No. 750,217. PATENTED JAN. 19, 1904.

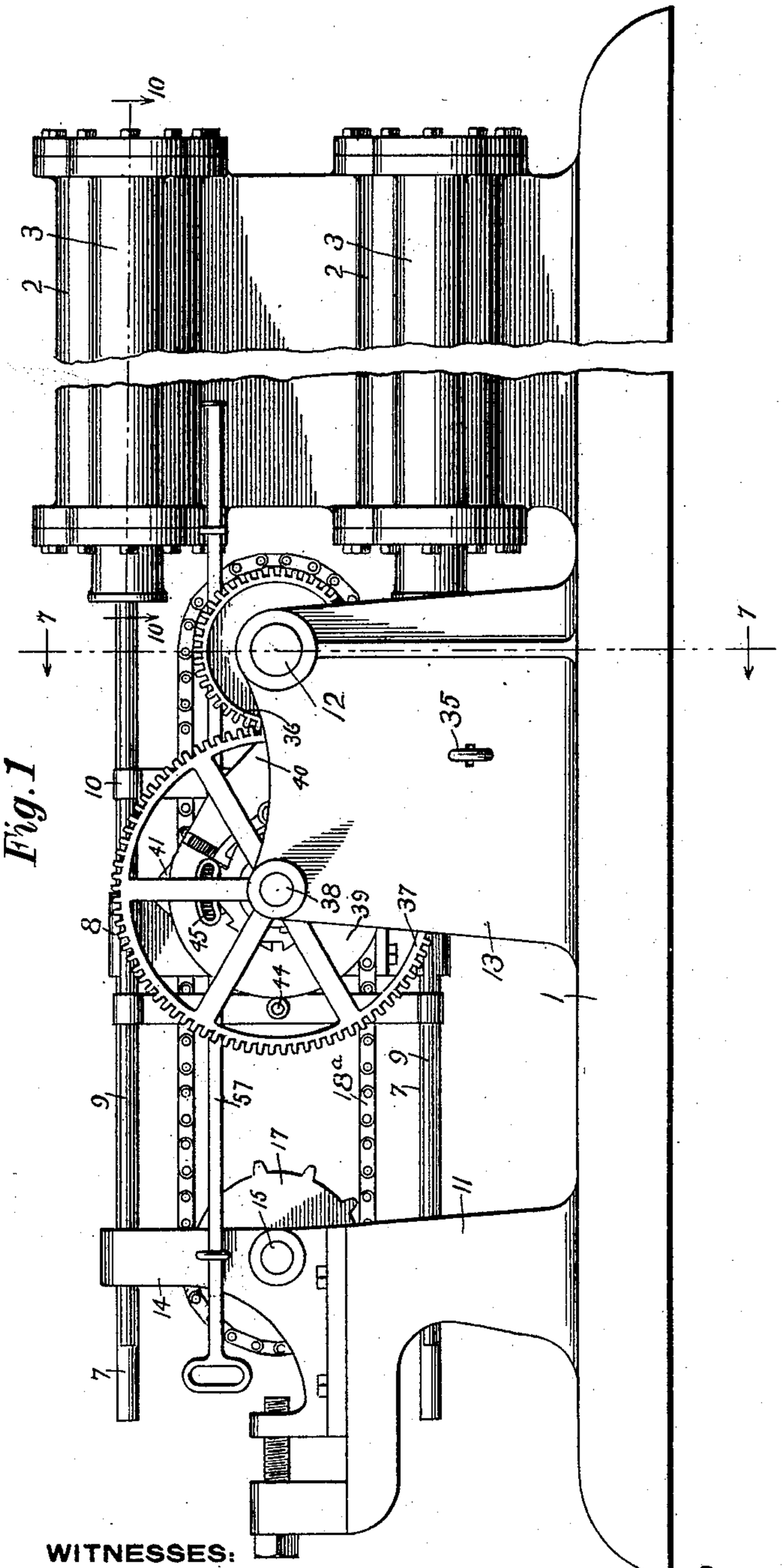
J. A. NORTON.

EXPANSIVE FLUID MOTOR.

APPLICATION FILED MAR. 12, 1903.

NO MODEL. 5 SHEETS—SHEET 1.

Fig. 1



WITNESSES:

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NO MODEL. 5 SHEETS—SHEET 2.

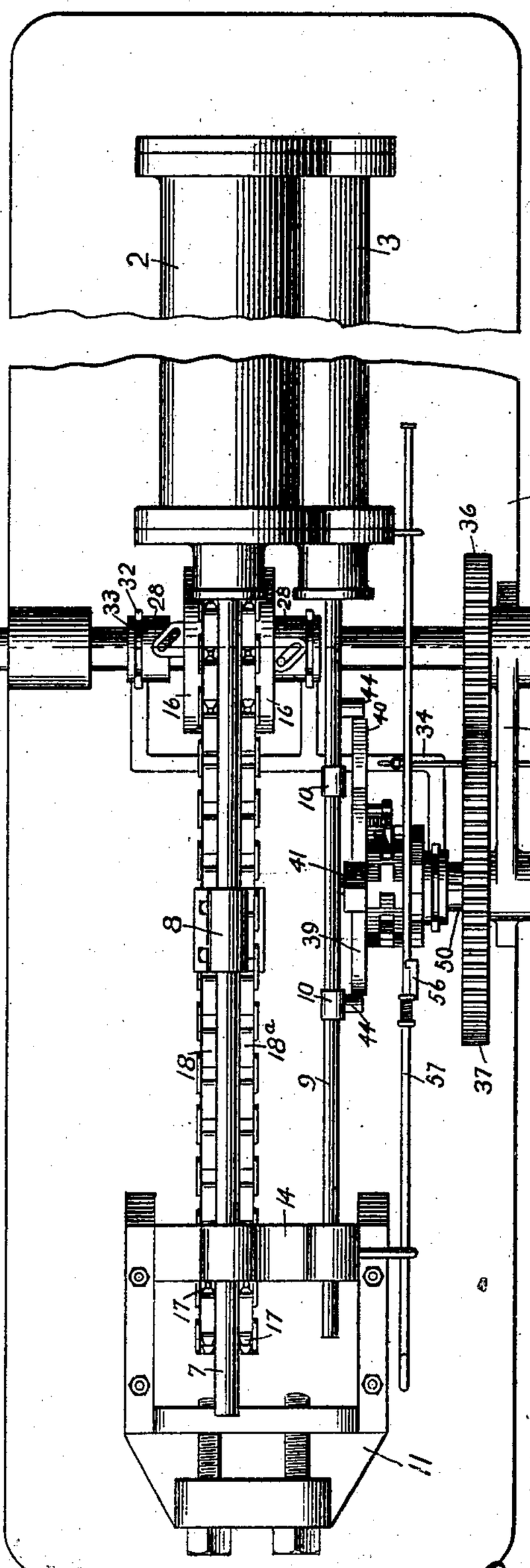

Fig. 2

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NO MODEL. 5 SHEETS—SHEET 3.

Fig.3

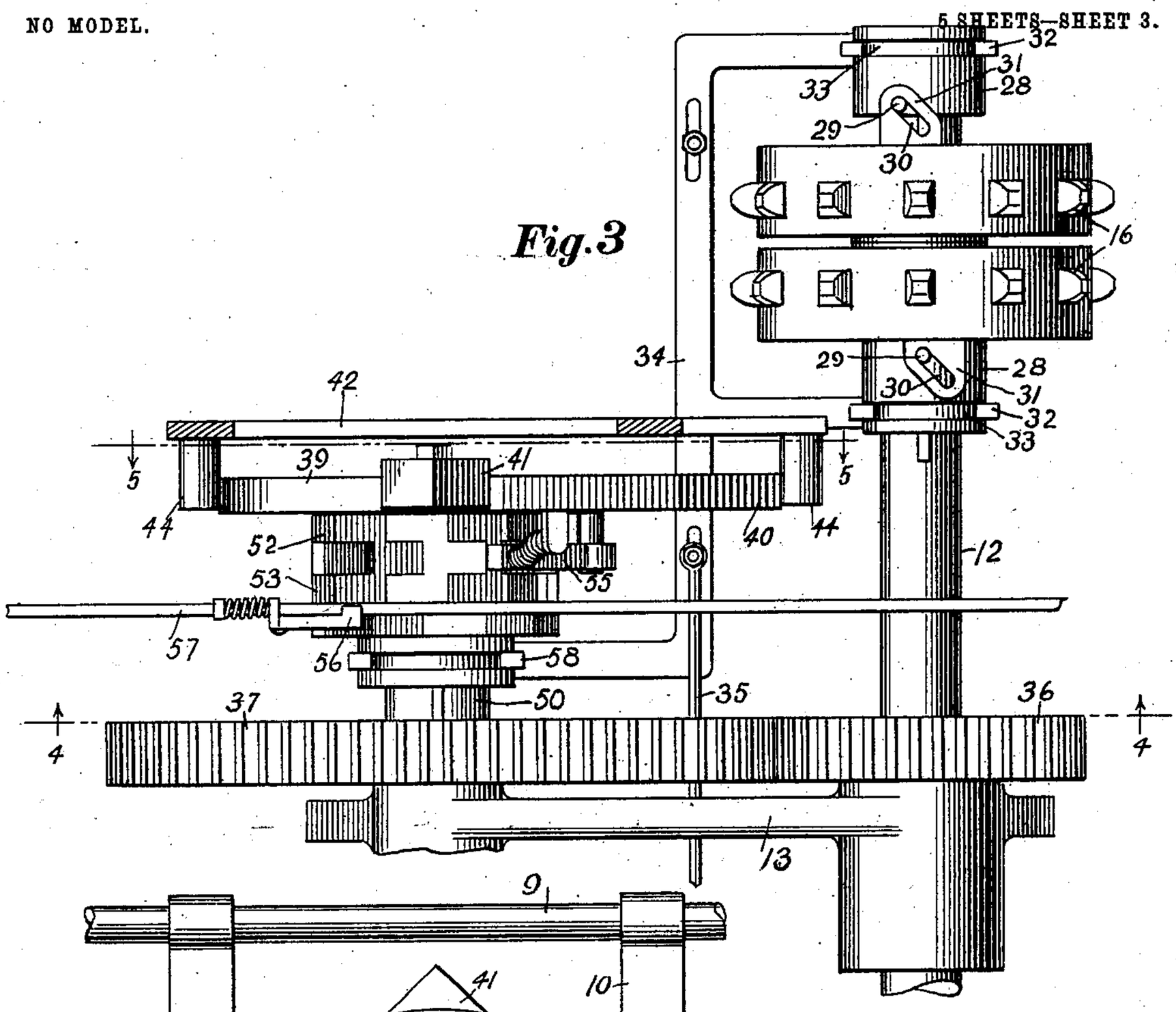

Fig.4

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NO MODEL. 5 SHEETS—SHEET 4.

Fig. 5

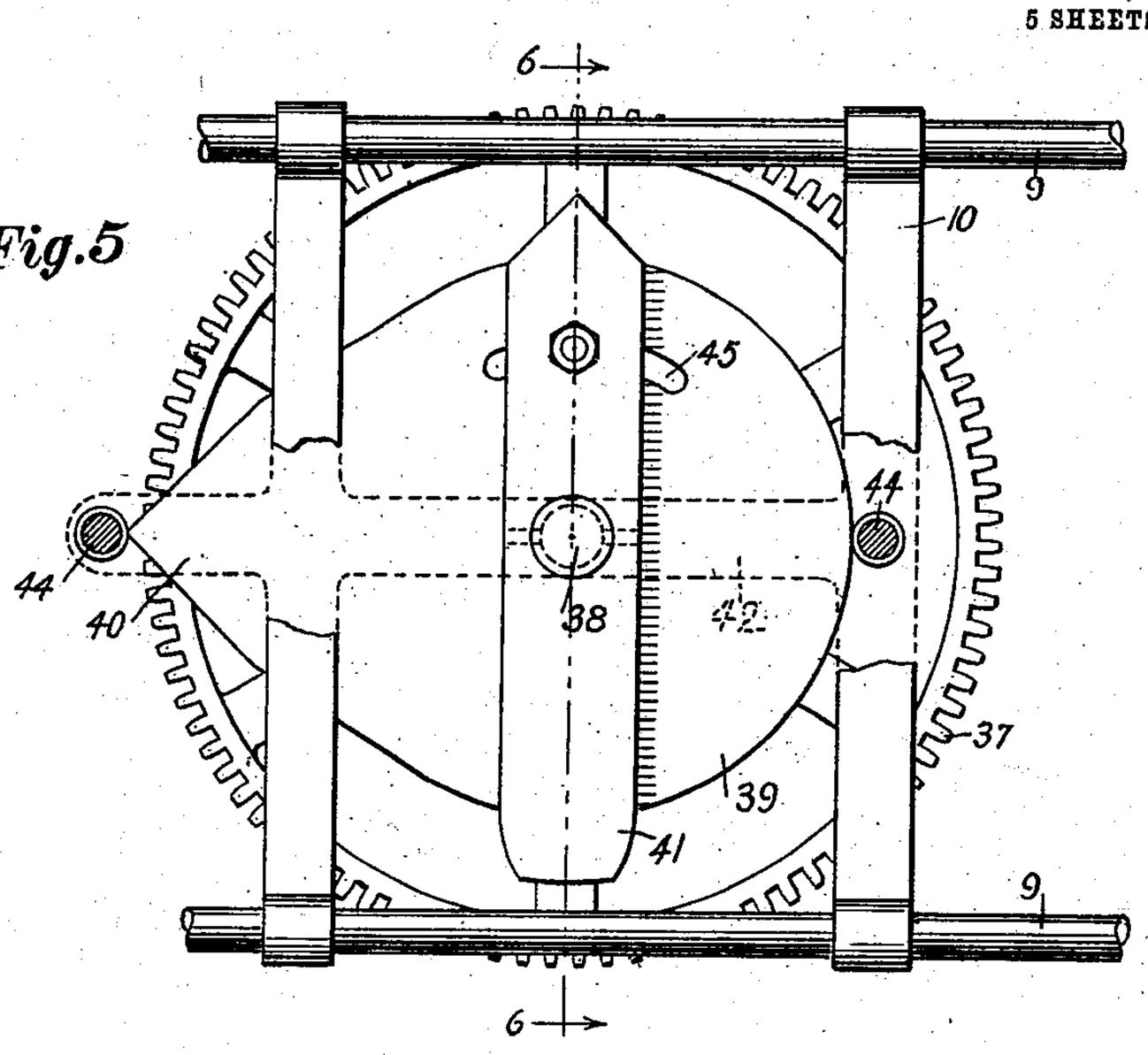
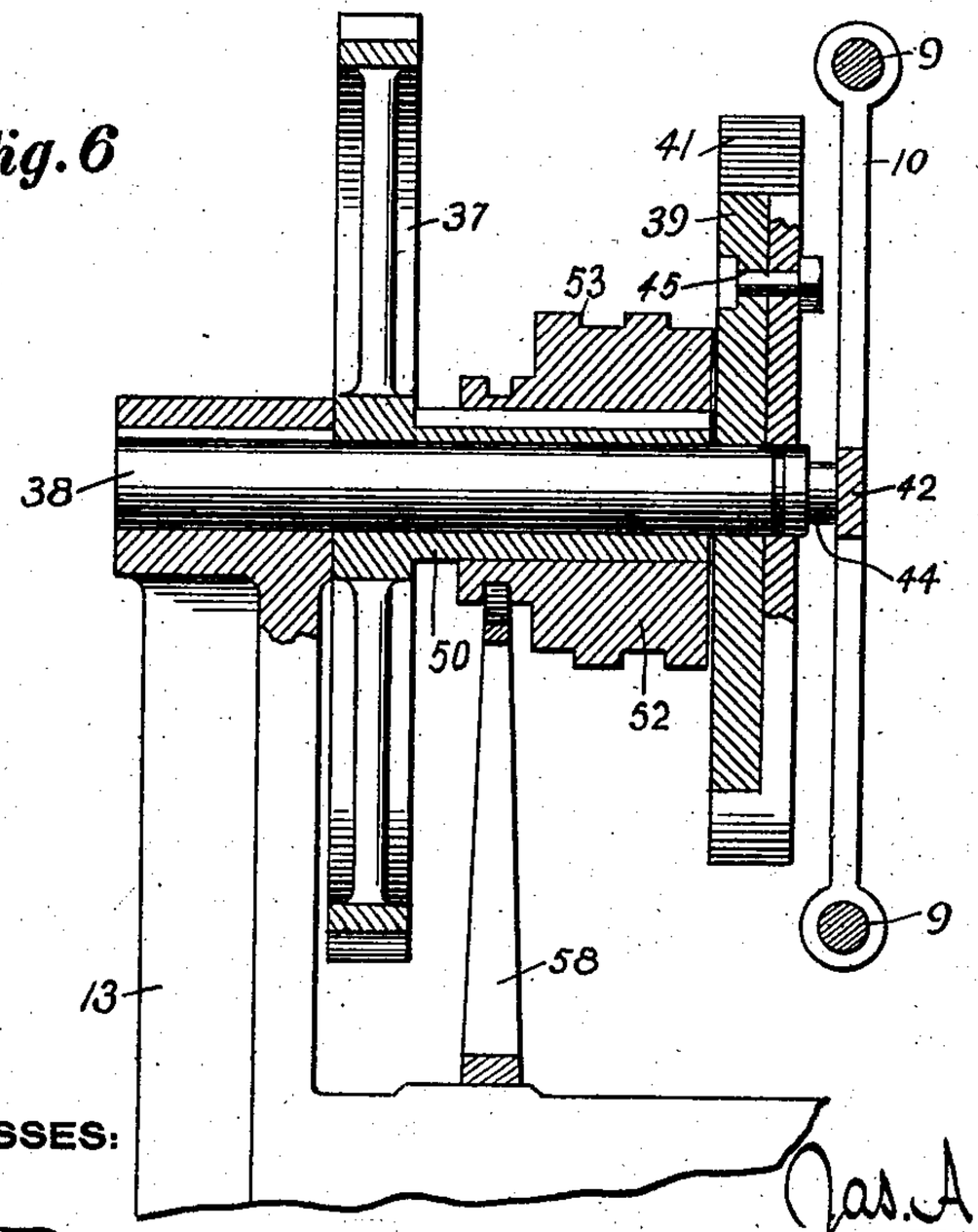


Fig. 6



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NO MODEL. 5 SHEETS—SHEET 5.

Fig. 8

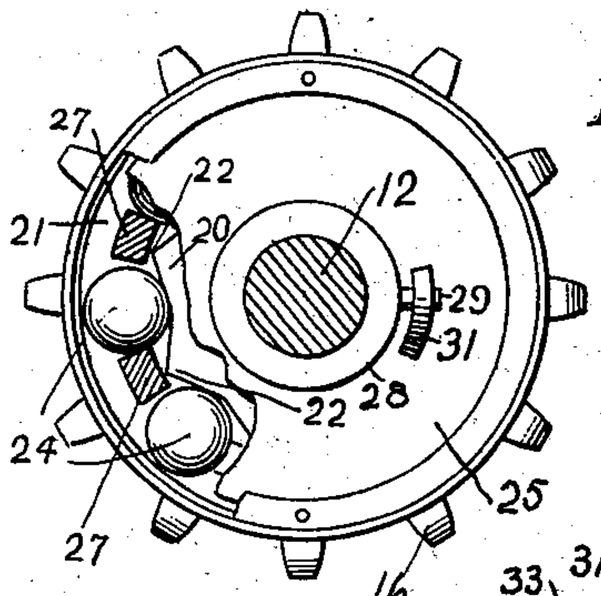


Fig. 9

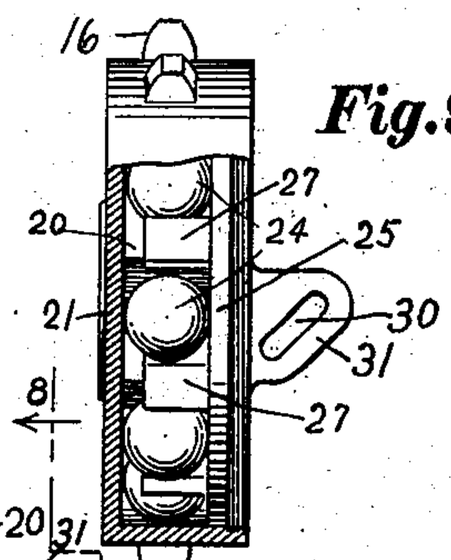


Fig. 7

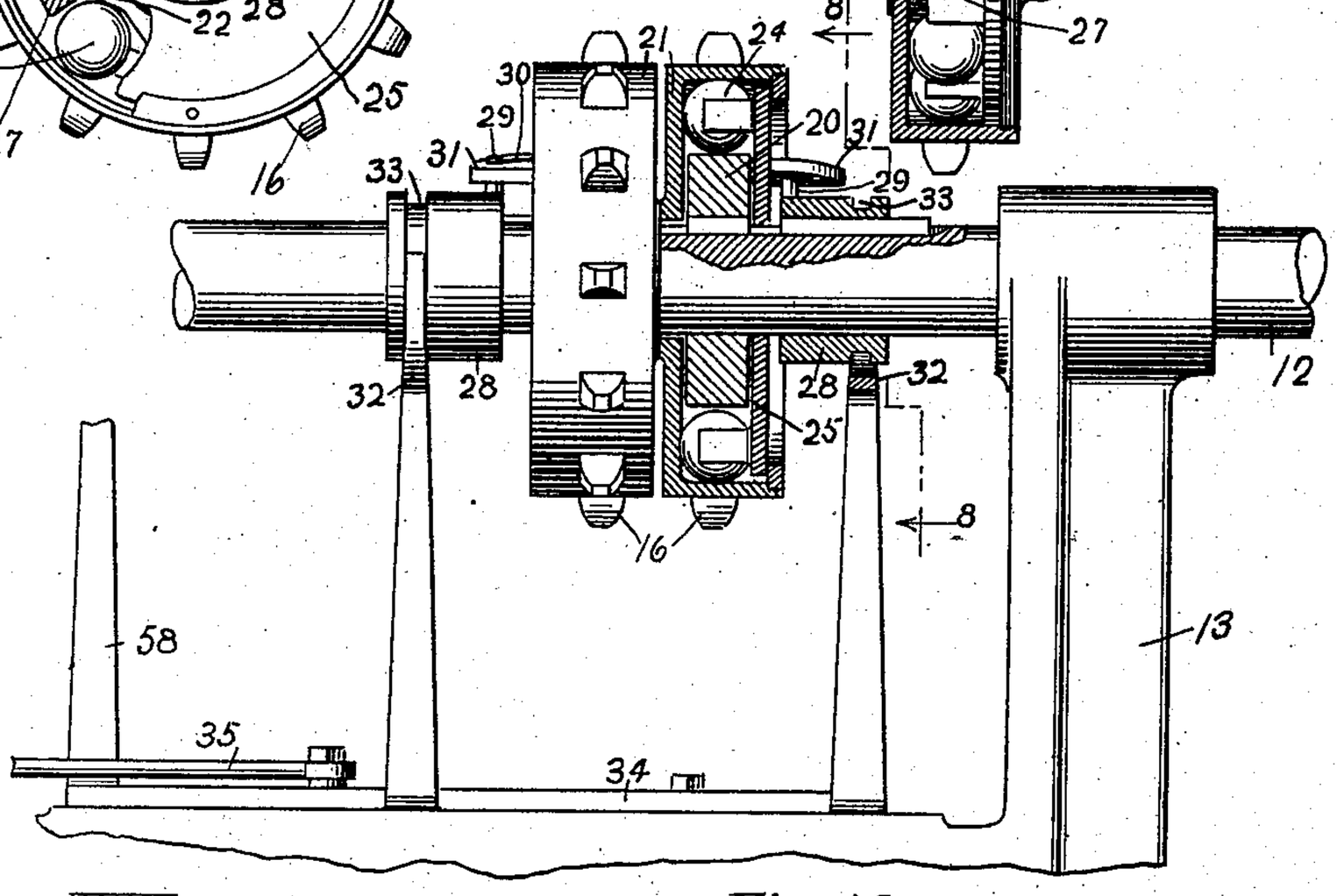
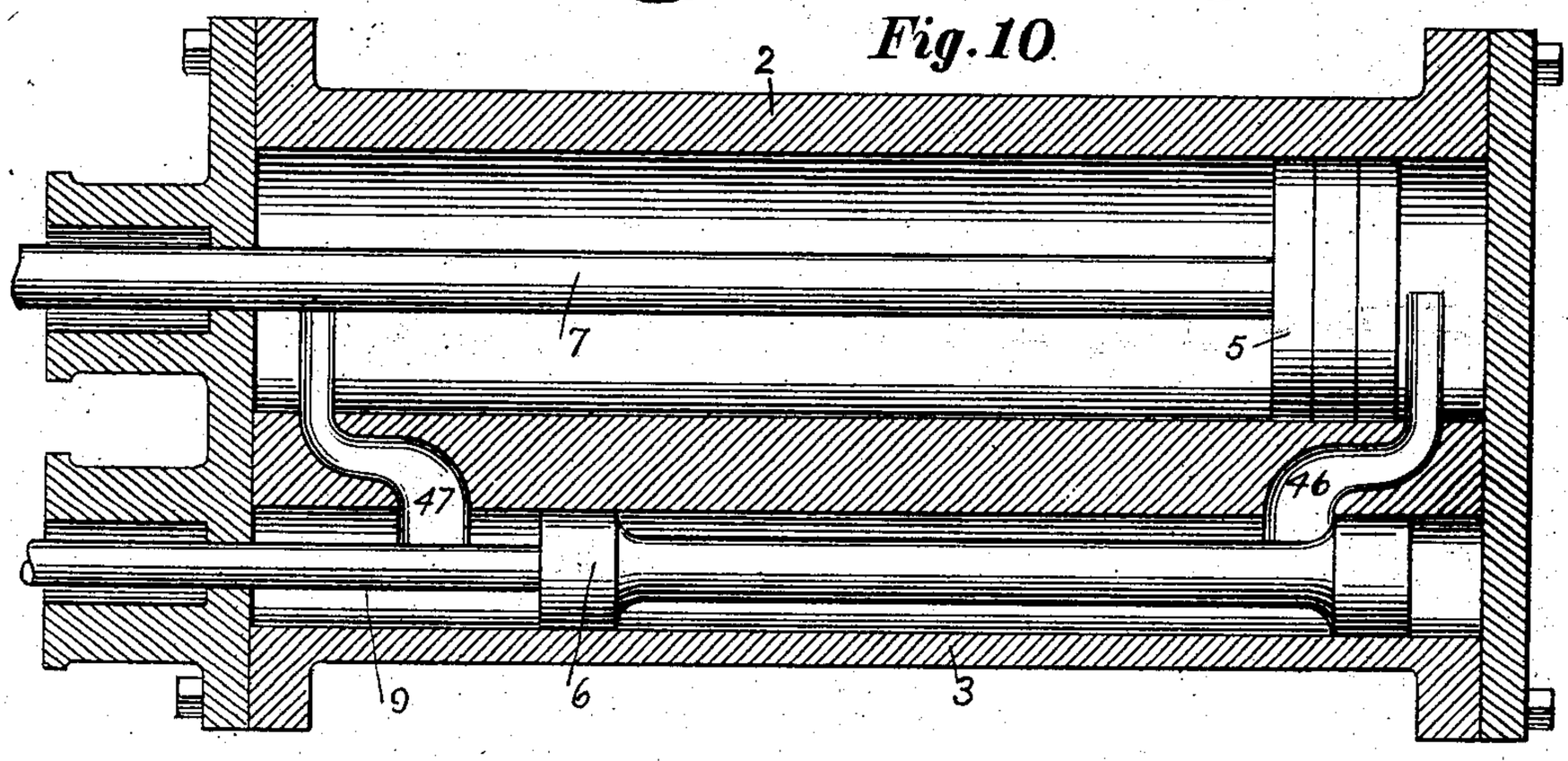


Fig. 10



WITNESSES:

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No. 750,217. Patented January 19, 1904.

UNITED STATES PATENT OFFICE.

JAMES A. NORTON, OF ODEBOLT, IOWA.

EXPANSIVE-FLUID MOTOR.

SPECIFICATION forming part of Letters Patent No. 750,217, dated January 19, 1904.

Application filed March 12, 1903. Serial No. 147,392. (No model.)

To all whom it may concern:

Be it known that I, JAMES A. NORTON, a citizen of the United States, residing at Odebolt, in the county of Sac and State of Iowa, have invented new and useful Improvements in Expansive-Fluid Motors, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

This invention is designed to consitute means for deriving continuous rotary motion and power from the action of pistons reciprocating in a cylinder under the force of an expansive fluid in which the expansive force of the fluid shall be more fully utilized and involve less action against dead resistance than in the familiar forms of such motors and in which also the amount of motive fluid taken and used shall to a large extent be regulated automatically by the work which the motor is doing without the intervention of special devices of the nature of a governor.

It consists of the features of construction which are set out in the claims.

In the drawings, Figure 1 is a side elevation of my improved motor. Fig. 2 is a longitudinal horizontal section at the line 2 2 on Fig. 1. Fig. 3 is a transverse vertical section at the line 3 3 on Fig. 1. Fig. 4 is a partly-sectional elevation showing the valve-controlling devices and their relation to the valve positions, section being made in vertical plane axially through the valve-chambers.

For supporting the mechanism in my improved motor I provide an integral base-frame 1, in which are formed the twin cylinders 2 2 and their respective corresponding valve-chambers 3 3. The cylinders 4 4 are arranged one above the other, and their corresponding respective valve-chambers 3 3 are also one above the other on the same side of the cylinders.

5 5 are the pistons in the cylinders 2 2.

6 6 are the valves in the valve-chambers 3 3, respectively. The two pistons have their stems 7 7 connected together rigidly by a cross-head 8, and the stems 9 9 of the valves 6 6 are similarly connected rigidly by a cross-head 10, from which it will be understood that the pistons travel in unison and in certain respects and for certain purposes operate as a single piston and that their valves similarly act in unison and control the admission of the motive fluid as a single valve might control its admission to a single chamber. The pistons 5 5 and valve-stems 7 7 are supported and guided at their ends remote from the cylinders and valve-chambers, respectively, in the upright standard 11 of the base-frame 1.

12 is the main shaft, journaled in bracket-arms 13 13, extending from the base-frame close to the cylinder-heads. The axis of the main shaft is midway between the two cylinders. Upon the standard 11 at the opposite end of the frame from the cylinders I mount in a slide-bearing bracket 14 a counter-shaft 15. On the main shaft 12 are two equal and similar sprocket-wheels 16 16, which are each connected to the shaft for driving by clutch devices, hereinafter described, which are arranged to drive in opposite directions, and on the counter-shaft 17 in line with the sprocket-wheels 16, respectively, are corresponding sprocket-wheels 17 17, connected with the sprocket-wheels 16 16, respectively, by drive-chains 18 18ª. The lower ply of one of the chains and the upper ply of the other are made fast to the cross-head 8, which connects the two piston-rods 7 7, so that the two chains travel in opposite directions and give rotary motion alternately in opposite directions to the sprocket-wheels upon the shafts 12 and 17 The opposite arrangement of the clutches causes the opposite movements of the sprocket-wheels to give the shaft continuous rotation in one direction. These clutches comprise each an inner element 20, rigid with the shaft, encompassed by an annular flange 21 of the sprocket-wheel 17, which is loose on the shaft. The central element has ribs or teeth 22, &c., projecting from a central sleeve or hub across an annular space between the said central sleeve or hub and said encompassing flange 21, said teeth or ribs being formed with long sloping sides defining between them portions of the annular space, in each of which there is lodged a roller 24, adapted to be gripped between one or the other of said sloping sides and the inner circumferential face of the annular flanges, according to whether the direction of rotation

of the flanges is in one direction or the other, the angle of the sloping face of the rib to the said circumferential face being such as to cause the roller when drawn into the same by rotation in the proper direction to cause the two parts to be gripped closely together, so that the outer element having the flange drives the inner element, and thereby rotates the shaft. In order that this clutch mechanism while adapted to drive in one direction only may be adjusted to control at will the choice of direction of driving, as is necessary, I provide a disk 25, which comprises a sleeve 26, by which it is mounted loosely on the shaft. This disk is adapted to close up the annular chamber in which the rollers are lodged on the side opposite the web of the sprocket-wheel, and from its face wings 27 27 protrude into the annular space between the ribs 22 22, two of such wings being arranged in each space between the ribs far enough apart to accommodate the rollers loosely between them. If the sleeve is rocked in one direction on the shaft, it will carry each roller off from one of the slopes of one of the two teeth between which it is lodged and into position where it will be free for lodgment upon the other slope, and will thus be adapted to communicate the rotary motion from the sprocket-wheel in one direction to the shaft, while in the other direction it will communicate no motion, because in that direction the balls cannot reach the proper inclined slope for gripping the shaft. When the sleeve is rocked in the other direction, the situation is reversed, the balls being brought against the slope from which they were held off before and held off from that upon which they were lodged before. For the purpose of rocking the disk 25 to these two positions while the shaft is in motion I provide a sleeve 28, feathered on the shaft 12 and having diametrically opposite radially-projecting arms 29 29, which engage slots 30 in bracket arms or posts 31, which protrude from the outer face of the disk 25, such posts being curved about the axis of the shaft and having their slots oblique or spiral with respect to the shaft, so that the movement of the sleeve 28 along the shaft will rock the disk 25 about the shaft one way or the other, according to the direction of such movement of the sleeve. The sleeve can be thrust longitudinally while the shaft is revolved by means of a forked shipping-lever 32, engaging a peripheral groove 33 in the sleeve. In order that the clutches at both ends of the shaft may be reversed at the same time, as is obviously necessary, I provide a slide-bar 34, mounted on the frame, having as rigid arms the forked shipping-levers above mentioned, and a handle or operating-lever 35 may be suitably mounted in any convenient position to slide said bar, and thus reverse both clutches simultaneously.

For operating the valves the following mechanism is provided: On the shaft 12 there is a gear 36, which meshes with a gear 37, loose on a shaft 38, extending rigidly from the frame between the horizontal planes of the plies of the drive-chain L. Clutched to the gear 37, so as to be rotated with it in one direction, but to be rotatable independently of it in the same direction when the gear is at rest for a purpose which will hereinafter appear, is a cam-wheel 39, on which are two cam elements, one of which, 40, may be rigid and, as illustrated, is integral with the wheel, while the other, 41, is adjustable to vary the circumferential or angular distance between its operating-terminal and the cam element 40 for changing the time of the cut-off, as will hereinafter appear. Alongside this cam-wheel and across the face of it extends a bar 42, connected with the cross-head 10, which connects the two valve-stems, said bar 42 being afforded a guide-bearing at 38 in the frame between the two valve-chambers. On the bar are two abutments 44 44, each preferably in the form of a stud and roll, projecting past the periphery of the disk and in position to be encountered by the cam-terminals as the disk rotates, such encounter being calculated to thrust the bar 42, and thereby the valves rigidly connected with it, in one direction or the other. The gear-wheel 37 is twice the size of the gear-wheel 36, making one-half of a revolution for each revolution of the former and of the main shaft and the two abutments 44 44 being at diametrically opposite points about the gear 36 are encountered at intervals of half a revolution of the latter by the cam projection 40, and thereby the valves are given a thrust alternately in opposite directions at each half-revolution of the gear 37 or each full revolution of the main shaft. The size of the sprocket-wheel 16 is such that a full stroke of the pistons actuating the chains 18 18[a] gives a full revolution to the main shaft, which thus makes two revolutions for each cycle in the piston's action, and the reversion of the valves by the cam 40 therefore occurs at the end of each stroke of the pistons in each direction. From the arrangement of the valves and ports as seen in Fig. 10 it will be understood that the movement of the valves thus caused admits the motive fluid behind the piston at the limit of each stroke. The cam 41 is designed to cut off the motive fluid, and the slope of its operating end is such as to give the valves a movement sufficient for cutting off the supply at one end without closing the exhaust at the other end, thus leaving the exhaust opened fully while the piston is completing its stroke until such time as the steam should be admitted to reverse the stroke. The angular distance between the cam-terminals 40 and 41 determines, it will be seen, the length of cut-off, and this can thus be regulated at will by adjusting the cam 41 on the cam-wheel. For stationary engines, in which such adjustment

would only be made from time to time when the general character of use is changed, I provide for adjusting the cam 41 by means of slots 45, through which the screws take which bind the cam-plate to the wheel. For engines in which the cut-off should be adjustable during running another means hereinafter described may be employed.

The operation of this structure may be understood by comparison of different views to be as follows: Both the pistons being, for example, at the end of the cylinder remote from the main shaft, the valves will be in position shown in Fig. 3. The inlet-ports are wide open and motive fluid is admitted beyond the pistons and immediately operates upon them to thrust them outward. During this movement toward the chain 18, carried by the crosshead 8, rotates the sprocket-wheel 16 in the direction in which its clutch engages and drives the main shaft, while the other sprocket-wheel 16ª revolves in the opposite direction by the chain 18ª works idly thereabout. The energy of the motive fluid operating upon both pistons is, however, operative for the purpose of driving the shaft, because the crosshead 8 transmits the motion from both pistons to both the chains.

It will be noticed that there is nothing in the mechanical connection of the pistons to reverse their own movement, and they will reach the limit of the stroke in the direction in which they are actuated by the incoming of the motive fluid as quickly as the work which is being done by the motor will permit them to move. If the work being done is heavy and the movement correspondingly slow, the pistons will make their full travel in the cylinders, because the resistance of the work on the shaft will prevent it from running ahead of the sprocket-wheel, and the valves therefore cannot be opened until the pistons have moved to the point for opening them. The cam-wheel will therefore make its full half rotary movement during the movement of the pistons in one direction and will reverse the position of the valves admitting the motive fluid at the opposite end in the same time with respect to the stroke as at starting. At some time in the course of the stroke, according to the position of the cam 41, the valves will be moved by the terminal of said cam engaging the proper abutment 44 and moving the valves a distance to cause the port 46 to be closed, but not sufficient to close the port 47 at the opposite end toward which the piston is moving and through which the exhaust is escaping. As the piston nears the limit of its stroke the wheel 39, having made a half-revolution, will bring the cam 40 against the other abutment 44, and thereby the valves will be moved in one stroke past the port 47, first covering that port and then opening it on the inlet side. The piston will thus encounter and compress the remnant of the exhaust motive fluid and the initial supply of fresh motive fluid while it is finishing its stroke and will then be reversed and the actions will be repeated in the same order at the opposite end of the cylinder.

It will be seen that the movement of the valves is determined by the rotation of the main shaft and is in definite time relation thereto by reason of the positive gear connection between said main shaft and the cam-wheel 39, by which the valves are operated. On the other hand, it will be seen that the movements of the pistons in the cylinders are independent of the rotation of the shaft to the extent that the shaft and the valve action may at a given time be more rapid than would result from positive connection with the pistons at that time, and also that the piston-strokes may be of any length in each direction, because their movement in either direction rotates the shaft in the same direction, and their movement for any distance in either direction may be reversed without other effect upon the rotation of the shaft than would be caused by their continuous rotation in the same direction. The result of this relation of movement is that when the engine is operated at high speed with light work the main shaft, and thereby the valves, may run ahead of the pistons during the retardment of the latter, which is caused at the period of compression at the end of each stroke. One effect of this is to shorten the cut-off, the piston sometimes barely coming to rest ready for reversing the stroke by the time the cam 41 reaches the point at which it operates the valve for cutting off. Another effect is that the stroke of the pistons will be shortened, because the alternate admission of the motive fluid at opposite sides of the piston is too rapid to allow it to make its full travel. Shortening the stroke of the pistons gives the sprocket-wheel 16 correspondingly less action on the main shaft by means of the clutches, and the secondary result will be that the speed of the shaft will gradually subside by reason of this diminished action upon it until at the point of most rapid movement of the pistons that of the sprocket-wheels equals it, and they will at this point impel it by means of the clutches. This reduction of the speed of the shaft correspondingly reduces the number of valve actions, and the short stroke of the pistons continuing these actions will be less frequent than the number of reciprocations of the pistons, since the valve actions correspond to the distance of travel and not to the number of reciprocations of the pistons. For example, if the stroke of the pistons has been reduced to less than one-half the maximum length, the number of valve actions may eventually decline to one-half, while the number of reciprocations of the piston remains the same, only lengthening to one-half full stroke, and in consequence the steam will be taken only at each alternate stroke of the pistons instead of at each stroke. Since no exact

relation between the two actions can be relied upon, the result would be that the valve actions will occasionally occur out of time with the piston actions, the steam being thus admitted at the wrong side of the pistons. When this occurs, the piston will be retarded so much that the valves will run ahead of it and open again upon the proper side after a stroke or two; but if the speed of the shaft should fall by reason of the work done during the lost stroke of the piston the piston will by that means recover its full stroke and immediately restore the speed.

One advantage of the structure herein described and shown is that when the piston's stroke is thus shortened by the action of the valves occuring with a rapidity due to the speed of the piston at the point of its highest speed the compression of the motive fluid, whose premature admission to the cylinder causes this shortening of the stroke, does not involve any loss of energy, because the piston is in this case stopped by the yielding medium, which gives back in its reaction all the energy expended in compressing it, and the amount of motive fluid which is discharged at the exhaust is in proportion to the stroke of the piston and not in proportion to the space in the cylinder which the steam may occupy.

The action above described of the valves with respect to the pistons being liable, as noted, to result in occasional dislocation of the former—that is, to situate them with respect to the strokes of the piston so that the motive fluid is admitted at the wrong side of the latter—it may sometimes happen that the motor will come to rest with the valve in such position that upon the admission of the motive fluid the pistons would not be started—as, for example, if the pistons being at one end of the cylinder, the steam should be admitted at the opposite end, tending to hold them in the position already occupied. In such case to rectify the valve action without rotating the main shaft it is necessary to have the cam-wheel 39 rotatable without communicating such rotation back to the gear 37. It is for this reason that the cam-wheel is not positively attached to the gear-wheel, but clutched, as already stated.

A convenient structure for the purpose is that illustrated, in which the gear-wheel 37 has a sleeve-hub 50 extending toward the cam-wheel 39, which is stopped against movement longitudinally with respect to the shaft. Feathered on the sleeve-hub 50 there is a wheel which comprises rigidly the ratchet-disk 52, having two series of ratchet-teeth facing in opposite directions, so as to be fed in opposite directions by a pawl adapted to engage the teeth, respectively, a similar ratchet-disk 53, preferably of greater diameter, and the grooved hub 54. A pawl 55 is pivoted on the back of the cam-wheel 39, having its nose overhanging the ratchet-disk 52 and adapted to engage the teeth of the disk in either direction, but of such width that it may be set to engage either one without engaging the other set of ratchet-teeth. A similar pawl 56 is carried by a bar 57, mounted on the frame and overhanging the ratchet-disk 53. A forked shipping-lever 58, connected with a slide-bar which carries the shipping-levers 32, and the movement which the ratchet-disks receive from the shipping-lever carries one set of ratchet-teeth on the disk 52 and the corresponding set of the disk 53 out from under their respective pawls 55 and 56 and the other set of ratchet-teeth of the disks, respectively, under or into engagement with said pawls, so that the direction of rotation of the cam-wheel 39 is changed at the same time that the action of the driving-clutches on the main shaft is reversed. When the valves are out of proper position, the operator either before admitting the motive fluid or after admitting it and finding that the pistons do not start will, by means of the lever connected with the bar 57, operate the pawl 56 to rotate the cam-wheel 39 until the valves are brought to proper position.

I claim—

1. An expansive-fluid motor comprising a plurality of cylinders and pistons operating therein, rigidly connected; valves controlling the admission and exhaust of motive fluid for the cylinders respectively; a main shaft and connections from the pistons for driving the same, comprising two clutches, each adapted to drive in one direction only, the driving direction of said clutches being the same, and means by which such clutches are rotated in their driving direction by the opposite strokes of the piston.

2. An expansive-fluid motor comprising two cylinders and pistons therein, rigidly connected; a driving-shaft and two clutches thereon, arranged to drive in the same direction, the exterior element of each said clutches being a sprocket-wheel; a counter-shaft and sprocket-wheels thereon corresponding to the clutch sprocket-wheels; a drive-chain connecting the clutch sprocket-wheels with the counter-shaft sprocket-wheels, opposite plies of said chains respectively being positively connected with the pistons for actuation by the latter, valves controlling the motive fluid into and out of the cylinders respectively, having their stems rigidly connected, and means actuated by the main shaft for moving the valves.

3. An expansive-fluid motor comprising cylinders, and pistons therein rigidly connected and operating together; a main shaft to which the pistons communicate rotary movement; two clutches by which such movement is communicated, arranged to engage the shaft for driving by movement in the same directions, and connections by which the pistons oscillate the clutch elements in opposite directions;

valve mechanism and means for operating it deriving actuation from the main shaft and in uniform time relation thereto.

4. An expansive-fluid motor comprising two parallel cylinders, and rigidly-connected pistons operating therein respectively; a main shaft extending transversely with respect to the plane of the axes of the two pistons adjacent to the ends of the cylinders from which the piston-stems emerge; a counter-shaft parallel with the main shaft more remote from said end; two sprocket-wheels loose on the main shaft, and corresponding sprocket-wheel on the counter-shaft, and chains connecting the corresponding wheels respectively, the pistons being positively connected to opposite plies of the chains for actuating them in opposite directions, and clutches connecting the sprocket-wheel with the main shaft arranged to drive said shaft by their alternate movements in the same direction; valves controlling the supply and exhaust of motive fluid for the cylinders respectively having their stems rigidly connected, and means for actuating said valves comprising a wheel rotated positively by connection with the main shaft, and located between the same and the counter-shaft.

5. An expansive-fluid motor, in combination with the cylinders and rigidly-connected pistons therein; valves for controlling the motive fluid having their chambers and paths of travel parallel with the cylinders respectively; a main shaft rotated by a clutch connection with the pistons; a wheel rotated by the main shaft having cam projections; an arm connected with the valve-stems extending across the face of such wheel and having abutments in the path of said cam projections, whereby the rotation of the wheel causes the projections to actuate the valve-stems in fixed time relation to the rotation of the main shaft.

6. An expansive-fluid motor comprising two cylinders and pistons therein; a main shaft having two clutch connections with said pistons adapted to rotate the shaft in the same direction by the opposite movements of the pistons; a wheel actuated in uniform time relation with the main shaft; valves controlling the motive fluid; a bar rigid with both said valves, and abutments on said bar between which the cam-wheel revolves, and which are encountered by the cam projections of said wheel in such revolution to actuate the valves longitudinally, one of said projections being adapted to be adjusted angularly with respect to the other to vary the cut-off.

7. An expansive-fluid motor comprising, in combination with the cylinder, a piston operating therein, and valves for controlling its operation; a main shaft and connections from the piston for rotating the same, consisting of two clutches, adapted to drive in the same direction, means for operating them in their driving direction by opposite strokes of the piston and means for reversing the clutching action of the clutches.

8. An expansive-fluid motor comprising, in combination with the cylinder and its piston, a controlling-valve; a main shaft and one-way driving-clutch connections from the piston for driving the same, means for operating the valves actuated in uniform time relation with the main shaft, and means for actuating said valve-operating devices independently of their actuation by the shaft for rectifying the relation of the valve action to the piston action.

9. In an expansive-fluid motor, comprising, in combination with the cylinder and piston, and its controlling-valves, a main shaft and one-way driving connections from the piston for driving same, means for reversing the clutching action of the clutches to reverse the direction of rotation of the main shaft; means for moving the valves actuated in uniform time relation with the main shaft, and comprising a clutch device for communicating rotary motion in one direction; means for reversing the action of such clutch connected with and operated by the means for reversing the action of the main-shaft clutches.

10. In an expansive-fluid motor comprising, in combination with the cylinder, its piston and controlling-valve, a main shaft and one-way driving-clutch connections from the piston for rotating the same; a wheel rotated in uniform time relation with the main shaft having cam projections for actuating the valves; an element connected with the valves for their actuation, having abutments at points diametrically opposite with respect to the axis of said cam-wheel.

11. In an expansive-fluid motor comprising a cylinder and its piston and controlling-valve, a main shaft and one-way driving-clutch connections from the piston for rotating the shaft; a wheel rotated in uniform time relation with the main shaft and having cam projections for actuating the valve, one of said projections being adjustable to vary the angular distance between the two for regulating the cut-off.

12. An expansive-fluid motor comprising, in combination with the cylinders and rigidly-connected pistons operating therein, a driving-shaft and two clutches thereon arranged to drive in the same direction, the exterior element of each of said clutches being a sprocket-wheel, a counter-shaft and sprocket-wheels thereon corresponding to the clutch sprocket-wheels; drive-chains connecting the clutch sprocket-wheels with the counter-shaft sprocket-wheels; a cross-head rigidly connecting the two pistons, said cross-head being attached positively to one ply of one of the drive-chains, and to the opposite ply of the other drive-chain; valves controlling the motive fluid into and out of the cylinders respectively; a cross-head rigidly connecting the stems of the valves; two abutments carried by

said cross-head, and cam devices rotated by connection with the main shaft for encountering said abutments to operate the valve-stems.

13. An expansive-fluid motor comprising, in combination with the cylinder and piston operating therein, valves for controlling its operation; a main shaft and connections from the piston for rotating the same, consisting of two clutches adapted to drive in the same direction; means for operating them in their driving direction by opposite strokes of the piston, said clutches comprising each an interior and an exterior element, and an annular group of balls between said elements, the inner element having for each ball a seat between which and the outer element the ball may be wedged by movement in either direction from the middle point of the seat; a third element which retains the balls between said inner and outer elements, having fingers between which the balls are checked; means for adjusting said third element to check the balls from passing the center of their seats respectively in one direction or the other, according to the adjustment, whereby the clutches may be set to drive in either direction according to the adjustment of said third element.

14. In an expansive-fluid motor, in combination with the cylinder and piston, main shaft and one-way driving-clutch on said main shaft, and connections from the piston for driving said clutch, the clutch comprising the outer element, 21, and the inner element, 20, and the annular ball between said elements, and the ball-retaining element, 25, the element, 20, having for each ball a seat which trends from its middle point in both directions converging toward the annular wall of the outer element, said retaining element having the fingers, 27, between which the balls respectively are checked, the sleeve, 28, feathered and adapted to move longitudinally on the shaft, and cam connections between said sleeve and said ball-retaining elements for rocking the latter on the shaft when the sleeve is moved longitudinally thereon, and a shipping-arm engaging said sleeve to thus move it longitudinally, whereby the driving direction of the clutch may be reversed at will.

15. An expansive-fluid motor comprising two parallel cylinders and rigidly-connected pistons operating therein respectively; a main shaft to which the pistons communicate rotary movement; two clutches by which said movement is communicated, arranged to engage the shaft for driving by movement in the same direction, the outer element of each of said clutches being a sprocket-wheel, and means for connecting said clutches with the piston, consisting of chains engaging said sprocket-wheels, and having opposite plies oppositely connected to the two pistons respectively, said clutches each comprising, in addition to said outer sprocket-wheel and inner element, an annular series of balls between the two elements and a ball-retaining element inclosing the annular chamber for the balls and provided with fingers projecting between the balls, the inner element having for each ball a seat which trends from a middle point in opposite directions convergingly toward the annular wall of the outer sprocket-wheel element; sleeves feathered on the shaft adjacent to the clutches respectively, having cam connections between said sleeves and said ball-retaining elements respectively, adapted to rock the ball-retaining elements on the shaft when the sleeves are moved longitudinally, the shipping-bar, 34, and forked arms therefrom engaging the sleeves, and means for operating the bar to slide the sleeves on the shaft at will to reverse the driving direction of the clutches.

16. An expansive-fluid motor comprising, in combination with two parallel cylinders rigidly united, parallel pistons rigidly connected, operating therein; valves for controlling their operation; a main shaft and connections from the pistons for rotating the same, consisting of two clutches adapted to drive in the same direction; means for operating them in their driving direction by opposite strokes of the pistons, and means for reversing the clutching action of the clutches.

17. An expansive-fluid motor comprising, in combination with two parallel cylinders rigidly joined, pistons operating therein, rigidly connected; controlling-valves; a main shaft and one-way driving-clutch connections from the pistons for driving the same; means for operating the valves actuated in uniform time relation with the main shaft, and means for actuating said valve-operating devices independently of their actuation by the shaft for rectifying the relation of the valve action to the piston action.

18. In an expansive-fluid motor comprising, in combination with two parallel cylinders rigidly joined, operating therein, and the controlling-valves for the same, a main shaft and one-way driving-clutch connections from the pistons for driving the shaft; means for reversing the clutching action of the clutches to reverse the direction of rotation of the shaft; means for moving the valves actuated in uniform time relation with the main shaft, and comprising clutch devices for communicating rotary motion in one direction; means for reversing the action of such clutch devices connected with and operated by the means for reversing the action of the main-shaft clutches.

19. In an expansive-fluid motor comprising, in combination with two parallel and rigidly-joined cylinders, their rigidly-connected pistons and controlling-valves; a main shaft and one-way driving-clutch connections from the pistons for rotating the shaft; a wheel rotated in uniform time relation with the main shaft, having cam projections for actuating the valves, and an element connected with the

valves for their actuation, having abutments at points diametrically opposite with respect to the axis of same cam-wheel.

20. In an expansive-fluid motor comprising two parallel rigidly-united cylinders and their respective rigidly-united pistons and controlling-valves, a main shaft and one-way driving-clutch connections from the pistons for rotating the shaft; a wheel rotated in uniform time relation with the main shaft, and having cam projections for actuating the valves, one of said projections being adjustable to vary the angular distance between the two for regulating the cut-off.

In testimony whereof I have hereunto set my hand, in the presence of two witnesses, at Denison, Iowa, this 16th day of February, A.D. 1903.

JAMES A. NORTON.

In presence of—
GEO. A. RICHARDSON,
KATE GAFFEY.