(No Model.)

4 Sheets—Sheet 1.

M. L. SEVERY.

STEAM ENGINE.

No. 590,861. Patented Sept. 28, 1897.

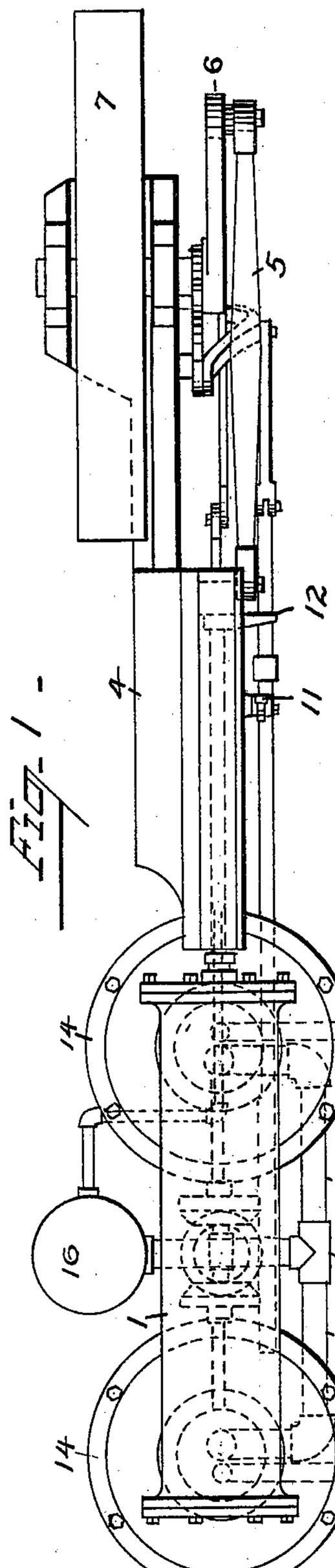

FIG. 1.

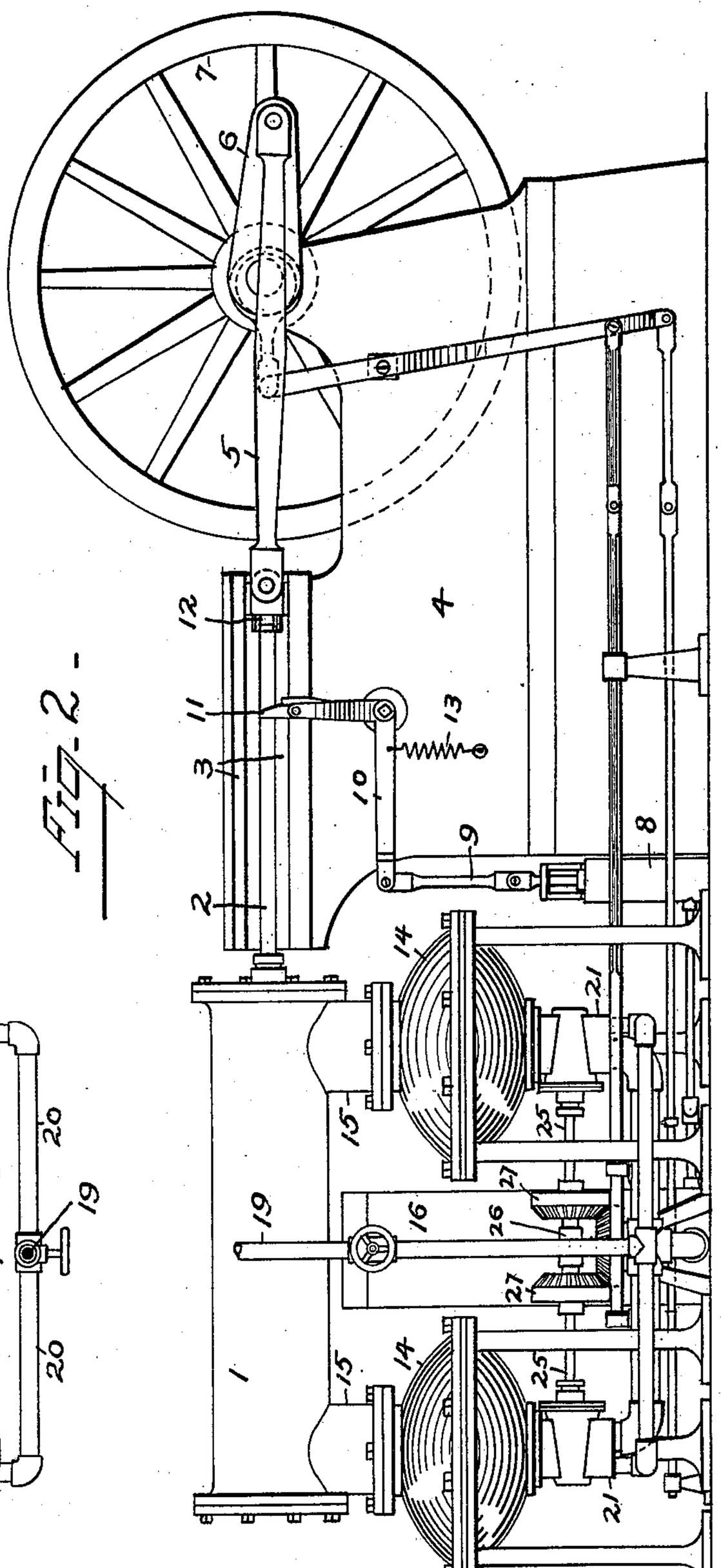

FIG. 2.

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(No Model.) 4 Sheets—Sheet 2.

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STEAM ENGINE.

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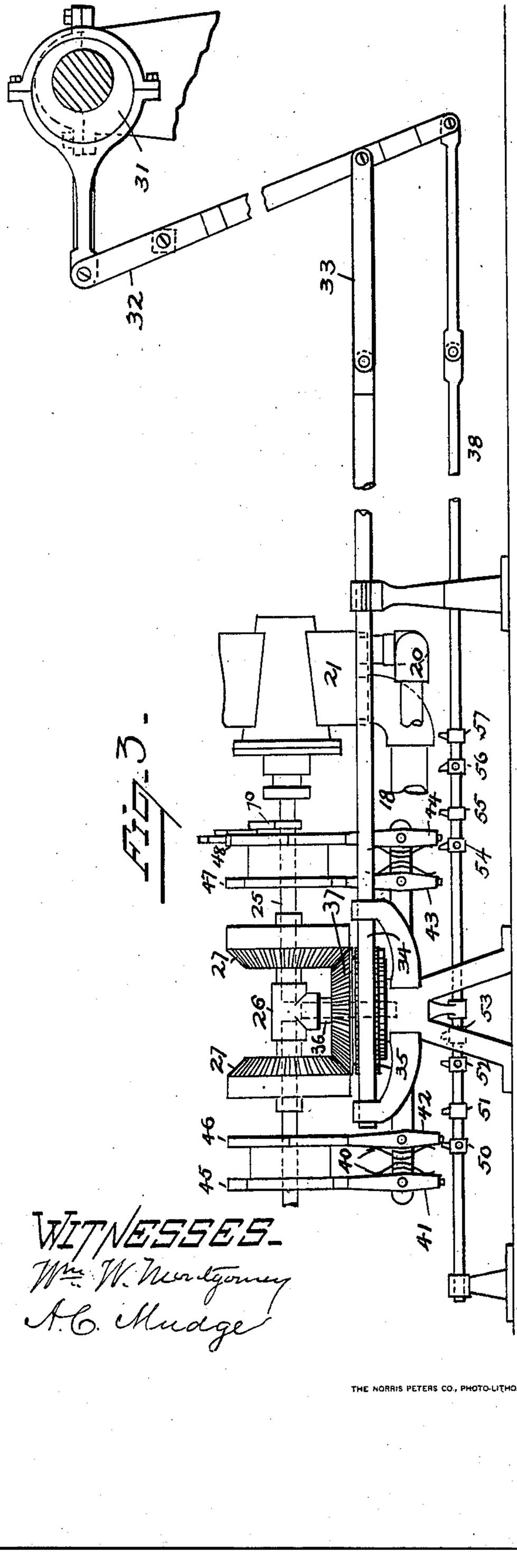

Fig. 3.

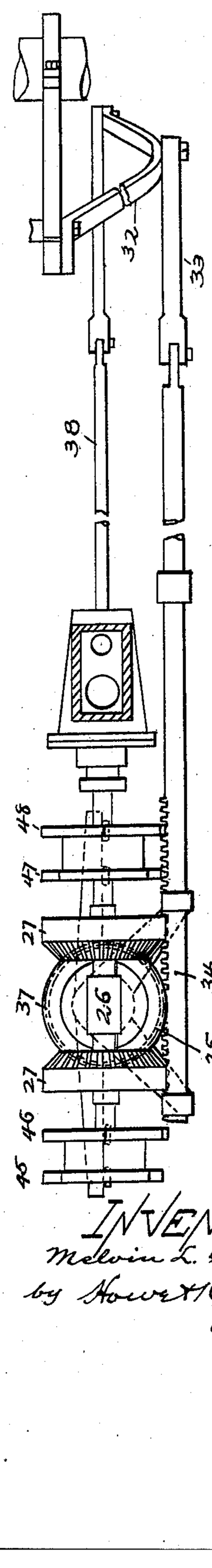

Fig. 4.

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(No Model.) 4 Sheets—Sheet 3.

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STEAM ENGINE.

No. 590,861. Patented Sept. 28, 1897.

Fig. 5.

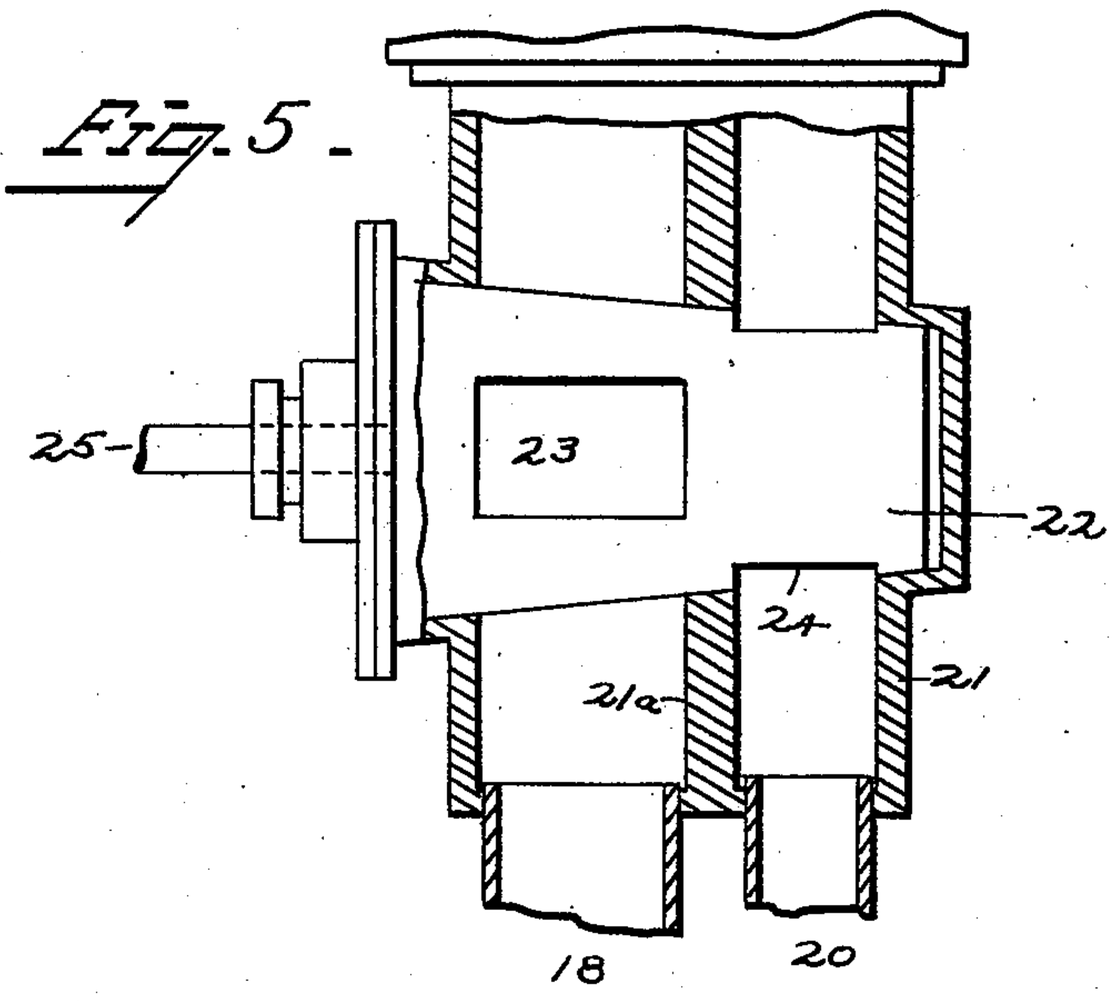


Fig. 6.

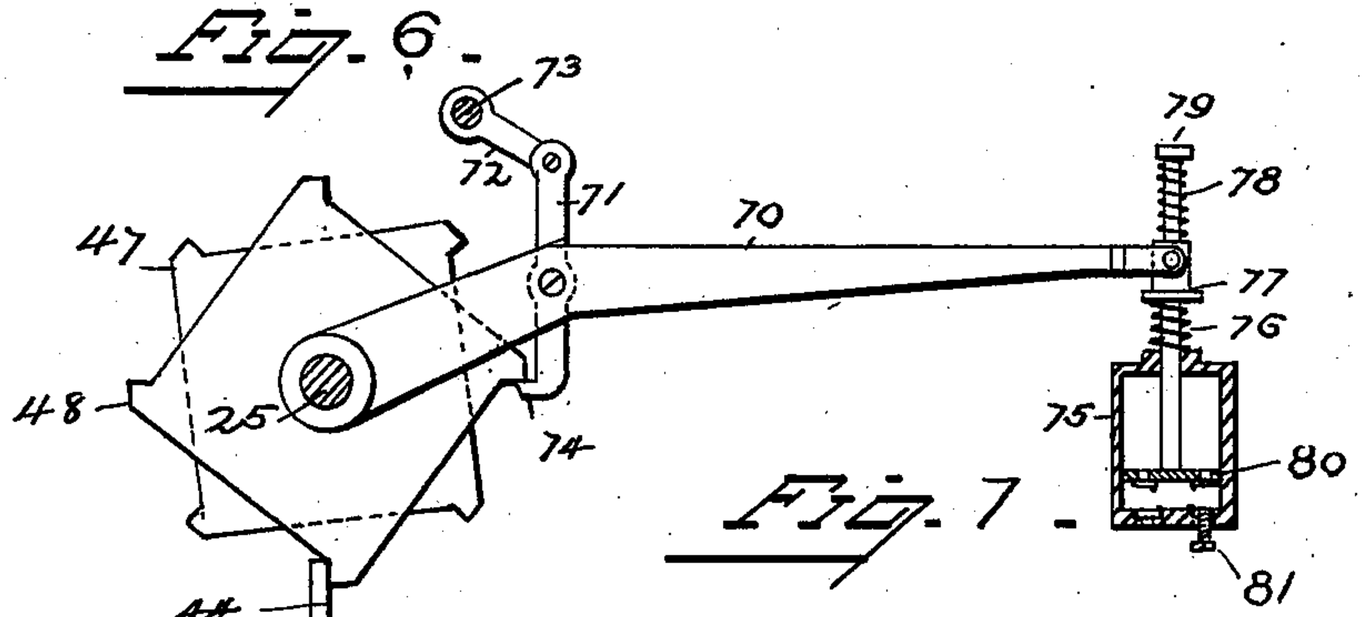
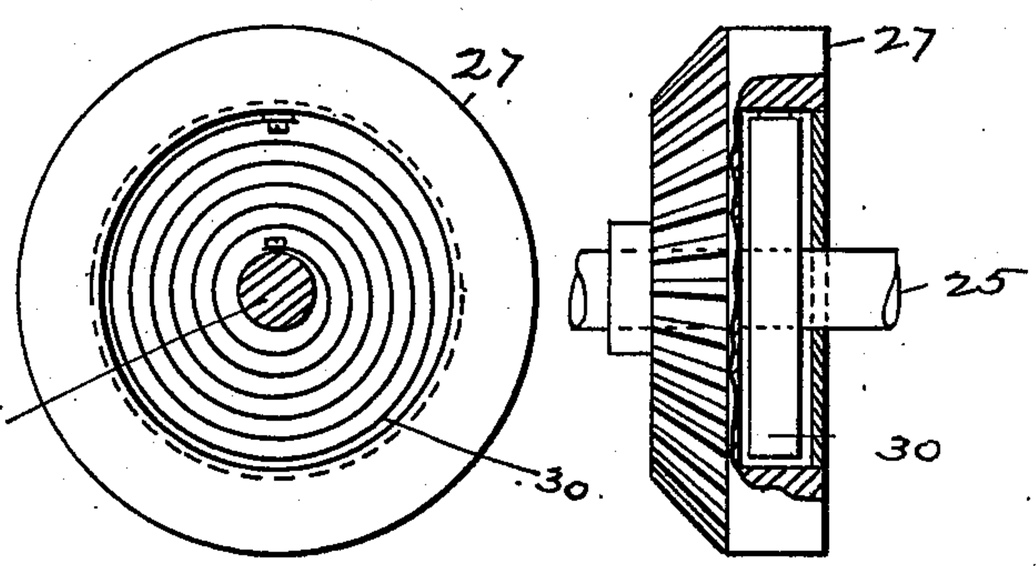


Fig. 7.



WITNESSES.

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(No Model.) 4 Sheets—Sheet 4.

M. L. SEVERY.

STEAM ENGINE.

No. 590,861. Patented Sept. 28, 1897.

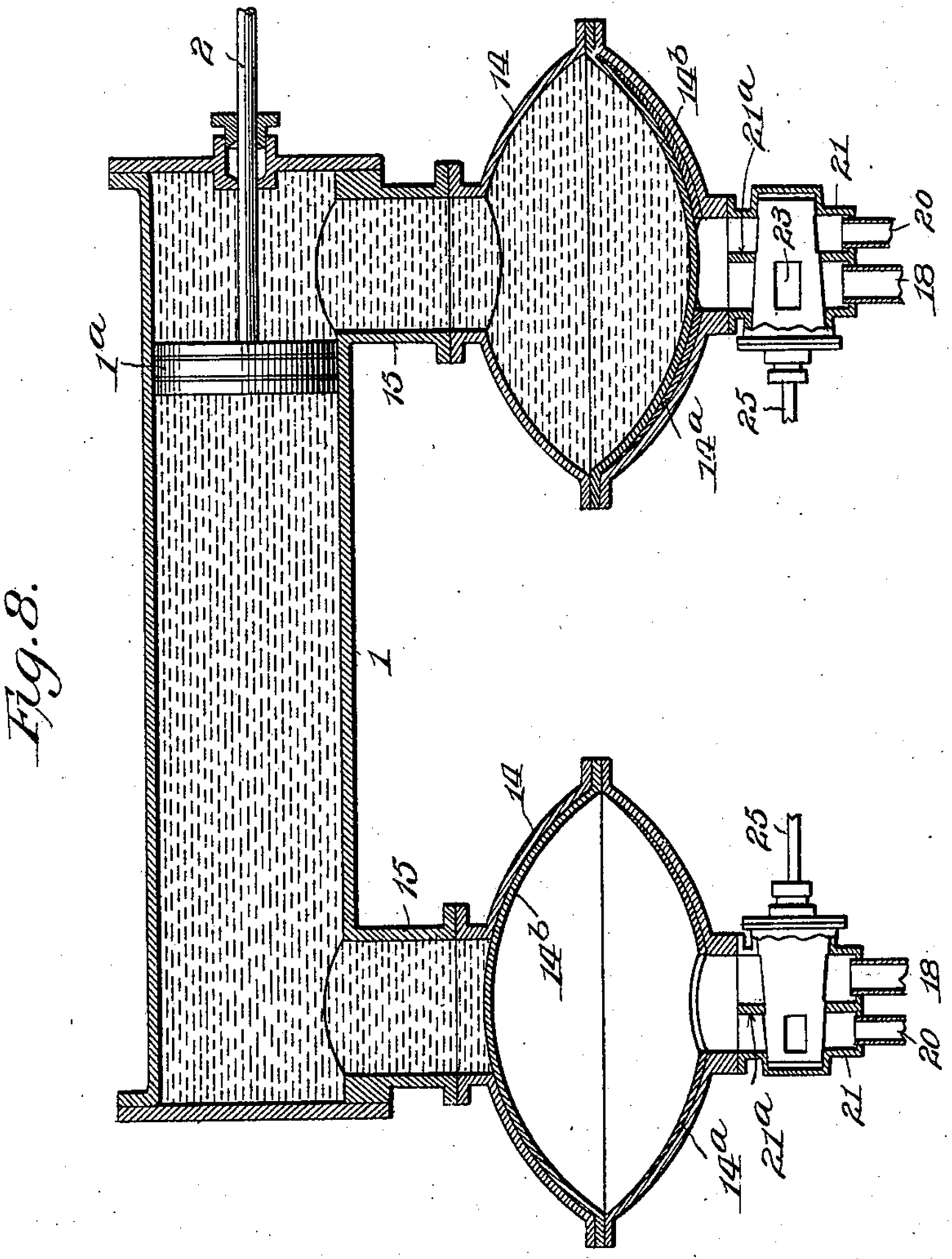

Fig. 8.

WITNESSES:

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UNITED STATES PATENT OFFICE.

MELVIN L. SEVERY, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO FRANCIS DOANE, OF NORWOOD, MASSACHUSETTS.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 590,861, dated September 28, 1897.

Application filed February 6, 1896. Serial No. 578,271. (No model.)

To all whom it may concern:

Be it known that I, MELVIN L. SEVERY, a citizen of the United States, residing in Boston, in the county of Suffolk and State of Massachusetts, have invented certain new and useful Improvements in Steam-Engines, of which the following, taken in connection with the accompanying drawings, is a specification.

The invention relates to steam or vapor engines; and it consists of the construction and combinations of parts herein described, and particularly pointed out in the claims.

In the accompanying drawings, Figure 1 is a plan view of the engine. Fig. 2 is a view in elevation of the same. Fig. 3 is a view in elevation of the mechanism for operating the valves and shows one valve only. Fig. 4 is a plan view of the same. Fig. 5 is a sectional view of the valve. Fig. 6 is a view in elevation of the toothed wheel on the valve-shaft and air-cushion mechanism connected therewith. Fig. 7 shows the beveled wheel on the valve-shaft, partly cut away to show the spiral spring within the same and the spring in front view. Fig. 8 is a sectional view of the cylinder, diaphragm-chambers, valve-chambers, and valves.

In the several figures the same numerals refer to the same parts.

Referring to the drawings, 1 is a hollow cylinder closed at one end and at the other end having an opening for the passage of the piston-rod. This cylinder is preferably of metal, and it may be jacketed with some non-conducting material, but this is not usually important, as the loss of energy by the cooling of this cylinder is but slight, as means are taken to prevent the heating of the fluid actuating its piston. In this cylinder is a piston 1^a, and 2 is the piston-rod of the same. 3 are the ways for this piston-rod, supported upon suitable standards 4, which may also afford support for the crank-shaft, as shown. 5 is the connecting-rod, 6 the crank, and 7 the fly-wheel, all of the usual construction.

8 is the condenser-pump, and 9 the rod for the same. To this pump-rod is attached the horizontal arm of the bell-crank lever 10, pivoted to the support 4. The vertical arm of this lever has pivoted to its extremity a finger 11, beveled off on the side toward the fly-wheel and engaging with a beveled lug 12 on the piston-rod. When the piston-rod makes its inward stroke, this lug 12 passes the finger 11 without moving the vertical arm of the bell-crank lever, but on the return movement of the piston-rod the lug 12 strikes the straight side of the finger, thus raising the pump-rod against the action of a spring 13, attached at one end to the horizontal arm of the bell-crank lever and at its other end to the standard, and this spring effects the return movement of the pump-rod.

14 14 are two chambers, placed below the cylinder and each connected with the same on opposite sides of the piston by a pipe 15. These chambers are preferably, as shown, formed by two segments of a sphere opposed to each other and suitably connected together, a convenient manner of accomplishing this result consisting in forming a flange on the rim of each segment and connecting these by means of bolts. The segments are of equal size and each chamber formed by them has a capacity substantially equal to that of the cylinder 1. It is desirable that the inner surface of these chambers should be formed of a material 14^a which is of low heat conductivity and preferably of low heat capacity, or that the chambers should be made throughout of such material, and a suitable material for the chambers is iron covered on the inside surface with glass, porcelain, or other vitreous or silicious material. Other materials may be used if sufficiently strong and affording a surface which is of low heat conductivity and preferably of low heat capacity. The chambers may be jacketed or otherwise covered with such non-conductor, if desired, but I prefer porcelaining them outside or using on their exterior surfaces the same non-conductor applied to their interiors to the ordinary methods of jacketing. The chambers may be made wholly of metal, but in this case the advantages due to the construction of the chambers either wholly or upon the inside of a material of low heat conductivity and capacity will not be obtained.

In the plane of the major axis of each chamber is a diaphragm 14^b, preferably of some flexible waterproof and air and steam tight material—as, for example, a rubber fabric where the vapor used is of low temperature—

which diaphragm is fixed in the chamber by having its edges fastened between the opposing edges of the chamber. The area of this diaphragm is substantially equal to that of the inner surface of each segment, so that the diaphragm will fit closely to the inner surface of each segment. These segments are not hemispheres, for the reason that there is a more satisfactory action of the diaphragm when the segments are of the form shown; and a suitable ratio between the major and minor axes of the chamber is that indicated by the drawings, but they may be more or less prolate, according to the nature of the diaphragm used and as may be found desirable for other reasons.

In the cylinder and in the chambers is oil, water, glycerin, or other suitable liquid in such quantity that when the diaphragm of one chamber is substantially in contact with the inner surface of the upper segment of that chamber and the diaphragm of the other chamber is substantially in contact with the inner surface of the lower segment of that chamber the cylinder will be filled with the oil, glycerin, or other liquid used. Consequently inasmuch as the piston is liquid-tight and fits the cylinder sufficiently tight to prevent liquid from flowing around it in any quantity the alternate flow of liquid into the chambers on opposite sides of the piston will cause the latter to reciprocate in the same manner as in the ordinary steam-engine when steam is alternately admitted and discharged on opposite sides of the piston.

Inasmuch as there is no steam or vapor in the cylinder there is no necessity of providing a steam-tight packing for the piston or for the piston-rod, it being sufficient that they do not leak the fluid used. There is no danger of the cylinder-head blowing out, and, while it is desirable to maintain the liquid used at a uniform temperature by making the cylinder of a poor conductor of heat in any suitable manner, there is no considerable loss of power by the sudden conversion of the condensed water or other actuating fluid in the cylinder into steam or vapor when the pressure in the cylinder is suddenly decreased by the opening of exhaust or condenser port, as is the case with engines of the usual construction. Moreover, the piston moves with very little friction. Consequently there is but little loss of power in that way.

The flow of oil or other liquid used into the chamber and the return of the same from a chamber into the cylinder is effected by the movement of the diaphragms of the chambers, caused by alternately admitting to and withdrawing the steam or vapor from under the diaphragms, as will be readily understood.

It is desirable in order to avoid wiredrawing and to obtain the full effect of the dynamic force of the steam or vapor that the valves in the supply and exhaust pipes should be suddenly opened and closed to their full extent, but without shock, and the mechanism illustrated in the drawings is designed to accomplish this result. This valve mechanism is not limited to use with the form of engine herein described, but it may be used with engines having the usual steam-cylinder and piston reciprocating in the same.

Referring to the drawings, 16 is the condenser, and 17 is a pipe extending therefrom, which pipe has two branches 18, one communicating with one chamber and the other with the other chamber.

19 is a steam or vapor supply pipe, which also has two branches 20, one extending to one chamber and the other to the other chamber.

21 is is a hollow chamber of suitable form divided by a vertical partition 21^a. The branch pipe 18 is connected to one side of this partition and the pipe 20 to the other side of this partition. In the chamber 21 and at right angles to the partition in the same is a conical way-cock 22, which extends through the partition and the chamber. In this cock are two ways 23 and 24 at right angles to each other, one on one side of the partition and the other on the other side, so that one way communicates with the induction-pipe and the other with the exhaust-pipe. Above the cock the two chambers formed in each chamber 21 by the partition communicate with the chamber 14, which chamber may be called a "receiver." The valves for the supply and exhaust are formed by this cock, and there is a similar construction for each chamber 14. It is therefore necessary to show but one of these valves in Fig. 3. The cock is attached to a shaft 25, the axis of which is in line with the axis of the cock, which shaft has its outer end stepped in a suitable support 26, and on this shaft is a hollow beveled vertical gear-wheel 27, and the parallel toothed wheels 45, 46, 47, and 48 set quartering and each having four equidistant teeth. The function of these toothed wheels will be hereinafter explained.

The beveled wheel 27 is loose upon the shaft 25, but is connected to the same by a spiral spring 30, placed within the wheel and having one end attached to the shaft 25 and the other to the inside of the wheel. When the wheel 27 is turned in one direction, it will not rotate the shaft 25, but will wind up the spring 30, and the shaft will be held against the action of the spring by one of the toothed wheels 45, 46, 47, or 48. When the wheel thus holding the spring is released, the spring will cause the shaft to turn till arrested by the other wheel, and this turning will suddenly rotate the shaft and with it the valve. As these opposite beveled wheels 27 are turned in opposite directions by the movement of the horizontal gear-wheel engaging with them it will be necessary that the spiral springs be turned in opposite directions.

The valves of the respective chambers are opposite to one another, and their shafts are in the same line. Consequently the beveled wheels 27 are parallel and their bevels are

opposed. These wheels 27 are rotated by the action of the piston-rod in the following manner.

31 is the usual eccentric upon the crank-shaft, having the usual eccentric strap and arm and lever 32 pivoted thereto, and to this lever is connected the reciprocating rod 33, as is usual in steam-engines, in order to convert the rotary motion of the shaft into a reciprocating motion to operate the slide-valves. At the end of this rod 33 is a rack-bar 34, the teeth of which engage with the teeth of a horizontal gear-wheel 35, connected by a pawl and ratchet to its shaft 36, which is stepped in the support 26. Owing to this connection the gear-wheel will be rotated only when the rack-bar moves in one direction. A horizontal beveled gear-wheel 37 is fixed on the shaft 36, and this engages with the parallel vertical beveled gear-wheels 27. On the movement of the rod 33 in one direction the beveled wheels 27 will be turned, winding up the springs 30, contained in each of them, so that when the reciprocating bar 33 moves in the other direction without effecting the rotation of the wheel 37 the wheels 27 will have a tendency to rotate in the direction opposite to the direction in which they were rotated by the movement of the rod 33, and the valve-shaft upon which each wheel is mounted will also have a tendency to rotate. This valve-shaft is normally prevented from rotating, but is released, so as to rotate and alternately open and close the valves of the supply and exhaust pipes, in the following manner.

38 is a horizontal reciprocating rod parallel with the rod 33 and attached at one end to the lever 32 by a pin. Upon this rod are secured fingers 50 to 57, inclusive, beveled on one side and straight on the other and arranged in sets, one set for the valve mechanism of one chamber and the other set for the valve mechanism for the other chamber. These fingers are alternately set in different vertical parallel planes. The reason for this difference of planes and arrangement of levers is that the fingers of each set act differently in accordance with the backward and forward movement of the reciprocating rod 38, to which they are attached, as will hereinafter be explained in describing the operation of the mechanism. Under each of the toothed wheels 45, 46, 47, and 48 are vertical levers 41, 42, 43, and 44, respectively, pivoted to a suitable support and retained in a vertical position by a suitable spring 40. The upper ends of these levers engage, respectively, with the wheels 45, 46, 47, and 48, while their lower ends are respectively in the paths of the fingers 50 and 52, 51 and 53, 54 and 56, and 55 and 57.

In the drawings the piston is shown as having completed its outward stroke. The diaphragm in the right-hand chamber 14 is near the inner surface of the lower segment of the chamber, and the upper part of this chamber is filled with oil, glycerin, or other liquid used, and the diaphragm of the left-hand chamber is near the inner surface of the upper segment of the chamber. The exhaust and induction ports of both chambers are closed.

In order to effect the return movement of the piston, it will be necessary to open the exhaust-port of the left-hand chamber and the induction-port of the right-hand chamber, so that the steam or vapor will escape from the left-hand chamber and be admitted to the right-hand chamber.

The steam or vapor entering the right-hand chamber will at once act on the diaphragm of this chamber. The liquid will be forced upwardly into the cylinder and the piston will move to the left, and the rod 38 will also move to the left.

The fingers 50 to 57, inclusive, are so set on the rod 38 that they will come in contact with the proper levers 41 to 44 and release the wheels 45 to 48 to alternately admit the steam or vapor to each chamber and at the same time open the exhaust-port of the other chamber. They will also be set so as to close the induction-port at any desirable point in the stroke, so as to allow the steam or vapor to act expansively.

In Fig. 6 is shown a means for cushioning the action of the valves, and it consists of a lever 70, mounted on the shaft 25, so as to turn freely thereon, and held in its normal position by a spring 78, attached thereto and to a stationary support 79. Under the free end of this lever is a chamber 75, provided with a piston 80. In this piston and in the bottom of the chamber are suitable valves for admitting air on the upstroke of the piston, but so arranged as to prevent the escape of air on the downstroke. The action of the mechanism is regulated by means of a screw-valve 81. Pivoted to the lever 70 is a pawl 71, having a lip 74 at its free end, and at its other end pivoted to a link 72, which is pivotally supported at 73. As the wheel 48 or 47 turns a tooth engages with the lip 74 and carries the lever 70 downward against the action of the spring 78 upon the rod of the piston 80, thus forming an air-cushion in the chamber 75. The pawl 71 being pivoted at two points will turn as it moves and draw the lip out from engagement with the tooth of the wheel and will be carried back to its normal position by the spring 78. The lip 74 is of sufficient length to cover both wheels 47 and 48.

In steam or vapor engines of the usual construction liquid formed in the cylinder by condensation will flash into steam or vapor when the pressure in the cylinder is decreased on opening the exhaust-port or condenser-port, and in so doing will absorb heat from the walls of the cylinder, so that a part of the energy of the steam next entering the cylinder will be wasted in restoring heat to the cylinder. This loss of energy sometimes amounts to as much as fifty per cent. of the total energy of the entering steam or vapor.

In engines of the construction herein de-

scribed, the walls of the chambers being made throughout of a material which is of low heat conductivity and preferably of low heat capacity, or having an inside surface thereof, condensed liquid cannot flash into steam or vapor abstract heat from the walls of chamber and leave them cold, and consequently leaves the chamber as liquid, thus preventing loss of energy in the hot steam that next enters the chamber.

I have shown in the drawings an engine provided with two steam or vapor diaphragmed chambers capable of forcing a liquid alternately against both sides of a piston within the cylinder; but it is obvious that a single chamber forcing the liquid against but one side of the piston in the cylinder could be used for a single-acting engine after the usual manner of such engines, and such an engine would be within the province of my invention.

Having thus described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In a steam or vapor engine, the combination, substantially as described, of two parallel chambers, each divided into two parts by a vertical partition, a steam or vapor supply pipe connected to one part and an exhaust-pipe connected to the other part; a horizontal cock extending through the chamber, two ways in said cock set at right angles to one another, one for the steam and the other for the exhaust; a shaft for each cock, each shaft in the same line and each carrying a beveled gear-wheel having the bevels opposite to one another; a spring in each wheel connecting the wheel to the shaft, the springs being turned in opposite directions; means for rotating these wheels in one direction by the movement of the piston and means for releasing the said wheels by the movement of the piston in the other direction to release said wheels step by step, so that they will alternately operate to open and close the induction and exhaust ports.

2. The combination, substantially as described, of the two-way cock having the ways at right angles to one another and in different planes; two parallel toothed wheels fixed on the shaft of the cock and set quartering, and each having four teeth; means for rotating said shaft; two pivoted levers each engaging at one end with one of the parallel toothed wheels and each having its other end in a different plane; a spring for each lever acting to return the same to a vertical position; a reciprocating rod; the pairs of beveled fingers on the rod, said fingers being alternately set in one of the parallel planes in which are the ends of the pivoted levers.

3. The combination, substantially as described, of the reciprocating rod having the rack-bar on the end thereof; a horizontal toothed wheel gearing with said rack-bar; a ratchet and pawl connecting this toothed wheel with its shaft; the said shaft; a horizontal beveled wheel fixed on said shaft; two vertical beveled wheels meshing with said horizontal beveled wheel and mounted loosely on two independent shafts; spiral springs connecting said vertical beveled wheels with their shafts; valves on one end of each of said shafts; and means for imparting a step-by-step rotary motion to said valves.

4. In a steam or vapor engine, the combination of the valve-shafts arranged end to end oppositely and in the same line; parallel toothed wheels on each shaft; parallel pivoted levers under the toothed wheels and having their lower ends in different vertical planes; a horizontal reciprocating rod; eight adjustable beveled fingers on said rod arranged in sets of two pairs each, one set for one valve and the other set for the other valve, the fingers being alternately placed in one of the parallel planes of the lower ends of the levers and the set of fingers on one side having the straight side of pair of fingers adjacent and the set of fingers on the other side having the beveled side of each pair adjacent.

5. In a steam or vapor engine, the combination of the cylinder 1 and piston 1^a therein; the diaphragm-chamber 14 and diaphragm 14^b; valve-chamber 21; valve 23 and valve-shaft 25; toothed wheels 47 48, and spring gear-wheel 27 on said shaft; shaft 36; gear-wheel 37 fixed to shaft 36 and meshing with gear-wheel 27; gear-wheel 35; rack-bar 34 engaging gear-wheel 35; levers 43 44 engaging the toothed wheels 47 48; reciprocating rod 38; and the fingers 54 55 56 57; all arranged and operating substantially as shown and described.

6. The combination of valve-chamber 21; valve 23; shaft 25; toothed wheels 47 48, and spring gear-wheel 27 on said shaft; shaft 36; gear-wheel 37 fixed to shaft 36 and meshing with gear-wheel 27; gear-wheel 35; rack-bar 34 engaging gear-wheel 35; levers 43 44 engaging the toothed wheels 47 48; reciprocating rod 38; and the fingers 54 55 56 57; all arranged and operating substantially as shown and described.

7. The combination of valve-shaft 25; toothed wheels 47 48; lever 70 loosely mounted on shaft 25; pawl 71 on lever 70 and adapted to be engaged by the teeth of wheels 47 48; pivoted link 72; and a cushion for lever 70; all arranged and operating substantially as shown and described.

In testimony whereof I have hereunto subscribed my name this 7th day of January, A. D. 1896.

MELVIN L. SEVERY.

Witnesses:
CHAS. A. KELLOGG,
WM. W. MONTGOMERY.

Correction in Letters Patent No. 590,861.

It is hereby certified that Letters Patent No. 590,861, granted September 28, 1897, upon the application of Melvin L. Severy, of Boston, Massachusetts, for an improvement in "Steam-Engines," was erroneously issued to Francis Doane, as owner of the entire interest in said invention; that said Letters Patent should have been issued to the inventor *Melvin L. Severy, and Francis Doane, jointly*, said Francis Doane being the assignee of nine-twentieths interest only in said patent, as shown by the record of assignments in this Office; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed, countersigned, and sealed this 26th day of October, A. D., 1897.

[SEAL.]

THOS. RYAN,
First Assistant Secretary of the Interior.

Countersigned:

BENJ. BUTTERWORTH,
Commissioner of Patents.