

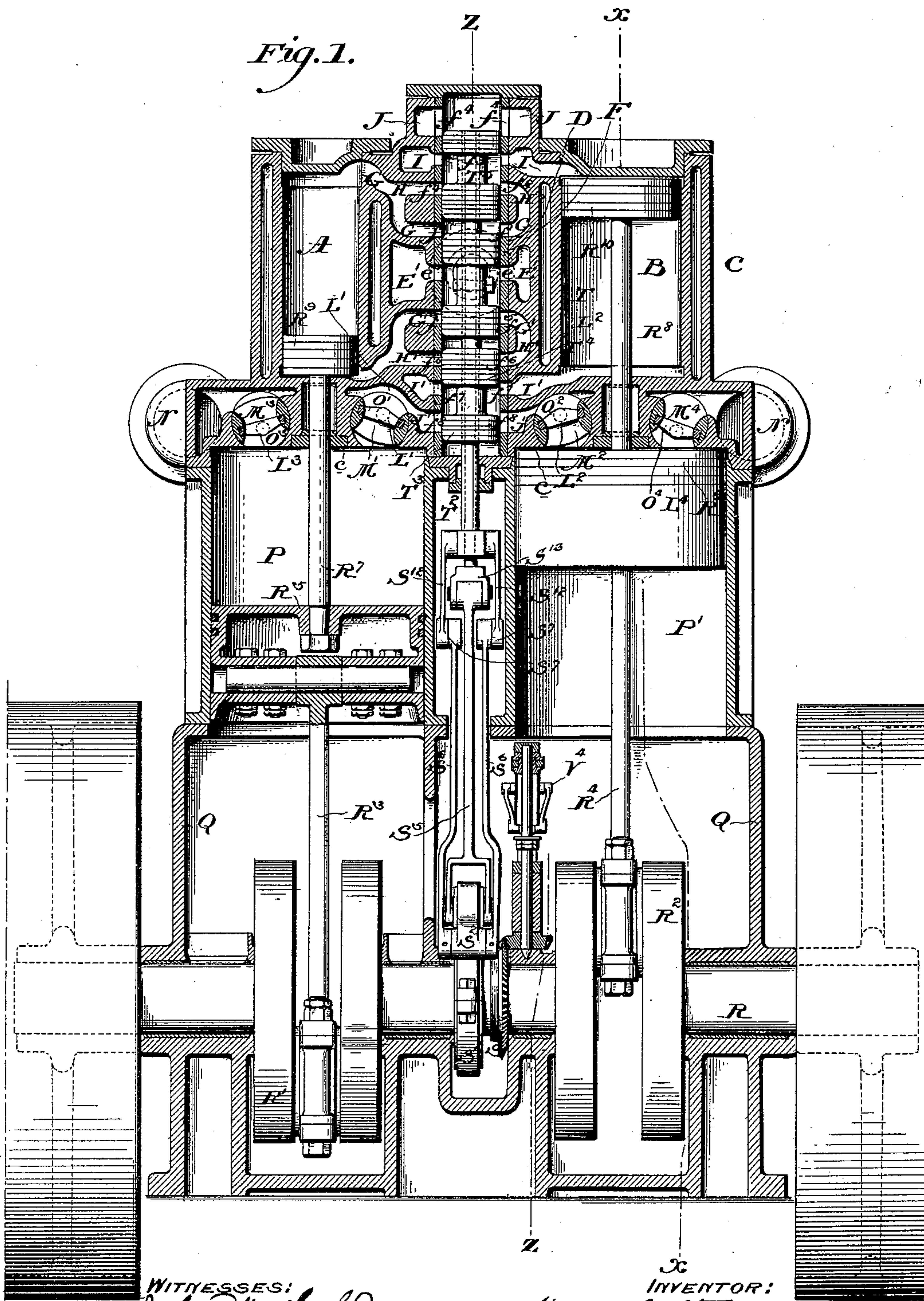
(No Model.)

6 Sheets—Sheet 1.

G. S. STRONG.
COMPOUND ENGINE.

No. 481,773.

Patented Aug. 30, 1892.



WITNESSES:
Joshua M. Mack, Jr.
David S. Williams,

INVENTOR:
George S. Strong
by his atty.
Francis T. Chambers

(No Model.)

6 Sheets—Sheet 2.

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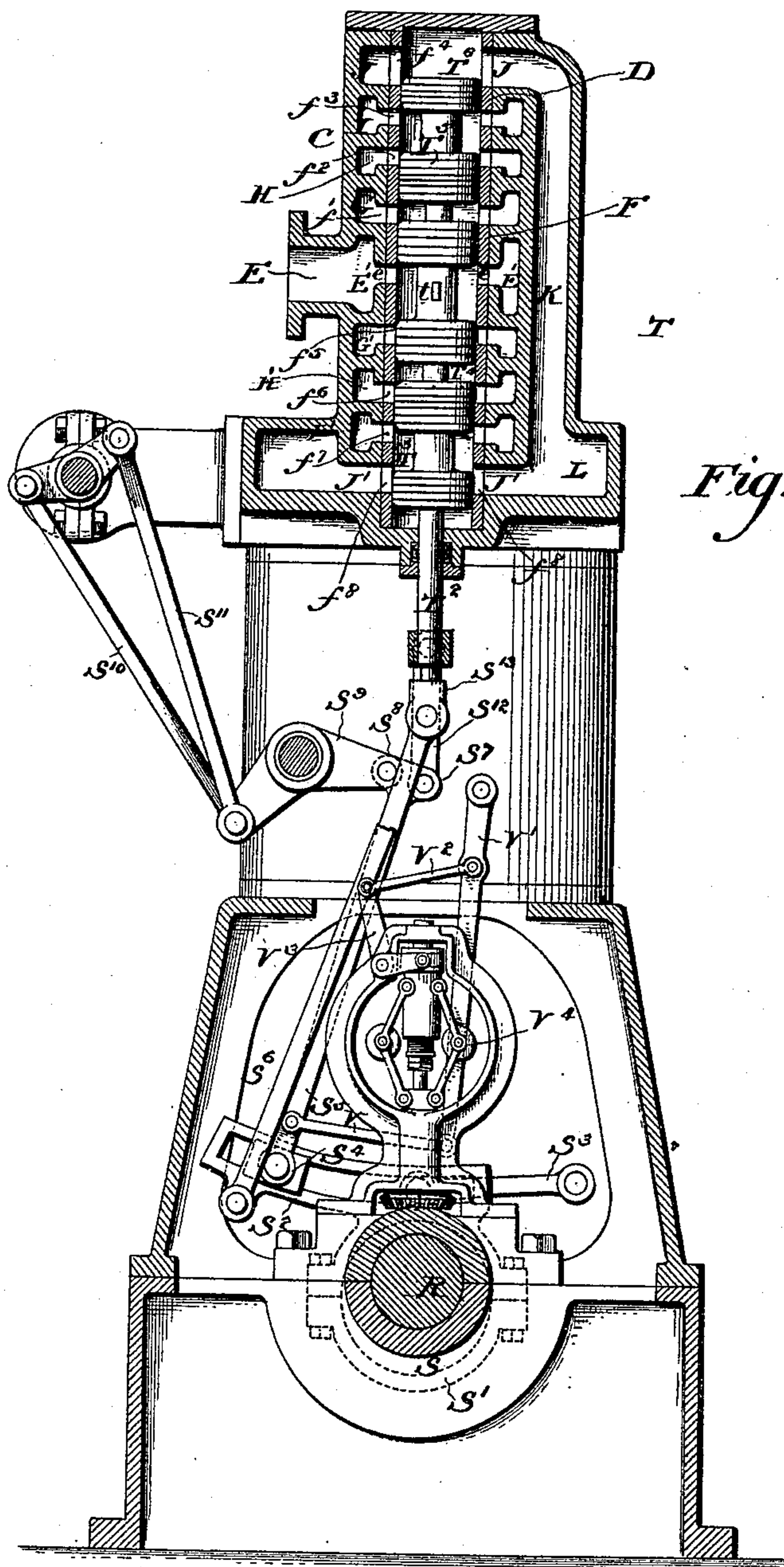


Fig. 2.

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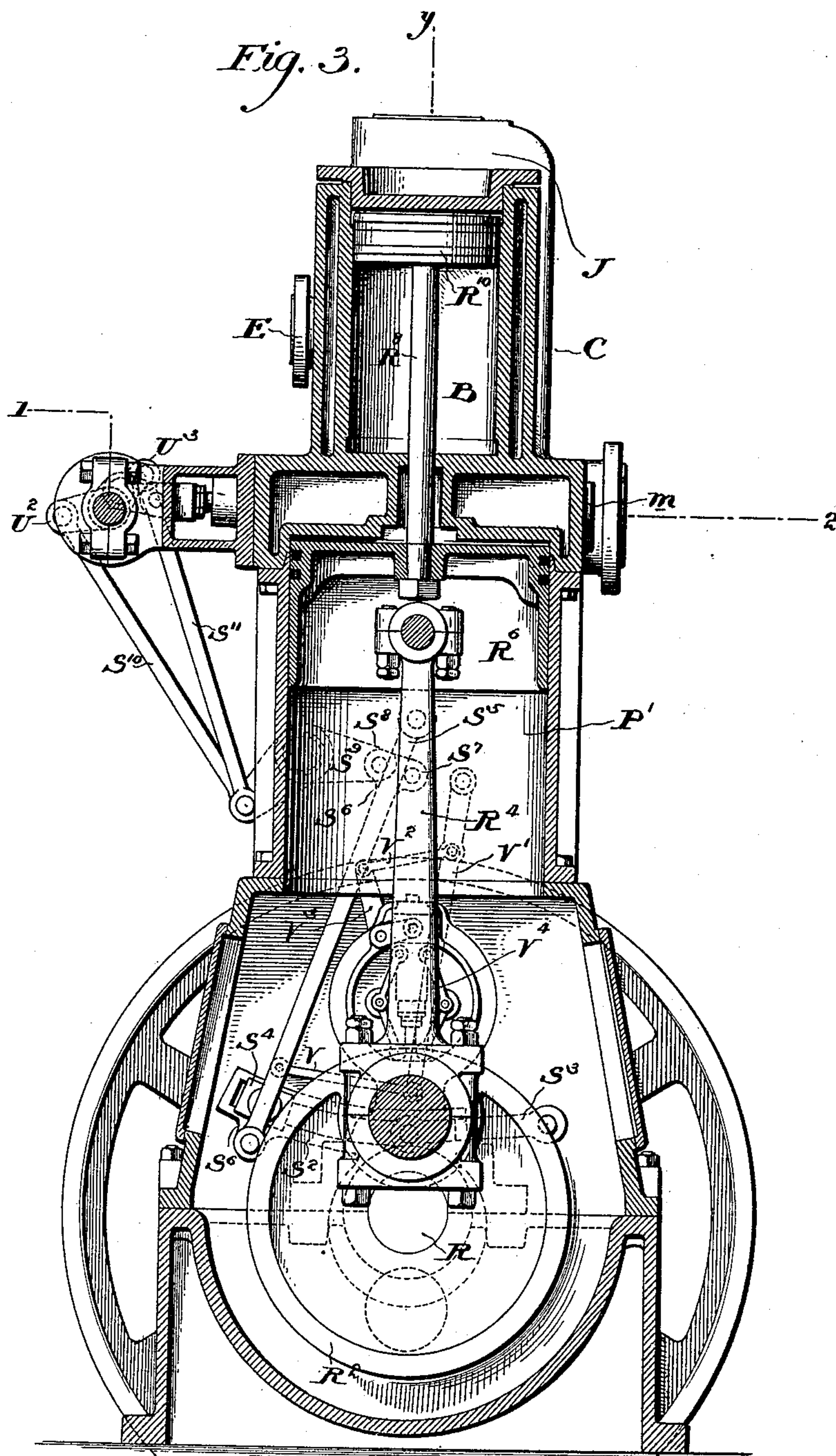
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Fig. 3.



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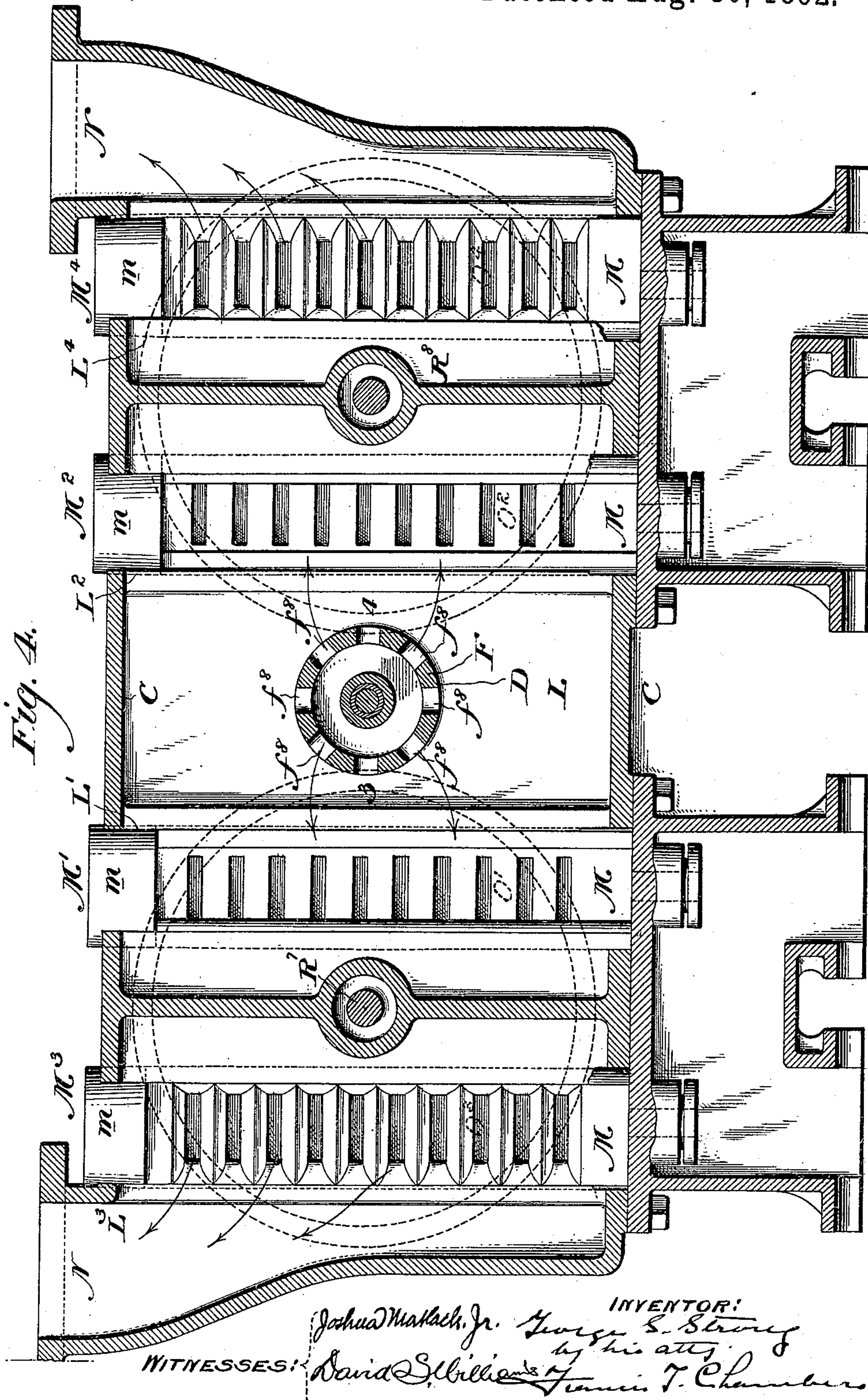
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6 Sheets—Sheet 5.

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Fig. 5.

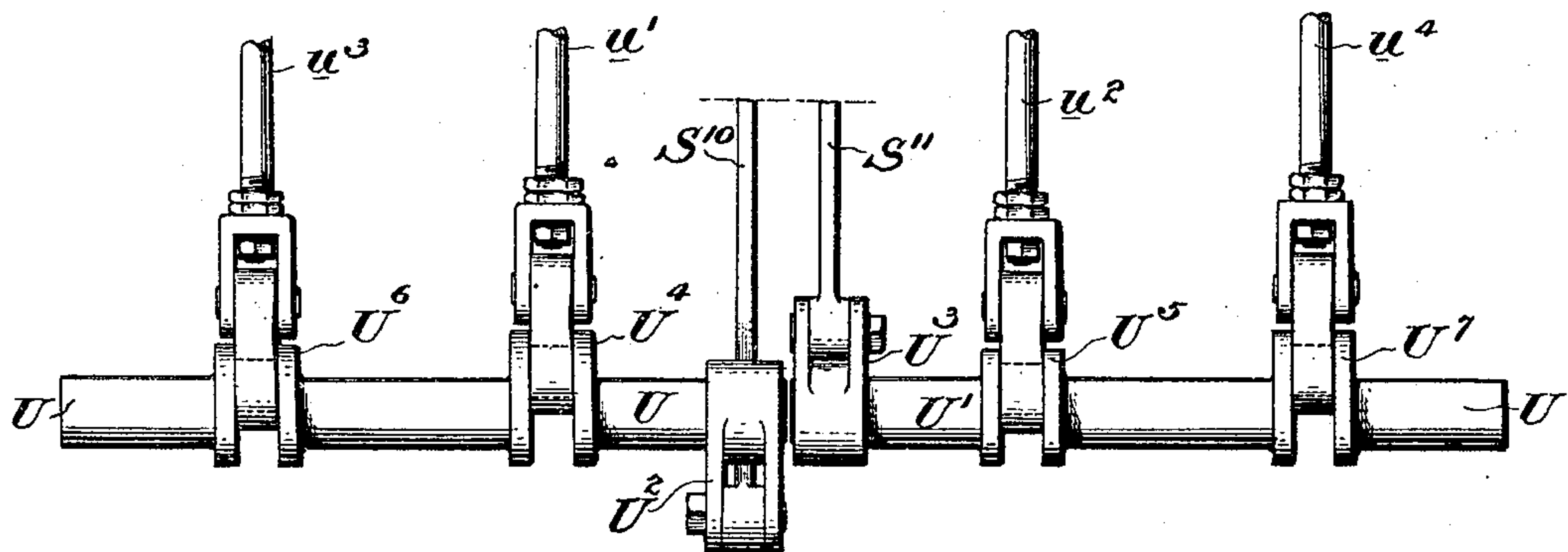
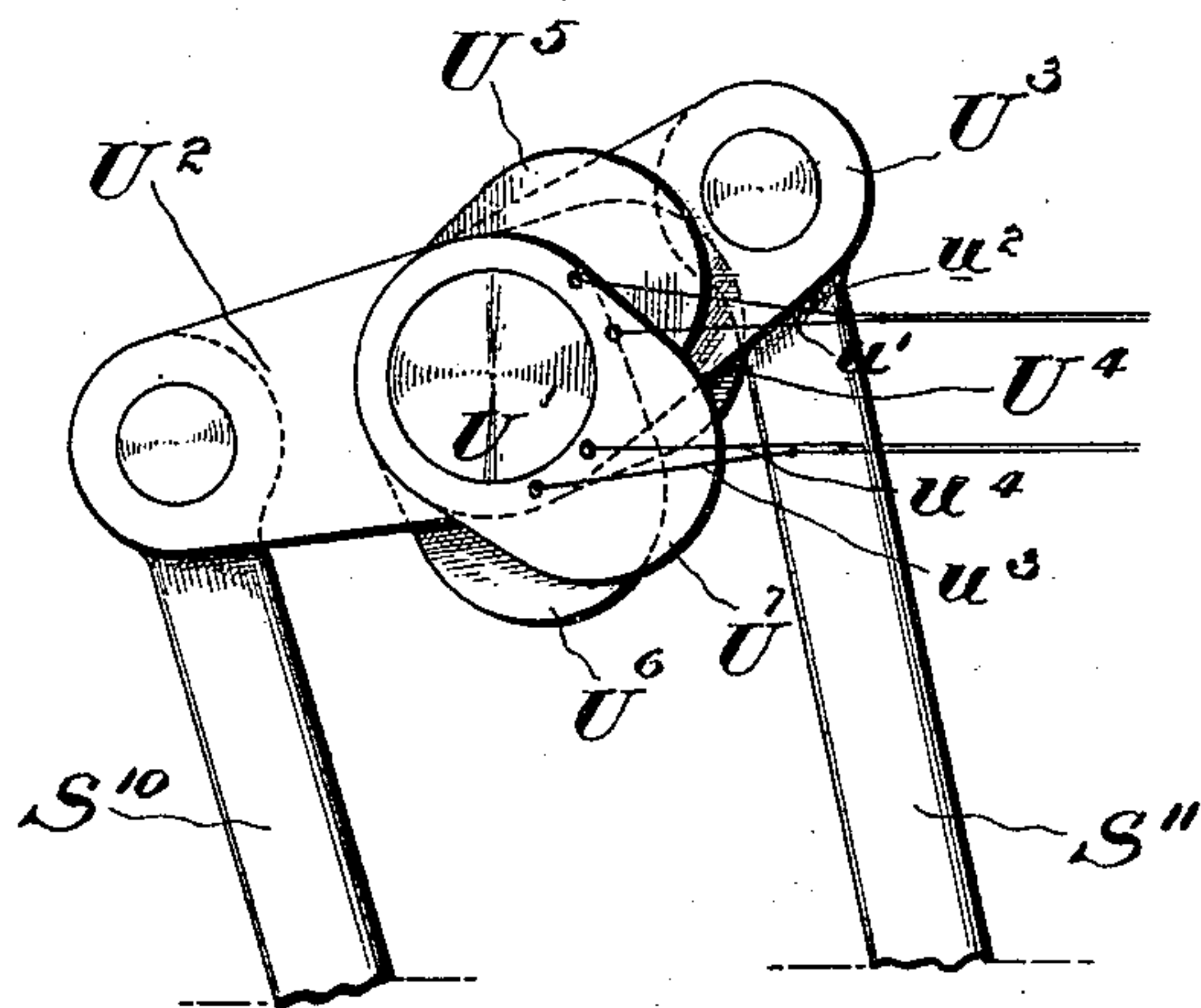


Fig. 6.



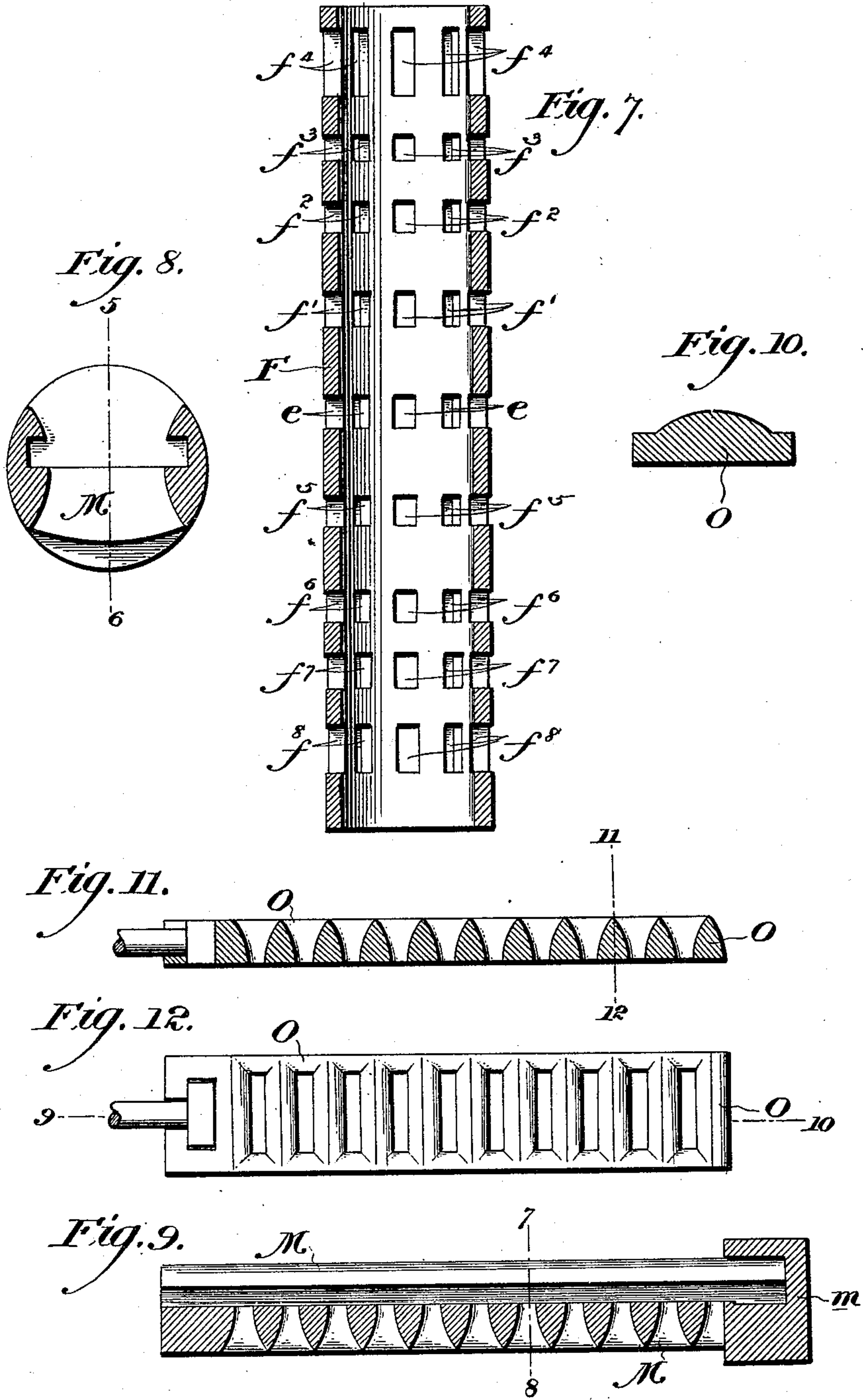
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UNITED STATES PATENT OFFICE.

GEORGE S. STRONG, OF NEW YORK, N. Y., ASSIGNOR TO JAMES N. GAMBLE,
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COMPOUND ENGINE.

SPECIFICATION forming part of Letters Patent No. 481,773, dated August 30, 1892.

Application filed July 28, 1891. Serial No. 400,951. (No model.)

To all whom it may concern:

Be it known, that I, GEORGE S. STRONG, of the city and county of New York, State of New York, have invented a certain new and
5 useful Improved Compound Engine, of which the following is a true and exact description, reference being had to the accompanying drawings, which form a part of this specification.

10 My invention relates to the construction of compound engines having four cylinders and in which the steam is used three times in as many separate cylinders, my object being to provide an improved engine of this class, and
15 the novel features which I desire to protect being hereinafter clearly set forth.

The invention will be best understood as described in connection with the drawings, in which it is illustrated, and in which—

20 Figure 1 is an elevation taken on the vertical section $y y$ of Fig. 3, but showing the links and cranks in full. Fig. 2 is a sectional elevation taken on the line $z z$ of Fig. 1; Fig. 3, a sectional elevation taken on the line $x x$
25 of Fig. 1; Fig. 4, a sectional plan taken on the line 1 2 of Fig. 3. Fig. 5 is a plan view of the shafts and cranks operating the valves of the low-pressure cylinders; Fig. 6, an elevation showing the angular position of the said
30 cranks. Fig. 7 is an enlarged sectional view of the bushing used in the valve-chamber situated between the two vertical cylinders. Fig. 8 is an end view of one of the valve-seats, taken on the section-line 7 8 of Fig. 9. Fig.
35 9 is a horizontal section through the valve-seat, taken on the line 5 6 of Fig. 8. Fig. 10 is a cross-section through one of the slide-valves, taken on the line 11 12 of Fig. 11. Fig. 11 is a side elevation of the slide-valve, taken
40 on the line 9 10 of Fig. 12; and Fig. 12 a plan view of the said slide-valve.

C is a casting, in which are formed two parallel vertical cylinders A and B, and also a chamber D, running parallel to the cylinders
45 and which serves as a piston-valve chamber. The portion $c c$ of the casting serves as the bottom head for the cylinders A and B and also contains the transversely-running or horizontally-arranged steam-passages L' , L^2 , L^3 ,
50 and L^4 . The valve-chamber D extends through the casting and is preferably provided with a

casing or bushing F, through which casing extend openings, which correspond with the various ports leading to and from the valve-chamber.

E is a coupling for the steam-supply pipe, by which the steam enters a supply-port E' , passing to the interior of the valve-chamber through the openings e in the casing F. 55

G and G' are ports leading, respectively, to the upper and lower ends of the cylinder A and connecting with the valve-chamber through openings $f' f^5$ in casing F. At a somewhat greater distance from the port E' ports H H' connect with the passages G G' 60 and with the valve-chamber through openings f^2 and f^6 . 65

I and I' are ports leading, respectively, to the top and bottom of cylinder B, connecting with the valve-chamber through openings f^3 70 and f^7 .

J J' are ports situated, respectively, at the top and bottom of the valve-chamber and both opening into an accumulator-chamber L, the port J' directly and the port J through a pas- 75 sage K.

Connecting with the accumulator-chamber L by means of passages $l l'$ are the transversely-arranged steam-passages L' and L^2 , formed in the lower portion c of the casting and open- 80 ing on the lower portion thereof. Lying parallel with these passages are exhaust-ports L^3 and L^4 , leading from the bottom of the casting to the exhaust-steam pipes N N. The passages L' and L^2 , &c., are made of cylindrical 85 form, and in each of them is secured a valve-seat of the kind indicated at M, Figs. 8 and 9, the circular end of the gridiron valve-seat being preferably slightly tapered, so as to fit in and fill the opening in the casting, as shown, 90 for instance, in Fig. 4. The two valve-seats M' and M^2 are placed so that their faces will be uppermost and the two marked M^3 and M^4 in the reverse position, as best shown in Fig. 1.

On each of the gridiron valve-seats moves 95 a valve, the character of which is shown in Figs. 10 to 12, inclusive, and which are marked, respectively, O' , O^2 , O^3 , and O^4 .

P and P' are cylinders opening at their lower ends and secured at their tops to the portion 100 c of the casting C, which serves as their head, the two cylinders being arranged in line or

tandem with the cylinders A and B, respectively, and the horizontal ports, which I have already described, opening to and from their upper ends.

5 Q indicates the main frame of the machine, on which the cylinders P and P' and through them the casting C is supported. Below cylinders P P' this frame is in the form of a casing, which incloses the shaft and the links,
10 governor, &c., connected with the shaft.

R is the main or driving shaft of the engine, R' and R² being cranks secured to the driving-shaft, situated at an angle of one hundred and eighty degrees to each other and placed,
15 respectively, in line with the cylinders A P and B P'. The crank R' is connected by a rod R³ with the piston R⁵, working in cylinder P, and this piston is connected by a rod R⁷ with the piston R⁹, working in cylinder A.
20 In like manner the crank R² is connected by rod R⁴ to the piston R⁶, working in the cylinder P', and this piston is connected by rod R⁸ with the piston R', working in cylinder B.

S is an eccentric, and S' an eccentric-strap, to which is attached the slotted link S², the link being pivotally connected, also, to the frame by means of the pivoted lever S³. This being a familiar link-motion to the extent described it need not be further specified.

30 S⁴ is a sliding block moving in the slotted link S², and from this block leads a connecting-rod S⁵, attached at its end to a valve-spindle T, to which spindle is attached the spool-valve T', working in the valve-chamber D', by which the steam is admitted from the passage E' to the passages G and G', leading to the top and bottom of cylinder A. The motion of this spool-valve and the cut-off of the steam by it are regulated by the governor
40 V⁴, which operates through the bell-crank lever V³, the rod V², the pivoted lever V', and the connecting-rod V, and the rod S⁵ changing the position of the sliding block S⁴ in the link S² in accordance with the work thrown on the
45 engine.

Permanently pivoted to the link S² is the rod S⁶, having at its end the two connecting-points S⁷ and S⁸. As shown in the drawings, two rods S⁶ are provided, one extending on
50 each side of the link S², but both working as one. At S⁷ connection is made through links S¹² S¹² with the sleeve valve-rod T², which surrounds the rod T and to which are attached the valves T³, T⁴, T⁵, and T⁶, of which the
55 valves T⁴ and T⁵ regulate the opening of the ports H' H and the valves T³ T⁶ the admission of exhaust-steam into the chambers J' and J. The point S⁸ on rod S⁶ is connected with the bell-crank lever S⁹, the other end of which
60 lever is connected by rods S¹⁰ and S¹¹ with the cranks U² and U³, respectively, and these cranks in turn are connected with the shafts U and U'. (See Fig. 5.) The shafts U and U' are journaled on a bracket extending out
65 from the casting C, the shaft U being provided with the additional cranks U⁴ and U⁶ and the shaft U' with the additional cranks

U⁵ and U⁷. The angular position of these cranks is best shown in Fig. 6, and each crank is connected, as shown, with one of the horizontal valves through the valve-stems *u' u³ u² u⁴*, the crank U⁴, for instance, connecting with the valve O', the crank U⁵ with the valve O², the crank U⁶ with the valve O³, and the crank U⁷ with the valve O⁴. 70 75

I will not in this application describe at length the passage of the steam from the port E' through the valve-chamber to the cylinder A, thence back through the valve-chamber to the cylinder B, and thence to a point of escape, first, because the operation of the valves can be readily followed by any one skilled in the art, and, second, because the combination of the high and low pressure cylinders A and B with the valve-chamber and valves by which
80 their conjoint operation is effected forms the subject-matter of another application for Letters Patent filed by me on the 7th day of July, 1891, bearing the Serial No. 398,670. I will merely state, then, that the steam first enters
90 the cylinder A, from which it is exhausted into the cylinder B, the piston in which is moving in the opposite direction to that in cylinder A, and that after having done its work in cylinder B the steam is exhausted
95 therefrom into one of the ports J or J', from which it passes to the accumulator L. From the accumulator the steam passes through valves O' and O² to the respective low-pressure cylinders P and P', these valves being
100 of course open alternately, so that the steam is admitted first to one low-pressure cylinder and then to the other, and the opening of the valves taking place simultaneously
105 with the admission of steam to the upper ends of the cylinders A and B, respectively. After having done its work in the cylinders P and P' the steam escapes through the exhaust-valves O³ and O⁴, these valves being opened alternately and simultaneously with the admission
110 of steam to the bottoms of the cylinders A and B, respectively.

Among the leading features of my invention I would especially mention the formation of the casting C, containing the various
115 cylinders, chambers, and ports described and by which all of the said parts are compactly formed and the construction of the engine simplified and cheapened. Another important feature of the engine is the combination,
120 with the two sets of tandem cylinders and the frame-casing O', of the two cranks R' and R², set at an angle of one hundred and eighty degrees to each other, by which arrangement the two sides of the engine are very perfectly balanced and the air in the casing preserved at
125 constant pressure. Another important feature is the combination, with the link S², of the various valves described and by which the action of the governor upon the engine effects only the cut-off of steam admission to
130 the high-pressure cylinder A, while the exhaust from that cylinder, the admission and exhaust in cylinder B, and the admission and

exhaust of the cylinders P and P' remain constant and uniform, although governed by the same link.

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

10 1. The casting C, having formed in it the parallel cylinders A and B, the piston-valve chamber D, also lying parallel to said cylinders, the transversely-lying valve-chambers L' L² L³ L⁴, formed in the portion c of the casting, which constitutes the lower head of cylinders A and B, and the ports connecting the valve-chambers and cylinders, as described.

15 2. The casting C, having formed in it the parallel cylinders A and B, the piston-valve chamber D, also lying parallel to said cylinders, the transversely-lying valve-chambers L' L² L³ L⁴, formed in the portion c of the casting, which constitutes the lower head of cyl-

inders A and B, and the ports connecting the valve-chambers and cylinders, as described, in combination with the cylinders P P', secured to the portion c of the casting and in line, respectively, with cylinders A and B. 25

3. In a compound engine, substantially as described, the combination of the link S² with the positively-connected rod S⁶, the valves T³ T⁴ T⁵ T⁶, actuated by rod S⁶ and governing the exhaust from cylinders A and B, the 30 valves O' O² O³ O⁴, governing the admission and exhaust of cylinders P P' and also actuated by rod S⁶, the rod S⁵, adjustably connected with link S², and the steam-admission valve T', actuated by rod S⁵, all substantially as and 35 for the purpose specified.

GEORGE S. STRONG.

Witnesses:

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