No. 748,192. PATENTED DEC. 29, 1903.

J. KNOWLES.

VALVE.

APPLICATION FILED MAR. 24, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 2.

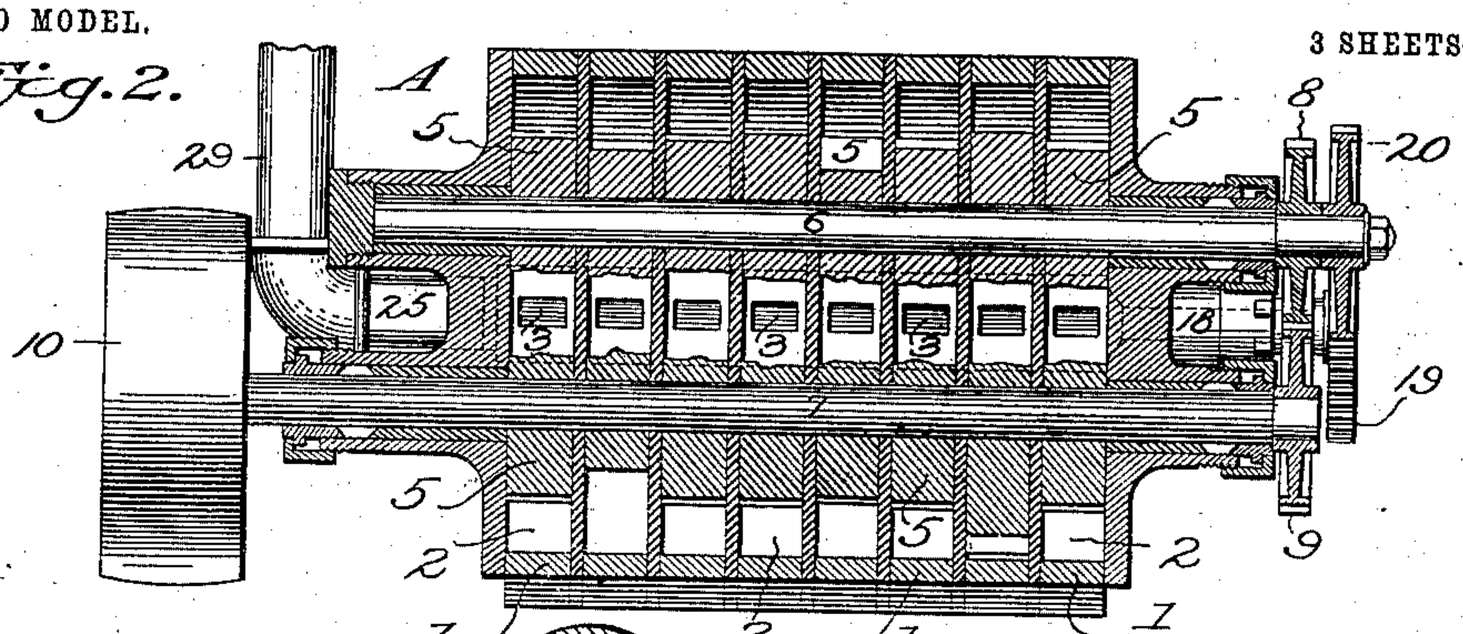

Fig. 1.

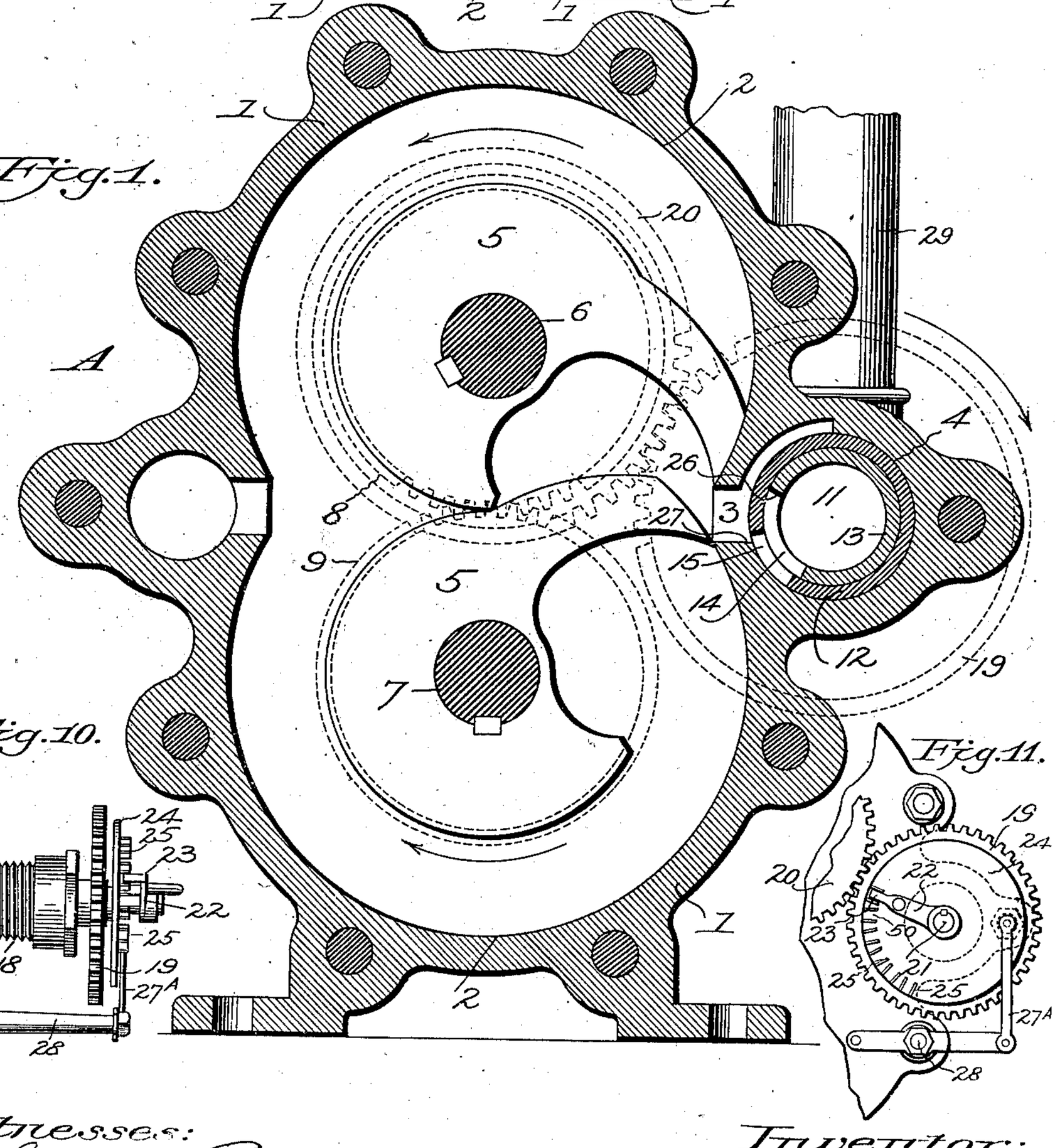

Fig. 10.

Fig. 11.

Witnesses:
G. Sargent Elliott
Joseph Nickinson

Inventor:
John Knowles
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Attorney.

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NO MODEL. 3 SHEETS—SHEET 2.

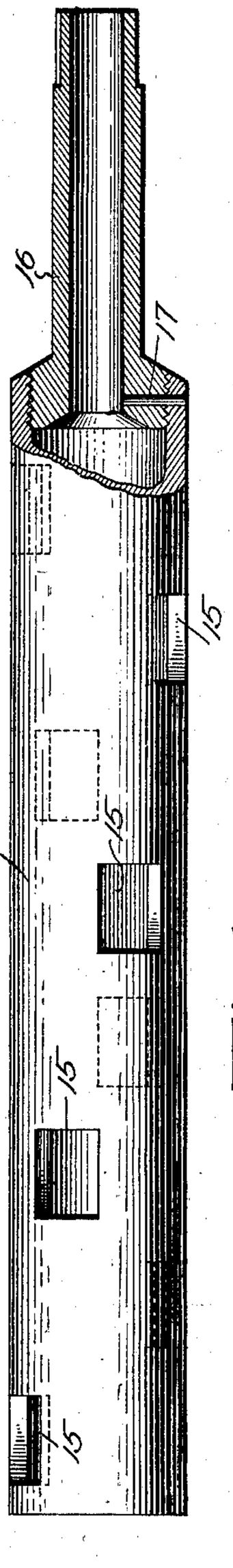

Fig. 3.

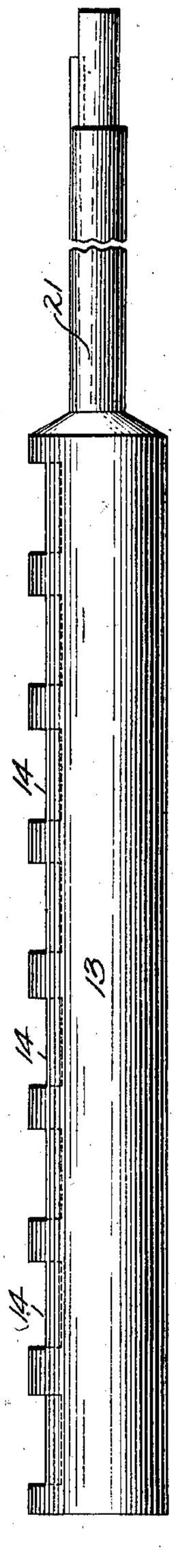

Fig. 4.

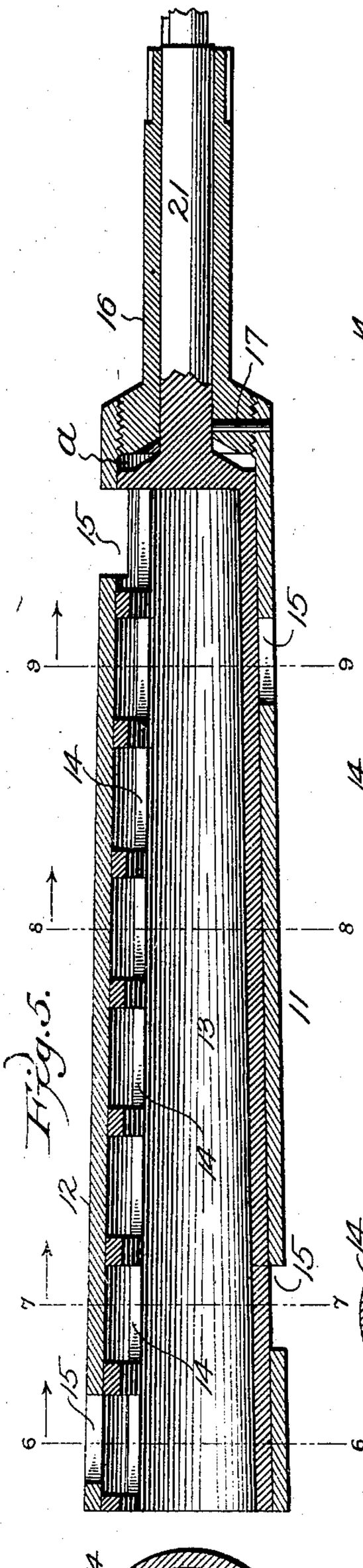

Fig. 5.

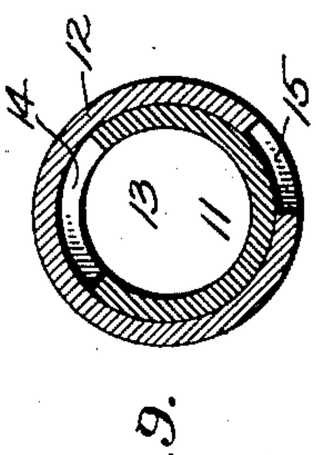

Fig. 9.

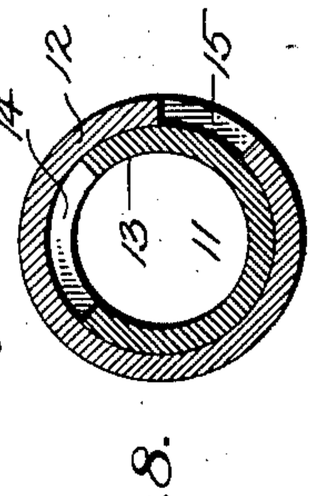

Fig. 8.

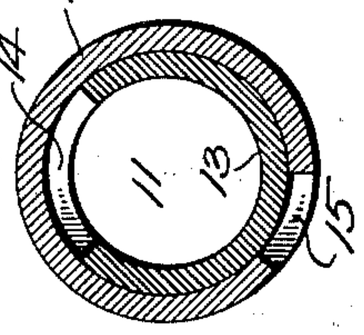

Fig. 7.

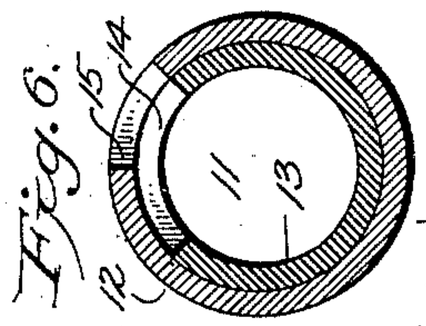

Fig. 6.

Witnesses:
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No. 748,192. PATENTED DEC. 29, 1903.

J. KNOWLES.

VALVE.

APPLICATION FILED MAR. 24, 1903.

NO MODEL. 3 SHEETS—SHEET 3.

Fig. 12.

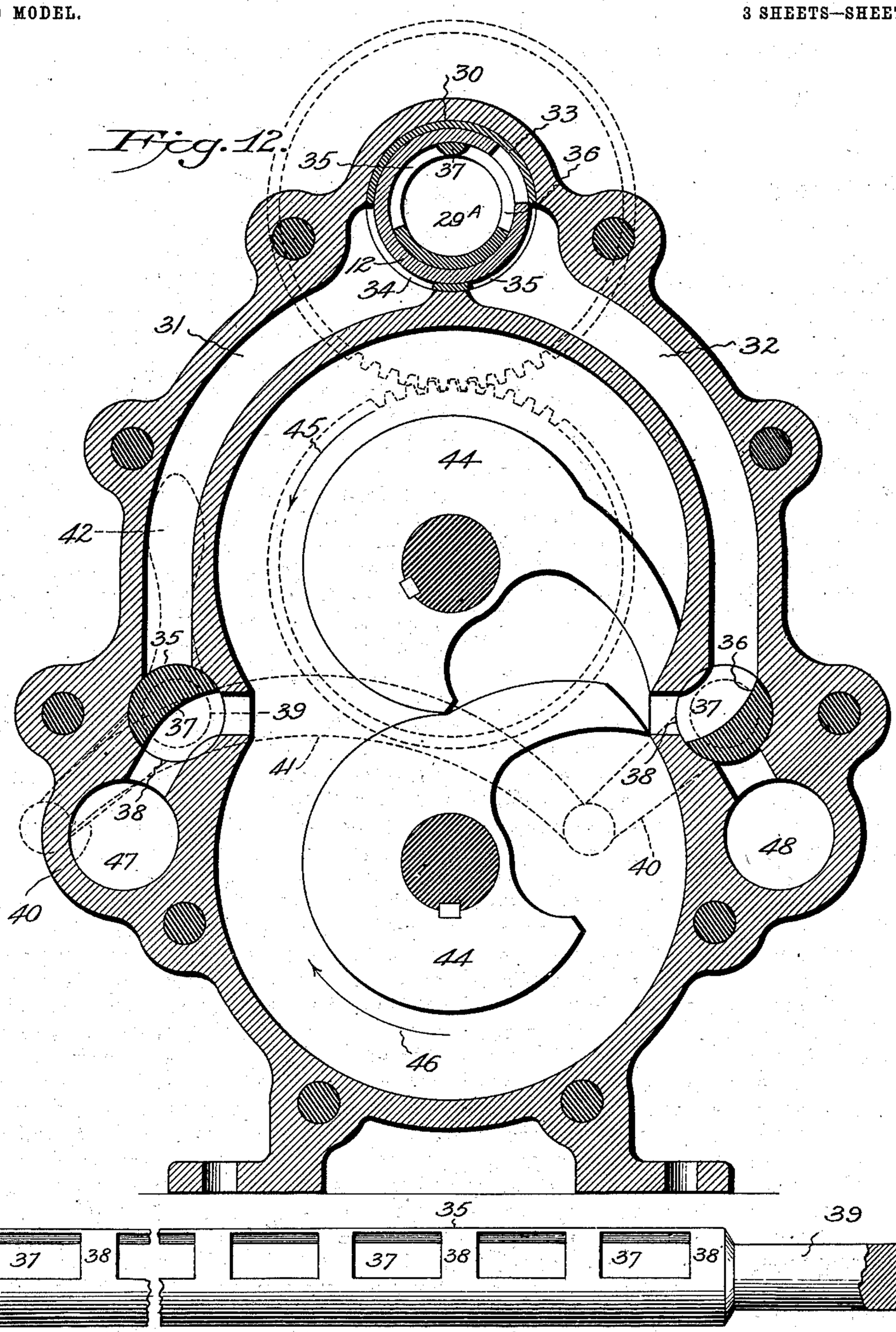

Fig. 13.

Witnesses

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Joseph Wilkinson

Inventor:

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No. 748,192. Patented December 29, 1903.

UNITED STATES PATENT OFFICE.

JOHN KNOWLES, OF COLORADO SPRINGS, COLORADO.

VALVE.

SPECIFICATION forming part of Letters Patent No. 748,192, dated December 29, 1903.

Application filed March 24, 1903. Serial No. 149,329. (No model.)

To all whom it may concern:

Be it known that I, JOHN KNOWLES, a citizen of the United States of America, residing at Colorado Springs, in the county of El Paso and State of Colorado, have invented certain new and useful Improvements in Valves; and I do 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, reference being had to the accompanying drawings, and to the figures of reference marked thereon, which form a part of this specification.

My invention relates to improvements in valves for steam-engines, pumps, and air-compressors, but especially for steam-engines of the rotary type.

The objects of the invention are to provide a valve comprising a steam-distributer and a variable cut-off adapted to cut off and use the steam expansively at several predetermined parts of the operative travel of the pistons; to provide a valve by which the steam may be cut off at any desired part of the stroke or travel of the pistons; to provide a valve that will permit a quarter or a half or three-quarters of the whole mechanical horse-power of the engine to be used at the will of the operator. I attain these objects by the mechanism illustrated in the accompanying drawings, in which—

Figure 1 is a transverse sectional view through a rotary engine, showing the position of my improved valve, the cut-off of which is set so that the full horse-power of the engine may be utilized. Fig. 2 is a longitudinal sectional view through a rotary engine, comprising a plurality of cylinders and pistons and showing the ports which connect the cylinders with my improved valve, which is shown in dotted lines. Fig. 3 is a side elevation, partly in section, of the steam-distributer or outer shell of my improved valve. Fig. 4 is a side elevation of the cut-off or inner shell thereof. Fig. 5 is a longitudinal sectional view of a modified form of my improved valve in which the distributer and cut-off are shown tapered, the cut-off being shown in position within the distributer. Figs. 6, 7, 8, and 9 are transverse sectional views on the lines 6 6, 7 7, 8 8, and 9 9, respectively, of Fig. 5 looking in the direction of the arrows. Fig. 10 is a fragmental side view illustrating the crank-arm for turning the cut-off, and Fig. 11 is a front elevation of the same. Fig. 12 is a sectional view of an engine, showing my valve in section and designed as a reversible valve for reversing the movement of the pistons of the engine. Fig. 13 is a side elevation of the combined steam-inlet and steam-exhaust valves shown in the section in Fig. 12.

Referring to the accompanying drawings, the letter A designates an engine which is similar in design and operation to that described and illustrated in Patent No. 667,713, which was issued to me on February 12, 1901, and in application Serial No. 124,582, filed September 23, 1902. I employ this form of engine to more clearly illustrate the operation of my improved valve, though it will be understood that the valve is applicable to any style of rotary engine employing a plurality of coöperating cylinders. This engine comprises a plurality of cylinders 1, each of which comprises a pair of coöperating piston-chambers 2, which are arranged one above the other and intersect each other, so as to form an oblong chamber with circular ends. The cylinders are bolted together in axial alinement between front and rear cylinder-heads, and each cylinder is provided centrally and at one side with steam-inlet ports 3, which communicate with a valve-port 4, which extends lengthwise of the engine and from one end to the other. Each cylinder is provided with a pair of coöperating rotary pistons 5, which are rigidly attached to shafts 6 and 7, which extend through the engine and are provided with intermeshing gears 8 and 9 at one end, while one of the shafts is provided with a pulley 10 at its opposite end.

The numeral 11 refers to my improved valve, which is located within the valve-port 4 so as to communicate with the cylinder-ports 3. This valve comprises a tubular outer sleeve 12, which is fitted closely but revolubly within the said valve-port and which I term the "steam-distributing" valve, and a cut-off valve 13, which is also in the form of a tubular sleeve and is revolubly mounted within the steam-distributing valve. The cut-off valve is provided with a number of ports 14, corresponding to the number of cylinders of

the engine and arranged in a straight line, each of said ports registering with one of the cylinder-ports 3. The ports 14 consist of apertures or slots which are cut through the periphery of the shell of the valve. The distributing-valve 12 is also provided with ports 15, corresponding in number to the parts in the cut-off and positioned to register with the ports of the said cut-off valve, so that as the distributing-valve rotates the ports as they register will form a continuous passage from the interior of the cut-off valve to the cylinder of the engine. The ports 15 are smaller in area than the ports in the cut-off valve and comprise apertures which are cut through the periphery of the shell. The ports 15 of the steam-distributing valve may be arranged in any desired order on the periphery thereof. In Fig. 3, however, I have illustrated the ports arranged in spiral order and at the same time arranged opposite one another in pairs, commencing at either end of the valve. The second port from the end is placed opposite the first port at that end, the next two ports are opposite one another, and so on throughout the length of the valve, though, if preferred, they can be arranged in a true spiral line from one end of the valve to the other. Thus the order of arrangement of these ports may be varied as may be desired so long as they are positioned to give each cylinder steam at each full revolution of the valve.

The distributing-valve 12 is interiorly threaded at one end, and a tubular valve-stem 16 is threaded to it and is prevented from becoming disconnected from the valve by a pin 17, which passes through the valve and stem. The valve-stem 16 passes through a suitable stuffing-box 18 on the forward cylinder-head, and a gear-wheel 19 is keyed or otherwise secured to it, which meshes with a gear 20 of corresponding size on the outer end of the upper piston-shaft, so that the distributing-valve and the piston-shaft will revolve in unison. The cut-off valve 13 is also provided with a valve-stem 21, which fits revolubly in the tubular valve-stem 16 and extends through and beyond the same, and its free end is provided with any suitable means for turning the cut-off so that the steam may be cut off at any desired part of the operative travel of the rotary pistons, as will more fully hereinafter appear. This may be accomplished by a crank-arm 22, which is suitably secured to the end of the stem 21 and which may be provided with a pointer 23, which moves over a suitable dial, so that the cut-off may be turned any desired distance. I am also able to automatically manipulate the cut-off valve to cut off or to increase the port opening under varying loads upon an engine and by the following mechanism: Upon the stem of the cut-off valve I mount loosely a disk 24, which is provided with a segmental row of lugs 25, that project from the side of the disk opposite to the pointer, which are spaced at a suitable distance apart to allow the pointer to rest between any two lugs. To the opposite side of the disk near its peripheral edge I pivotally secure a rock-arm 27^A, which is pivoted intermediate of its ends to the end of a bracket-bolt 28, that projects from the adjacent cylinder-head. The free end of this rock-arm may be connected in any suitable manner to any suitable form of an engine-governor which I do not illustrate, but which may be arranged in any suitable manner to move the rock arm and lever and turn the disk and the pointer and crank-arm and cut-off valve to open the ports and increase the volume of steam or to close them and cut off the steam to suit varying loads an engine may be subjected to. The steam-inlet to the valve is in the rear cylinder-head, into which the rear end of the valve preferably projects a short distance, as shown in dotted lines in Fig. 2, and a threaded hole is formed in the said head at this point, into which a pipe 29 is screwed, which connects with a suitable steam-supply.

In Fig. 5 I have illustrated a modified form of my improved valve in which the same is shown tapered from its rear to its forward end. This construction provides for taking up the wear of the steam-distributer and cut-off and for always maintaining a steam-tight connection between them. The ports 14 of this cut-off are slightly longer than the ports 15 of the distributer, and at the forward end of the valve a vertical space *a* is left between the end of the cut-off and the threaded end of the stem of the distributing-valve. Now as the surfaces of the distributer and cut-off become worn the cut-off is drawn forward in the distributer, so as to keep a close joint between them, and its ports 14 being of greater length than the ports 15 of the distributer will not diminish the area of the latter ports as the cut-off is moved forward. Thus a simple and thoroughly-effective means is provided for taking up the wear in the valve and for maintaining a steam-tight connection between the members. In all other respects this valve is identical with the valve hereinbefore described.

In Figs. 12 and 13 I illustrate my improved valve adapted to be used to control a reversible engine, in which case it is especially adapted for use with marine and hoisting engines. This reversible valve 29^A comprises the cut-off and steam-distributing-valve, with a slightly different arrangement of the cut-off valve, the steam-distributing valve being arranged the same as in the direct valve. These two valves are seated in a circular port 32, which is located, preferably, centrally at the top of the engine and at the intersection of two ports, 31 and 32, that extend to opposite sides of the cylinder in operative relation to the pistons. The steam-distributing valve 12 is preferably seated in a bushing 33 of suitable material, which is seated in

the port 30 and which is provided with ports 34 and 35, which register with the steam-passages of the engine. The steam-distributing valve is exactly like the valve used in the non-reversible engine. The cut-off valve, however, is constructed with a pair of ports 35 and 36 of equal size arranged side by side in the rotative axis of the valve and separated from one another by an axial rib 37, which extends the entire length of the valve and divides each pair of ports which are arranged along the valve on each side of the rib in the same manner as in the valve in Fig. 13. At the entrance of the steam-passages 31 and also 32 into the cylinders I place suitable valves 35 and 36. The valve 35 is shown closed, while the valve 36 is shown open, and to reverse the direction of movement of the engine it is necessary to close the valve 36 and open the valve 35, which will reverse the rotary direction of the steam-distributing valve, allowing the steam to flow through the steam-passage 31 to the valve 35. These valves 35 and 36 comprise cylindrical stems with ports 37 cut in them. Each of these ports comprises a recess cut diametrically through the periphery of the stem at equal distances apart throughout the length of the valve, leaving semicircular integral disk portions 38 between the ports, the ports being in area practically one half of the circumference of the tubular valve and the blank portion the other half. The ports of these valves register opposite the steam-passages of each cylinder of the engine. (Shown in Fig. 12.) These valves are each provided with an extension 39, which projects through suitable stuffing-boxes formed on the cylinder-heads. The extension 39 projects beyond their stuffing-boxes, and these are connected together by any suitable device that will move both at the same time and reverse their positions, so that the one that is closed will be opened and the one that is open will be closed. I preferably use for this purpose a crank-arm 40, which is secured to the end of each extension, the free ends of which are connected together by an arm 41, which is provided with a handle 42. This construction, which is shown in Fig. 12 in dotted lines, is fully shown and described in the application above mentioned. They are reversed, because while the reversing-valve will deliver steam to either side of the engine and will run it in either direction nevertheless the engine cannot be reversed when running in one direction until these valves are reversed. The reversing-valve is operated in the same manner as the direct form of valve shown in the other views; but the steam flows into both of the steam-passages 31 and 32 of the cylinder as the distributing-valve rotates; but as the passage 31 is closed by the valve 35 the steam passes through the passage 32 and the valve 36, which is open into the cylinder 43 between the pistons 44, rotating them in the direction of the arrows 45 and 46. The exhaust-steam passes out through the exhaust-valve 35 into the exhaust-passages 47 and 48 to the atmosphere. To reverse the direction of the engine, it is only necessary to move the handle 42 to close the valve 36 and open the valve 35. The steam from the distributing-valve will then flow through the passage 31 and valve 35 and rotate the pistons 44 in the opposite direction, and the exhaust-steam will escape through the valve 36 and the passages 49 and 50. As soon as the rotative direction of the pistons is reversed the direction of movement of the distributing-valve is also reversed and through the medium of the gears connecting the shafts of the pistons and the stem of the distributing-valve.

The cut-off valve may also be connected to a suitable adjustable index mechanism, which may be arranged in any suitable manner, and may also be attached to an engine-governor in such a manner as to automatically regulate the amount of cut-off to varying speeds and loads.

The operation of my improved valve is as follows: Steam is admitted to the interior of the cut-off valve through the pipe 25. The cut-off valve is stationary, but its position is adjustably changeable by hand through the medium of the crank-arm 22, which is secured upon its stem and by which the cut-off has previously been set at the desired position. The steam-distributing valve revolves on the cut-off continuously while the piston revolves, and it is geared to the upper piston-shaft, so as to revolve in unison with the said shaft and its piston. The steam passes from the interior of the cut-off valve through its ports and the ports of the revolving steam-distributing valve into the cylinder through the cylinder-ports 3 and forces the rotary pistons around, as indicated by the arrows in the drawings. The steam may be admitted into the cylinders consecutively or into each alternate cylinder, as illustrated by the arrangement of ports in the distributing-valve shown in Fig. 3, or in any desired order. In order to use the steam expansively at any desired point of cut-off, it is only necessary to turn the cut-off valve by means of the pointer, so that the space between the edges 26 of its ports and the opposite edges 27 of the cylinder-ports will be increased or diminished, as may be desired. Thus the port of the cut-off valve is wide open in Fig. 1, and when it is desired to cut off at one-sixth of the operative stroke or movement of the pistons it is only necessary to spring the pointer back out of the notch it is shown in in Fig. 11, which indicates the cut-off edge 26 of the port of the cut-off valve to the notch 50, which will move the port of the cut-off valve, so as to reduce the opening formed by its ports and the cylinder-ports one-sixth of their area, and as the distributing-valve rotates around the cut-off valve it will close its ports one-sixth quicker. A suitable governor will then automatically

adjust the cut-off to compensate for any varying loads the engine is subject to.

I am not only able to use steam expansively by the employment of my improved valve, but I am also enabled to develop several different horse-powers. Thus if the engine illustrated should be applied to an automobile the cut-off could be operated to utilize different horse-powers for different grades of ascent. For instance, on level roads but little power would be required and the cut-off could be set to cut off the steam at one-sixth of the stroke. If climbing a slight hill, the steam could be cut off at two-sixths or one-third of the stroke, and if a steep hill was to be ascended the steam could be cut off at two-thirds of the stroke. In each case more steam would be required and more would be supplied to the engine. This feature, which is one of great value, is especially adapted to hoisting-engines for mining purposes. If an engine equipped with my improved valve is employed in hoisting rock or dirt from a shaft, say, a thousand feet deep, for the first two hundred feet the steam could be cut off at one-sixth of the operative stroke of the pistons, the next two hundred feet the steam could be cut off at two-sixths, or one-third of the stroke, the next two hundred feet at three-sixths, or one-half of the stroke, and so on until the last two hundred feet, where the steam would be used under direct pressure and not expansively.

While I have illustrated and described the preferred construction of my improved valve, I do not wish to be limited to the exact construction and arrangement shown, as many changes might be made without departing from the spirit of my invention.

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

1. In a combined steam-distributing and cut-off valve; an inner tubular valve, having ports in its periphery which are arranged in a straight line, and an inlet at one end; an outer tubular sleeve which is revolubly mounted on the inner tubular valve, having ports which are arranged in spiral order around its periphery, but which register with the ports of the inner valve, substantially as shown.

2. In a combined steam-distributing and cut-off valve, a tubular sleeve having a hollow stem at one end, and ports arranged in staggered form in its periphery; a tubular valve which fits revolubly within said tubular sleeve, having a stem adapted to fit within the hollow stem of the tubular sleeve, and to extend beyond the same, ports arranged in a straight line, which register with the ports in the sleeve, and an inlet at the opposite end from the stem, substantially as shown.

3. In a combined steam-distributing and cut-off valve, a tubular sleeve having ports arranged in staggered form around its periphery, and a hollow stem at one end; a tubular valve which fits revolubly in said sleeve, having a stem which is designed to fit revolubly within the hollowed stem of the sleeve, and to extend beyond the same; ports arranged in a straight line in the periphery of said valve, having a greater width transversely than the ports in the sleeve, but adapted to register with the same and an inlet in the opposite end of said valve from its stem, substantially as shown.

4. In a combined steam-distributing and cut-off valve, a tapered tubular sleeve, having a plurality of ports arranged spirally in its periphery and a hollowed cylindrical stem at one end; a tapered tubular valve which fits revolubly in said sleeve, having a stem designed to fit revolubly in the stem of the sleeve and to extend beyond the same; ports of greater area than the ports in the sleeve, which are arranged in a straight line, and are adapted to register with said sleeve-ports and an inlet in the opposite end of the valve from its stem, substantially as shown.

5. In a valve for rotary engines, the combination with an engine having a plurality of cylinders, an inlet parallel with said cylinder and ports connecting said inlet with the cylinders, of a steam-distributing tubular sleeve, revolubly mounted in said inlet, having ports arranged spirally in its periphery, which register with the cylinder-ports; a tubular cut-off revolubly mounted in said sleeve, having ports which register with the ports in the sleeve, and with the cylinder-ports, and a steam-inlet at one end of said cut-off, substantially as shown.

6. In a valve for rotary engines, the combination with an engine having a plurality of cylinders, a valve-chamber parallel with the cylinders, and ports connecting the valve-chamber with the cylinders, of a tubular steam-distributing sleeve revolubly mounted in said valve-chamber, having a plurality of ports arranged spirally in its periphery, which register with the cylinder-ports, and a tubular stem at one end; a tubular cut-off revolubly mounted in said sleeve having ports arranged in a straight line which register with the sleeve-ports, and a stem which extends through and beyond the stem of the sleeve; a steam-inlet at the opposite end of the cut-off, means for turning the cut-off a predetermined distance, and means for revolving the sleeve around the cut-off, substantially as shown.

7. In a valve for rotary engines, the combination with a rotary engine having a plurality of cylinders, piston-shafts extending through said cylinder, a valve-chamber through said engine parallel with the cylinder, and ports connecting the chamber with the cylinders; of a tubular steam-distributing sleeve, revolubly mounted in the valve-chamber, having ports arranged spirally in its periphery which register with the cylinder-ports, and a tubular stem at one end; a tubular cut-off valve revolubly mounted in

the sleeve, having a straight line of ports in its periphery, which register with the sleeve-ports; a steam-inlet at one end and a stem at the opposite end which extends through and beyond the tubular stem of the sleeve; means for turning the cut-off a predetermined distance, and means as gearing for connecting the sleeve-stem with the piston-shaft so that the said sleeve will revolve upon the cut-off, substantially as shown.

8. In a combined steam-distributing and cut-off valve, the combination with a rotary engine having a plurality of cylinders; a valve-chamber through said engine parallel with the cylinders, and ports connecting the chamber with the cylinders; of a tapered tubular sleeve, revolubly mounted in the valve-chamber, having a plurality of ports arranged spirally around its periphery, which register with the cylinder-ports, a tubular tapered cut-off, revolubly mounted in the sleeve, having a straight line of ports which register with the sleeve-ports, and a steam-inlet at one end; means for turning said cut-off a predetermined distance, and means for revolving the sleeve upon the cut-off, substantially as shown.

9. In a valve; an inner tubular valve, having two axial rows of ports in its periphery, the said ports being arranged in pairs side by side and each pair being divided by a narrow rib portion of the periphery of the valve, a steam-passage into the one end of said valve, a stem on the opposite end of said valve, means connected to said stem for adjusting said valve, an outer tubular valve rotatably mounted on said inner tubular valve and arranged and adapted in operative relation to inner tubular valve, and means for operating said outer valve, substantially as described.

10. In a combined steam-distributing and cut-off valve, the combination of a tubular valve having two ports arranged in the rotative axis of said valve and separated from one another by a peripheral rib portion of said valve and having a plurality of said ports arranged along the length of said valve, an open end at one end of said valve and a stem at its opposite end, with a tubular sleeve rotatively mounted on said tubular valve, having a hollow stem fitting revolubly over said stem and containing a row of ports arranged to register over the ports of said inner tubular cut-off valve, and means for operating said valves, substantially as described.

11. In an engine-valve, the combination with the inner tubular cut-off valve provided with a stem, the tubular steam-distributing valve revolubly mounted on said cut-off valve, a disk loosely mounted on the stem of said cut-off valve, a pointer secured to said stem, an index on said disk adapted to confine said pointer in said positions, and to secure said disk to said pointer, and means including suitable levers and a suitable engine-governor connected to said disk for automatically turning said disk to variably control said cut-off valve to the requirements of said engine, substantially as described.

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

JOHN KNOWLES.

Witnesses:
G. SARGENT ELLIOTT,
BESSIE THOMPSON.