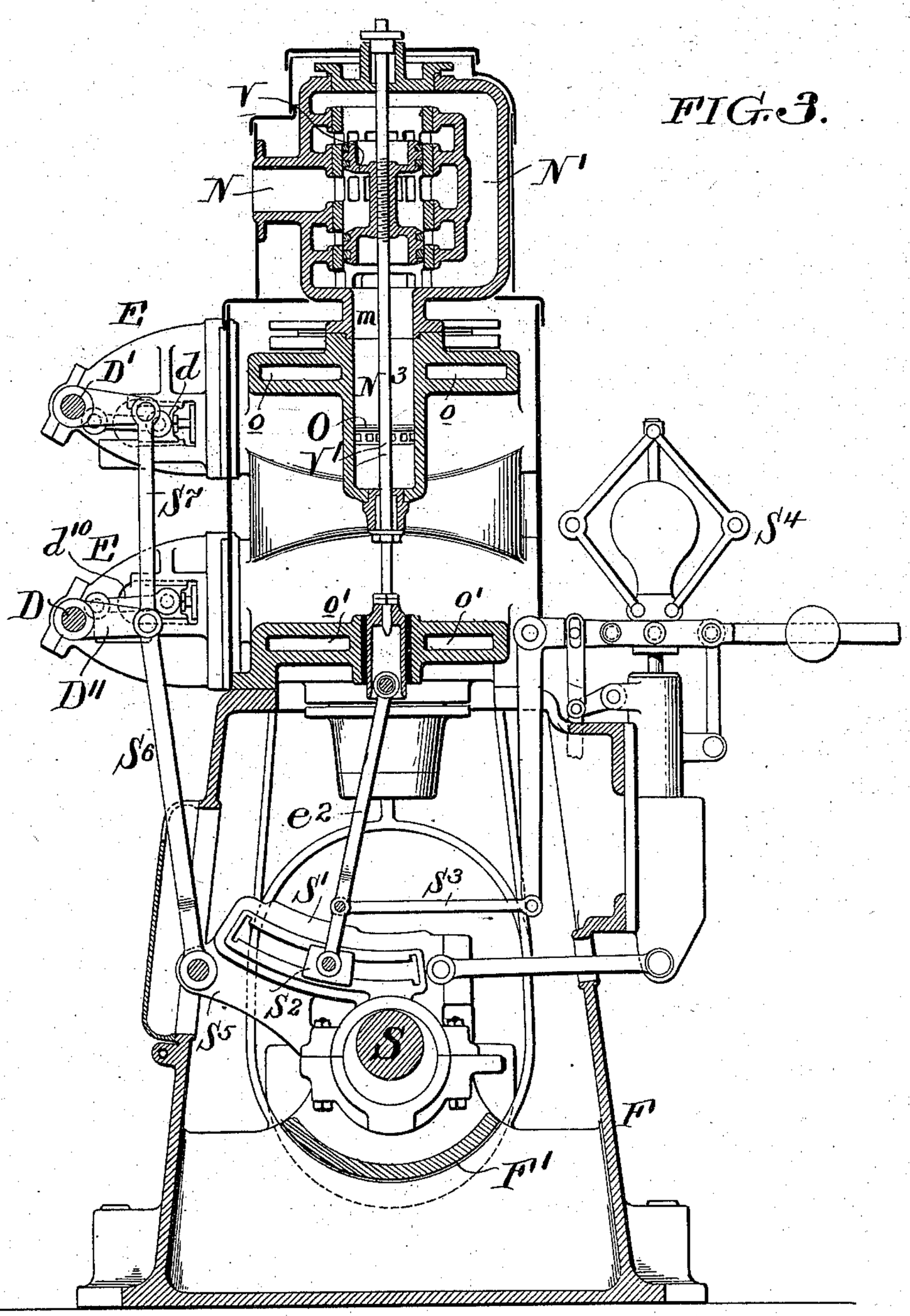
FIG. 3.



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STEAM ENGINE.

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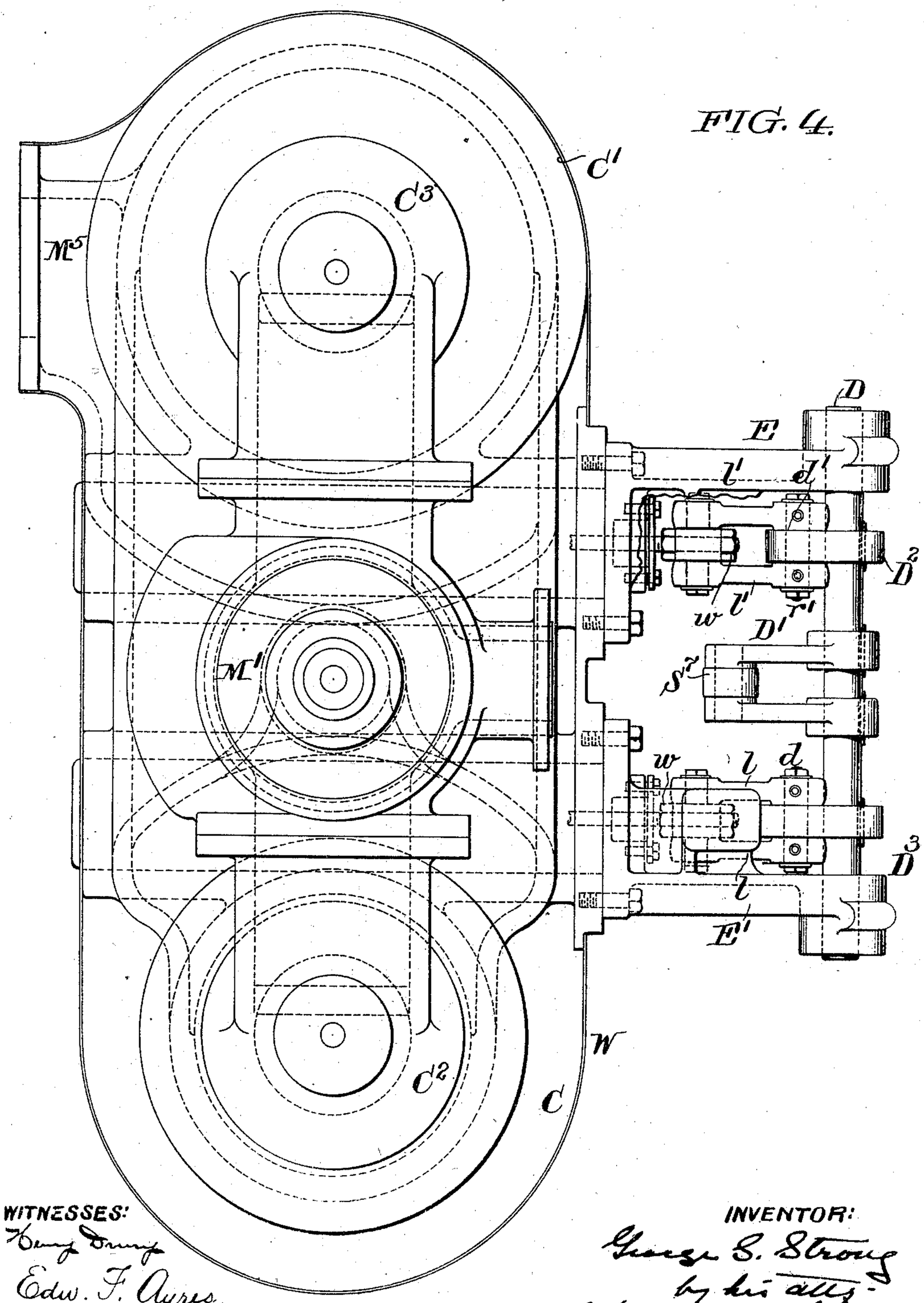
FIG. 4.



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(No Model.) 5 Sheets—Sheet 5.

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No. 559,501. Patented May 5, 1896.

FIG. 5.

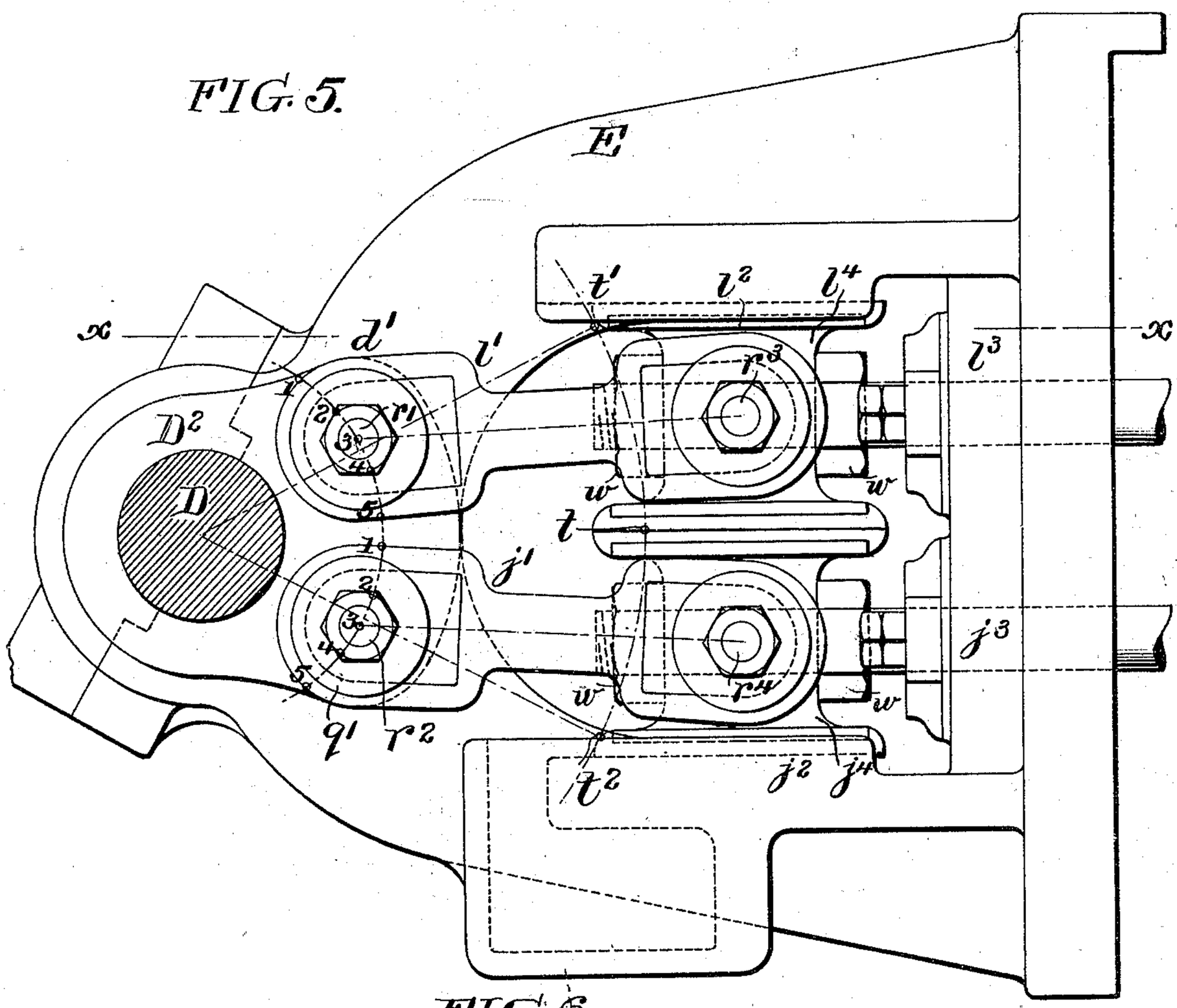


FIG. 6.

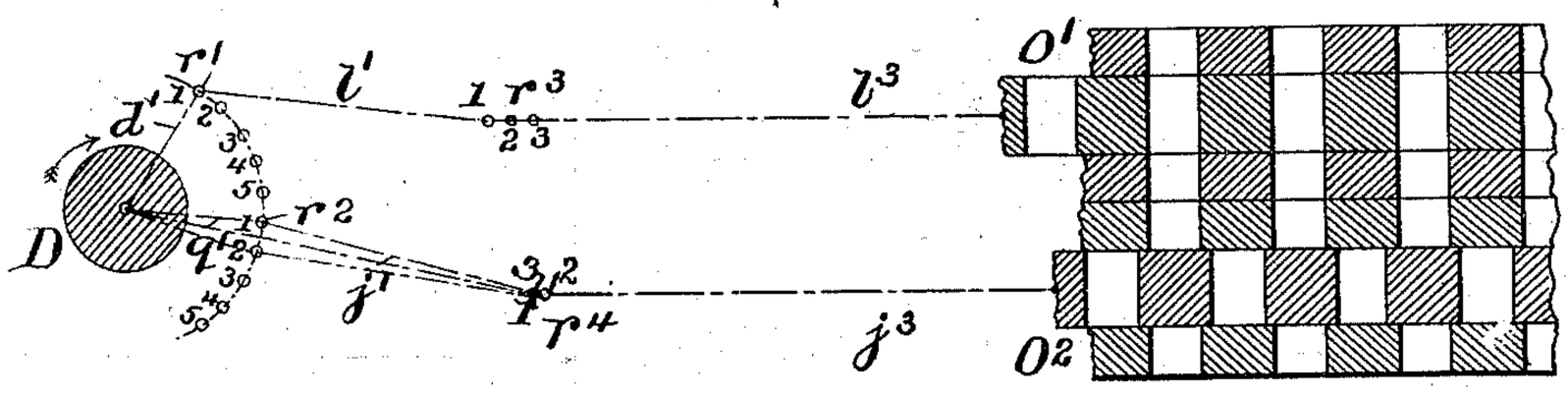
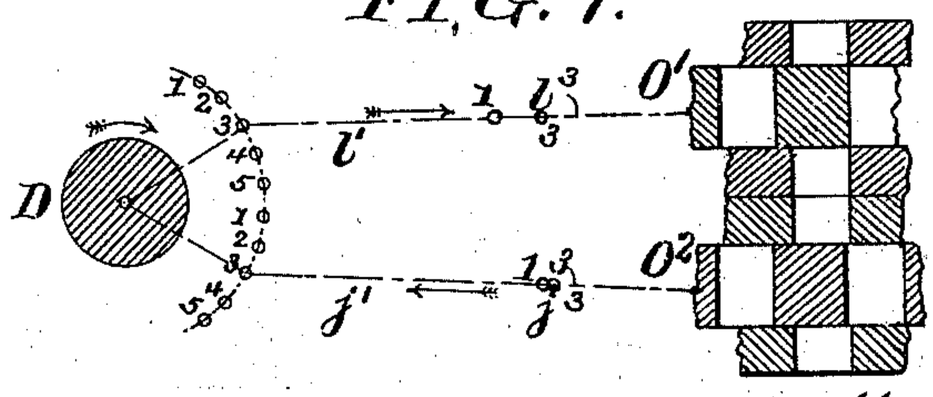


FIG. 7.



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UNITED STATES PATENT OFFICE.

GEORGE S. STRONG, OF NEW YORK, N. Y., ASSIGNOR TO THE BALANCED LOCOMOTIVE AND ENGINEERING COMPANY, OF SAME PLACE.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 559,501, dated May 5, 1896.

Application filed November 17, 1894. Serial No. 529,109. (No model.)

To all whom it may concern:

Be it known that I, GEORGE S. STRONG, a citizen of the United States, residing in the city, county, and State of New York, have invented a certain new and useful Improvement in Steam-Engines, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part thereof.

My invention relates to valves for steam-engines and devices for imparting motion thereto, and has for its main objects to provide a simple valve motion for actuating the valves, especially those used in a compound engine, to reduce the number of these valves necessary to be employed and otherwise to simplify the construction and arrangement of the valves and their connections.

My invention will be best understood as explained in connection with the accompanying drawings, in which—

Figure 1 is a front sectional view of a compound steam-engine embodying my invention. Fig. 2 is a section on the line $z\ z$ of Fig. 1. Fig. 3 is a section on the line $y\ y$ of Fig. 1. Fig. 4 is a plan view, on an enlarged scale, showing details of the valve-actuating mechanism. Fig. 5 is an enlarged detail view of the cranks which operate the valves, and Figs. 6 and 7 are two figures showing the valves in different positions.

I have shown my arrangement of valves and my improved valve motion as applied to a particular compound engine in which, referring more particularly to Figs. 1, 2, and 3, F is a frame on which is supported the bearings F′, the crank-shafts and also the other parts which go to make up the engine. C C′ is a casting in which are formed cylinders $c\ c'$. A casting C^2, having a cylinder c^2 formed therein, and a casting C^3, having cylinder c^3 formed therein, form the heads of the cylinders $c\ c'$, respectively, and are themselves provided with heads $D^2\ D^3$. A is a piston having a trunk a^2 projecting in one direction and a trunk a^4 of the same size projecting in the other direction and adapted to reciprocate in the cylinder c. A piston A′, similar in construction and provided with trunks $a^3\ a^5$, is arranged in the cylinder c'. The trunks $a^2\ a^3$ serve as single-acting high-pressure pistons, the piston A as a double-acting intermediate-pressure piston and the piston A′ as a double-acting low-pressure piston. $g\ g'$ are pins, by means of which the connecting-rods G G′ are pivoted on the cross-head trunks $a^4\ a^5$, and S^{11} are suitable cranks on the main shaft S. e is an eccentric which serves, by means of a strap e', to give the proper motion to the valve-operating mechanism, preferably through a link S′. S^4 is a governor operating through a lever s^3 to regulate the throw of the valve, as will be explained. W is a suitable casing surrounding the cylinders, and M^5 the exhaust-port. This much of my engine is substantially like that described in my application, Serial No. 529,260, filed November 19, 1894, and is not made subject to claims in this application.

While my arrangement of valves and their operative connections can very advantageously be used with an engine whose general arrangement is substantially similar to that described above, they may be used to advantage with almost any type of compound engine, and I do not wish to be considered as limiting the application of my improvements to the particular engine described.

Referring again to the drawings, especially Figs. 1 and 2, V is a valve, preferably a piston-valve, adapted to admit steam to and permit it to exhaust from the high-pressure cylinders, and, as shown, is adapted to reciprocate in the valve-chamber M′. V′ is a valve-stem connected at e^5 with the rod e^2.

In the position of the parts shown in Fig. 1 high-pressure steam from the inlet N is entering the cylinder c^2 through the passage or port o^2, and steam is exhausting from the cylinder c^3 through the port o^3 and passage N′ to the chamber N^3 in the casing M, the chamber N^3 acting as a receiver. Independent valves O P permit the steam from the chamber N^3 to enter alternately the top and bottom of the cylinder c. The ports $o\ p$ lead from the cylinder c to the cylinder c', and valves O′ P′ are arranged in said ports or conduits $o\ p$, and when opened serve not only as the inlet-valves for the cylinder c' but also as exhaust-valves for the cylinder c, thus permitting me to dispense with one set of valves. Valves $O^2\ P^2$ permit the steam to escape from the cylinder

c' through passage M^4 to the final exhaust M^5. This arrangement of valves forms an important part of my invention, which consists, first, in the combination of the valve V for admitting steam to a high-pressure piston or pistons with independent valves for governing the admission and exhaust of steam to and from the lower-pressure cylinders, and, second, in the combination with cylinders, as $c\ c'$, where c' is adapted to receive steam already expanded in the cylinder c irrespective of any specific construction of the cylinder, of ports $o\ p$, wherein a single valve, preferably close to the lower-pressure cylinder, serves as the inlet-valve of the low pressure and at the same time as the exhaust of the high pressure, other valves governing respectively the exhaust and admission of these two cylinders.

To operate the valve V, I preferably connect the rod e^2, which is pivoted to the valve-stem V′ at e^5, to a block S^2, fitting in a groove s' in a link S′, though of course the rod e^2 could be pivoted directly on the link if desired. By providing the block, however, the operation of the valve V can be regulated by a governor by shifting said block along the groove in the usual way.

To operate the valves O P, &c., I pivot to the end of the link S′, as to the ear S^5 thereon, a rod S^6, which serves to operate all the valves which govern the flow of steam in the low and intermediate cylinders, a connecting-rod S^7 connecting the upper set of valves with the operating-rod S^6.

Referring now more particularly to Figs. 4 and 5, $d'\ q'$ are cranks set at an angle to each other, and are preferably mounted on a supporting-shaft, as D. In referring to d' and q' as "cranks," I wish to be understood as employing the word in its broadest sense and including eccentrics as well as cranks proper. In the construction shown a plate D^2 is secured to the shaft D, and the crank action is obtained by pivoting links, as $l'\ j'$, to the plate at $d'\ q'$, respectively, $r'\ r^2$ being pins on which the links are secured. These links $l'\ j'$ connect the plate with the valve-stems $l^3\ j^3$, $r^3\ r^4$ being pins at these points, and cross-head guides $l^2\ j^2$ are provided to properly guide the connecting-links $l'\ j'$. I preferably secure the stems $l^3\ j^3$ to the cross-heads $l^4\ j^4$ by means of suitable nuts $w\ w$, so that the position of the valve may be adjusted, and I prefer, as shown in Fig. 4, to provide two links $l'\ l'\ j'\ j'$, &c.

The stems $l^3\ j^3$ are connected to the valves O′ O^2, which are shown as gridiron slide-valves, though of course any other sort of valves, as rotary valves, may be employed if desired. I also secure to the shaft D a crank d, which operates the valve O and is connected to it by the links l, arranged in the same way as the links $l'\ j'$, &c. This crank d is set in the same relative position as the crank q', since the valves O and O^2 are opened and closed simultaneously. D′ is a crank-arm which is connected to the rod S^6 either directly or through the rod S^7. The operation of these cranks $d'\ q'$, and of course the crank d, will be understood by reference to Figs. 5, 6, and 7. The travel of the cranks $d'\ q'$ is laid off from 1 to 5, and when these cranks are in their central position at 3 the crank D′ is at its central position, as indicated at $t\ t'\ t^2$, being the limits of the oscillations of this crank. When the cranks d', q', and D′ are in the positions 1, 1, and t', respectively, the valve O′, operated by the crank d', is open wide, while the valve O^2 is closed. The cranks $d'\ q'$ now travel from 1 to 2, &c. Now it will be noted that the crank d' in traveling from 1 to 2 moves the valve O′ a considerable amount, as indicated by the position 2 of the pin r^3, while the valve O^2 has hardly been moved, since the point 1 is about as far on one side of the line drawn from the center of the shaft D to the pin r^4 as the point 2 is on the other. When the cranks $d'\ q'$ come to 3, as shown in Fig. 7, both valves will be closed, and as the cranks continue their motion the valve O′ will simply be slid slightly farther in its seat, while the valve O^2 will be quickly thrown wide open. D^{10} is a similar shaft, having cranks similar to the cranks $d\ d'\ q'$, and which serve to operate the valves P P′ P^2, which govern the flow of steam to and from the lower end of the cylinders $c\ c'$. The cranks D D^{10} are conveniently mounted on brackets E E′, arranged on the front of the engine.

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

1. In an engine as described having two single-acting high-pressure pistons and double-acting intermediate and low pressure pistons, a valve for governing the flow of steam to and from the high-pressure pistons, and independent valves for admitting steam to and permitting its exhaust from the other cylinders.

2. In an engine as described having two single-acting high-pressure pistons and double-acting intermediate and low pressure pistons, a valve for governing the flow of steam to and from the high-pressure pistons, means for regulating the amount of throw of said valve, and independent valves for admitting steam to and permitting its exhaust from the other cylinders.

3. In a compound engine a cylinder, a port o leading from said cylinder to a low-pressure cylinder, a port o' leading from port o into the low-pressure cylinder, a valve O adapted to admit steam into the port o and the high-pressure cylinder, a valve O′ situated on the inlet side of the port o' opening from port o and serving when opened to permit the escape of steam from the port o to port o', and from the high-pressure cylinder to the low-pressure cylinder, a valve O^2 situated in port o on the delivery side of the port o' and means for operating said valves as specified and whereby the valves O′ and O^2 are each opened when the other is closed.

4. In a compound engine having two single-acting high-pressure cylinders c^2 and c^3 and double-acting intermediate and low pressure cylinders c c', steam-ports o p leading from the cylinder c to the cylinder c', a receiver N^3 for the steam-exhaust from the high-pressure cylinders, inlet-valves O P opening from the receiver to the ports o and p, valves O′ P′ in ports o and p for governing the flow of steam from the cylinder c to the cylinder c', exhaust-valves O^2 P^2 for governing the flow of steam from the cylinder c' and means for actuating said valves as described.

5. In a compound engine the combination with high and low pressure cylinders as c and c', a port o connecting said cylinders, a steam-chamber, valve O opening from the steam-chamber into port o, a valve O′ controlling the passage of steam through port o to the cylinder c' a valve O^2 controlling the exhaust of the cylinder c', a rock-shaft D, cranks as d' q' set at an angle to each other on said shaft, and connections from one crank to valves O O^2 and from the other crank to valve O′, all substantially as described and so that the valve O′ is closed while valves O, O^2 are open.

6. In a compound engine the combination with high and low pressure double-acting cylinders c and c' of ports o and p connecting said cylinders, a steam-chamber, valves O and P opening from the steam-chamber into ports o and p, valves O′ and P′ controlling the passage of steam through ports o and p to the cylinder c', valves O^2 P^2 controlling the exhaust of cylinder c', rock-shafts D D^{10}, cranks as d' q' set at an angle to each other on the said shafts and connections from one crank of each pair to valves O O^2 and P P^2, and from the other cranks to valves O′ and P′, all substantially as described, and so that the valves O′ P′ are closed while O O^2 and P P^2 are open and O′ and P′ opened alternately.

7. The combination with the cylinders c^2 c^3, single-acting pistons therein and conduits for steam leading into one end of each of said cylinders, of a single valve adapted to govern the passage of live steam into said cylinders and its exhaust therefrom, intermediate and low pressure cylinders c c', valves O P for admitting steam to the top and bottom of the cylinder c, valves O′ P′ adapted to serve as exhaust-valves of the cylinder c and inlet-valves for the cylinder c', final exhaust-valves O^2 P^2, and means for operating said valves.

8. The combination with the cylinder c and valves O P for admitting steam thereto, of a cylinder c' of larger size than the cylinder c, valves O′ P′ for governing the flow of steam from the cylinder c to the lower pressure c' and final exhaust valves O^2 P^2, a shaft D, cranks d' q' set at an angle to each other on said shaft, a connection from these cranks to the valves O′ O^2 respectively, a crank d on said shaft connected to the valve O, a corresponding shaft D^{10} and cranks for operating the valves at the bottom of the cylinders and connections from a moving part of the engine for giving an oscillating motion to the shafts, D D^{10}.

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