No. 696,612. Patented Apr. 1, 1902.

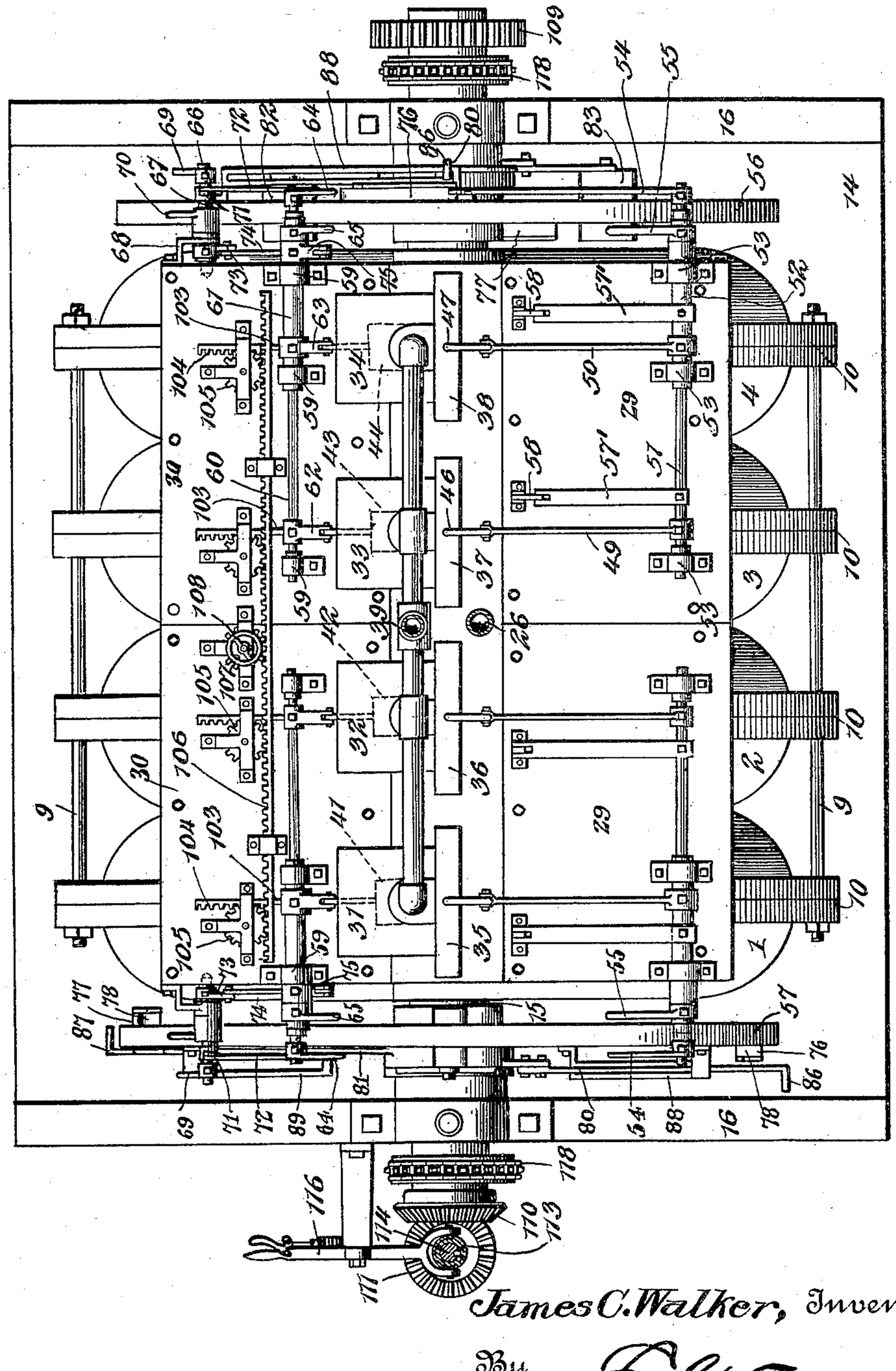
J. C. WALKER.

MOTOR.

(Application filed Feb. 14, 1901.)

(No Model.) 5 Sheets—Sheet 1.

Fig. 1.



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(No Model.) 5 Sheets—Sheet 2.

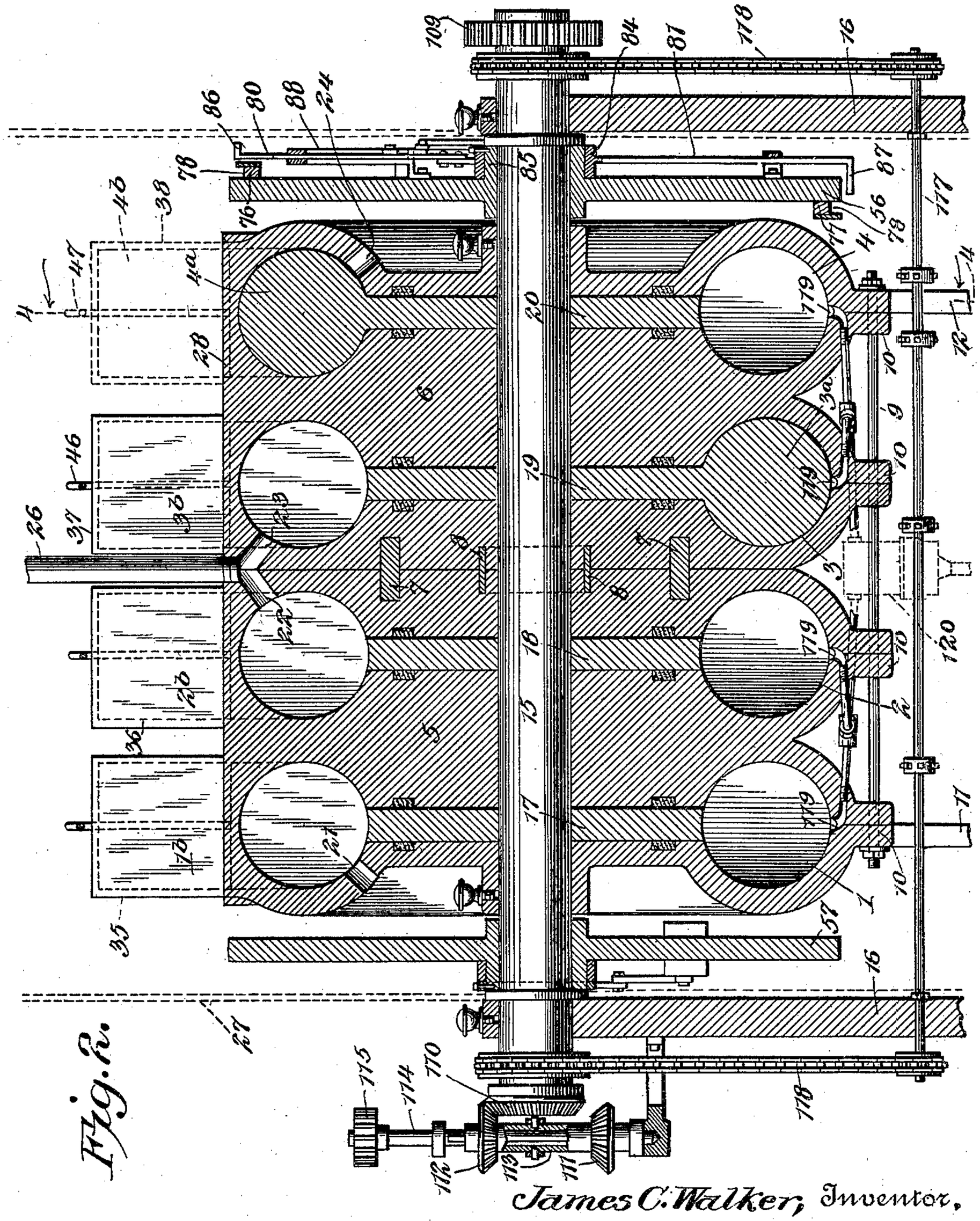

Fig. 2.

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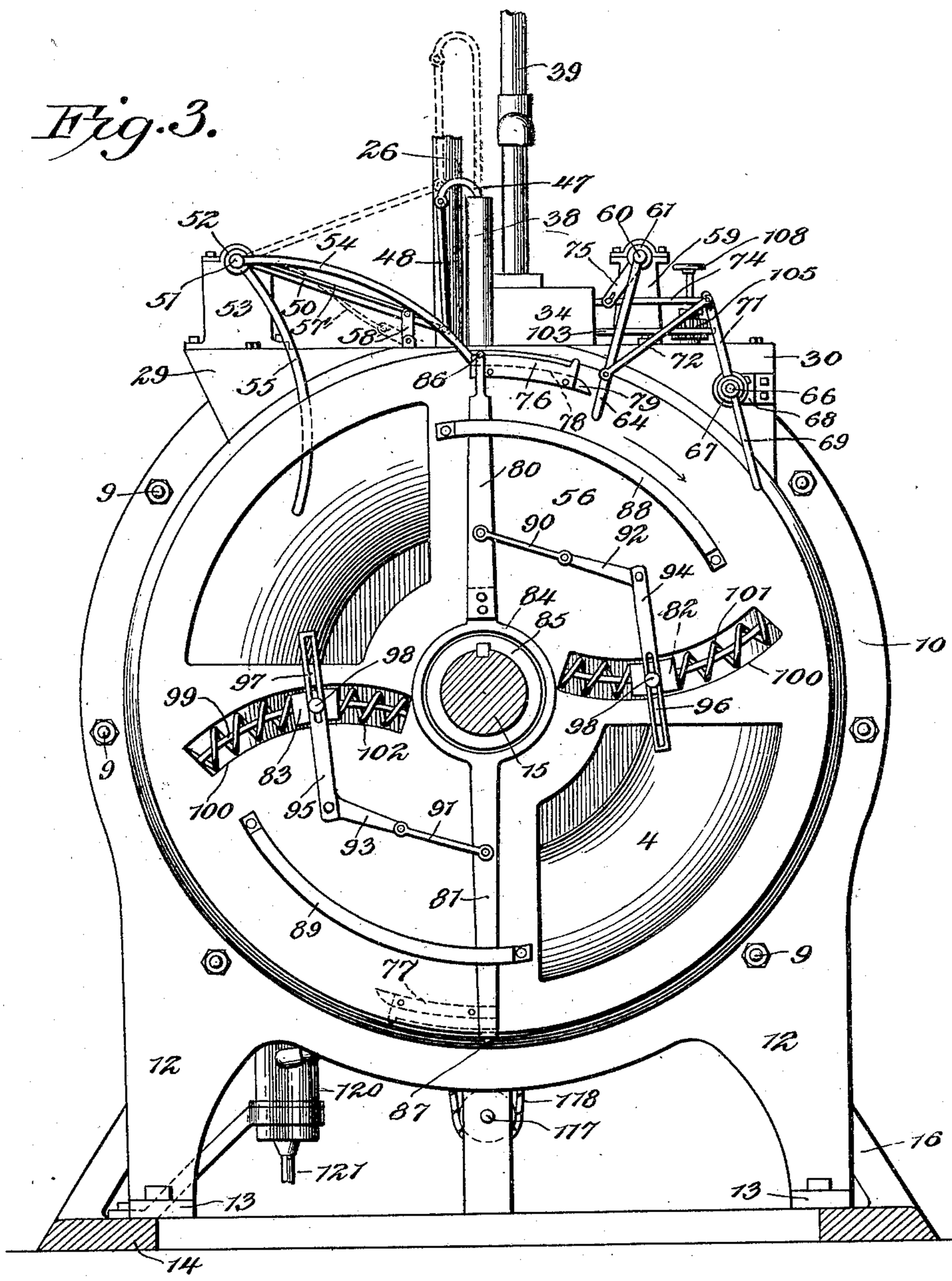
Fig. 3.



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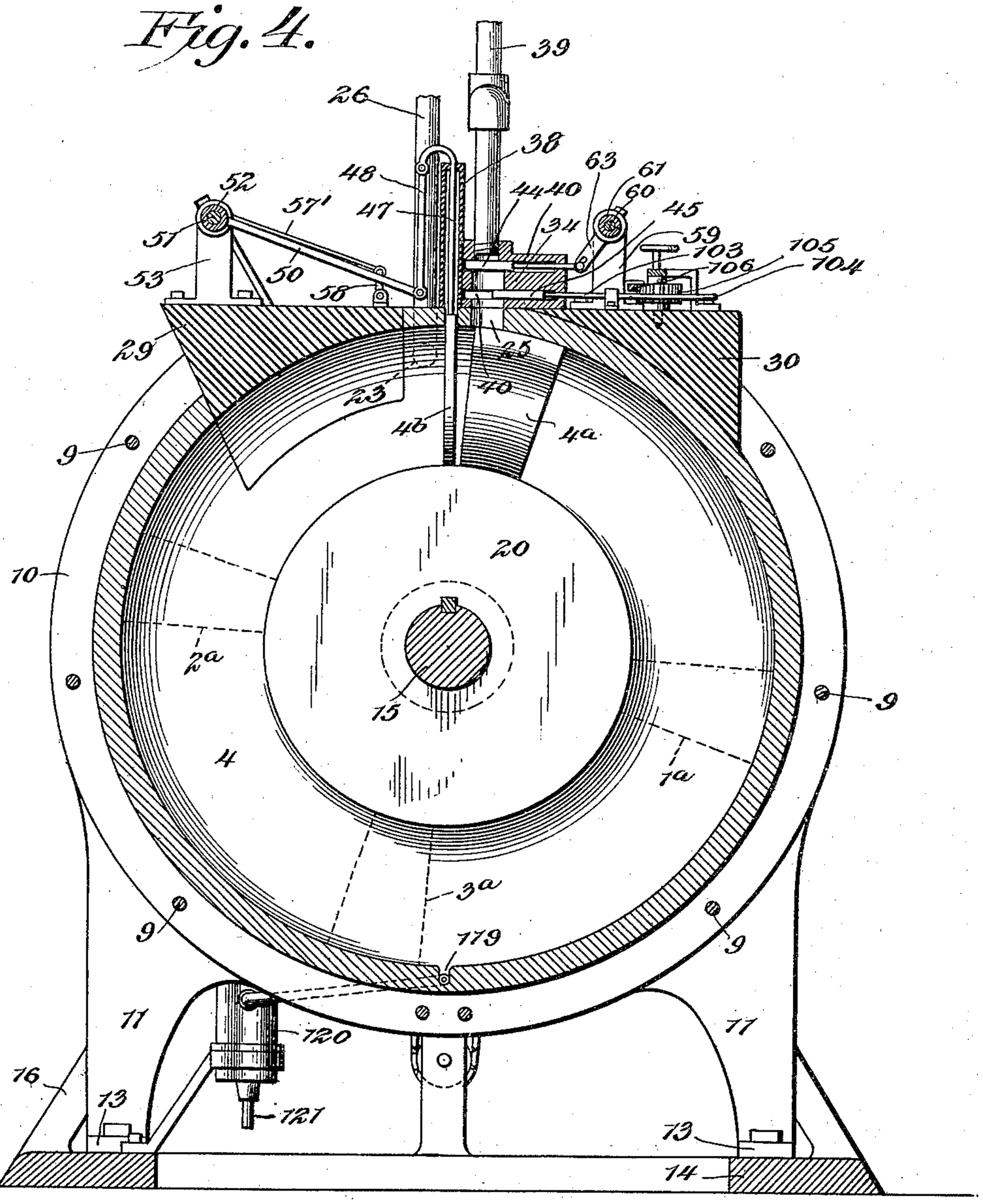
(No Model.) 5 Sheets—Sheet 4.

Fig. 4.



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5 Sheets—Sheet 5.

Fig. 5.

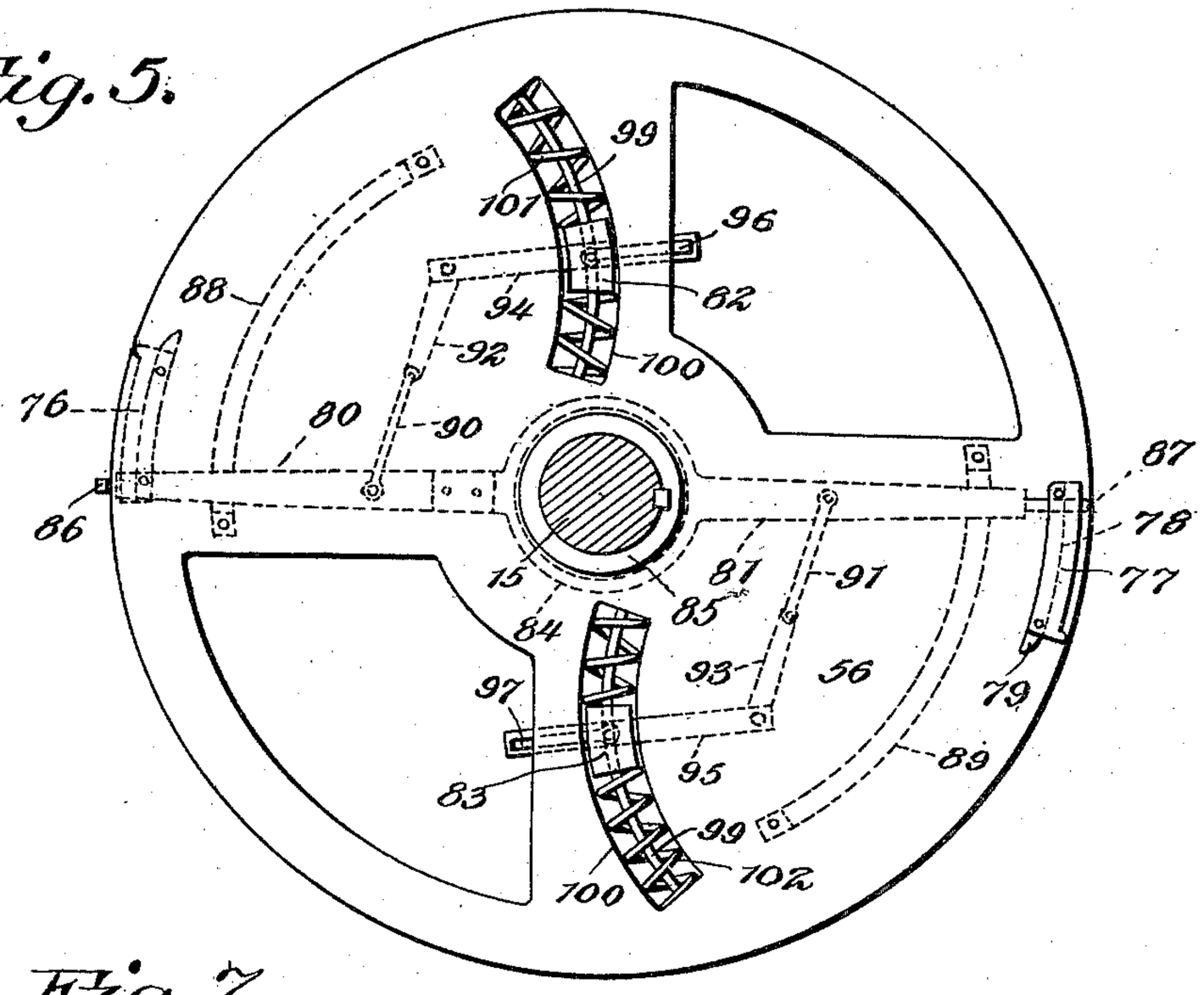


Fig. 7.

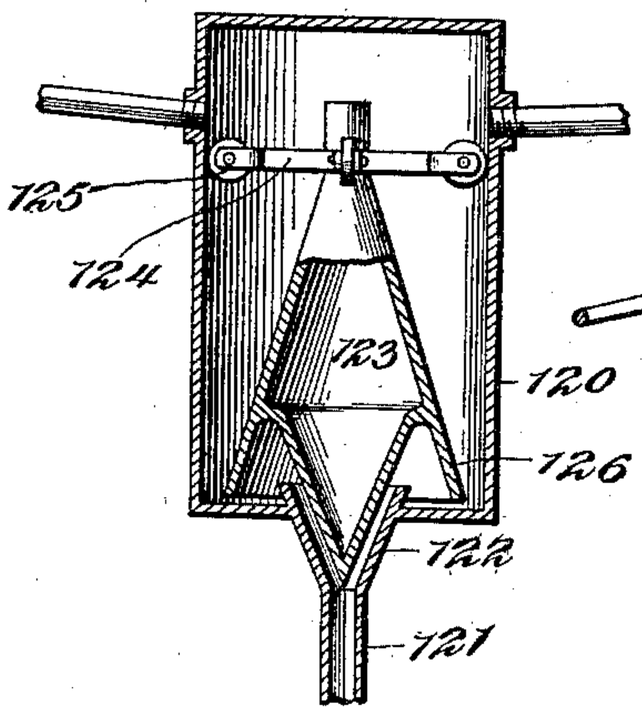
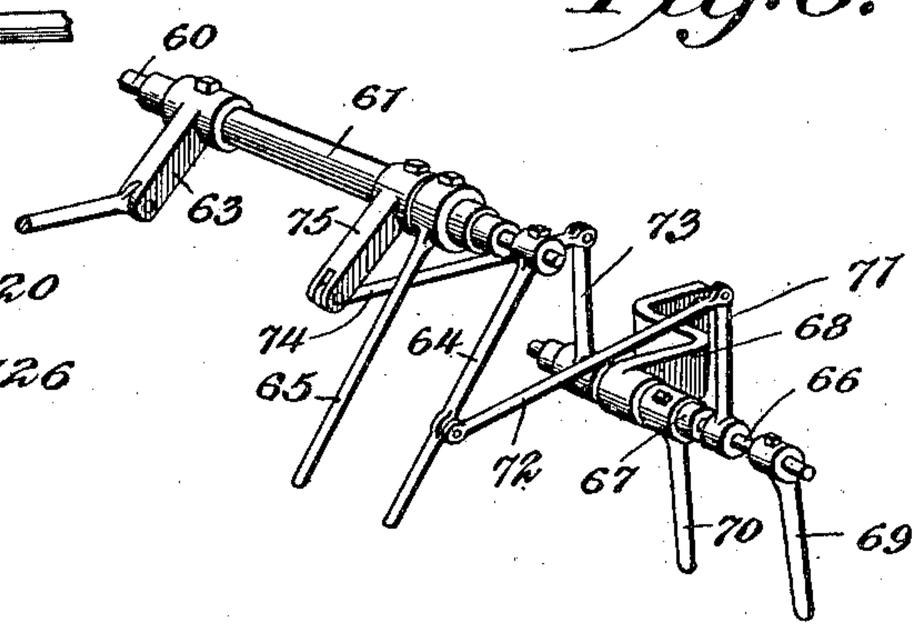


Fig. 6.



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UNITED STATES PATENT OFFICE.

JAMES C. WALKER, OF WACO, TEXAS.

MOTOR.

SPECIFICATION forming part of Letters Patent No. 696,612, dated April 1, 1902.

Application filed February 14, 1901. Serial No. 47,322. (No model.)

To all whom it may concern:

Be it known that I, JAMES C. WALKER, a citizen of the United States, residing at Waco, in the county of McLennan and State of Texas, have invented a new and useful Motor, of which the following is a specification.

My present invention relates to a novel translating device or motor of that class which are usually designated as "multiple-cylinder rotary engines" and which are distinguished by the aggroupment of a series of stationary circular cylinders pierced axially by a common engine or power shaft that serves as a support for the piston-disks carrying piston-heads disposed to move within the cylinders. Motors of this character are illustrated in Letters Patent of the United States granted to me and numbered 515,631 and 611,555.

The object of the present invention is to improve the constructions illustrated in these patents by providing exceedingly simple, positively-operating, and inexpensive controlling devices for automatically opening and closing the abutments and throttle-valves in such predetermined order as will cause the pistons within the several cylinders to be subjected in rotation to the propulsive energy developed by the direct impact of steam and to be controlled by novel cut-off mechanism in a manner to increase or diminish the period of steam intake and to correspondingly diminish or increase the extent of movement of the piston under the expansive force of the motive agent.

A further object of the invention is to provide the several cylinders with manually-operated controlling-valves separate from and independent of the automatically-controlled valves and designed to be set by the operator or engineer for the purpose of determining the maximum dimensions of the induction-openings, and thereby limiting the extent of steam induction which may be effected by the automatic operation of the governor.

A still further object of the invention is to produce a motor of very compact form and of great capacity to enable its use in connection with a novel generator which forms the subject-matter of my concurrent application for Letters Patent No. 47,321.

Still further and subordinate objects of the invention will hereinafter more fully appear as the necessity for their accomplishment is developed in the course of the succeeding description of the preferred form of my invention illustrated in the accompanying drawings and defined in the appended claims.

In said drawings, Figure 1 is a top plan view of my motor complete. Fig. 2 is a central longitudinal section therethrough. Fig. 3 is an end view thereof. Fig. 4 is a transverse section taken on the line 4 4 of Fig. 2. Fig. 5 is an elevation of the controlling or cut-off disk located at the end of the motor opposite to that illustrated in Fig. 3. Fig. 6 is a detail perspective view of the valve-gear employed in connection with the controlling-valves of one pair or group of cylinders; and Fig. 7 is a detail sectional view, partly in elevation, of the water-trap.

Referring to the numerals employed to designate corresponding parts throughout the views, 1, 2, 3, and 4 indicate a series of coaxial cylinders which are organized into two groups, the cylinders 1 and 2 being the component members of one group and the cylinders 3 and 4 of the other. The engine or motor casing is made up of two parts 5 and 6, each comprehending a group of cylinders and connected to the other, as by suitable pins 7 and possibly also by an annular band 8, the pins 7 and band 8 being wedged within suitable recesses in the opposing faces of the casing sections 5 and 6. As best seen in Fig. 2 of the drawings, each of these casing-sections is made up of a number of cast parts, and the entire structure is assembled in rigid union by a series of assembling-bolts 9, extending through peripheral flanges 10, projecting beyond each cylinder, the relation of these flanges and bolts being clearly shown in Figs. 2, 3, and 4.

The manner of supporting the motor is not essential to the present invention; but in the drawings I have illustrated the vertical supporting-frames 11 and 12 as being formed integral with the peripheral flanges of the end sections of the casing and provided with foot-flanges 13, by means of which the motor may be bolted to the bed-plate 14, which in practice is rigidly supported upon the top of the generator to which reference has been made.

Piercing the casing axially is disposed the

engine or power shaft 15, journaled at its opposite ends beyond the casing in the upper ends of suitable supporting-standards 16, upstanding from the bed-plate 14, as shown in Figs. 2, 3, and 4, and upon this shaft are mounted for rotation therewith a series of piston-disks 17, 18, 19, and 20, carrying the heads or pistons 1^a, 2^a, 3^a, and 4^a, located, respectively, within the cylinders 1, 2, 3, and 4. The pistons within the cylinders of each group are disposed at diametrically opposite points, and the pistons of the cylinders of opposed groups are disposed in quartering relation. The meaning of this statement will be more clearly apparent by reference to Fig. 4, wherein it may be seen that the pistons 1^a and 2^a are disposed at diametrically opposite points and that the pistons 3^a and 4^a, while being likewise diametrically opposite, are disposed in alternating arrangement with the pistons 1^a and 2^a, the reason for this relative distribution of pistons being, as is well understood in the art, for the purpose of facilitating the subjection of said pistons successively to the direct impact of the inflowing motive agent. In this type of engines the cylinders are necessarily provided with movable abutments 1^b, 2^b, 3^b, and 4^b, and these abutments are disposed in a line along the top of the engine and directly above the axis thereof. In a similar manner—that is to say, at the top of the engine—are located the exhaust-ports 21, 22, 23, and 24 and the induction-ports 25, located at opposite sides of the abutments. This relative arrangement of the exhaust and induction ports is best seen in Fig. 4 of the drawings, and by reference to Fig. 5 it will be noted that the exhaust-ports 22 and 23 of the cylinders 2 and 3 are in communication with an exhaust-pipe 26, common to both of these ports, while the exhaust-ports 21 and 24 are disposed to exhaust directly within a casing 27, (indicated in dotted lines in Fig. 2,) which casing is in communication with the water-chamber of the generator, (not illustrated,) in order that the condensation may be fed back to the generator for subsequent utilization.

Referring more particularly to Figs. 1 and 4 of the drawings, it will be noted that above the casing of the engine extended horizontal platforms 29 and 30 are secured by bolts or otherwise. The platform 29 is let into the cylinders, as shown in Fig. 4, by cutting away the latter to the desired extent and by forming the under surface of the platform 29 in a manner corresponding to that portion of the cylinder contour which it occupies. Therefore this platform 29 is not only removable, but when removed is designed to permit access to the interior of the engine to be gained for the purpose of repairing any interior parts which may have become worn or otherwise deranged. The platform 30 is also removably bolted to the engine-casing, as stated; but the latter is not cut away to receive it. Upon the section 30 are disposed a series of valve-chests 31, 32, 33, and 34, and supported upon the engine-casing intermediate of the platforms 29 and 30 are a series of abutment-casings 35, 36, 37, and 38. The valve-chests are disposed directly above the several induction-ports, and the abutment-casings are located above and are designed to receive these abutments, as shown. Each of the platforms 29 and 30 is preferably constructed in two separate sections, each section being supported by two of the four cylinders shown. The motive agent—as, for instance, steam—is supplied to the motor through a supply-pipe 39, having a number of branches communicating with the several valve-chests, the passage through each of which is controlled by a pair of valves disposed, as illustrated in Fig. 4, one above the other and movable within suitable ways 40. The upper valves, which I shall designate by the numerals 41, 42, 43, and 44, are controlled automatically by suitable valve-operating mechanism, to be described, and said valves will therefore be designated as the "controlling-valves" of the engine. The lower valves, which may be indiscriminately designated by the numeral 45, are manually operated by common actuating mechanism and are intended to be shifted for the purpose of determining the maximum dimensions of the induction-opening, so that the engine may be set for the generation of sufficient power for any given load and will be prevented from having its capacity increased beyond such predetermined extent by the operation of the automatic valve-operating mechanism.

Before proceeding with a description of the novel mechanisms which I employ for the operation of the abutments and controlling-valves it may be well to refer briefly to the general operation of the engine as thus far described and the sequence of operation which is maintained between the several coöperative elements already enumerated. Starting with the pistons in the positions indicated in Fig. 4, it will be noted that the piston 4^a within the cylinder 4, through which the section is taken, is advanced slightly beyond the abutment 4^b, which is depressed, and has passed just beyond the rear edge of the adjacent induction-port 25. In this position of the parts the controlling-valve 44 must be opened for the purpose of admitting steam behind the piston 4^a and between it and the abutment 4^b. Assuming that this has been done, the piston will advance under the direct impact of the motive agent through any given arc of its travel which may be determined upon as the most effective and economical in the continuous operation of the device. In the present instance, as will be hereinafter more fully explained, the travel of the piston under the direct impact of the motive agent—that is to say, with the steam-space of the cylinder in direct communication with the source of supply—is approximately one-eighth of the piston travel. This proportion has been de-

termined upon for the reason that it is desired to utilize the expansive energy of the steam for the propulsion of the motor through a given travel subsequent to the cutting off of the fluid-supply. If then the steam is cut off under normal conditions at the termination of, say, one-eighth of the piston travel, the second eighth of such travel will be effected under the high expansive energy of the steam, and before the energy of the latter has been appreciably diminished the next succeeding piston—in this instance 2^a—will have moved to its initial position and will be propelled under the direct impact of live steam, while the piston 4^a is traveling through the third eighth of its travel under the somewhat diminished energy of the steam within the cylinder 4. This sequence of operation is maintained until all of the pistons have been subjected to the direct action of the motive agent, and it will be seen that under these conditions and with the parts restored to their normal positions, as shown in Fig. 4, the piston 4^a will again advance under the live steam, while the energy thus exerted is augmented by the expansion of the motive agent within the several other cylinders acting with more or less effective force upon the pistons 1^a, 3^a, and 2^a in like proportion as those pistons are nearer to or farther from the induction-ports. It is evident, however, that in order for the pistons to advance to the position of the piston 4^a in Fig. 4 the abutments must be elevated into the abutment-casings, and it is also evident that means must be provided for automatically operating the controlling-valves to open and close the induction-ports at predetermined points of the travel of the several pistons.

The means for effecting the successive elevation of the abutments are divided into two groups, each of which controls the operation of the abutments of a group of cylinders. These groups are identical in construction, and I shall therefore describe the mechanism for controlling the abutments 3^b and 4^b of the cylinders 3 and 4. The abutments 3^b and 4^b are provided with abutment-stems 46 and 47, extending upwardly from the abutments through the abutment-casings, above which their extremities are curved, as shown in Fig. 4. These stems are pivotally connected to the upper ends of the links 48, connected at their lower ends to oscillatory arms 49 and 50, connected to rock-shafts 51 and 52, supported in bearing-brackets 53, upstanding from the platform 29. The shaft 52 is comparatively short and is of hollow formation, in order that the shaft 51 may be passed through it, and provided upon its extremity in front of said hollow shaft with an abutment-operating arm 54. The end of the hollow shaft 52 adjacent to the arm 54 is provided with a similar abutment-operating arm 55, located in laterally-spaced relation to said arm to permit the interposition of the periphery of the operating-disk 56, keyed or otherwise secured upon the engine-shaft 15 beyond one end of the engine-casing and corresponding to a similar operating-disk 57, mounted upon the shaft at the opposite end of the engine. The shafts 51 and 52 are designed to be rocked at proper intervals for the purpose of vibrating the arms 49 and 50 to effect the elevation of the abutments 3^b and 4^b into the abutment-casings as the pistons pass to the positions in which they receive the initial impact of steam. I therefore provide each of said shafts with retracting or returning mechanism, which may, and preferably does, consist of a spring 57′, secured to its shaft at one end and connected at its opposite end to a pivoted link 58, upstanding from the platform, as best seen in Figs. 3 and 4. The rocking of the shafts 51 and 52 for the purpose of elevating the abutments is obviously effected through the rotation of the controlling-disk 56; but before describing the precise manner in which this end is accomplished I will proceed with a description of one group of valve-operating mechanism and will then describe the manner in which the rotation of the controlling-disk effects the raising and lowering of the abutments and the subsequent opening and closing of the corresponding controlling-valves, which in the present instance are the valves 43 and 44 within the steam-chests 33 and 34 of the cylinders 3 and 4.

Behind the valve-chests 33 and 34 are mounted in suitable bearing-brackets 59 a pair of valve-shafts 60 and 61. The shaft 60, like the shaft 51, is comparatively long and passes through the shaft 61, which is hollow. Each of these shafts, which are designed to rock, is provided with a vibratory arm 62 and 63, pivotally connected, as indicated in Figs. 1, 3, and 4, with the stems of the controlling-valves 43 and 44 and are additionally provided upon their outer extremities with the valve-opening arms 64 and 65, disposed, like the arms 54 and 55, at opposite sides of the perimeter of the operating-disk 56. It should also be noted that the arms 54 and 64 are designed for the operation of the abutment and controlling-valve of the cylinder 3 and are both located in front of the disk 56, as shown in Fig. 3, while the arms 55 and 65 are in like manner operatively related to the abutment and controlling-valve of the cylinder 4 and are located between the disk 56 and the adjacent end of the engine-casing. It will now appear that if the projection upon the operating-disk 56 should swing either of the valve-opening arms 64 or 65 in the direction of the arrow in Fig. 3 the result would be to rock either of the shafts 60 or 61 and by the vibration of one of the arms 62 or 63 effect the retraction of one of the valves 43 or 44 to permit the ingress of steam to one of the cylinders 3 or 4. It is therefore evident that provision must be made for returning the opened valve to its closed position after the directly-impelled piston has moved through a predetermined arc under the direct impact

of the motive agent. I therefore mount at any desired distance in advance of the arms 64 and 65 a pair of coaxial shafts 66 and 67, the former of which is encircled by the shaft 67 and both of which are supported in any suitable manner—as, for instance, by a bracket 68, bolted to one end of the platform. These shafts are provided with valve-closing arms 69 and 70, the former, extended from the shaft 66, being disposed in front of the outer face of the operating-disk 56, and the arm 70, extending from the extremity of the shaft 67, being disposed opposite the periphery of the disk, as best seen in Fig. 1 of the drawings. It is evident that these valve-closing arms are designed for the return of the valves to their closed positions, and it therefore follows that suitable connections must be effected between the opening and closing devices. I therefore provide the shaft 66 with an upstanding arm 71, to the end of which is pivoted a link 72, having pivotal connection at its opposite end to the valve-opening arm 64 of the valve 43, and in like manner the upstanding arm 73, upon the inner end of the shaft 67, is pivotally connected to a link 74, which is in turn connected to an arm 75, extending from the shaft 61.

Attention will now be directed more particularly to Figs. 1, 2, and 3, wherein it will be observed that the operating-disk 56 is provided at diametrically opposite points and upon its opposite side faces with what may be designated as "trip-blocks" 76 and 77. These blocks are somewhat elongated in form and are provided with longitudinal recesses 78 in their upper faces and with buffer-springs 79 at their front ends, the recesses being provided for the reception of the ends of the several operating-arms, actuated or tripped by the blocks, and the springs 79 being designed to cushion the shock incident to the impact of the blocks against the arms. As the operating-disk rotates with the engine-shaft, driven by the several pistons, the trip-block 76 strikes against the lower end of the abutment-operating arm 54 and swings the latter upwardly to elevate the abutment 3^b within the cylinder 3 just before said abutment is reached by the piston 3^a. The length of the block 76 is such that the arm 54 will be retained in its elevated position for the purpose of holding the abutment elevated until the piston 3^a has passed beyond the abutment nearly to the position assumed by the piston 4^a in Fig. 4. By this time the block 76 will have advanced a sufficient distance to permit the arm 54 to drop from its rear end, with which movement the abutment, impelled by gravity and by its spring 57, will drop back to its position across the cylinder. (See Fig. 4.) Continued rotation of the disk will almost immediately bring the block 76 into engagement with the valve-opening arm 64 of the valve 43, said valve being opened to admit steam to the interior of the cylinder just as the piston passes beyond the rear edge of the induction-port, the position of the parts at this time being clearly illustrated in Fig. 4, in which the controlling-valve is about to open. In like manner the shifting of the abutment 4^b and of the controlling-valve 44 will be subsequently effected by the trip-block 77 as the latter is presented in turn to the abutment-operating arm 55 and valve-opening arm 65.

By reference to Fig. 1 it will be noted that the valve-closing arms 69 and 70 are not located in the paths of the trip-blocks 76 and 77, and hence it follows that these blocks are not employed for the purpose of closing the valves, although the utilization of the blocks for this purpose might be effected provided it is not desired to employ speed-regulating mechanism or automatic governing devices in connection with the means for closing the valves. In the illustrated embodiment of my invention, however, such automatic control of the motor is contemplated, and the valve-closing arms are therefore, as we have seen, located out of the paths of the blocks and are designed for actuation by the governor-arms 80 and 81, the positions of which are controlled by centrifugally-operated governing members 82 and 83. The governor-arms are provided with a common hub 84, encircling and freely revoluble upon the hub 85 of the disk 56 and are substantially identical in construction, except that the arm 80 is offset somewhat from the face of the disk in order to avoid interference with the trip-blocks 76 or the abutment-operating arm 54 and has an outstanding terminal finger 86, movable in a path obstructed by the valve-closing arm 69. On the other hand, the arm 81 is disposed close to the outer face of the disk, because the trip-block 77, to which it is adjacent, is located at the opposite side of the disk, and said arm instead of being provided with an outstanding terminal finger is provided with a terminal finger 87, which is disposed opposite the periphery of the disk and is movable in a path obstructed by the valve-closing arm 70 of the valve 44. As seen in Fig. 3, the governor-arms are movable within arcuate guides 88 and 89, the former of which is offset to accommodate the offset arm 80, and both of said arms are pivotally connected through the medium of links 90 and 91 with the short arms 92 and 93 of a pair of governor-levers 94 and 95 of bell-crank form, fulcrumed upon the face of the disk, as shown, and having their long arms formed with elongated slots 96 and 97, engaging headed pins 98, upstanding from the sliding weights or governor members 82 and 83. The members or weights referred to are mounted to move in oppositely-disposed arcuate paths at diametrically opposite sides of the disk and are guided in such movement upon curved guide-bars 99, located within arcuate openings or slots 100 in the disk. The weights or members 82 and 83 are designed to be urged outwardly by centrifugal force for the purpose

of swinging the governor members to change the positions of the governor-arms in a manner to be described; but said parts are normally retained in the positions illustrated in Fig. 3 of the drawings by counteractive springs 101 and 102, located within each of the openings 100 and bearing against the opposite ends of the weight or member movable therein.

Returning now to a consideration of the operation of the controlling mechanism, it is evident that further rotation of the controlling-disk 56 after the abutment has been raised and lowered and the controlling-valve opened will present the finger 86 to the valve-closing arm 69 or the finger 87 to the valve-closing arm 70, as the case may be. In either instance the valve-closing arm will be swung for the purpose of rocking the connected valve-shaft to close the controlling-valve in a manner which will be obvious. Under normal conditions the governor-arms 80 and 81 will assume the positions illustrated in Fig. 3 of the drawings to present the trip-fingers at or about the rear ends of the trip-blocks 76 and 77. In this position of the parts each cylinder will take steam while the finger is passing from the position opposite the induction-port until it reaches the valve-closing lever, which obstructs its path, and the subsequent travel of the piston will be effected under the expansive force of the steam occluded within the cylinder between the abutment and the piston in the usual manner. If now the normal load is decreased, the motor, being relieved of a considerable resistance, will operate at a higher speed. This will cause the governor members or weights 82 and 83 to be urged outward by centrifugal force against the resistance of the springs, and the governor-levers 93 and 94 will be swung upon their fulcrums to effect the shifting of the governor-arms 80 and 81—that is to say, the position of these arms with respect to the trip-blocks or valve-opening mechanism will be advanced, to the end that the closing of the valves will be accelerated in proportion to the response of the governor members or weights to the action of centrifugal force. Consequently the governor-arms will be advanced accordingly as the controlling-disk is rotated at a more or less high rate of speed, and the period of steam intake will be shortened in direct ratio with the advance of the governor-arms.

We have now learned in what manner the motor is constructed and automatically controlled by mechanism which effects the automatic raising and lowering of the abutments and the automatic opening and closing of the controlling-valves. I have premised, however, that it is desirable to equip a motor of this character with a series of throttle-valves operated by mechanism common to all of them, so that the maximum induction of steam may be controlled and, in fact, may be entirely cut off for the purpose of stopping the motor. In Fig. 4 the construction and relation of the individual throttle-valves 45 will be noted, and in Fig. 1 will be found the common operating means by which all of these valves are simultaneously operated in corresponding degree. To each of these valves 45, which are disposed below the controlling-valves 44, is connected a valve-stem 103, formed upon its outer or rear end with a rack 104. The several valve-racks 104 mesh with a series of spur-pinions 105, mounted in suitable bearings upon the platform and meshing with an operating-rack 106, common to all of them. For the purpose of shifting the rack 106 to simultaneously rotate the several pinions 105, and thereby operate the several throttle-valves, I provide an operating-pinion 107, meshing with the rack 106 and designed to be rotated by means of a hand-wheel 108, which constitutes a throttle-controller. This arrangement places the motor absolutely under the control of the operator or engineer, because the controlling-valves are absolutely dependent for their effective operation upon the opening controlled by the throttle-valves intermediate of the controlling-valves and piston. For instance, if the engineer desires to limit the capacity of the engine for any reason it may be done by closing the throttle-valves to the desired extent, and this will determine the maximum size of the induction-opening irrespective of any position to which the controlling-valves may be moved by their operating mechanism. On the other hand, the ultimate maximum capacity of the engine may be obtained by fully retracting the throttle-valves, after which the engine will be subject only to the control of the automatic devices.

In order to complete the description of the controlling mechanism, it is only necessary to state that the controlling-disk 57 and the parts operatively related therewith for the control of the abutments and valves of the cylinders 1 and 2 are identical in construction and arrangement with the parts already described in connection with the disk 56 and the cylinders 3 and 4, the only difference being that the trip-blocks and governor-arms are disposed in quartering relation to corresponding parts at the opposite end of the engine in order that the cylinders will take steam successively for the purpose of rendering the operation of the engine under effective pressure continuous as long as the throttle-valves are open.

For the purpose of transmitting motion from the engine a pinion 109 is keyed upon one end of the shaft 15, and when it is desired to provide for the reversal of the motion imparted without necessitating the reversal of the engine the opposite end of the shaft 15 may be provided with a bevel gear-wheel 110, disposed to be engaged by either of a pair of bevel-pinions 111 and 112, mounted upon a sleeve 113, slidably carried by a power-transmitting shaft 114. This shaft is

supported in suitable brackets extending from the standards 16, as illustrated, and is provided upon one end with a pinion 115, to which the mechanism to be operated is geared. The shifting of the sleeve 113 is effected by a reversing-lever 116, as best seen in Fig. 1, and as the sleeve is splined upon the shaft 114 it will be noted that said shaft will be rotated in one direction or the other, accordingly as the pinion 111 or the pinion 112 is thrown into mesh with the bevel-gear 110 upon the engine-shaft.

Inasmuch as my engine is designed to be inclosed within a casing supported upon the generator in the manner stated, I have provided a pump-shaft 117, journaled below the shaft 15 and geared thereto, as by sprocket-chains 118, passed around suitable sprockets upon the shafts 117 and 15, as best illustrated in Fig. 2. In this manner the pump-shaft 117 is operated for the purpose of driving a series of pumps, which are essential to the proper operation of the generator described in my concurrent application referred to.

In consequence of the contemplated relation of the motor and generator it is particularly desirable to effect the discharge of the condensation from the several cylinders through a common discharge-pipe. I therefore form a small catch-basin 119 at the bottom of each cylinder. These basins, as best illustrated in Figs. 2 and 4, are placed in communication, through the medium of suitable piping, with a condensation-trap, which comprises a casing 120, from which is led a discharge-pipe 121, whose upper end 122 is of conical form and extends into the casing 120 and a short distance above the bottom wall thereof. Within the casing is disposed a float-valve 123, guided in its movement by a series of arms 124, having rollers 125, which contact with the walls of the casing. The float-valve 123 has the general form of a double cone, the lower end of which is designed to extend into and close the conical end 122 of the discharge-pipe and the upper cone of which is extended below the inverted base of the lower cone to form an annular flange 126, encircling and extended below the upper edge of the conical end 122 to define a water-trap. As the water of condensation gradually accumulates within the casing or chamber 120 its level rises and the area of its surface increases as the exposed area of the float-valve decreases. As soon, therefore, as the pressure exerted upon the water is greater than that exerted to seat the valve the latter will open and will permit the escape of the water of condensation until the area of the water-surface has decreased and the effective area of the valve has increased to the proper extent to cause the reseating of the valve. It is evident that the provision of the water-trap in the manner stated will prevent the escape of steam from the engine-cylinders, but will permit the constant discharge of the water of condensation.

Inasmuch as the operation of the engine has been clearly detailed during the description of the various groups of mechanism, I do not deem it necessary to enter into an elaborate discussion of the various sequences of movement heretofore noted. It may be stated briefly that the pistons of adjacent cylinders are in diametrically-opposed relation and are set quartering with respect to the other pair or group of pistons. The controlling-disks 56 and 57, rotating with the engine-shaft, effect in proper sequence the raising of the abutments, the closing thereof after the pistons have passed, and the opening and closing of the controlling-valves, the interval between the opening and closing being regulated automatically, as we have seen. The throttle-valves are disposed for simultaneous actuation manually by the manipulation of the throttle-controller 108. The water of condensation is disposed of during the operation of the engine, and provision is made for transmitting the motion of the latter in the desired direction.

From the foregoing it will appear that I have produced a simple, durable, and efficient motor of the rotary type particularly designed for utilization for the propulsion of automobiles or other similar vehicles; but while the present embodiment of the invention appears at this time to be preferable I desire to reserve the right to effect such changes, modifications, and variations of the structure shown as may be properly comprehended within the scope of the protection prayed.

Having thus described the invention, what is claimed as new, and desired to be secured by Letters Patent, is—

1. In a rotary engine, the combination with a cylinder, an engine-shaft, and a piston movable within the cylinder to operate the shaft, of a sliding abutment, induction and exhaust ports disposed at opposite sides of the abutment, a controlling-valve for the induction-port, rock-shafts having operative relation with the abutment and controlling-valve, respectively, abutment-operating arms and valve-opening arms extending from said shafts, a trip-block movable with the shaft and disposed to contact directly with said arms for the purpose of operating the abutment and controlling-valve in succession, valve-closing arms connected to the valve-opening arms, and means movable with the engine-shaft for operating the valve-closing arms.

2. In a rotary engine, the combination with a cylinder, an engine-shaft, and a piston movable within the cylinder to operate said shaft, of a sliding abutment, induction and exhaust ports at opposite sides thereof, a controlling-valve for the induction-port, rock-shafts operatively related to the abutment and controlling-valve respectively, operating-arms extending from said rock-shafts, a controlling-disk movable with the engine-shaft, a trip-block fixed to said disk and disposed to

contact directly with said arms to operate the abutment and to open the controlling-valve, and a device for effecting the return of the controlling-valve, said device being positioned by centrifugal force.

3. In a rotary engine, the combination with a cylinder, engine-shaft, and piston, of a sliding abutment, induction and exhaust ports, a controlling-valve for the induction-port, an abutment-operating arm and a valve-opening arm operatively connected respectively with the abutment and controlling-valve, a valve-closing arm disposed beyond the valve-opening arm, and means, movable with the engine-shaft, for operating the several arms in succession.

4. In a rotary engine, the combination with a cylinder, piston, engine-shaft, and the sliding abutment, of a removable front platform formed of a section of the cylinder, a rear platform disposed above and supported by the cylinder, induction and eduction ports opening into the cylinder, an abutment-casing mounted on the cylinder between the platforms, and valve-chest mounted upon the rear platform, abutment-operating mechanism mounted on the front platform, and valve-operating mechanism mounted upon the rear platform, a controlling-disk movable with the engine-shaft, and a trip-block carried by said disk and disposed to effect the successive actuation of the abutment and valve operating mechanism.

5. In a rotary engine, the combination with a cylinder, piston, shaft, and sliding abutment, of platforms carried by and disposed above the cylinder, an abutment-casing and a steam-chest mounted upon the cylinder, abutment-operating mechanism mounted on the cylinder, and valve-opening mechanism supported above the platforms, valve-closing mechanism disposed beyond the valve-opening mechanism and operatively connected therewith, a controlling-disk movable with the shaft and provided with a trip-block disposed to effect the actuation of the abutment-operating mechanism and the valve-opening mechanism in succession, and a centrifugally-operated governor-arm disposed to effect the subsequent actuation of the valve-closing mechanism to effect the automatic cut-off of the motive agent.

6. In a rotary engine, the combination with a cylinder, piston, shaft, and sliding abutment, of a controlling-valve, a valve-opening arm operatively connected therewith, a separately-mounted valve-closing arm having operative connection with the valve-opening arm, and means for operating said arms in succession, said means including a device positioned by centrifugal force and disposed to operate the valve-closing arm.

7. In a rotary engine, the combination with a piston, cylinder, shaft, and sliding abutment, of a rock-shaft having a pair of laterally-extending arms, one of which is operatively related to the abutment, a spring extending laterally from the rock-shaft, and a link having pivotal connection to the fixed part of the engine and to the free end of the spring.

8. In a rotary engine, the combination with a cylinder, piston, shaft, and sliding abutment, of a controlling-valve, a pair of rock-shafts in laterally-spaced relation and provided respectively with a valve-opening arm and a valve-closing arm, means connecting said arms to effect their movement in reverse directions, and means for operatively connecting one of the rock-shafts with the controlling-valve, and means operated by the engine-shaft for operating said arms in succession, said means including a device positioned by centrifugal force and disposed to actuate the valve-closing arm.

9. In a rotary engine, the combination with a plurality of cylinders, pistons, sliding abutments, and a common shaft, of a controlling-disk carried by said shaft, controlling-valves for said cylinders, interfitting rock-shafts operatively connected with the abutments and provided upon their contiguous ends with operating-arms disposed adjacent to the opposite side faces of the controlling-disk, a pair of interfitting rock-shafts having operative relation to the controlling-valves and provided upon their adjacent ends with valve-opening arms, disposed adjacent to the opposite faces of the controlling-disk, and trip-blocks disposed at opposite sides of the disk and designed respectively to effect the successive actuation of the abutment-operating arms and the valve-operating arms.

10. In a rotary engine, the combination with a plurality of cylinders and valve-chests, of a superimposed platform removably carried by the cylinders, abutment-casings also carried by the cylinders, valves located in the valve-chests, sliding abutments disposed to be withdrawn into the abutment-casings, valve-operating mechanism for the several valves and abutment-operating mechanism for the several abutments, said abutment-operating mechanism being mounted on the removable platform, and means for operating said mechanism.

11. In a rotary engine, the combination with pistons, abutments, controlling-valves and a plurality of sectional equidistant cylinders, connected in a rigid organization, of a platform surmounting the cylinders and of sectional form, two of said sections serving to close a series of openings formed in the cylinders, whereby the removability of said platform will permit access to the interiors of the cylinders to be gained for purposes of repair.

12. In a rotary engine, the combination with a plurality of cylinders, pistons, sliding abutments, and a common shaft, of a controlling-valve, valve-operating mechanism, abutment-operating mechanism, a controlling-disk, blocks carried by the disk for operating the abutment-operating mechanism, and for moving the valve-operating mechanism in one di-

rection, and a pair of rigidly-connected centrifugally-operated governor-arms loosely mounted on the shaft and operatively related to and movable with the disk and disposed to shift the valve-operating mechanism in the opposite direction.

13. In a controlling device for rotary engines, the combination with the shaft and disk, of spring-retained governor members carried by the disk, bell-crank governor-levers fulcrumed upon the disk and having sliding connection with said members, and a plurality of governor-arms connected with said governor-levers and provided with laterally-disposed terminal fingers.

14. In a controlling device for rotary engines, the combination with a shaft, and a disk having oppositely-disposed arcuate slots, of spring-retained governor members movable within said slots, bell-crank levers fulcrumed upon the disk and having sliding connection at one end with said members, a pair of diametrically-disposed rigidly-connected governor-arms having operative connection with the ends of the governor-levers opposite the members, said governor-arms being provided with oppositely-disposed terminal fingers, and a guiding device mounted upon the disk to guide the movements of the governor-arms.

15. In a rotary engine, the combination with the cylinder, piston, shaft, valve and sliding abutment, of abutment-operating mechanism mounted on the cylinder, valve-opening mechanism supported above the cylinder, valve-closing mechanism disposed beyond the valve-opening mechanism and operatively connected therewith, a controlling-disk movable with the shaft and provided with a trip-block disposed to effect the actuation of the abutment-operating mechanism and the valve-opening mechanism in succession, and a centrifugally-operated governor-arm disposed to effect the subsequent actuation of the valve-closing mechanism to effect the automatic cut-off of the motive agent.

16. In a rotary engine, the combination with the cylinder, piston, engine-shaft and movable abutment, of a controlling-valve, a valve-opening arm connected thereto, a valve-closing arm, means connecting said arms to effect their movement in reverse directions, a disk movable with the engine-shaft, and relatively adjustable devices movable with the disk and disposed to operate the valve-opening arm and the valve-closing arm, in succession.

17. In a rotary engine, the combination with a plurality of cylinders, pistons, sliding abutments and an engine-shaft common to the several pistons, of a controlling-disk carried by said shaft, controlling-valves for said cylinders, abutment-operating arms disposed adjacent to the opposite side faces of the controlling-disk, valve-opening arms disposed adjacent to the opposite faces of the controlling-disk, and trip-blocks disposed at opposite sides of the disk each of said blocks being disposed to effect the successive actuation of an abutment-operating arm and a valve-operating arm.

18. In a rotary engine, the combination with a plurality of cylinders, pistons, sliding abutments, and an engine-shaft common to the several pistons, of a controlling-disk carried by said shaft, controlling-valves for said cylinders, abutment-operating arms disposed adjacent to the opposite side faces of the controlling-disk, valve-opening arms disposed adjacent to the opposite side faces of the controlling-disk, a pair of valve-closing arms operatively connected to the valve-opening arms, trip-blocks disposed at opposite sides of the disk and each disposed to effect the successive actuation of an abutment-operating arm and a valve-opening arm, and centrifugally-operated governor-arms disposed at one side of the disk and arranged to operate the valve-closing arms.

19. In a rotary engine, the combination with the cylinders, pistons, controlling-valves, valve-operating arms, an engine-shaft common to the several pistons, and a disk movable with the shaft, of governor members carried by the disk, governor-levers fulcrumed upon the disk and having connection with said members, and a plurality of governor-arms connected to said governor-levers and provided with laterally-disposed terminal fingers for engagement with the valve-operating arms.

20. In a rotary engine, the combination with the engine-cylinder, piston, controlling-valve, valve-operating arm, and the engine-shaft, of a disk movable with said shaft, a longitudinally-recessed trip-block mounted on the disk to actuate the valve-operating arm, and a spring-buffer disposed at one end of said recessed trip-block to minimize the shock incident to the contact of the block with the arm.

21. In a rotary engine, the combination with a plurality of cylinders and pistons, of a steam-chest, a plurality of controlling-valves located in the chest and each controlling the passage of the motive agent to a cylinder, means for automatically operating said valves in rotation, a plurality of throttle-valves located in the steam-chest between the controlling-valves and cylinders, and operating mechanism connected to all of the throttle-valves for moving them in unison.

22. In a rotary engine, the combination with a cylinder, piston, shaft, valve and sliding abutment, of abutment-operating mechanism, valve-opening mechanism, valve-closing mechanism disposed beyond the valve-opening mechanism and operatively connected therewith, a controlling-disk operated by the engine and provided with a trip-block disposed to effect the actuation of the abutment-operating mechanism and the valve-opening mechanism in succession, and governor mechanism disposed to effect the subsequent actuation of the valve-closing mechanism.

23. In a rotary engine, the combination with a plurality of cylinders, pistons, abutments,

and a shaft, of a controlling-valve, a valve-opening arm connected therewith, a separate valve-closing arm connected to the valve-opening arm, a controlling-disk operated by the engine, a block carried by the disk and disposed to operate the valve-opening arm, a governor-arm swung from the shaft and provided with a terminal finger disposed to operate the valve-closing arm, and centrifugally-operated mechanism for positioning the governor-arm.

24. In a rotary engine, the combination with a plurality of cylinders, pistons, abutments, and a common shaft, of controlling-valves for the cylinders, valve-opening arms connected to the valves, valve-closing arms connected to the valve-opening arms, a controlling-disk operated by the engine and provided at diametrically opposite points with blocks disposed to operate the valve-opening arms, rigidly-connected governor-arms loosely mounted on the shaft and extended therefrom in opposite directions, oppositely-extended fingers located at the outer extremities of the governor-arms and arranged to operate the valve-closing arms, and centrifugally-operated mechanism carried by the disk for positioning the governor-arms.

25. An engine-casing comprising two separate groups of cylinders, means disposed beyond the peripheries of the cylinders for effecting their rigid connection, securing-pins having their opposite ends extended into the opposed faces of the adjacent cylinders, and a securing-band arranged concentric with the cylinders and likewise extended into the opposed faces thereof.

In testimony that I claim the foregoing as my own I have hereto affixed my signature in the presence of two witnesses.

JAMES C. WALKER.

Witnesses:
F. M. MAXWELL,
JNO. T. BATTLE.