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A. J. VANDEGRIFT.

STEAM ENGINE.

No. 462,182. Patented Oct. 27, 1891.

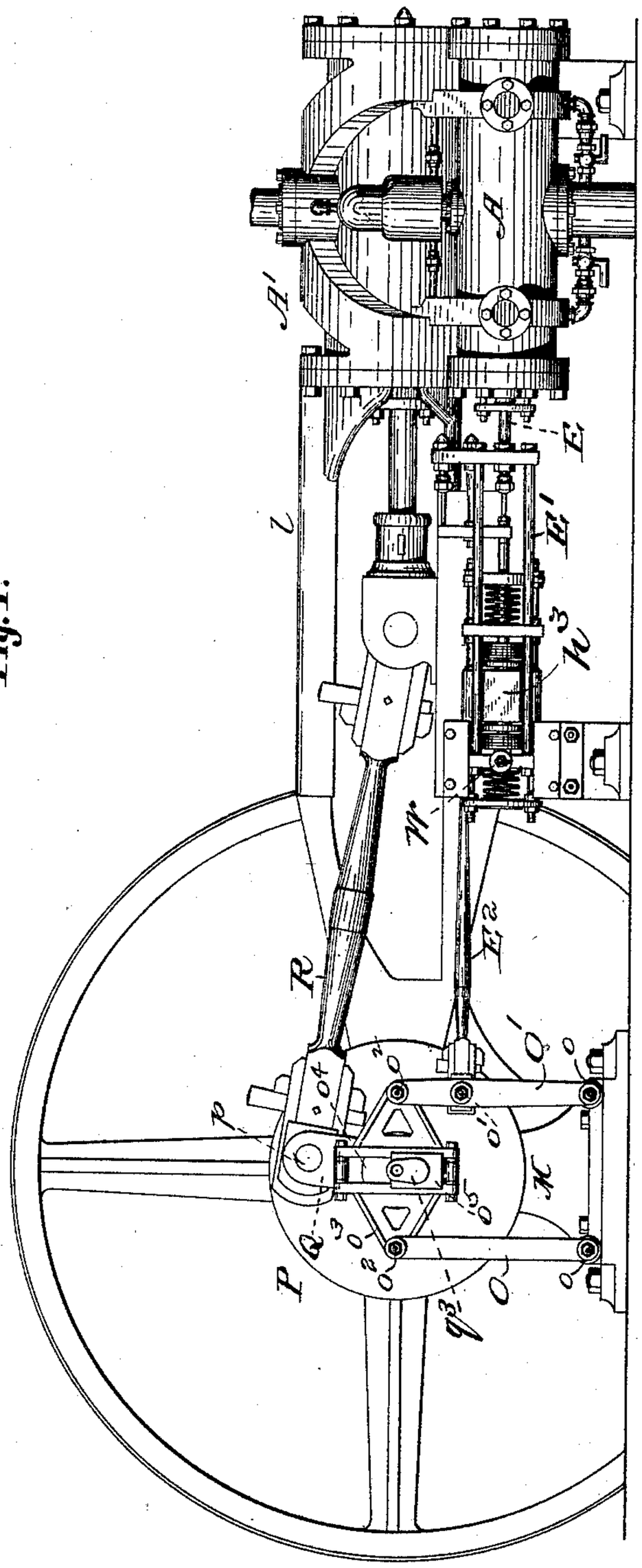

Fig. I.

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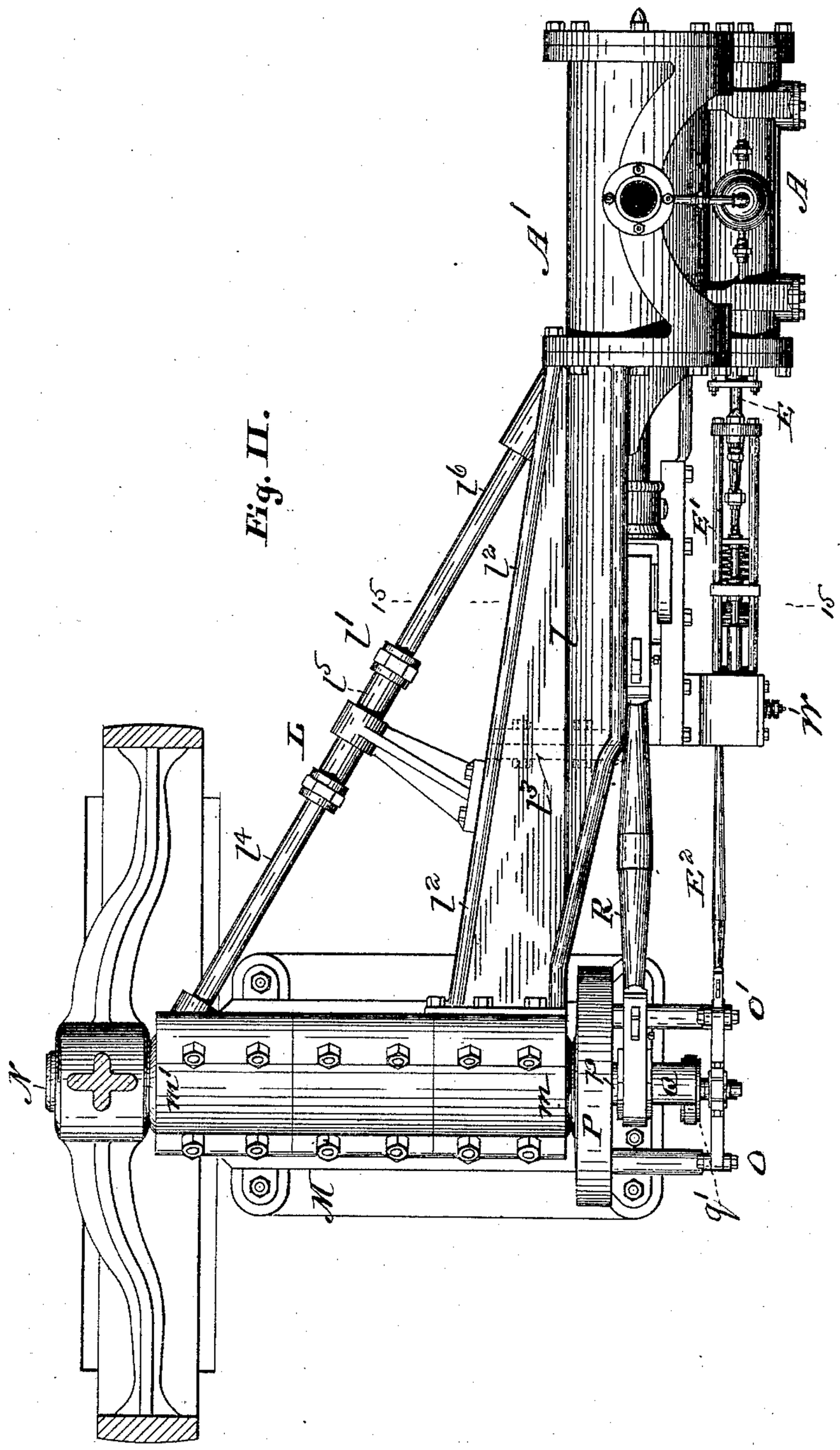
STEAM ENGINE.

No. 462,182. Patented Oct. 27, 1891.

Fig. II.



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A. J. VANDEGRIFT.

STEAM ENGINE.

No. 462,182. Patented Oct. 27, 1891.

Fig. III.

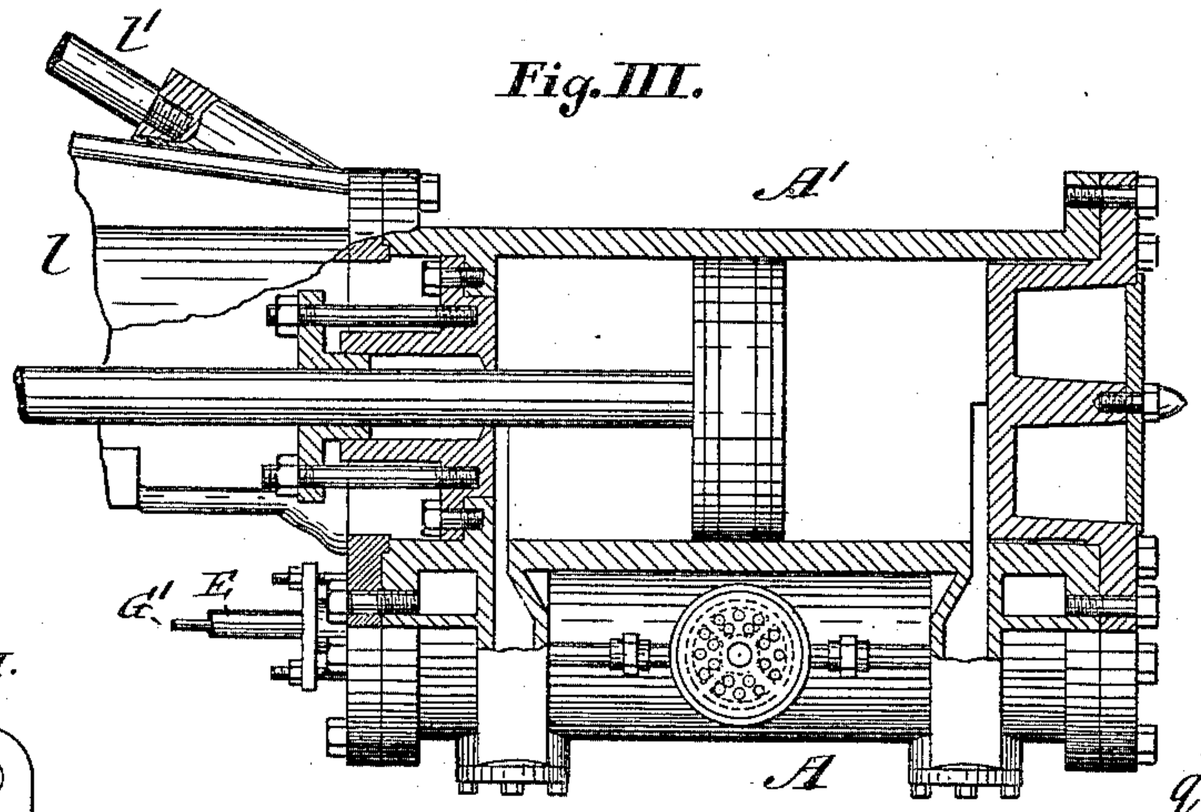


Fig. VII.

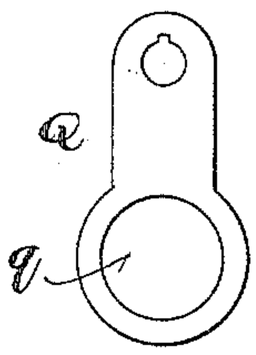


Fig. VIII.

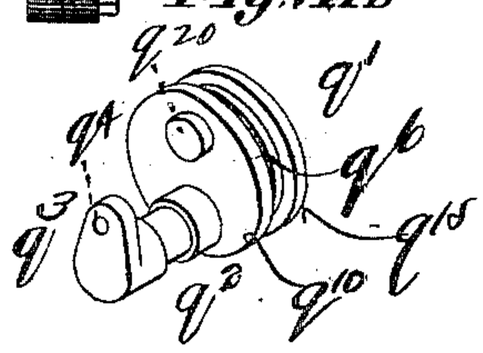


Fig. IV.

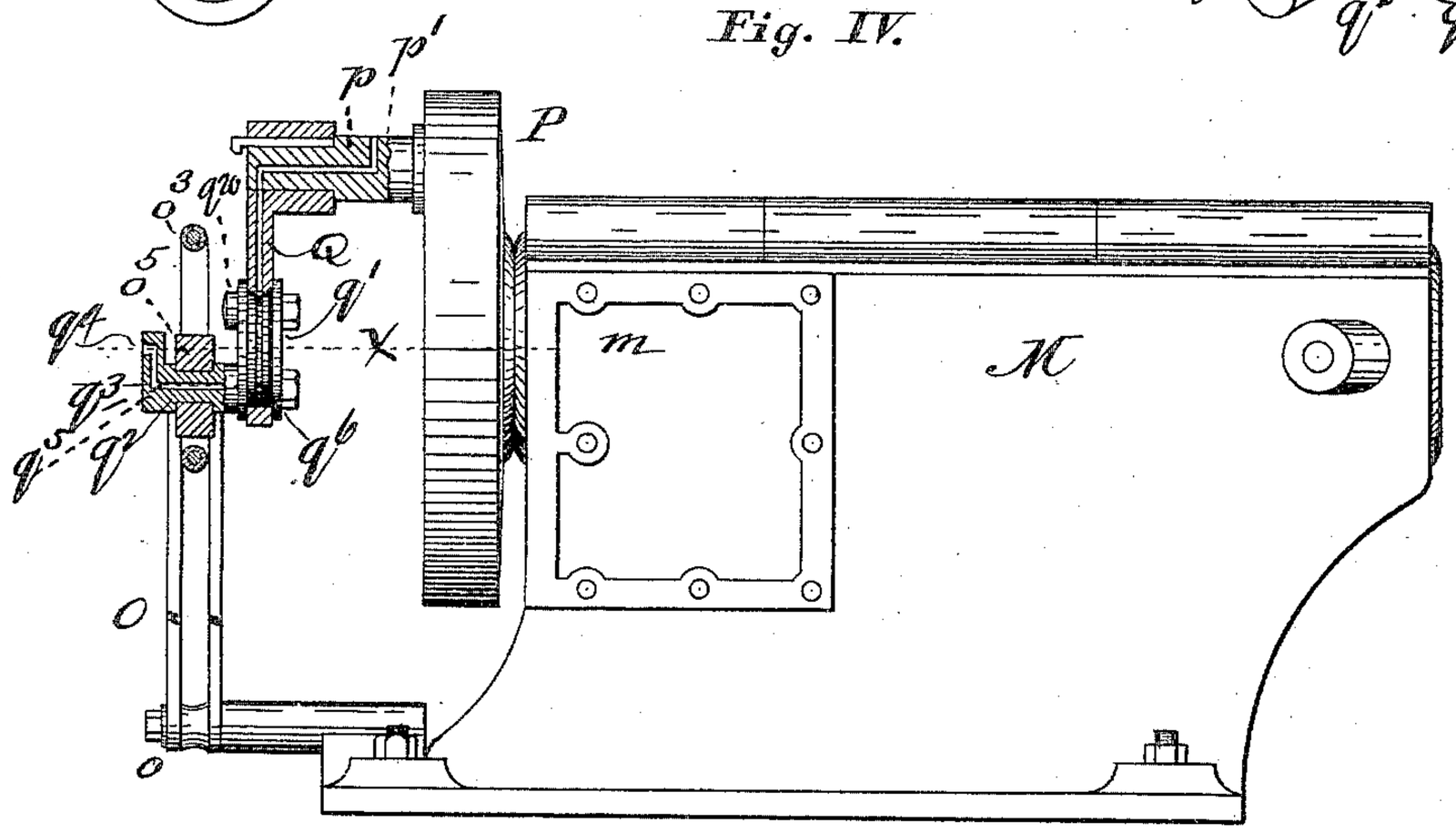


Fig. V.

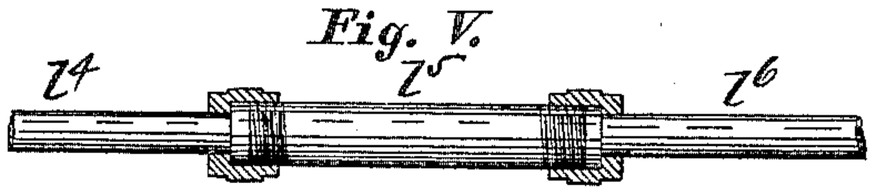
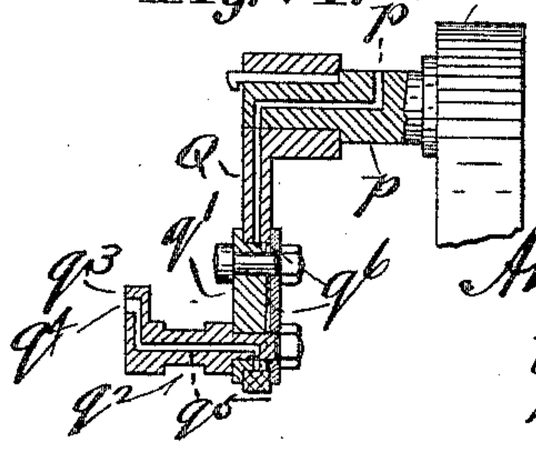


Fig. VI.



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A. J. VANDEGRIFT.

STEAM ENGINE.

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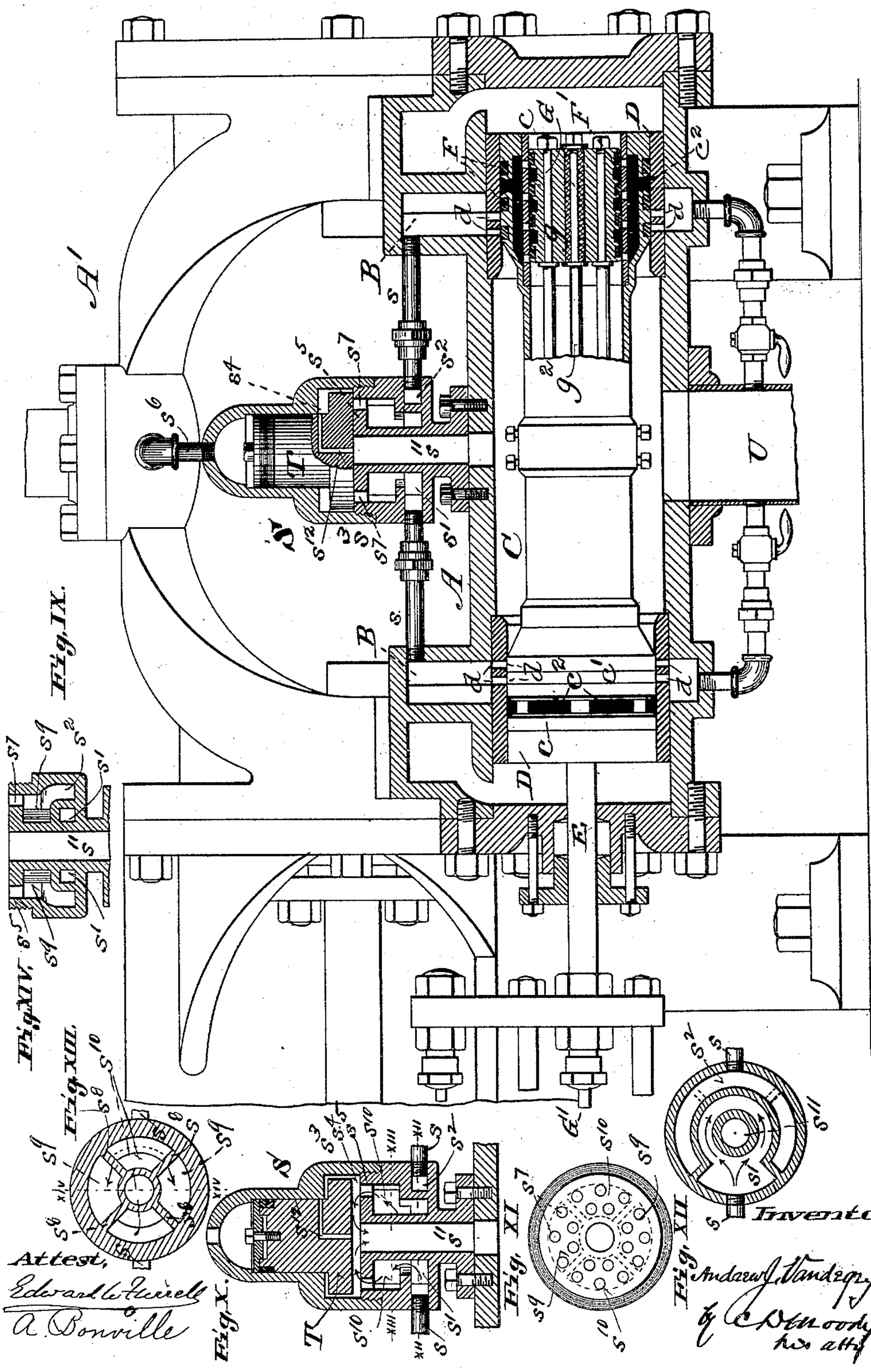

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A. J. VANDEGRIFT.

STEAM ENGINE.

No. 462,182. Patented Oct. 27, 1891.

Fig: XV.

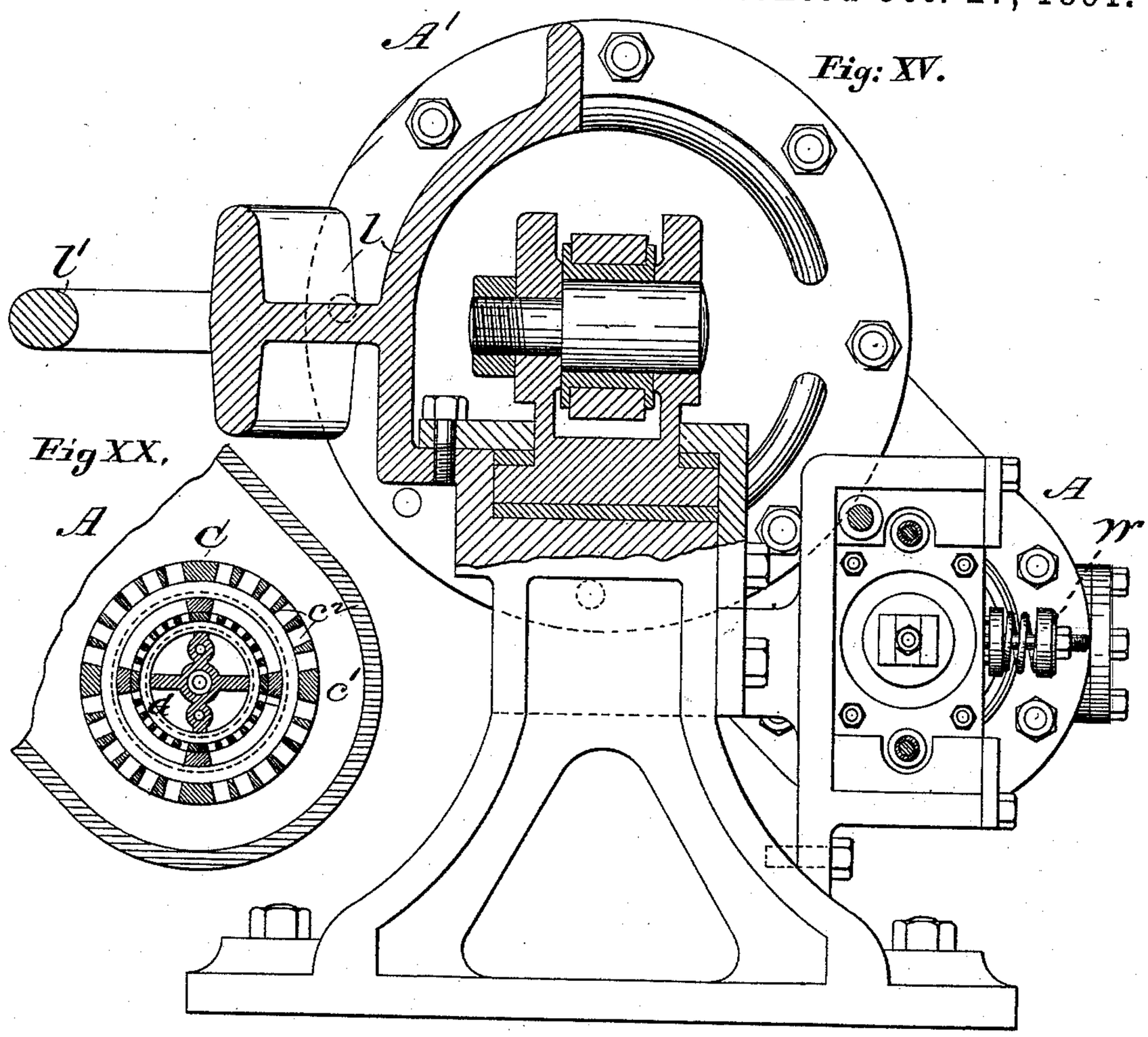


Fig XX.

Fig. XVI.

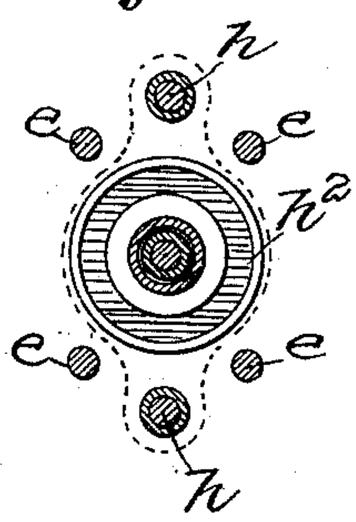


Fig. XVII.

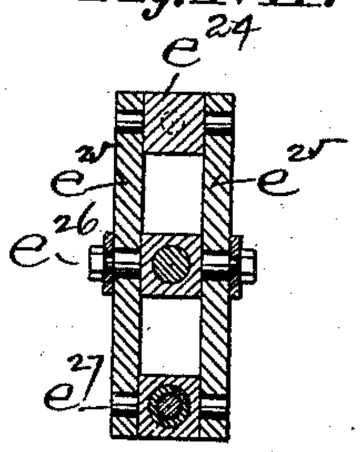


Fig. XVIII.

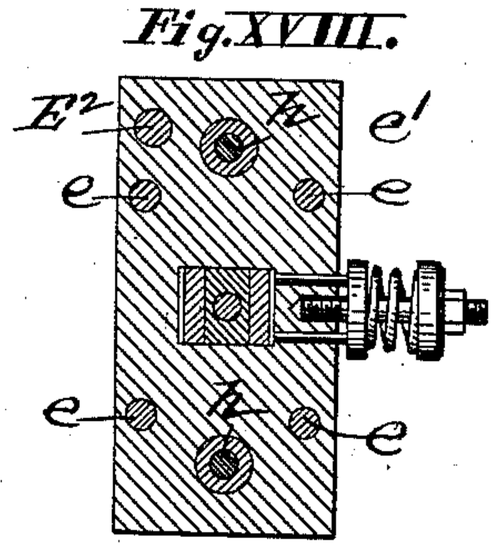
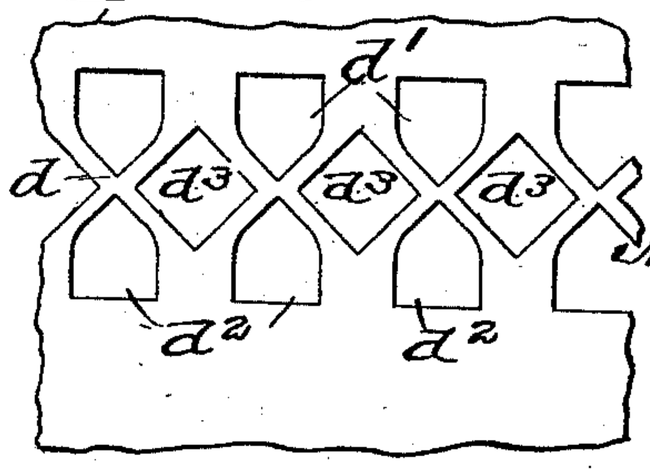


Fig. XIX.



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A. J. VANDEGRIFT.

STEAM ENGINE.

No. 462,182. Patented Oct. 27, 1891.

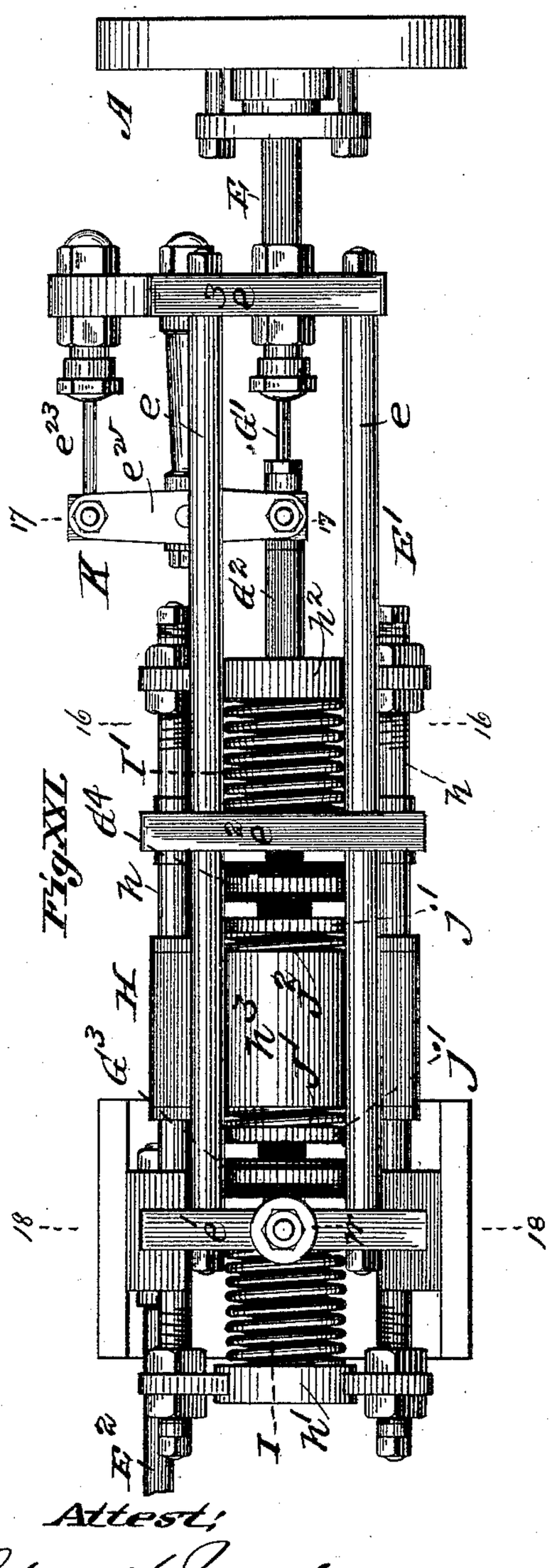

Fig. XXII.

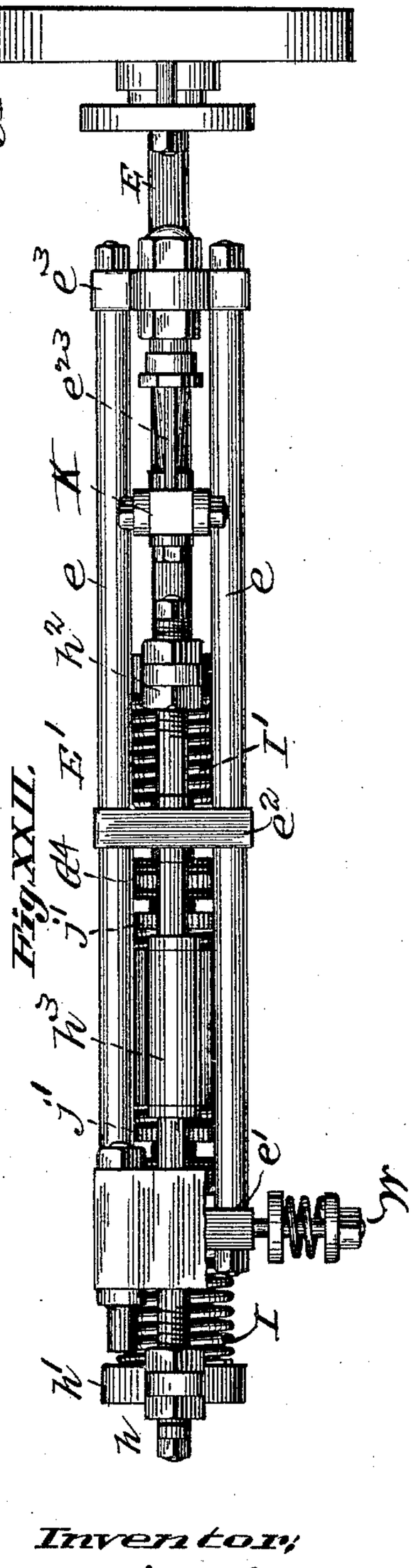

Fig. XXI.

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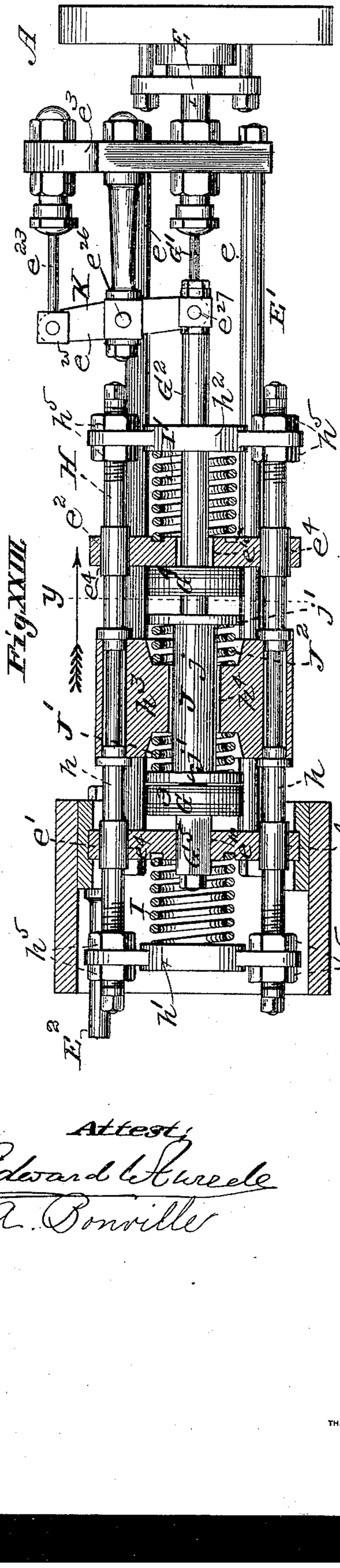
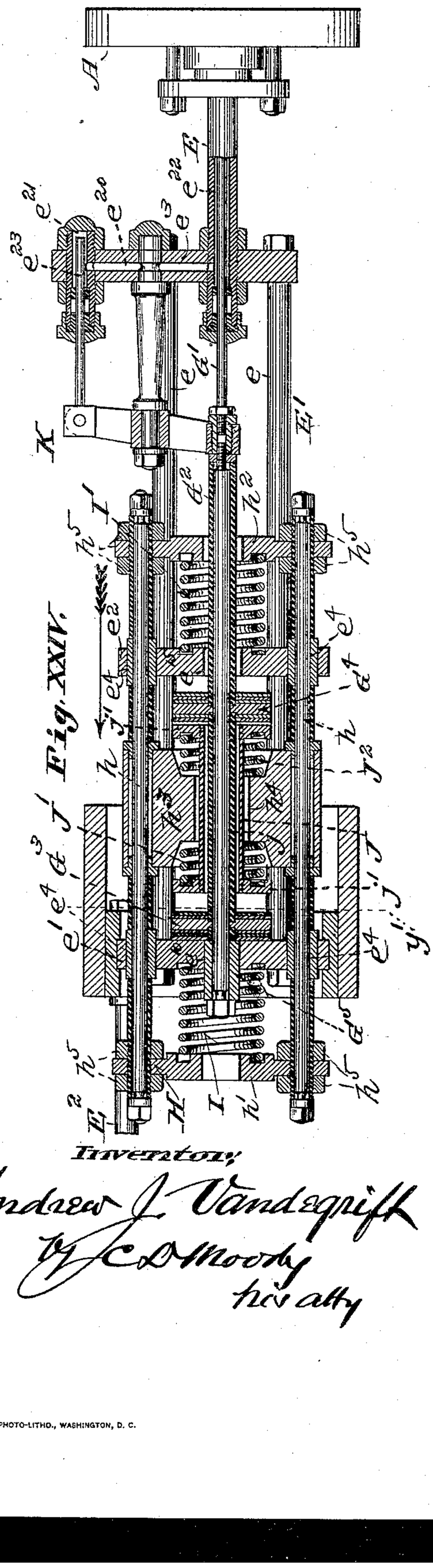
STEAM ENGINE.

No. 462,182. Patented Oct. 27, 1891.





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A. J. VANDEGRIFT.

STEAM ENGINE.

No. 462,182. Patented Oct. 27, 1891.

Fig. XXV.

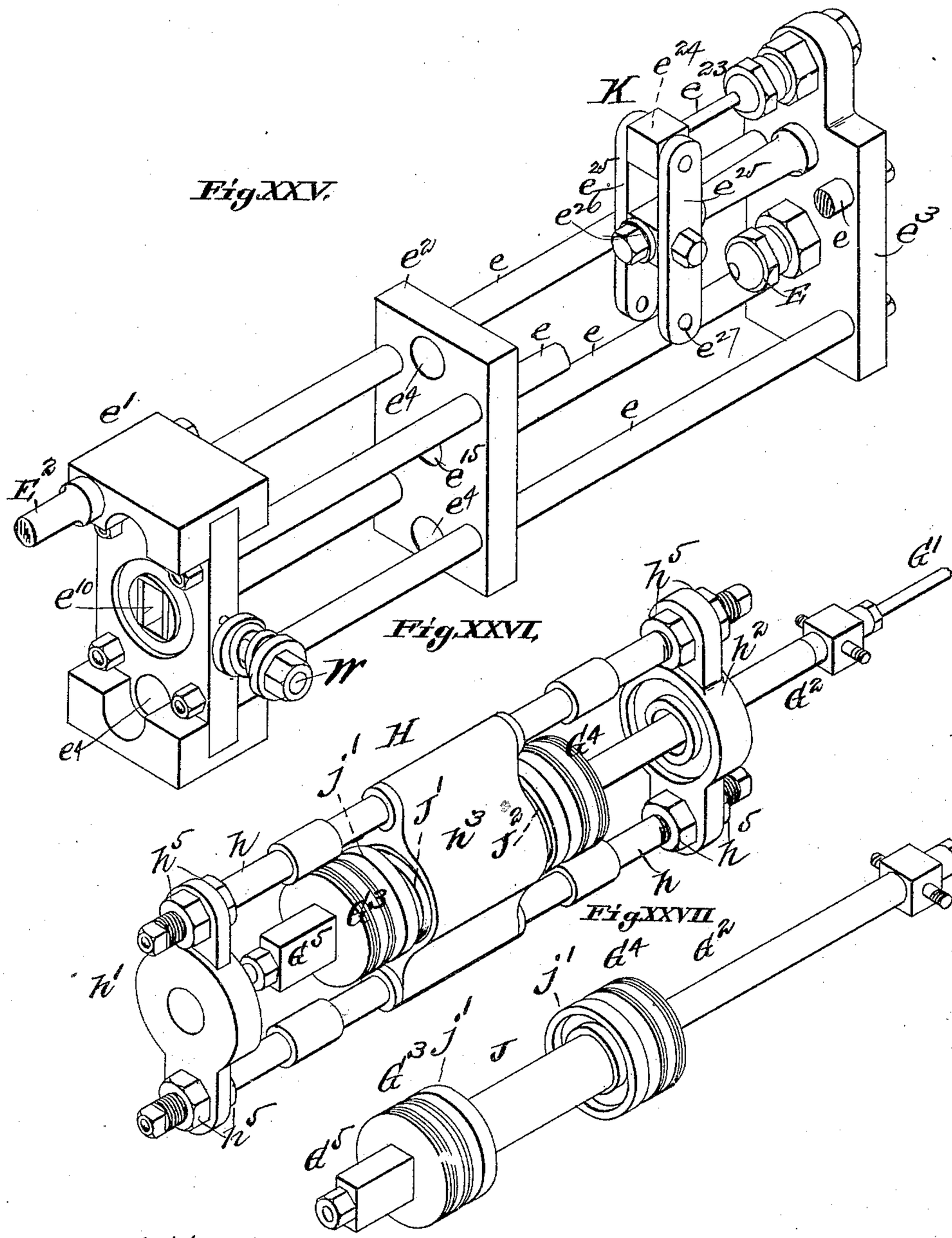

Fig. XXVI.

Fig. XXVII.

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A. Bonville.

Inventor;

Andrew J. Vandegrift

by C. B. Moody

his atty

UNITED STATES PATENT OFFICE.

ANDREW J. VANDEGRIFT, OF ST. LOUIS, MISSOURI.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 462,182, dated October 27, 1891.

Application filed January 3, 1891. Serial No. 376,612. (No model.)

To all whom it may concern:

Be it known that I, ANDREW J. VANDEGRIFT, of St. Louis, Missouri, have made a new and useful Improvement in Steam-Engines, of which the following is a full, clear, and exact description.

The improvement relates mainly, but not exclusively, to that class of steam-engines which are known as "automatic-cut-off engines," substantially as is hereinafter set forth and claimed, aided by the annexed drawings, making part of this specification, in which—

Figure I is a side elevation of the improved engine; Fig. II, a plan of the same; Fig. III, a horizontal section of the engine-cylinder, including parts immediately therewith connected; Fig. IV, a view, partly in elevation and partly in section, showing the plumber-block, the crank, the main-valve-rod-moving device, and the wrist-pin-oiling device; Fig. V, a view of the middle section of the engine-frame brace; Fig. VI, a sectional view of the wrist-pin-oiling device, the view being analogous to a portion of the construction shown in Fig. IV, but showing more of the parts in section; Fig. VII, a side elevation of the return-crank attached to the wrist-pin and used in operating the main-valve-rod-moving device; Fig. VIII, a view in perspective showing the disk carried by the crank last named; Fig. IX, a vertical longitudinal section of the valve-chest. The view shows the engine-cylinder in elevation beyond. Fig. X, a vertical central section of the relief device; Fig. XI, a top view of the relief-valve seat; Fig. XII, a horizontal section on the line 12 12 of Fig. X; Fig. XIII, a horizontal section on the line 13 13 of Fig. X; Fig. XIV, a vertical section on the line 14 14 of Fig. XIII; Fig. XV, a vertical cross-section of the engine-frame on the line 15 15 of Fig. II; Fig. XVI, a cross-section of the cut-off on the line 16 16 of Fig. XXI. Fig. XVII is a cross-section on the line 17 17 of Fig. XXI; Fig. XVIII, a cross-section on the line 18 18 of Fig. XXI; Fig. XIX, a detail, being a view of the ports used in the main-valve-chest linings; Fig. XX, a cross-section of the main and cut-off valves; Fig. XXI, a side elevation of the cut-off mechanism; Fig. XXII, a plan of the same; Fig. XXIII, a vertical longitudinal sectional view of the cut-off mechanism, the parts being as when the main-valve stem is moving toward the cylinder and the cut-off-valve stem has just completed its movement in the main-valve stem in the same direction; Fig. XXIV, a view of the parts shown in Fig. XXIII, but as when the valve-stems, respectively, are moving and have moved in the opposite direction; Fig. XXV, a view in perspective showing the frame which forms part of the main-valve stem, and which carries the cut-off-valve-operating mechanism; Fig. XXVI, a view in perspective showing the device carried by the main-valve-stem frame and used in operating the cut-off-valve stem, which is included in the view; and Fig. XXVII a view in perspective showing the outer portion of the cut-off-valve stem, and being that portion which is included in Fig. XXVI.

The views are not all upon the same scale.

The same letters of reference denote the same parts.

A represents the main-valve chest. Its steam-ports leading to the cylinder A′ are shown at B B. The main valve C is what is styled a "piston-valve," and having its ends *c* enlarged to fit the steam-chest opposite the ports B B, and between its ends being reduced in diameter, substantially as shown, to provide for the passage of the exhaust-steam to the escape. Opposite the ports B B the valve-chest is preferably furnished with linings D D, so that the main valve in its working does not come immediately into contact with the shell of the valve-chest, but is made to work in the linings D D. Each lining has a series of perforations *d*, extending around the lining for the passage of the steam to and from the ports. E represents the main-valve stem.

F F represent the packing-rings of the main valve, and F′ F′ those of the cut-off valve G. The steam passes from the main-valve chest to the cylinder as follows: The main valve is tubular, and the live steam which enters the chest passes first into the interior of the cut-off valve, alternately at opposite ends thereof, and from the interior it passes through the shell *c′* of the main valve into the perforations *d* in the lining D, and thence into the port B. The shell *c′* is suitably perforated or shaped at c^2 to provide for the passage of the steam, as described.

The cut-off valve G consists substantially

of two similar connected tubular-like parts, such as g, which are adapted to operate in connection with the main valve and with the ports B B. The preferable mode of uniting the parts g is by means of the rods g^2. The parts g can thus be moved forward and backward as one piece within the main valve. The cut-off-valve stem G′ extends longitudinally through the main-valve stem E, which is perforated to receive it.

As thus far described, the construction is substantially similar to that shown in Letters Patent No. 367,476, granted to me August 2, 1887, for an improvement in steam-engines.

The construction in the respect under consideration in a general way consists as follows: Of a tubular piston-valve adapted to be moved reciprocatingly in the valve-chest and having lateral perforations in its shell, through which the steam passes to the ports leading to the cylinder, and, second, of a tubular cut-off valve of the piston type adapted to be moved reciprocatingly with and at intervals held stationary within the main valve, and so as to open and close the lateral passages therein. The present construction, among others, differs in this respect. The cut-off valve is carried with the main valve, but in place of being at said intervals held stationary within the main valve is at those intervals caused to move upon the main valve, and thus to effect the opening and closing of the lateral passages referred to.

The construction and operation of the present cut-off valve and the parts more immediately therewith connected will now be described. The main-valve stem E after passing out through the head of the valve-chest takes the form of a frame E′, and beyond the frame it is extended at E^2 in the form of a rod to connect, and preferably in the manner hereinafter described, with the valve-rod-actuating mechanism—that is, the stem E, the frame E′, and the rod E^2 together move as one part and communicate the motion of the valve-rod-actuating mechanism to the main valve. The preferable form of the frame E′ is as follows: Four longitudinally-extended rods e e e e are attached to three cross-plates e', e^2, and e^3. The stem E is fastened, substantially as shown, to the cross-plate e^3. The rod E^2 is attached to the cross-plate e', substantially as shown. The cross-plate e^2 is secured to the rods e at a point between the positions of the cross-plates e' e^3, and in practice being somewhat nearer to the cross-plate e' than to cross-plate e^3, substantially as shown at G^2, and is provided with two tappets G^3 and G^4.

The stem-extension G^2 and tappets are held and are operated within or upon the frame E′, and as follows: H represents another frame. It is carried by the frame E′ in the movement of the last-named part but also movable therein, as presently described. It consists, substantially, of the longitudinally-extended rods h h, the end plates h' h^2, and an intermediate part styled the weight h^3. The described parts are relatively arranged and connected substantially as shown, the weight being midway between the end plates and the rods h being connected with the end plates, which are spaced farther apart than are the cross-plates e' e^2 of the frame E′. The frame H is sustained in position by means of its rods h h, which pass through perforations e^4 e^4 in the upper and lower parts, respectively, of the cross-plates e' e^2, and the springs I and I′. The spring I is arranged between the end plates h' and the cross-plate e'. The spring I′ is held between the cross-plate e^2 and the end plate h^2. The said end plates and cross-plates are suitably shaped, substantially as shown, to receive the ends of the springs so as to retain them in place. The cut-off-valve-stem extension G^2 works through the weight h^3, which is perforated at h^4 to receive said extension, and the tappets G^3 and G^4 come, respectively, beyond the opposite ends of the weight and between the cross-plates e' e^2, and the end G^5 of the stem-extension G^2 is squared, as shown, and works through a corresponding perforation e^{10} in the cross-plate e'. The cross-plate e^2 is perforated at e^{15} for the rod-extension G^2 to work through it. The weight h^3 is designed to coact with the tappets G^3 G^4 upon the stem extension G^2, the weight in moving in one direction striking one of the tappets and in moving in the opposite direction striking the other of the tappets; but it is preferable to impart the impulse elastically to the tappets, and to that end an intermediate device, consisting, say, of the spool J and the springs J′ J^2, is employed. The body j of the spool surrounds the stem-extension G^2 in the perforation h^4 in the weight, and the heads j' j' of the spool project beyond the ends, respectively, of the weight, and between the heads and the opposing ends, respectively, of the weight are the springs J′ J^2, substantially as shown. Thus constructed and combined the device J J′ J^2 becomes part of the weight and moves with it, and the frame H and the spool-heads are the parts which come immediately into contact with the tappets, respectively. The operation of this feature of the construction is as follows: Suppose the main-valve stem to be moving in the direction of the arrow in Fig. XXIII. The frame H, carrying the weight as described, moves with the frame E′, but at the same time is free to slip upon the frame E′. The rate of the movement of the frame E′ is variable, due to the movement of the return-crank. As that crank is moving toward its live-center the rate of the main-valve movement increases, and is most rapid as the crank passes its live-center, after which the movement of the main valve, including the frame E′, slackens; but as the frame H moves with the frame E′ it not only acquires the highest speed which the frame E′ acquires, but it also acquires a momentum due to its weight and speed, and when the frame E′

slackens its movement the frame H, being free, slips upon the frame E′ in the direction in which the main valve is moving. The frame H moves upon the frame E′ until that spool-head J′ or J², as the case may be, encounters and strikes that tappet upon the cut-off-valve-stem extension which is in the direction of the movement of the frame H. The cut-off-valve stem in consequence is at once sharply moved in the main-valve stem in the same direction with the main-valve stem, and the desired movement of the cut-off valve thereby effected.

In Fig. XXIII the parts are as when the weight has acted upon the tappet G⁴ and has caused the cut-off-valve stem to move to the right until the tappet G⁴ has encountered the cross-plate e^2. The movement of the cut-off valve has been effected, the combined frames E′ and H and both valve-rods are continuing to move to the right, and the frame H is still slipping upon the frame E′.

In Fig. XXIV the parts are arranged as when the main-valve rod is moving in the opposite direction to that of Fig. XXIII—that is, to the left, as shown. Thus at each half-stroke of the main valve in the manner described, the frame H moves upon the frame E′ in the direction in which the frame E′ is moving, and in its said movement some part of it—such as the parts herein described as connected with the weight—encounters a tappet upon the cut-off-valve rod, and thereby causes the cut-off valve to move upon the main valve and cut off the steam. The described movement of the frame H is according to the rate at which the main valve at its highest rate is moving. If faster, then the frame H moves more rapidly and acts sooner upon the cut-off valve. If slower, then the frame H moves less rapidly and acts later upon the cut-off valve. The springs I and I′ are of value not only as a means for adjusting the frame H evenly in the frame E′, but also in the regulation of the point at which the cut-off valve should operate. The right-hand spring I′, Fig. XXIII, has been compressed and is now expanding and aiding the frame H in its described movement to the right upon the frame E′. In Fig. XXIV the left-hand spring I has been compressed and is now expanding and aiding the frame H in its movement to the left upon the frame E′. After the cut-off valve has been thus moved to the right or left the spring I or I′ continues to expand and the frame H, carrying the weight, continues to follow the tappet just struck, but the spool-head does not quite overtake the tappet. The limits of the movement of the spool are indicated substantially by the broken lines $y\ y'$, Figs. XXIII and XXIV, respectively.

By means of the nuts $h^5\ h^5$ the end plates $h'\ h^2$ can be adjusted upon the rods $h\ h$, so as to compress the springs I I′ more or less between the end plates of the frame H and the cross-plates of the frame E′, and inversely to the degree of compression of said springs is the promptness with which the frame H acts to move the cut-off valve. The springs are needed for another reason. At each described half-stroke of the frame H upon the frame E′ one of the springs I I′ is being compressed, and the other of the springs, which at the previous half-stroke of the frame H has been compressed, is expanding. The expanding spring initiates and aids in effecting the movement of the frame H upon the frame E′—that is, as the frame H, by reason of its momentum is slipped upon the frame E′ it causes one of the springs I or I′ to be compressed, and as soon as the frame E′ moves in the opposite direction the compressed spring begins to expand and act upon the frame H. The described momentum of the frame H therefore acts indirectly as well as directly to produce its movement upon the frame E′.

With a cut-off-valve mechanism such as described, in which the cut-off valve is not moved positively by means of some other part attached to it, but is dependent upon its own momentum, it is essential that it be as free to move in one direction with the frame E′ as in the other direction with the frame E′. Accordingly an additional feature of the cut-off mechanism is the cut-off-stem equalizer K, by means of which the steam-pressure in the valve-chest is prevented from interfering with the proper working of the cut-off valve. A passage e^{20} is carried from the annular space e^{22} around the rod G′ within the rod E, through the cross-plate e^2 into a chamber e^{21}, in which a stem e^{23} of the same diameter as the rod G′ works. The stem e^{23} is attached to a block e^{24}, which in turn is jointed to links $e^{25}\ e^{25}$, pivoted at e^{26}, and jointed to a block e^{27} upon the rod G′. The steam-pressure by this means presses equally upon the stems e^{23} G′, and the cut-off-valve rod is thus balanced, and but for this the steam would exert a pressure upon the stem G′ due to its cross-sectional area, and the cut-off valve would move more easily outward than inward.

The engine-frame L is improved as follows: It consists of the girder l, connected at one end with the cylinder A′ and at the other end with the plumber-block M and the brace l'. The plumber-block is made unusually long, substantially as shown, and the girder leads from one end m of it to the cylinder, and the brace leads from the other end m' of the plumber-block and connects with the girder at or near its junction with the cylinder. By this means the plumber-block and the cylinder are very rigidly connected, and a very desirable bearing is provided for the main shaft N. Another feature of the frame is the provision whereby in larger engines it can be readily taken apart for the purpose of transportation. To this end the girder l is made in parts $l^2\ l^2$, which are adapted to be bolted together, as indicated at l^3, and the brace l' is made in sections l^4, l^5, and l^6. These brace-sections are screwed together when

used, as indicated, substantially in Fig. V, and the end sections l^4 l^6 are placed in position by screwing them, respectively, upon the plumber-block and the girder, substantially as shown.

It is well understood that a pitman moved by a crank or eccentric does not move a valve the same distance in the last quarter of the back stroke that it does in the last quarter of the forward stroke, owing to the fact that in the forward throw the last quarter of the stroke is completed as the pitman is approaching the line of motion, thereby adding to the distance moved, while on the last quarter of the back stroke as it approaches the line of motion it takes from the distance moved, and difficulty is accordingly experienced in adjusting the valve of a steam-engine in which a pitman and crank or eccentric are employed. To remedy this difficulty and obtain a more even movement for the main valve and the other parts therewith connected, I preferably do not connect the rod E^2 directly with any part—such as an eccentric—upon the main shaft, but with a part adapted to be moved evenly past the plane of the main shaft, and by this means secure an even movement for the main valve in its chest. This is accomplished, preferably, in the following manner:

O O′ represent a pair of parallel bars pivoted at their ends o o to enable them to be tilted toward and from the main-valve chest. The rod E^2 is jointed at o' to the bar O′. The bars are jointed at o^2 o^2, respectively, to a frame o^3, which is slotted vertically at o^4. A slide o^5 is held and adapted to be moved vertically in said slot.

P represents the crank attached to the main shaft N, and p is the wrist-pin upon the crank. The wrist-pin has keyed to it a return-crank Q. The return-crank points from the wrist-pin toward and past the center x of motion or longitudinal axis of the main shaft. The return-crank is perforated at q to hold the disk q'. The disk in the rotation of the main shaft and crank P is carried around with the return-crank Q. The disk is provided with a wrist-pin q^2. This last-named pin is connected with a disk eccentrically, and it is journaled in the slide o^5, by means of which arrangement the slide in the rotation of the disk q^2 is caused to move in an orbit around the center of motion of the main shaft. In consequence of this the parallel bars are caused to turn on their pivots o o, and the desired movement of the main valve is thereby effected.

Advantage is taken of the parts last above described to provide means for oiling the wrist-pin q as follows: The wrist-pin q^2 upon the outer side of the slide o^5 is extended, as shown at q^3, in the form of a small return-crank to come opposite the central portion of the main shaft. At this point is an inlet q^4 to a passage q^5, which leads through the wrist-pin q^2, thence into a groove q^6 in the periphery of the disk q', thence through the return-crank Q, and thence through the wrist-pin p to the surface thereon at p', where the pitman R is applied to the wrist-pin. By introducing oil into the inlet q^4 it is carried by reason of the centrifugal action into the passage q^5 and along the same and the oil ultimately finds its way to the point p'. The disk is preferably made in two parts q^{10} and q^{15}, which are bolted together by means of the wrist-pin q^2 and another bolt q^{20}. The part q^{10} is grooved in its periphery to form the passage q^6.

S represents a device for relieving undue pressure in the cylinder or main-valve chest in those steam-engines in which a piston-valve is used, and it is especially useful at those times when the exhaust is cut off and the stroke of the engine has not yet been completed, as is apt to occur in a cutting-down engine or reversing-engine, such as a locomotive-engine. By means thereof excessive pressure within the parts named can be relieved without waste of the live steam. Its leading feature is a valve-chamber connected with both ends of the cylinder and main-valve chest and containing a valve which controls the escape of said pressure from the cylinder and chest, but which is held to its seat by means of the live-steam pressure acting through a passage disconnected from those used in effecting the described relief, but which is insufficient to keep the valve seated when the pressure which has to be relieved exceeds that produced upon the valve by the live-steam pressure. When such excess of pressure occurs, the valve unseats and the relief may be to the exhaust or to the other end of the cylinder or chest, or to both. The preferable construction for the purpose in question is the one exhibited. Leading from the ports B B are tubes s s, which connect, respectively, with the compartments s' s^2 in the relief-valve chamber s^3. T represents the relief-valve. It is contained and adapted to rise and fall in the compartment s^4 of the valve-chamber above the valve-seat s^5. The compartment s^4 at a point above the relief-valve and by means of the tube s^6 is connected with the main steam-supply, and accordingly the working steam-pressure is upon the upper end of the relief-valve. In the valve-seat are a number of perforations s^7, through which the pressure to be relieved flows. Beneath the valve-seat by means of the vertical partitions s^8 the interior of the valve-chamber above the compartments s' s^2 is divided into four compartments s^9 s^9 and s^{10} s^{10}. The perforations s^7 in opposite quarters of the valve-seat connect with two s^9 s^9 of said compartments, and in the other opposite quarters of the valve-seat the perforations connect with the other two s^{10} s^{10} of said compartments, thereby preserving an equilibrium and enabling the valve to rise and fall evenly. The compartments s^9 s^9 connect with the compartment s^2, and the other two compartments s^{10} s^{10} connect with the compartment s'. The action is as follows:

If excessive steam-pressure occurs at one end of the cylinder or valve-chest, the steam passes through that tube *s* which connects with that end of the cylinder or valve-chest, and thence into the compartment *s'* or s^2, as the case may be, and thence the steam passes up through either the compartments s^9 s^9 or the compartments s^{10} s^{10}, and through those of the perforations in the valve-seat which are above the compartments through which the steam has passed, and lifting the relief-valve evenly from its seat, and thence passing downward through other of the perforations in the valve-seat and through the other of the compartments s^{10} s^{10} or s^9 s^9, as the case may be, and ultimately through the other passage *s* into the other end of the valve-chest and cylinder. In the central part of the relief-valve chamber is a port s^{11}, which leads through the valve-seat to connect with that part of the main-valve chest which leads to the exhaust U. Two exits for the described excessive steam-pressure are thus provided—namely, either to the exhaust or to the other end of the valve-chest and cylinder. Any pressure which leaks downward between the valve and wall of the valve-chamber can escape through the passage s^{12} in the relief-valve to the port s^{11} and thence to the exhaust.

In Fig. XIX is shown the preferable form of perforations to be used in the valve-chest linings D for the described passage of the steam. They provide amply for the passage of the steam. The perforations are also so shaped and relatively arranged as on the one hand to prevent the valve-packing rings from protruding so as to catch in the perforations, and on the other hand to provide a continuous surface for the valve and its parts to work evenly upon. It will be noted that the perforations in question are in three rows, an outer row *d'*, in which the perforations are square at the outer end thereof, and extending thence inward the full width substantially of said outer end, and then tapering substantially as shown; second, an inner row d^2, in which the perforations are similar to those just described, but pointing in the opposite direction, and, third, an intermediate row d^3 of square-shaped perforations, arranged to point between the perforations in the rows *d'* d^2, substantially as described.

W represents a brake for regulating the speed of the cut-off-valve stem. This brake in itself is similar substantially to the one shown in the patent above referred to; but it works to especial advantage in the present construction and in connection with the squared portion G^5 of the cut-off-valve stem. By tightening a brake upon said portion the speed is increased and by loosening the brake the speed is diminished.

In carrying out the present improvement I desire not, saving in respect to the relief device, to be restricted to a piston-valve engine, as nearly, if not quite, all of the other described features of the improvement can be used in many forms of steam-engines.

I claim—

1. In an automatic-cut-off steam-engine, a main-valve rod having a weight sliding thereon and actuating a cut-off-valve rod.

2. In an automatic-cut-off steam-engine, a main-valve rod carrying a weight, said weight sliding upon said rod in the direction of its movement, substantially as and for the purpose set forth.

3. In an automatic-cut-off steam engine, a main-valve rod carrying a weight, said weight sliding upon said rod in the direction of its movement and actuating a cut-off-valve rod.

4. In an automatic-cut-off steam-engine, a main-valve rod carrying a weight, said weight in the movement of said rod moving with and at times faster than said rod, for the purpose described.

5. In an automatic-cut-off steam-engine, a main-valve rod carrying a weight, said weight in the movement of said rod moving with and at times faster than said rod and actuating a cut-off-valve rod.

6. In an automatic-cut-off steam-engine, a main-valve rod carrying a weight which in the movement of said rod is impelled by said rod to move upon said rod in the direction in which said rod is moving, for the purpose described.

7. In an automatic-cut-off steam-engine, a main-valve rod carrying a weight which in the movement of said rod is impelled by said rod to move upon said rod in the direction in which said rod is moving and when thus impelled actuating the cut-off-valve rod.

8. In an automatic-cut-off steam-engine, a main-valve rod carrying a weight which in the movement of said rod is impelled by said rod to move upon said rod in the direction in which said rod is moving, said impulsion being imparted to said weight by means of springs which in turn are supported from said rod, substantially as and for the purpose described.

9. In an automatic-cut-off steam-engine, a main-valve rod which alternately acts in the direction in which said rod is moving to move a weight adapted to move upon said rod, for the purpose described.

10. In an automatic-cut-off steam-engine, a main-valve rod provided with springs and also with a weight, said springs in the movement of said rod alternately acting to move said weight in the direction in which said rod is moving to effect the movement of a cut-off valve.

11. In an automatic-cut-off steam-engine, a main-valve rod provided with springs and with a weight, said springs in the movement of said rod alternately acting to move said weight in the direction in which said rod is moving upon said rod and effect the movement of a cut-off valve in the same direction in which the main valve is moving.

12. In an automatic-cut-off steam-engine, a weight adapted to slide upon said rod to and fro in the direction in which said rod is moving, and as it slides to strike and thereby sharply impel a cut-off-valve rod.

13. In an automatic-cut-off steam-engine, a main-valve rod carrying two springs, and an interposed weight, said springs in the movement of said rod alternately acting to move said weight, and in such work being supported from said rod, and one of said springs being contracted as the other thereof is expanding and moving said weight.

14. In an automatic-cut-off steam-engine, a cut-off-valve rod whose movement is actuated by a part sliding upon the main-valve rod in the same direction in which said main-valve rod is moving.

15. The combination of the rod E, the frame E′, the rod-extension E^2, the frame H, carrying the weight and the springs I and I′, and the cut-off-valve rod provided with the tappets, substantially as described.

16. The combination of the frame E′, the frame H, having the weight h^3, and the spool J and springs J′ J^2, the springs I and I′, the cut-off-valve rod, and the tappets, substantially as described.

17. In an automatic-cut-off steam-engine, the combination of the tubular main-valve rod, the cut-off-valve rod and the equalizer device K, substantially as described.

18. The combination of the main-valve rod, the pivoted parallel bars O O′, the slotted frame o^3, the slide o^5, and the wrist-pin q^2, substantially as described.

19. In a steam-engine, the combination of the valve-rod and the pivoted parallel bars O O′, substantially as and for the purpose described.

Witness my hand this 30th day of December, 1890.

ANDREW J. VANDEGRIFT.

Witnesses:

C. D. MOODY,

B. F. REX.