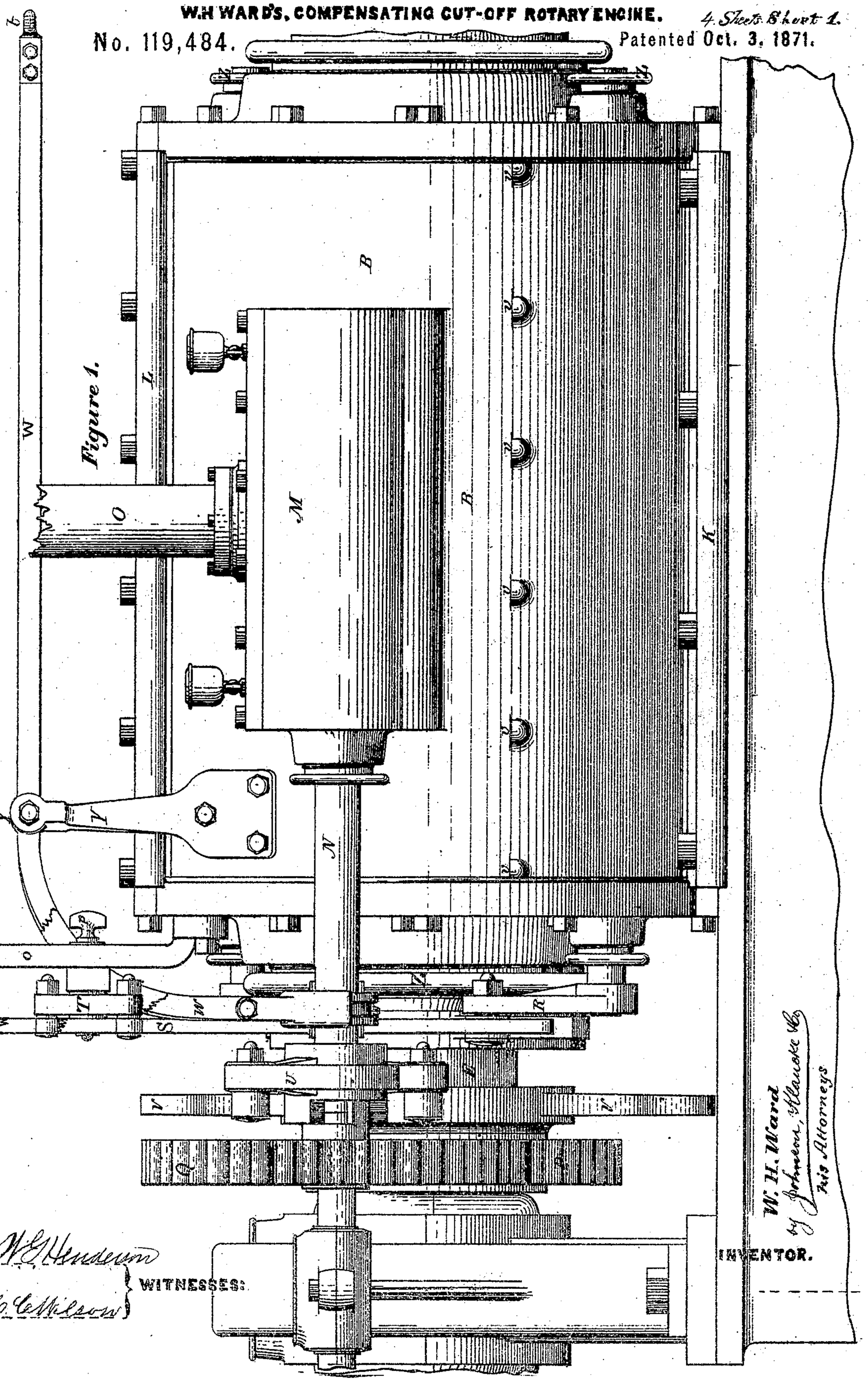
W.H WARD'S, COMPENSATING CUT-OFF ROTARY ENGINE.

4 Sheets-Sheet 1.

No. 119,484. Patented Oct. 3, 1871.



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W. H. Ward. *Rotary Engine.*

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FIG. 2.

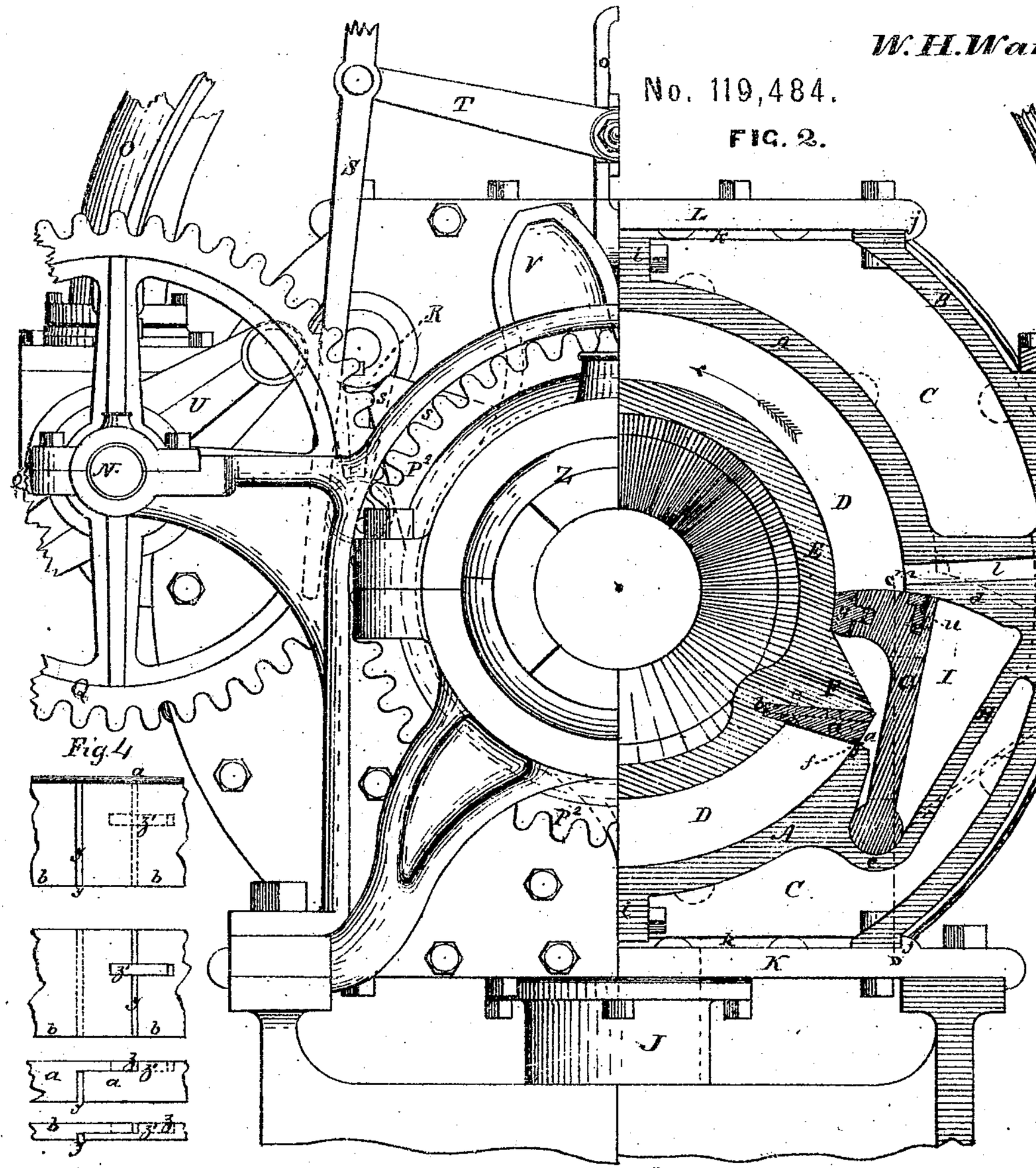
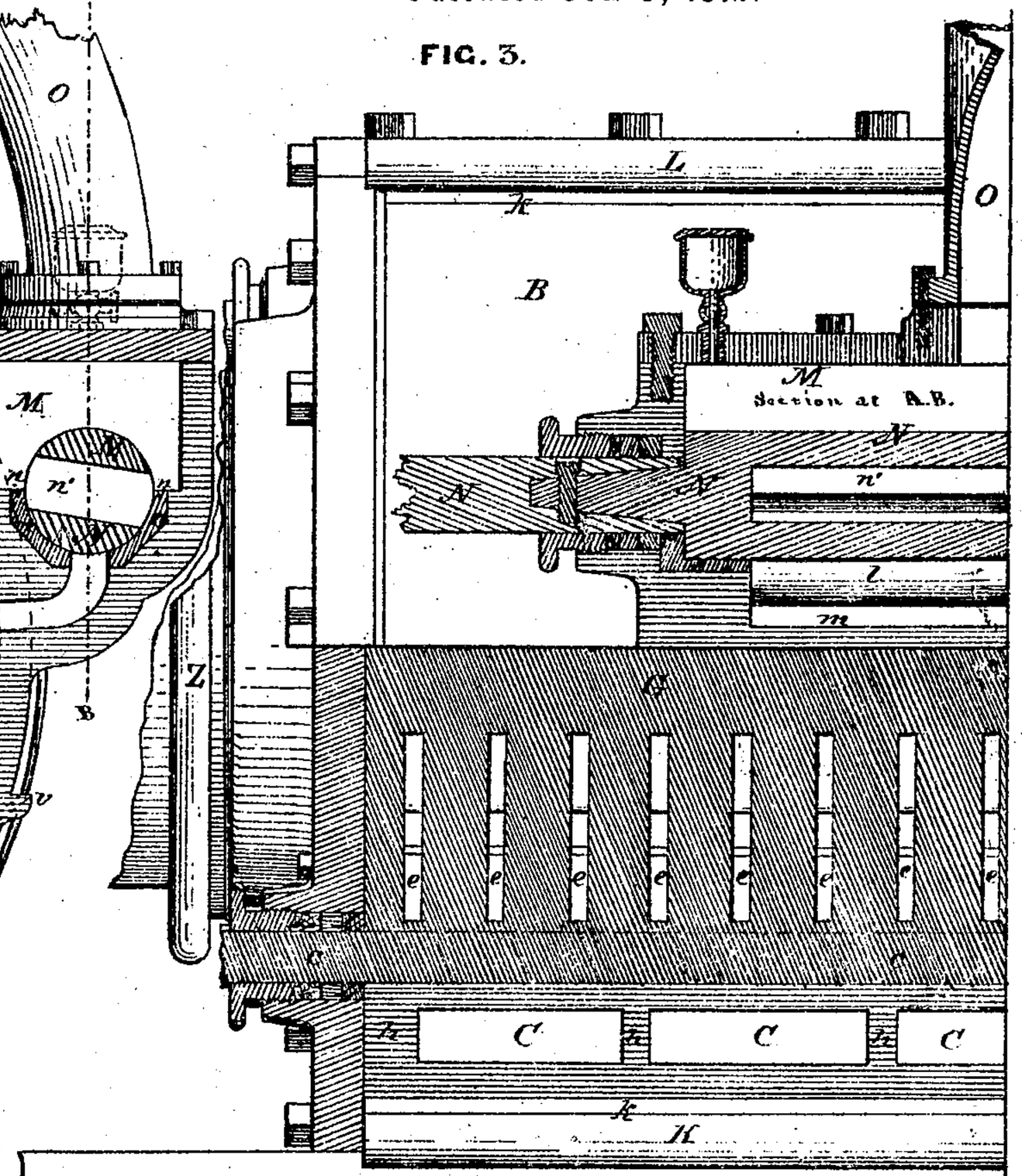


FIG. 3.



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Sheet 2.
4 Sheets

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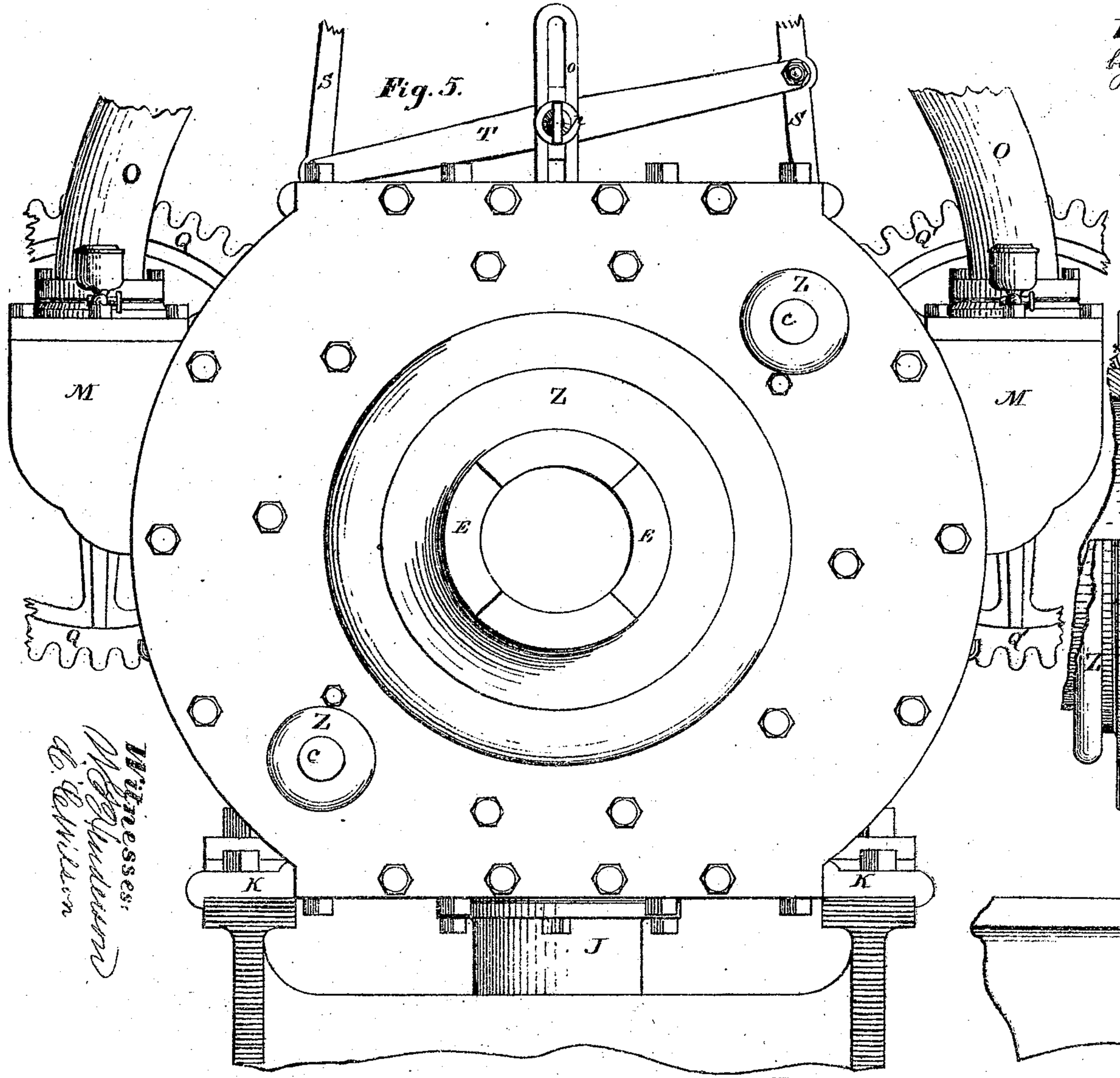
Fig. 5.



Witnesses:
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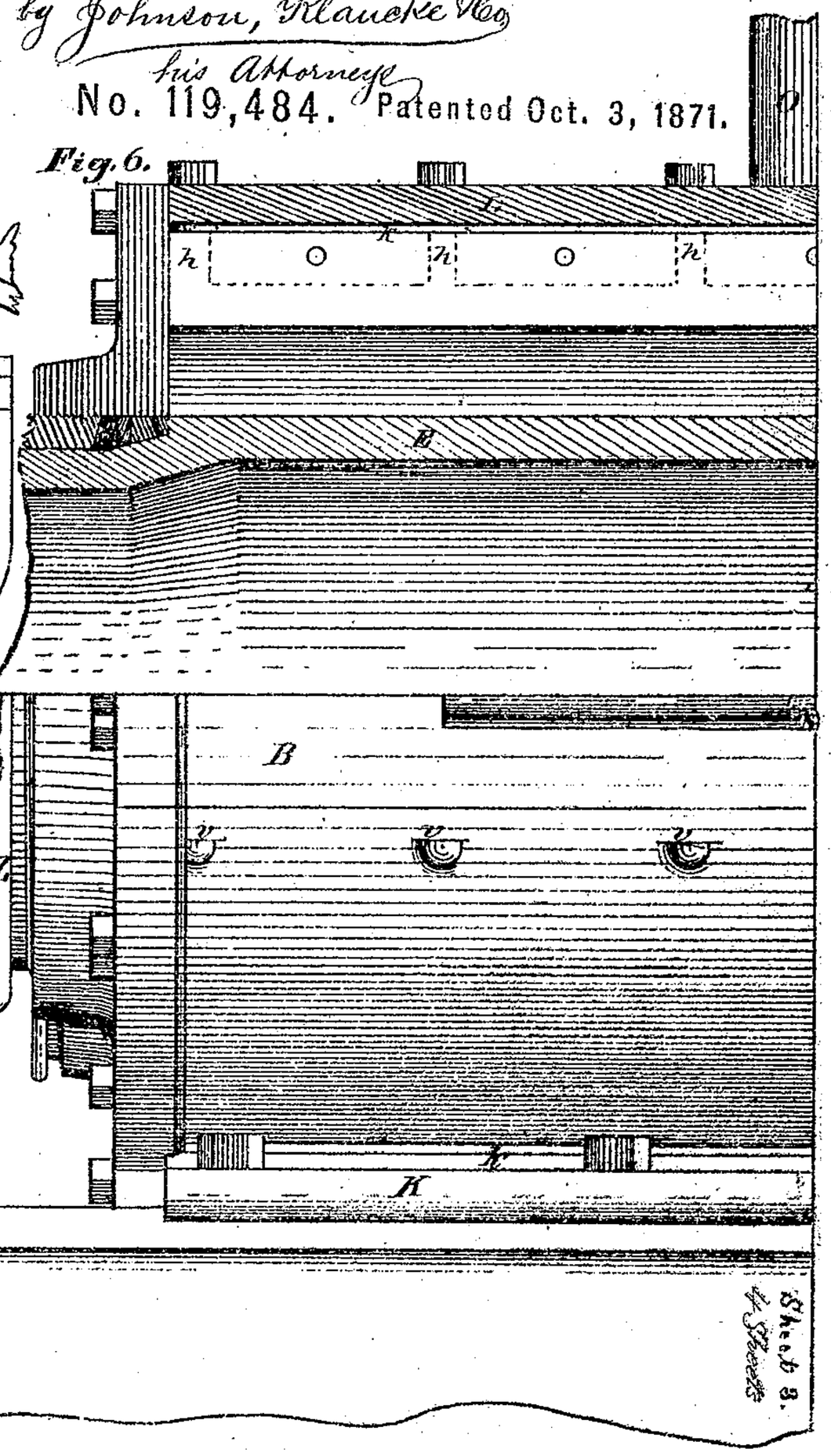
Fig. 6.



Sheet 3.

4 Sheets. Sheet 4.

No. 119,484. Patented Oct. 3, 1871.

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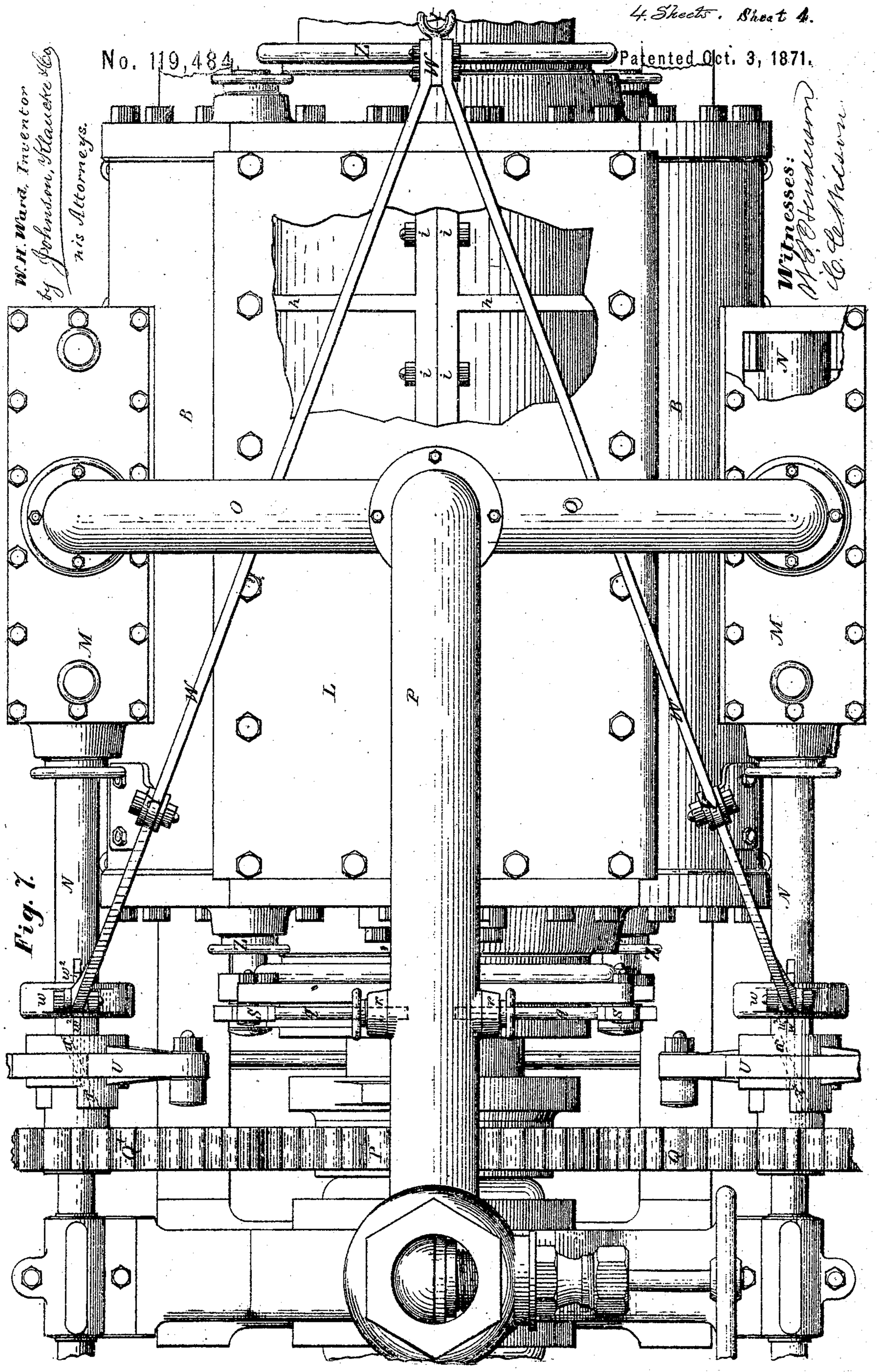

UNITED STATES PATENT OFFICE.

WILLIAM HENRY WARD, OF AUBURN, NEW YORK.

IMPROVEMENT IN ROTARY STEAM-ENGINES.

Specification forming part of Letters Patent No. 119,484, dated October 3, 1871.

To all whom it may concern:

Be it known that I, WILLIAM HENRY WARD, of Auburn, in the county of Cayuga and State of New York, have invented certain new and useful Improvements in Rotary Steam-Engines, of which the following is a full, clear, and exact description, which will enable those skilled in the art to construct and use my invention.

The object of my invention is to obtain a direct rotary motion of the engine by a direct action of the steam on the revolving rotator within the revolving case, and also to obtain a compensating rotary feed and cut-off, whereby the steam is used expansively by the automatic action of the governor.

In the accompanying drawing, Figure 1, Sheet 1, represents an elevation of a rotary steam-engine embracing my invention. Fig. 2, Sheet 2, represents a partial elevation and cross-section of the feed end of the engine. Fig. 3, same sheet, represents a vertical longitudinal section of a portion of the engine taken at the dotted lines A B and C D of Fig. 2. Fig. 4, same sheet, represents the joint-connection longitudinal-compensating-rotator wing-packing in detail. Fig. 5, Sheet 3, represents an end elevation. Fig. 6, same sheet, represents a partial longitudinal section and elevation of the engine. Fig. 7, Sheet 4, represents a plan or top view of the same.

The case of the engine consists of an inner hollow cylinder, A, and an outer shell, B, between which is formed a continuous chamber, C, into which the exhaust steam escapes from the inner working-chamber D, and thus forms a heater for the inner cylinder, and relieves the engine of all back pressure in a manner to be more fully hereafter described. Within the working-chamber D a rotator, E, is arranged, provided with wings F fitted to revolve in working contact with the interior surface of the hollow cylinder A, and rendered steam-tight by a packing, *a*, which is made compensating by the pressure of the steam against its inner edge at *b*, and which is kept to its seat by screws and the pressure of the steam against its face. In the example shown the length of the wings F of the rotator is about seven inches, and the packing *a* is in two sections, halved together, as shown at *y z* in Fig. 4, Sheet 2, in such manner as to allow the steam to press in the joints and force each section out lengthwise against the heads of the case and insure a tight-working joint at the ends of the wings. At the joint where the packing is halved it is crossed by a rib or tongue, *z'*, fitted into a groove, to prevent the escape of steam on the back of the packing and cause the steam to act against the packing endwise. Within the exhaust-chamber C two vibrating resisters, G, are arranged so as to work on opposite sides of the rotator and perform the function of dividing the chamber D into pressure and exhaust-divisions. For this purpose the chamber C has oblique partitions H on opposite sides, which unite the hollow cylinder A in such manner as to form recesses I within which the resisters G are caused to swing into and recede from the working-chamber. These partitions H form seats, which serve as hinges *c* for the resisters, and also closed tops *d* for the steam faces of the resisters. The recesses I communicate with and and form part of the exhaust-chamber C by means of openings *e* made in the resisters G, as shown in Fig. 3, Sheet 2, of the drawing, and by similar openings in the partitions H. These openings are arranged so as not to be opposite each other, but the solid parts of the partitions H form backs to the openings *e* of the resisters. The wings of the rotator and the resisters pass each other at the recesses I by the force of the exhaust steam, in connection with the automatic action of certain devices to be presently described, by which the resisters are borne away from the wings at the proper moment. When the wings F reach and pass the point *f* of the case A the exhaust steam forces itself against the inner sides of the resisters and bears them back into the recesses I with a quick movement, and allows the wings to pass. In this operation the exhaust steam passes through the openings *e* in the resisters against the solid parts of the partitions H, and thus forms resisting-cushions, which prevent the resisters from coming in collision with the partitions, and, at the same time, act as a spring to aid the return movement of the resisters. The exhaust steam passes through the openings in the partitions into the exhaust-chamber C, where its heat is utilized to keep the chamber C hot, and thus prevent the condensation of the pressure steam in the working-chamber. The exhaust-chamber is provided with a suitable exit-pipe, J, which is open at all times. The inner case A and the outer shell B are connected to each other by division-ribs or rings *h*, Figs 3 and 7, so as to serve as braces to the case. These two shells are cast in equal parts and bolted together, as shown at *i* in Figs. 2 and 7. The outer shell is not a true cylinder, but is provided

with a flat bed and cap-plate, K and L, to facilitate access to the inner cylinder in putting the parts together, and also form clamps *j* for rendering the outer shell rigid. The interior division braces do not joint the cap and bed-plate, but openings *k*, Figs. 2, 3, and 6, are left between them to allow free circulation for the exhaust steam throughout the chamber C, and to allow the water to pass out from between the divisions of the chamber to the exit-pipe. The induction steam-chests M are arranged on opposite sides of the case B and communicate with the steam-chamber D by ports *l*, the issues *m* of which are located and arranged in close proximity to the swinging ends of the resisters, in order that the steam may act upon the wings F as soon as they pass the resisters. At the junction of the steam-chests M and ports *l* revolving valves N are arranged upon packing-seats *n*, provided with longitudinal openings *n'*, which, as the valves N revolve, put the steam-chests M in communication with the working-chamber D, and also cut off such communication simultaneously at given intervals. These steam-chests communicate with each other by an arched pipe, O, and with the steam-generator by a connecting-pipe, P. The wings F, resisters G, and valves N are adjusted to work in unison with each other. The valves are revolved by means of gear-wheels, one of which, P^2, is secured to the shaft of the rotator and gears into similar wheels Q Q' on the shafts of the said valves. The inward movements of the resisters are effected by means of cranks R, Figs. 1 and 2, on their projecting ends, arranged to receive the action of levers S simultaneously. These levers are pivoted to an adjustable cross-connection, T, secured to the case A by a standard, *o*, and thumb-screw *p*, as shown in Figs. 1, 2, and 5. They are operated automatically by means of the pressure of the steam in the main feed-pipe P by means of steam-packed plunge-rods *q*, Fig. 7, working in stuffing-boxes *r*, so that their inner ends receive the continuous force of the steam in the feed-pipe, and their outer ends bear against the upper ends of the levers S, so that when the exhaust steam forces the resisters back into the recesses I the cranks R are vibrated and force the lower ends of the levers apart, and, at the same time, their upper ends together, which forces the said plunge-rods *q* inward against the pressure in the feed-pipe. In order to insure this movement of the resisters the shaft of the rotator is provided with two cams, *s*, Fig. 2, which come in contact with the cranks R at the moment the wings pass the exhaust points *f*, and thereby effect the positive action of the resisters. The use of these cams is not deemed essential for causing the resisters to pass out of the way of the rotator-wings, as the force of the exhaust steam will effectually accomplish this result. The object of using the pressure of the incoming steam against that of the exhaust to force the resisters back, is to prevent the collision of the resisters with the inclined partitions H, thus forming counteracting steam-cushions to their outward swinging movements. As soon as the force of the exhaust steam is spent against the resisters, and the wings have passed them, the pressure of the steam in the pipe P forces the plunge-rods *q*, Fig. 7, outward, causing the lower ends of the levers *s* to approach each other and bear the cranks inward against the inclined sides of the cams *s*, which forces the resisters inward against the rotator. This movement takes place while the cams *s* are passing the anti-friction rollers of the valve-cranks.

From the foregoing description it will be seen that the gear-wheels cut off the steam communication at regular points in the revolution of the engine.

In order to use steam more expansively a compensating cut-off is employed and operated by the governor. This cut-off consists of two clutch-arms, U, mounted upon the shafts of the revolving valves, so as to form a clutch-connection with the gear-wheels Q Q', which are, for that purpose, loose upon their shafts. The clutch-arms U are also loose upon their shafts N, and are connected to the arms W of the governor by means of a sliding sleeve, *w*, which has a slide key, w^2, and pin, fitting into an oblique groove, *x x*, in the hub of the clutch-arm, Fig. 7. The clutch-arms U revolve constantly with the valves N, but they are caused to have a movement at specified times in advance of that produced by the gear-wheels, by means of two long teeth, *v*, Fig. 1, adjusted and secured to the shaft of the rotator, and in position to come in contact with the clutch arms U and bear them around a certain distance at a greater speed than that produced by the gearing, so as to rotate the valve in advance of the gear and cut off the steam sooner and allow it to act more expansively in the working-chamber. This movement is controlled by the action of the governor, and is therefore automatic. As the arms of the governor are extended under a greater velocity by reason of the engine having less work to perform or a higher steam pressure, a collar on the stem of the governor will come in contact with the levers W at their junction *t*, Fig. 7, and elevate that point so as to cause them to vibrate upon their fulcrums Y, and draw their opposite ends toward the governor, which moves the slide keys w^2, with their pins in the slots *x x*, in the clutch-hub, and changes the relative position of the arms U with respect to the clutch of the gear and the operating teeth, and bring their acting parts sooner in contact with each other. When the speed of the governor decreases the reverse movement of the pivoted arms W and their clutches will take place and bring the acting parts later in contact, and thus form a variable or compensating-governor cut-off. The wearing points of the resisters are shod with suitable wear packing *g*, which bears against the smooth surface of the rotator, and joint-packing *u*, to act against the arches of the recesses I to form steam-tight joints between said recesses and the chamber D, and said packing is kept tight by the pressure of the steam acting against the inner edges, and being of two equal lengths, and lapped the one over the other, is also forced endwise by the pressure of the steam to keep its ends tight. The journal-bearings of the rotator and valves are

provided with suitable stuffing-boxes Z and packing-rings to render them tight, said stuffing-boxes being made with right-and-left-hand screw-threads to render them self-tightening by the friction of the journals. The seats of the resisters are lubricated by means of channels *v* leading from the outer case, as shown in Figs. 1 and 2 of the drawing.

It will be seen from the foregoing description that the backs of the wings of the rotator are always free from any back pressure whatever by reason of the perpetual communication of the exhaust-chamber C with the steam-space in which the backs of the wings move. This free communication also affords a constant egress for the water which collects in the chamber D by being swept therefrom by the revolving action of the wings, and thereby renders the use of water-cocks entirely unnecessary.

It will also be seen that, by reason of the perpetual exhaust, the engine can be used with great advantage as a condensing-engine by attaching a condenser at the exhaust-pipe J, or otherwise forming a vacuum.

Having described my invention, I claim—

1. A perpetual open exhaust, in combination with a winged rotator, E F, and a revolving feed and cut-off valve, N, operating as and for the purpose described.

2. In a rotary steam-engine, the combination of the continuous revolving steam-feed and cut-off valves N with the continuous revolving rotator and open-hinged resisters, arranged and operating as described.

3. The recesses I, arranged directly within the exhaust-chamber C, to receive and accommodate the swinging movement of the resisters, as described.

4. The openings in the resisters for the escape of the exhaust steam from the working-chamber, essentially as described.

5. The openings in the partitions H, in combination with the openings *e* in the resisters, to afford a constant and free communication between the chambers C and D, essentially as described.

6. The openings in the resisters and the partitions arranged to alternate with each other to form a steam-cushion between these parts to prevent their contact, essentially as described.

7. The revolving cut-off valves N, made to have a movement in advance of the speed imparted by their gearing by means of the clutch devices upon their shafts, operated and controlled by the action of the governor, essentially as described.

8. The resisters, having a movement inward simultaneously to divide the steam-chamber by means of cranks R, levers S, and plunge-rods *q*, operated by the pressure of the steam in the feed-pipe, as described.

9. The exhaust-chamber C, made to encircle and inclose the working steam-chamber, for the purpose of using the exhaust steam to heat the cylinder of the working-chamber, as described.

10. The packing, halved and lapped and provided with a steam cut-off tongue, *z*, to afford longitudinal adjustment, as described.

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