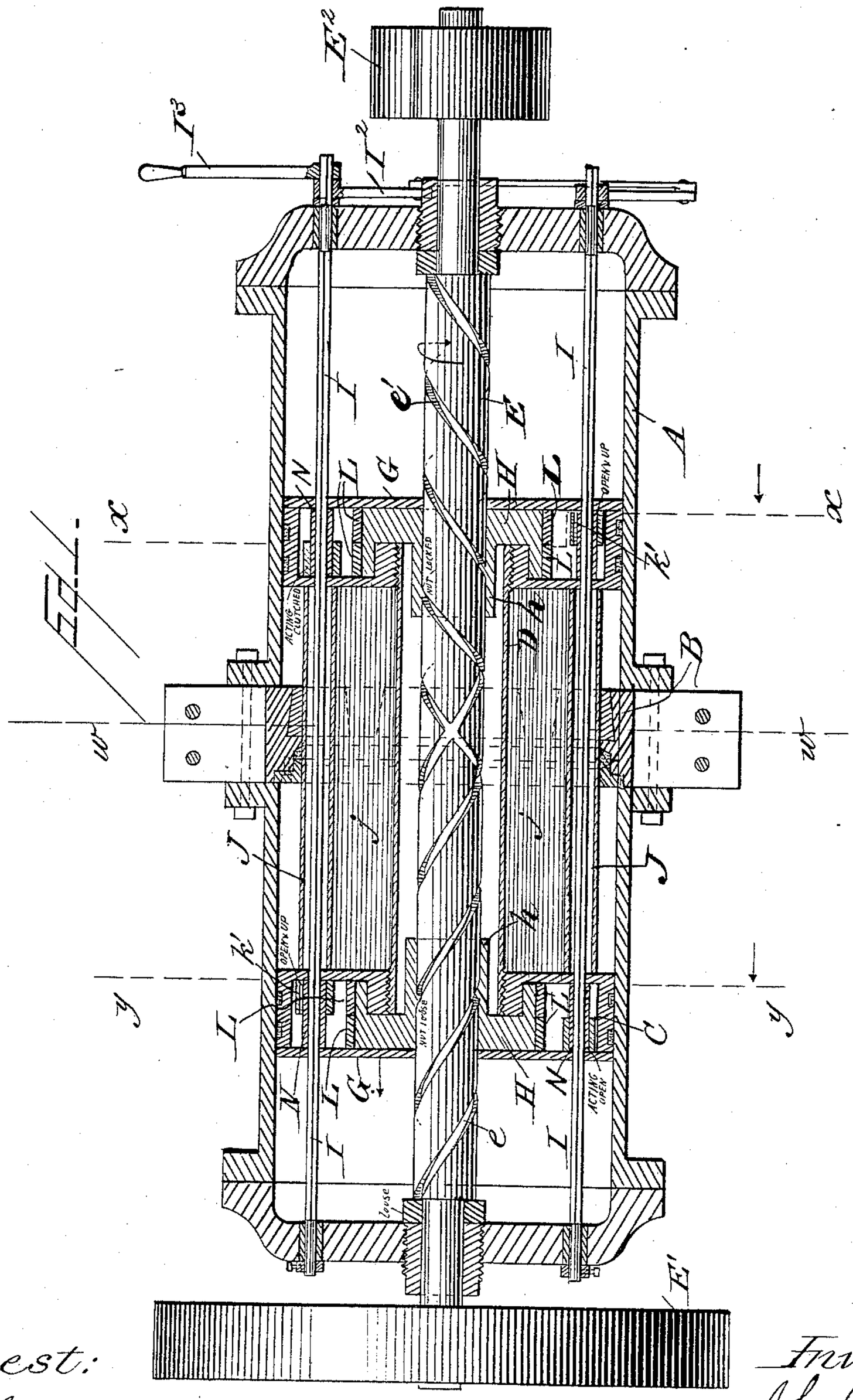
(No Model.) 4 Sheets—Sheet 1.

J. V. RICE, Jr

STEAM ENGINE.

No. 465,099. Patented Dec. 15, 1891.



Attest:
F. H. Schott
Wm L. Boyden

Inventor
John V. Rice Jr.
per F. E. Tasker,
his Atty.

(No Model.) 4 Sheets—Sheet 2.

J. V. RICE, Jr.

STEAM ENGINE.

No. 465,099. Patented Dec. 15, 1891.

FIG. 2.

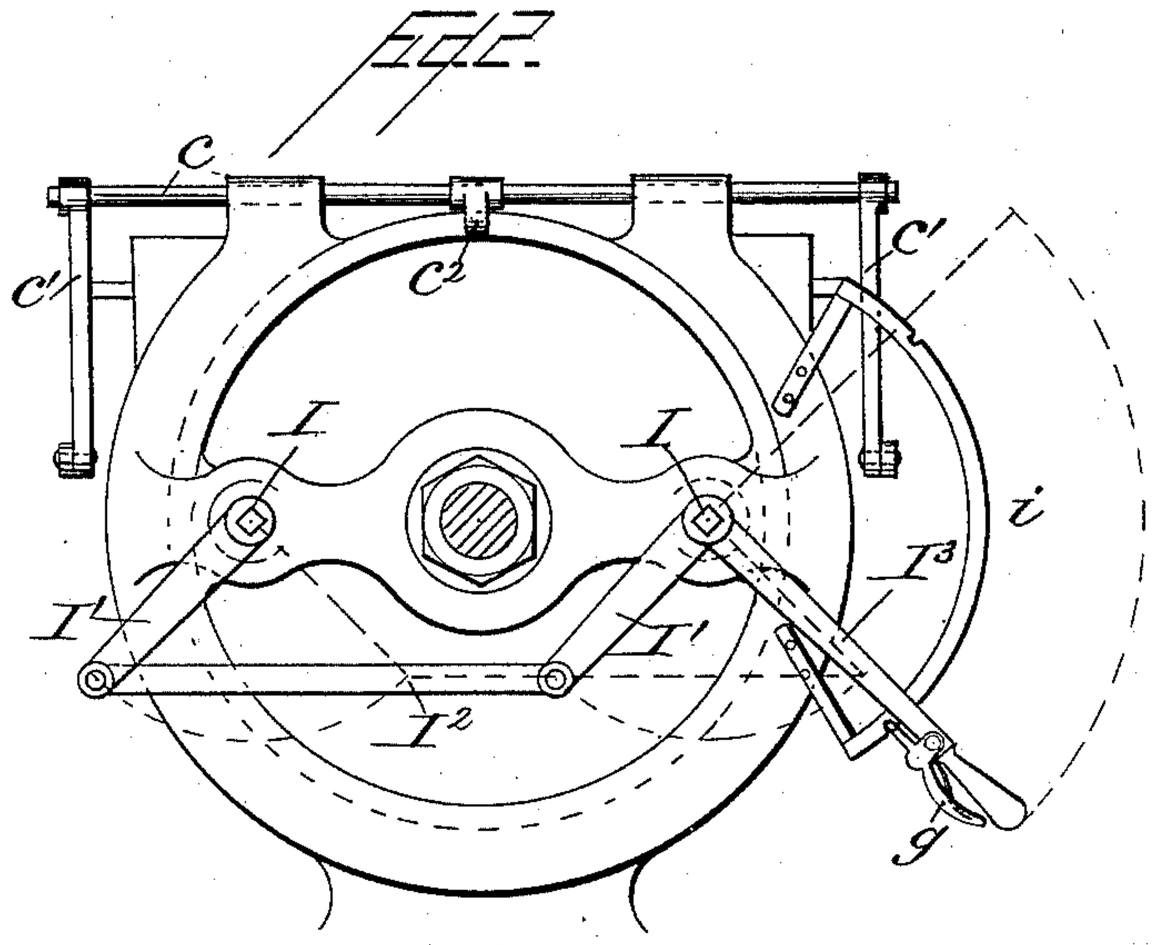
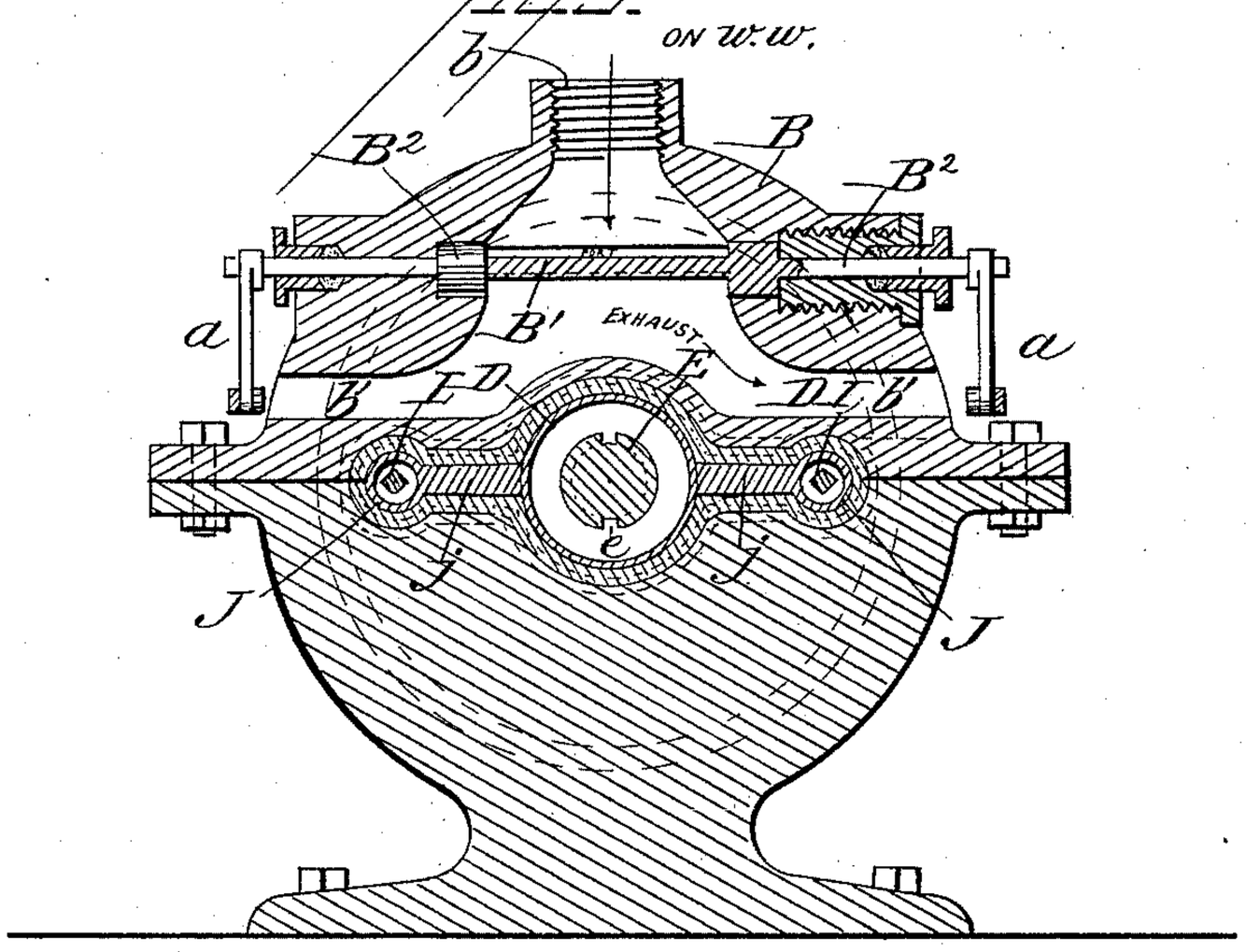


FIG. 3.



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(No Model.) 4 Sheets—Sheet 3.

J. V. RICE, Jr.

STEAM ENGINE.

No. 465,099. Patented Dec. 15, 1891.

FIG. 4.

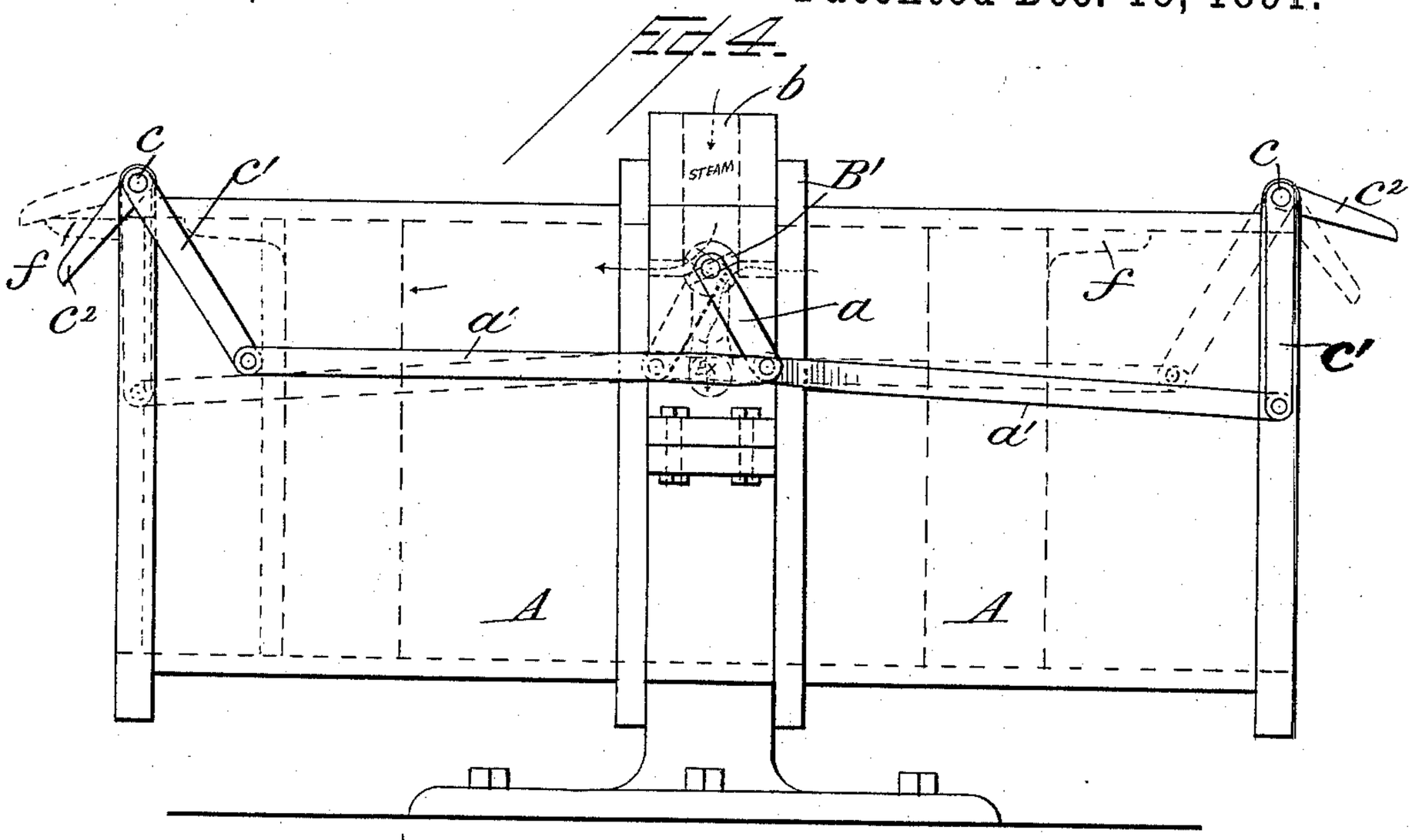


FIG. 5. ON yy.

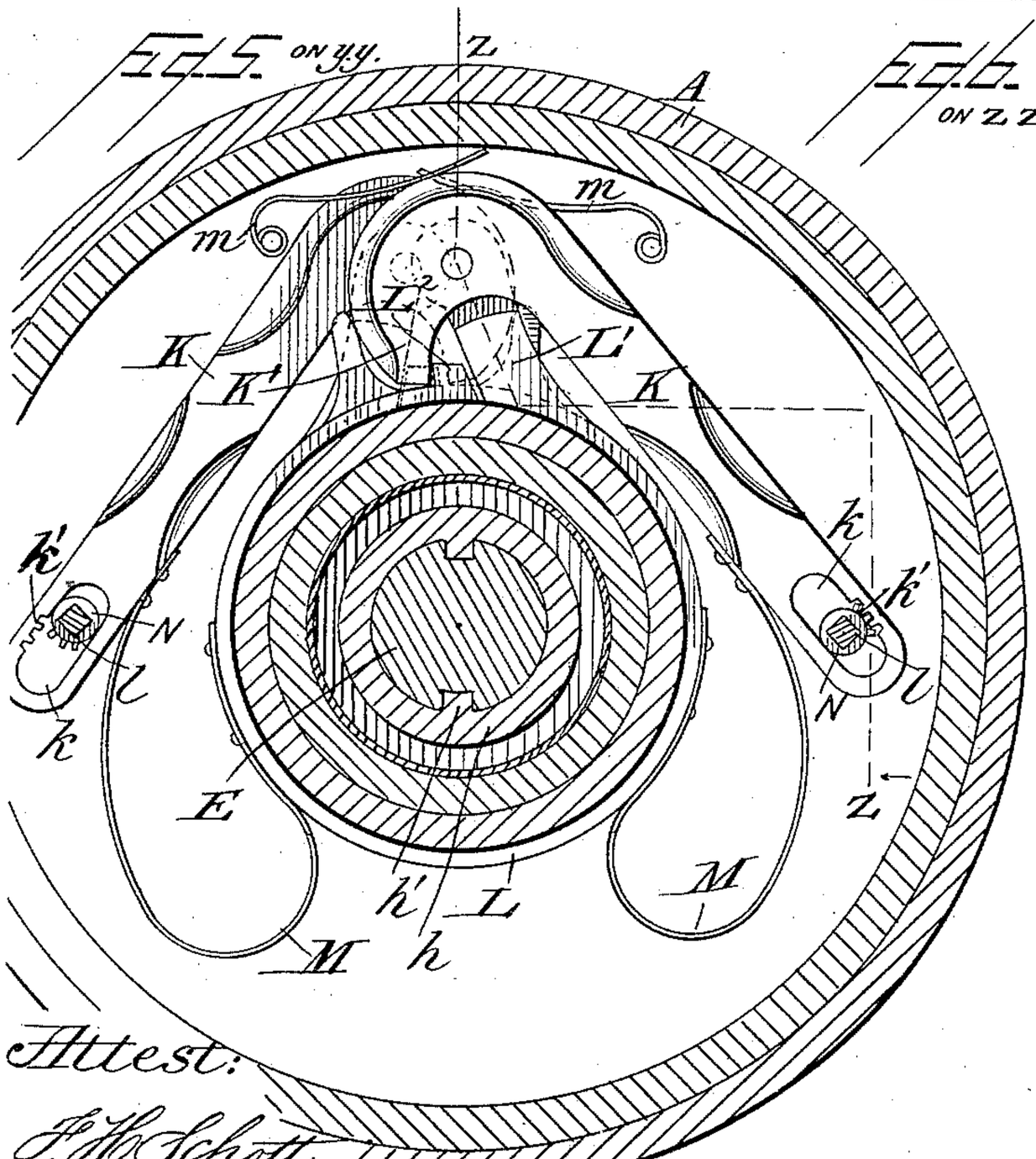
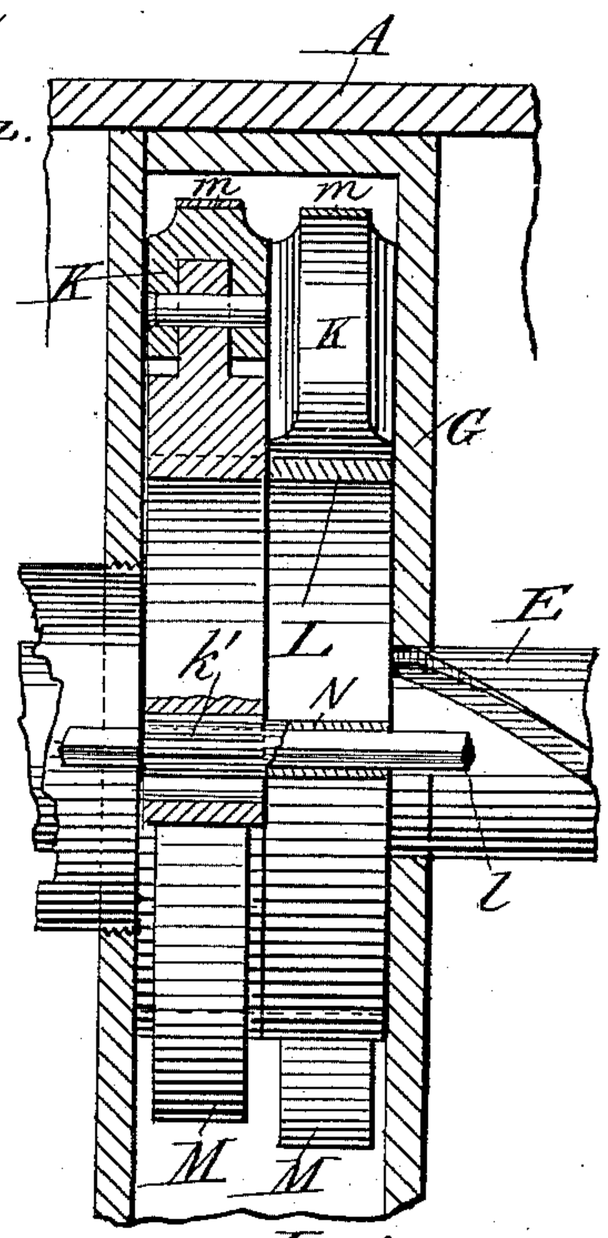


FIG. 6. ON Z Z.



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his Atty.

(No Model.) 4 Sheets—Sheet 4.

J. V. RICE, Jr.

STEAM ENGINE.

No. 465,099. Patented Dec. 15, 1891.

Fig. 7.

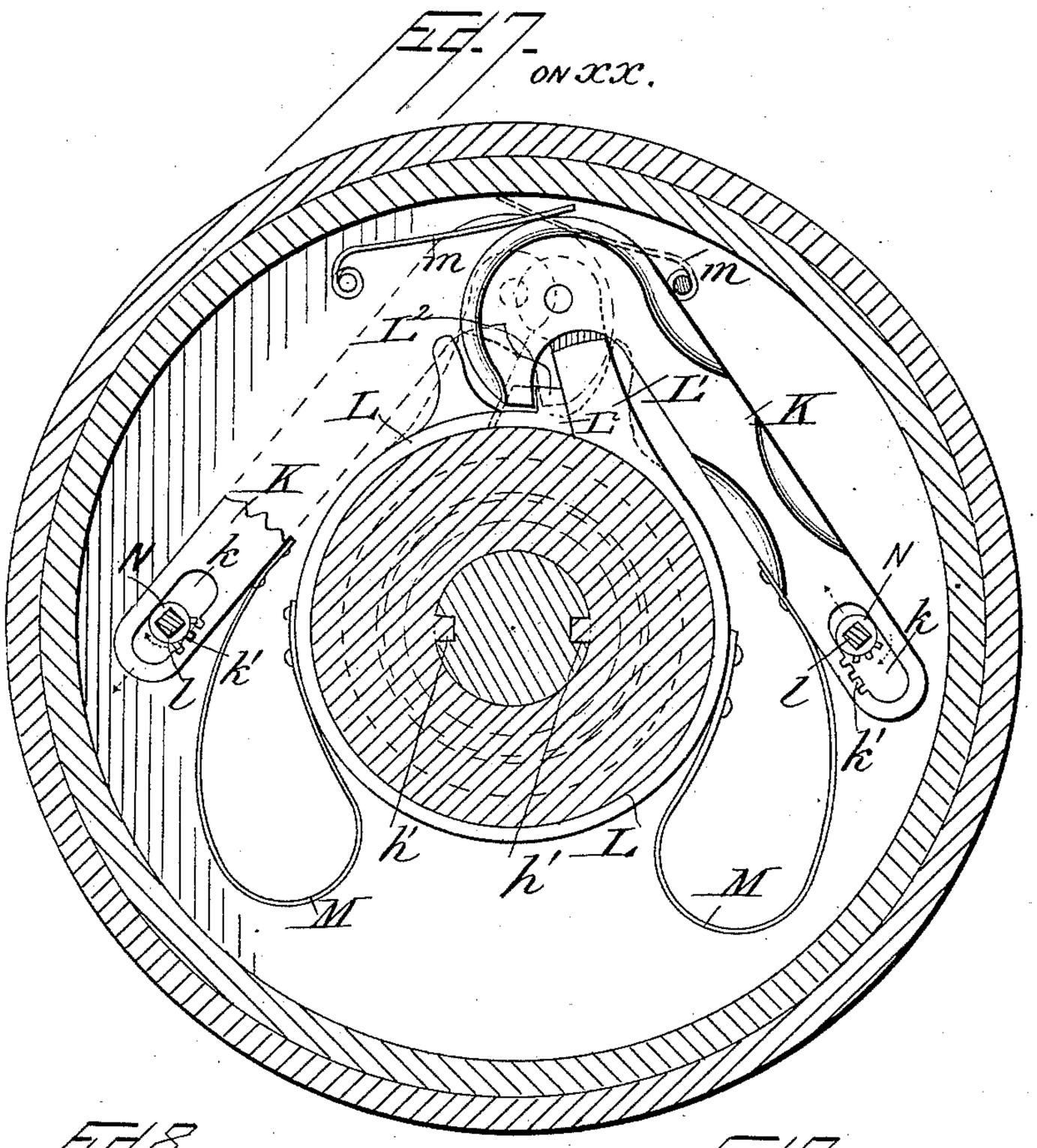


Fig. 8.

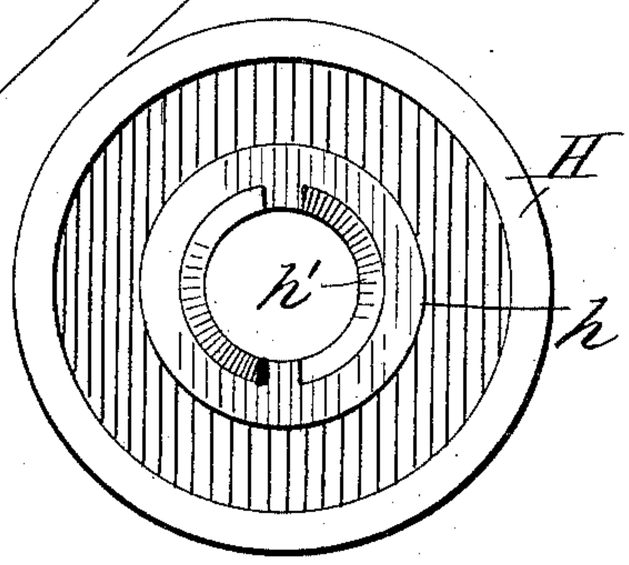
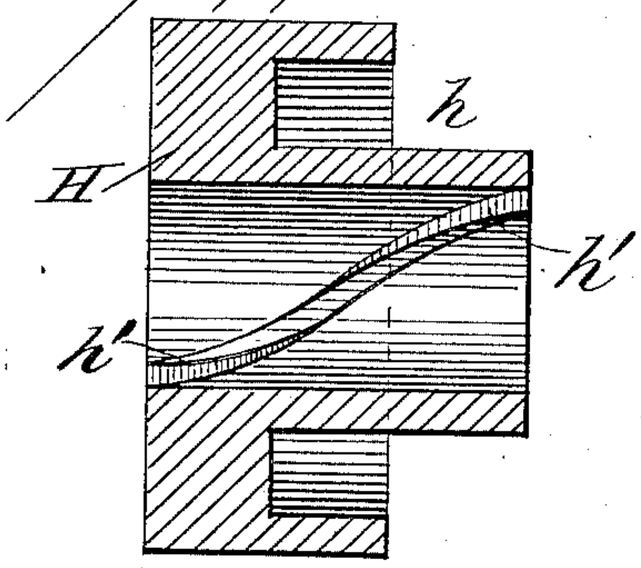


Fig. 9.



Attest:

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Inventor

John V. Rice Jr.

per Fred E. Tasker,

his Atty.

UNITED STATES PATENT OFFICE.

JOHN V. RICE, JR., OF CHESTER, PENNSYLVANIA.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 465,099, dated December 15, 1891.

Application filed May 14, 1891. Serial No. 392,722. (No model.)

To all whom it may concern:

Be it known that I, JOHN V. RICE, Jr., a citizen of the United States, residing at Chester, in the county of Delaware and State of Pennsylvania, have invented certain new and useful Improvements in Steam-Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My present invention refers to an improvement in steam-engines belonging more particularly to that kind or class known as "direct-acting engines," the special type or form which this invention is designed to improve upon being that embraced in my pending application for Letters Patent, filed November 4, 1890, Serial No. 370,316, the primary object being to increase the speed so as to provide a very high speed for the many uses for which such an engine is indispensably necessary; and the present invention therefore consists in the construction, arrangement, and combination of parts, substantially as will be hereinafter described and claimed.

In the annexed drawings, illustrating my invention, Figure 1 is a horizontal section of my improved engine. Fig. 2 is a right-hand end elevation, as represented in Fig. 1, with the pulley at that end removed. Fig. 3 is a cross-section on the line *w w* of Fig. 1. Fig. 4 is a side elevation of my improved engine. Fig. 5 is an enlarged cross-section on the line *y y* of Fig. 1. Fig. 6 is a transverse section on the line *z z* of Fig. 5. Fig. 7 is an enlarged cross-section on the line *x x* of Fig. 1. Fig. 8 is an end elevation, and Fig. 9 is a cross-section, of one of the internally-ribbed disks or sleeves.

Similar letters of reference designate corresponding parts throughout all the different figures of the drawings.

In the example of my engine, presented in the drawings by way of illustration simply, A designates the cylinder, it being simply the cylinder of an engine of the single-cylinder direct-acting kind, said cylinder being preferably open-ended to the atmosphere, there being at each end a suitable skeleton or other frame arranged to support certain of the mechanical parts.

Midway or thereabout of the length of the cylinder A is a transverse partition or diaphragm B. (See Figs. 1, 3, and 4.) This partition is suitably channeled or provided with passages, so that there may be an inlet on the top at *b*, to which a steam-conveying pipe may be coupled, and also there may be the exhaust-outlets on each side of the cylinder at *b' b'*. (See Fig. 3.) The steam which enters the inlet *b* finds its way into the cylinder through suitable ports or passages in the partition B, as shown in dotted lines in Fig. 4, said ports being controlled by a valve B', consisting, preferably, of a flat strip arranged to rotate by being provided with journals B^2 B^2, having bearings in the partition B. (See Fig. 3.) The exhaust likewise takes place through these ports, and therefore the valve B' regulates both the admission and exhaust of steam. As shown in Fig. 4, it permits the space on one side of the diaphragm B to communicate with the steam-inlet for the admission of steam and the space on the other side of said diaphragm to simultaneously communicate with the exhaust-passages for the outlet of the exhaust-steam. When the valve shifts, a reverse condition takes place and steam is allowed to enter at the other side of the partition. Secured rigidly to the projecting ends of the journals B^2 B^2 are short arms *a a*, which are pivoted to links *a' a'*, (see Fig. 4,) extending longitudinally in each direction toward the ends of the cylinder, where they are pivotally connected to arms *c' c'*, which are secured on the ends of horizontal shafts *c c*, supported in suitable bearings at the ends of the cylinder. (See Figs. 2 and 4.) These shafts *c c* are also provided with short inclined rigid projections or arms c^2, that lie in such a position as to be struck by the projections *f f* (shown in dotted lines in Fig. 4) on the heads of the piston as said heads during their movements near the ends of each stroke. The contact of the projections *f f* with the projections c^2 c^2 at each end of the stroke will, through the intermediate connections which I have described, operate to shift the valve B' and cut off and supply the steam in the proper manner. Of course this is only one of many ways of operating the cut-off and supply valve. I give it simply as an example. It is an easily-arranged and inexpensive contrivance, and will

operate as successfully as other more complicated forms which might be employed. It will be observed, however, that the mechanism employed in my other application above referred to may be adopted in this, if desired, or any other approved devices may be substituted for this here shown, including a governor, if need be.

Within the cylinder A is a double-headed piston. C and C′ denote the piston-heads. They are hollow and connected together by the central tubular connection D, which may be of any suitable length and diameter. This tubular connection passes through an opening in the center of the partition B, where a suitable packing is provided to form a tight joint.

Referring to Figs. 1 and 3, it will be noted that the hollow piston-heads C and C′ are also connected together by small tubes or pipes J J, located on each side of the central tubular connection D. Said tubes J J are secured at each end to the inner faces of the heads C and C′, and they are also rigidly connected to or formed integral with the flat plates or webs *j j*, which connect them horizontally with the tubular connection D, all as represented clearly in Fig. 3. It will thus be seen that the hollow piston-heads C and C′ are connected together by the large tube D, the smaller tubes J J, and the connecting plates or webs *j j*, and that all these parts move through suitable openings in the central transverse diaphragm, which openings are properly packed, so that there is a tight joint to prevent the escape of steam. Each of the piston-heads C and C′ is provided with an outside cover G. Through the tubular connection D, as also through both the piston-heads C and C′, passes a longitudinal spirally-grooved shaft E, which is supported at each end in bearings in the end frames of the cylinder. This shaft is preferably provided with collars next to its bearings to prevent endwise displacement, and the said bearings are preferably screwed into the frames, as shown in Fig. 1. The shaft E has the spiral grooves *e* and *e′*, which run in opposite spirals from each end of the shaft and meet and cross at the middle of the shaft, said middle portion being provided with both spiral grooves, so that both of the internally-ribbed disks or sleeves may travel over this part. The tubular connections J J are employed for the purpose of inclosing the horizontal parallel rods I I, which form a part of the reversing mechanism of the engine. These rods I I are preferably square in cross-section, as shown. They are supported at each end in suitable bearings in the end frames of the cylinder, and at those points are arranged so as to provide neat journals, which can turn nicely in their bearings, so as to permit an easy and convenient oscillation of the shafts whenever it is desired to partially rotate them. These shafts are provided at points inside of the cylinder-heads with devices arranged to engage the movable arms belonging to the clutch-rings, which are located within said piston-heads, and accordingly the vibrations of the rods I I operate to tighten or loosen the clutch-rings, all as will be hereinafter fully explained when we come to describe the construction and function of said rings.

The adjacent ends of the rods I I at one end of the cylinder, as shown in Figs. 1 and 2, are provided with the rigid arms I′ I′, which are connected together by means of the link I^2. I^3 designates a hand-lever rigidly connected to the end of one of the rods I and immovable relative to the arm I′, connected to the end of said rod.

i designates a notched sector, which is adapted to be engaged by a catch *g* on the hand-lever I^3. Lever I^3 is intended to occupy either the position shown in full lines in Fig. 2 or that shown in dotted lines in said figure. When it occupies the position shown in full lines, then the several parts of the engine will be arranged so as to rotate the shaft E in one direction. When the hand-lever I^3 is in the position shown in dotted lines, then the several parts of the engine will have been changed or reversed, so that the shaft E will be driven in the opposite direction. Thus it will be seen that the engine can be simply and easily reversed at any time by simply manipulating the hand-lever I^3 in the proper manner. The main shaft E is preferably provided at one end with a band-wheel E′ and at the other end with a pulley E^2.

Within each of the hollow piston-heads C and C′ is an internally ribbed or feathered "block" or "sleeve," "disk" or "nut," as it may be indifferently termed, which surrounds the horizontal shaft E and has its ribs in engagement with the grooves of said shaft. These blocks or sleeves are preferably of a cylindrical or disk form. One of them is shown in elevation in Fig. 8 and in section in Fig. 9. H designates the cylindrical internally-ribbed disks, which preferably have the sleeve-like extension *h*, which projects within the tubular connection D. Inside of the disk is a spiral rib *h′*, and this is in engagement with the grooves *e* and *e′* of the shaft E, as the case may be. Within each of the hollow piston-heads are also two clutch-rings L L, which encircle the disks H H and at times tightly grip the same, while at other times they relax their hold and are loose thereon. When one or the other of each of these pairs of clutch-rings is gripped upon its disk, then as the piston advances the result of the rectilinear movement of the disk will, owing to its engagement with the shaft, cause the latter to be rotated. When the disk is clutched by neither of the encircling clutch-rings, then as the piston moves forward the said disk will rotate idly. Adjacent to each of the rings L is a lever K, which occupies a position preferably parallel to a tangent of the ring L, the levers K belonging to each pair of rings being situated in opposite inclined positions, as shown. The ring L is split

or divided at one point, and the two contiguous ends thereof are enlarged, one of them forming a shoulder L^2 and the other forming the enlarged extension L′, which is pivoted within a slot cut in the curved end of the adjacent lever-arm K, which end of the lever-arm is provided with a hook-like projection K′, which depends behind the stop or shoulder L^2, so that whenever the said lever-arm K is properly moved to accomplish such a result the shoulder L^2 will approach nearer to the end L′, and thus the two contiguous ends of the split ring will be brought close together, and consequently the ring will clutch tightly upon the disk which it encircles. Whenever the point K′ is moved more or less from behind the shoulder L^2, then the resiliency of the spring metal of the clutch-ring will cause the shoulder L^2 to recede from the part L′, and thus the ring will lie loosely upon the disk which it encircles. Each of the lever-arms K is provided at its lower end with a slot *k*, on one side of which is a series of a greater or less number of teeth, forming a rack *k*′. On each of the horizontal rods I within the hollow piston-heads is located a short segment gear, sleeve, or tube N, whose teeth *l* are adapted to engage the teeth of the rack *k*′ on the inner edge of the slot *k* of the arm K. It will thus be seen that as the rods I I rotate, the teeth *l* being in engagement with the teeth *k*′, the result will be to actuate the arms K.

M designates a flat spring bent into the form of a loop and having one end riveted to the ring L, while the opposite end is riveted to the adjacent portion of the lever K. Furthermore, another flat spring *m*, secured on the inside face of the cover of the piston-head or to some other convenient part, bears upon the upper pivotal end of the lever K, as shown in Fig. 5. All four of the clutch-rings are constructed similarly, and adjacent to them are four lever-arms K, constructed in the manner that I have specified, all the parts being equipped for service in the manner that I have just indicated.

When the rods I I occupy the position shown in Fig. 1, with the lever-handle I^3 in the position indicated, then it will be observed by referring to Fig. 5 and also to Fig. 7, both of which are cross-sectional views and look inwardly upon the arrangement of the clutch-ring within the piston-heads, how the said clutch-rings are disposed for operation at this time. It will be seen that one clutch-ring in each piston-head will be in its operative position while the other is in its idle position—that is to say, one of the levers K (the right-hand one shown in Fig. 5) will be up—and thus the ends of the clutch-ring separated and the clutch-ring idle, while the other lever K—that is, the left-hand one in Fig. 5—will be down, which will cause the ends of the corresponding clutch ring to be close together and nearly in actual contact.. Also, by referring to Fig. 7 it will be seen that the right-hand lever K is down, and consequently the ends of the corresponding clutch-ring are close together, almost in actual contact, if not quite, and thus the said clutch-ring is in operative position, while the other clutch-ring having the lever-handle K (shown at the left-hand of Fig. 7) is so arranged in consequence of the elevation of said lever that its ends are separated, and therefore the clutch-ring is idle. Therefore, looking again at Fig. 1, we see that the left-hand clutch-ring in the right-hand piston-head—that is, the piston-head C′—is in operative position, while the right-hand clutch-ring in piston-head C′ is in its inoperative position, and that the left-hand clutch-ring in the piston-head C is in operative position, while the right-hand clutch-ring in the piston-head C is in its inoperative position.

Having thus finished fully the description of the construction and arrangement of all the several parts of the engine and having indicated in some measure the mode of its procedure for practical operation, I will now add a few words relative to the exact operation of the engine when it is doing actual work. Suppose, for instance, that the piston is moving toward the left, in the direction shown by the arrow in Fig. 1. We have already seen that the reversing mechanism is so placed that the left-hand clutch-rings in each piston-head are in operative position while the right-hand clutch-rings are in their inoperative positions. These clutch-rings have been so placed that the contiguous ends near the split in each one are almost in contact, although not quite so. Now as the piston starts to move in the direction shown by the arrow in Fig. 1 the tendency of the disk or nut encircled by the left-hand ring in piston-head C′ will be to rotate in consequence of its connection with the shaft; but such rotation will be incipient merely, because at the first impulse the disk nut or block will act frictionally on the inside of said left-hand ring in such a manner as to cause the contiguous ends thereof adjacent to the split to be thrown together and quite into contact, or nearly so, whereby the ring will bind upon the disk, clamping or gripping the same firmly and preventing rotation, so that instead of having the disk rotate the forward action of the piston will cause the shaft to rotate. The spring bearing upon the top of the left-hand ring assists in clamping it frictionally upon the disk, and the more work the shaft has to perform the more the friction and the tighter the grip. It will be evident that when the disk is clamped to the ring the tendency will then be for the disk to turn the said ring and its arm around with it; but the bolt or rod that lies in the slot in the arm prevents this, and the said slot at the bottom of the lever-arm admits of the tightening or loosening of the clutch-ring. So much for the position and action at this time of the disk within the left-hand clutch-ring of piston-head C′. Now observe the simultaneous position and action

of the disk or nut which is encircled by the left-hand ring within piston-head C. Said nut being located on the reversely-cut spiral of the shaft will manifestly have a tendency to rotate in a direction contrary to that of the rotation of the disk of which we have just been speaking. Such reverse rotation will not, however, produce the same clamping effect upon the encircling ring as is produced by the rotation of the other disk, because it will cause the disk or nut to act frictionally on the inside of the ring in such a manner as to throw the contiguous ends at the split in the ring away from each other; or, in other words, to keep them separated, thereby keeping the clutch-ring loose and unclutched upon the disk during the entire reciprocation of the piston.

Having now observed the operation of the parts during the first reciprocation of the piston to the left, we proceed to notice it during the next reciprocation toward the right hand. When the piston begins this return-stroke in the opposite direction, the disks or nuts, being made to move in the opposite direction rectilinearly from what they were before, will of course rotate or have tendencies to rotate in directions opposite to what they did before. The result will be that the nut or block which is encircled by the left-hand clutch-ring in piston-head C will, instead of revolving idly, become the active actuating agent for the shaft during this stroke, because revolving, as it does, in a direction opposite to what it did during the other stroke it will cause the encircling ring to clutch or grip it tightly, since the contiguous ends at the split in said ring will be drawn together and the friction of the block on the inner periphery of the ring will bind ring and block together; also, it will be noted that the disk or nut which is encircled by the left-hand clutch-ring in piston-head C′ will now revolve idly, its direction of rotation not being the proper one to cause the clutch-ring to bind frictionally thereon. In this way the shaft during the successive reciprocations of the piston will be rotated continuously forward or in the same direction.

Whenever it is desired to reverse the direction of rotation of the shaft E, the operator can lay hold of the handle I^3 and shift it over into its other position, and the result will be to bring the other clutches which have heretofore stood idle into action, they being the right-hand clutch-rings in both piston-heads, and therefore the result of their operation will be to revolve the shaft E in the other direction.

Many changes may be made in the construction, arrangement, proportion, size, &c., of the various parts of my improved engine without departing from the invention, and I reserve the liberty of varying the construction in its details to suit the exigencies and demands of different cases.

Obviously the impelling power in my engine may be steam, air, gas, or any other fluid or liquid.

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

1. In an engine having a spirally-grooved shaft, which is rotated by means of an annular surrounding reciprocating piston intermittently clutched to or connected therewith, the piston having two hollow heads united by a tubular connection, substantially as described.

2. In an engine, the linear reciprocating piston having two hollow heads joined by a tubular connection, in combination with the cylinder, the spirally-grooved rotary shaft passing axially through the piston and its tube, and means for intermittently making connection between the piston and the shaft, whereby the latter is rotated by the reciprocations of the former, substantially as described.

3. In an engine, the combination of a cylinder, a double-headed piston whose heads are hollow and have a tubular connection, a spirally-grooved shaft passing through the piston, and a disk or block and a clutch-ring in each piston-head.

4. In an engine, the combination of a cylinder, a piston moving therein having hollow heads connected by a tubular connection, a grooved shaft passing through the piston, a circular block or disk having an internal rib or feather, whereby it is permanently connected to the grooved shaft, and a split ring pivoted to an arm connecting with the piston-head, whereby the circular block is clutched and intermittently prevented from rotating and caused to impart a rotation to the grooved shafts.

5. In an engine, the combination of a cylinder, a double-headed piston whose heads are hollow and have a tubular connection, a shaft provided with oppositely-running spiral grooves and located through the piston, internally-ribbed blocks or disks located within the piston-heads and permanently connected to the grooved shafts, and a pair of split rings in each piston-head encircling the aforesaid blocks or disks, said rings being pivoted to movable arms, and being adapted to clutch the disks for the purpose of preventing them from rotating and causing a rotation to be imparted to the grooved shaft, substantially as described.

6. The combination of a cylinder, a double-headed piston whose heads are hollow and have a central tubular connection and also two other tubular connections on each side of the central one, a grooved shaft running through the central tubular connection, rods running through the side tubular connections, a block or disk within each head engaging the grooved shaft, clutch-rings surrounding said blocks, and arms to which said clutch-

rings are pivoted, said arms being engaged by the aforesaid rods, substantially as described.

7. The combination of a cylinder, a double-headed piston whose heads are hollow, a grooved shaft having grooves running in opposite spirals, a circular block or disk H, within each head engaging the grooved shaft, and a clutch ring or rings L, divided at a certain point in their circumference and adapted to clutch said block or disk H, substantially as described.

8. The combination of a steam-cylinder having open ends and a central transverse partition, a piston having hollow heads which are connected by means of a central tubular connection, said heads being situated on opposite sides of the central partition and the said tubular connection working through an opening in the central partition, a spirally-grooved shaft running through the tubular connection, and means for connecting the aforesaid piston-heads to this spiral shaft, consisting of clutch-rings encircling circular blocks or disks, which are permanently connected to the grooved shaft and intermittently connected in this way to the piston-head, together with a valve operated in any suitable manner to supply the steam, substantially as described.

9. The combination of a steam-cylinder having open ends and a central transverse partition, a piston having hollow heads which are connected by means of a central tubular connection and two side tubular connections, said heads being situated on opposite sides of the central partition and the side tubular connections, and a joining-web on each side of the central connection between it and the side ones, all working through an opening in the central partition, together with a spirally-grooved shaft running through the central tubular connection, the reversing-rod running through the side tubular connections, and means for connecting the aforesaid piston-heads to the central spiral shaft for the purpose of revolving it, substantially as described.

10. The combination of a steam-cylinder, a piston having two hollow heads connected by a central tubular connection, and two side tubular connections, a grooved spiral shaft running through the central connection, reversing-rods running through the side tubular connections and provided within each head with geared sleeves, the circular disks or blocks internally ribbed to engage the spiral shaft, a divided clutch-ring in each head encircling said disk, and a movable arm pivoted to said clutch-ring and engaged by the aforesaid gear-sleeve on the reversing-rods, substantially as described.

11. The combination of a steam-cylinder with the piston having two hollow heads connected by a tubular connection, circular blocks or disks located within said heads and having internal ribs which connect them with the spiral shaft which runs through the piston, a pair of clutch-rings within each head encircling the said blocks or disks, and an arm pivoted to each of the said clutch-rings and engaged at its other end by a reversing-rod, substantially as described.

12. The combination of a steam-cylinder, a piston having hollow heads connected by a central tubular connection, the spirally-grooved shaft E, running through said piston, the internally-ribbed disks H, situated within the hollow heads and permanently connected to the shaft E, and the clutch-rings L, within the hollow heads and encircling the disks H, together with the arms K, pivoted to said clutch-rings and operating, as specified, to cause said rings to clutch or to release their hold, together with the reversing-rods which operate to govern the position of the levers K, substantially as described.

13. The combination of a cylinder, a piston moving therein having hollow heads connected by a tubular connection, the internally-ribbed disks H, the grooved shaft E, to which said disks are permanently connected, the ring L, encircling the disks within the hollow heads, said rings having at one end the extension L′ and at the other the shoulder L^2, a lever-arm K, pivoted to the extension L′ of the ring L, and having a depending projection K′, operating against the shoulder L^2, said lever K being slotted, so that a rack connection may be provided with a reversing-rod which passes through it, substantially as described.

14. In an engine, the combination of a cylinder, a piston working therein, a spirally-grooved rotary shaft passing axially through the piston, a disk, block, or similar device, and a clutch-ring for intermittently making connection between the piston and the shaft, substantially as described.

15. In an engine, the combination of a cylinder, a piston moving thereon having hollow heads connected by a tubular connection, a grooved shaft passing through the piston, a block or disk on the shaft, and a split ring for clutching the said block, so as to cause the reciprocations of the piston and impart a rotation to the shaft.

16. The combination of a cylinder, a piston therein, a grooved rotary shaft passing axially through the piston, a clutch-ring, and an intermediate device within the ring engaging the grooved shaft, the intermittent clutching of which ring upon this device makes connection between the piston and shaft, substantially as described.

17. The combination of a cylinder, a piston therein, a spirally-grooved rotary shaft passing axially through the piston, a cylindrical disk or nut encircling the shaft and having an internal spiral rib which is in engagement with the spiral grooves, and an encircling

split clutch-ring for making connection between the piston and said disk, substantially as described.

18. In an engine having a spirally-grooved shaft which is rotated by means of an annular surrounding reciprocating piston intermittently clutched to or connected therewith, and a circular split clutch-ring for accomplishing this intermittent clutch, substantially as described.

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

JOHN V. RICE, JR.

Witnesses:
HENRY S. PRICKETT,
HARRY G. FIRTH.