No. 874,303. PATENTED DEC. 17, 1907.

E. O. & L. H. COCHRAN.

MOTOR.

APPLICATION FILED MAR. 15, 1906.

5 SHEETS—SHEET 1.

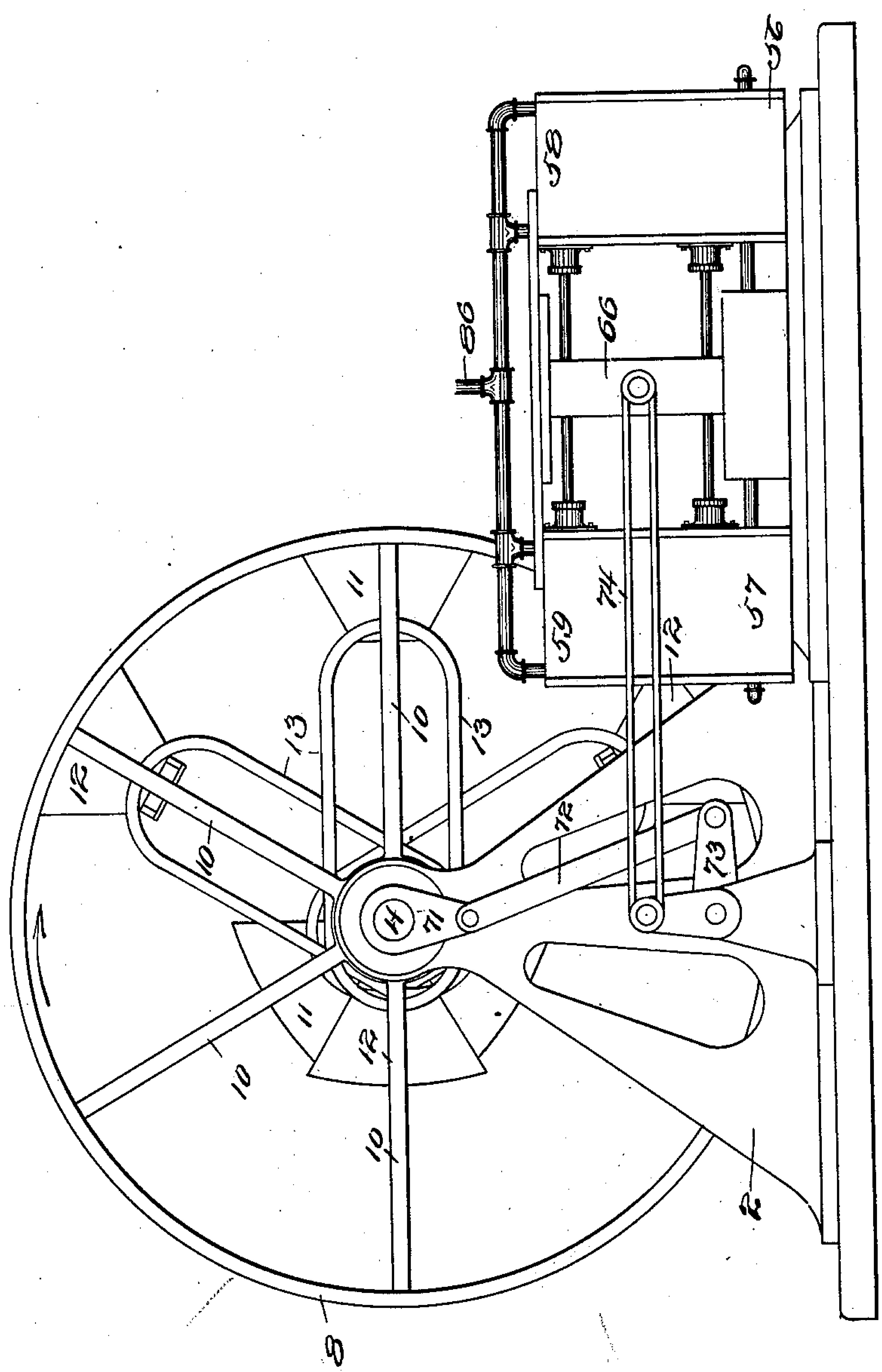

Fig. 1.

Witness

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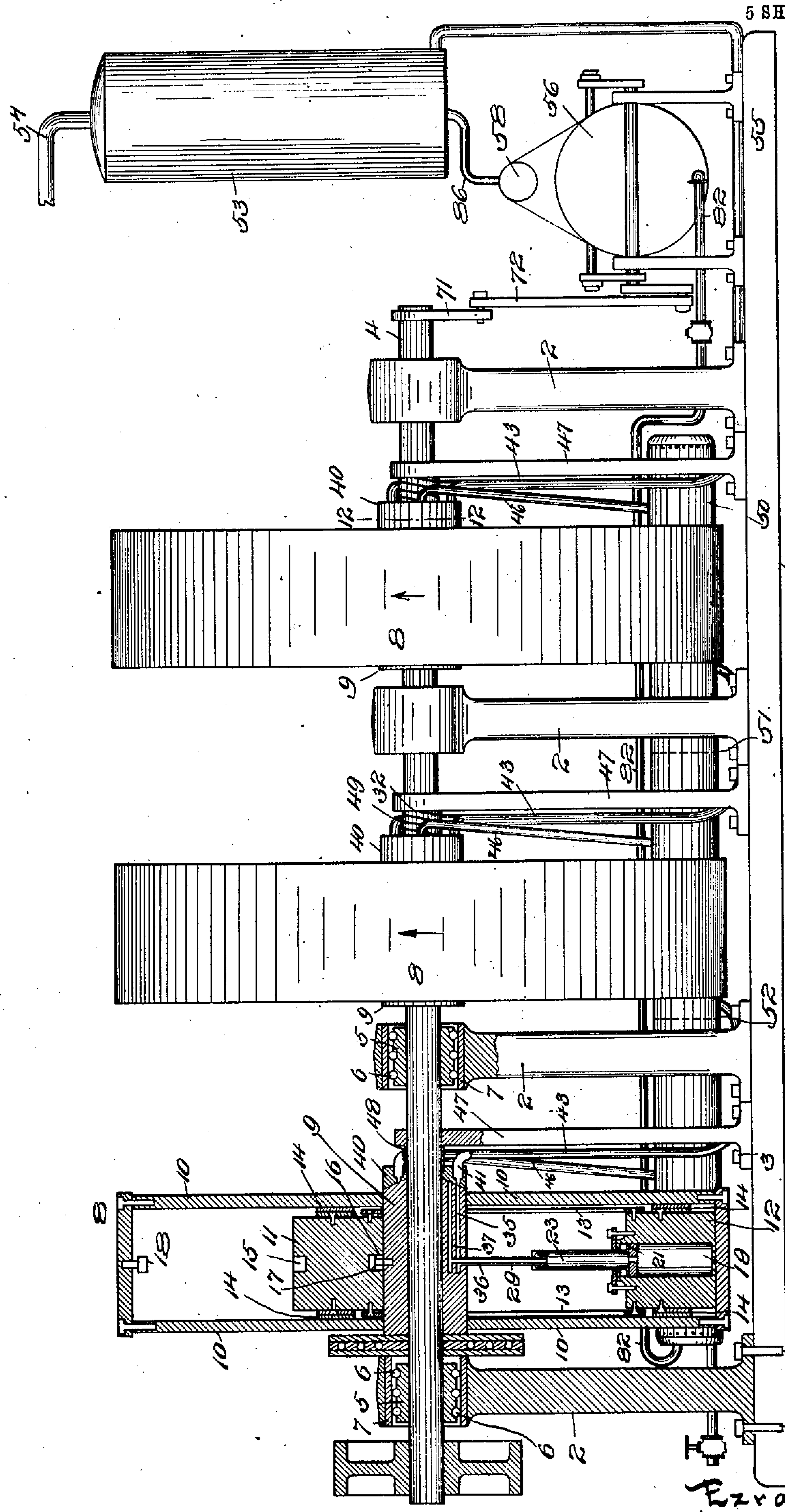

Fig. 2.

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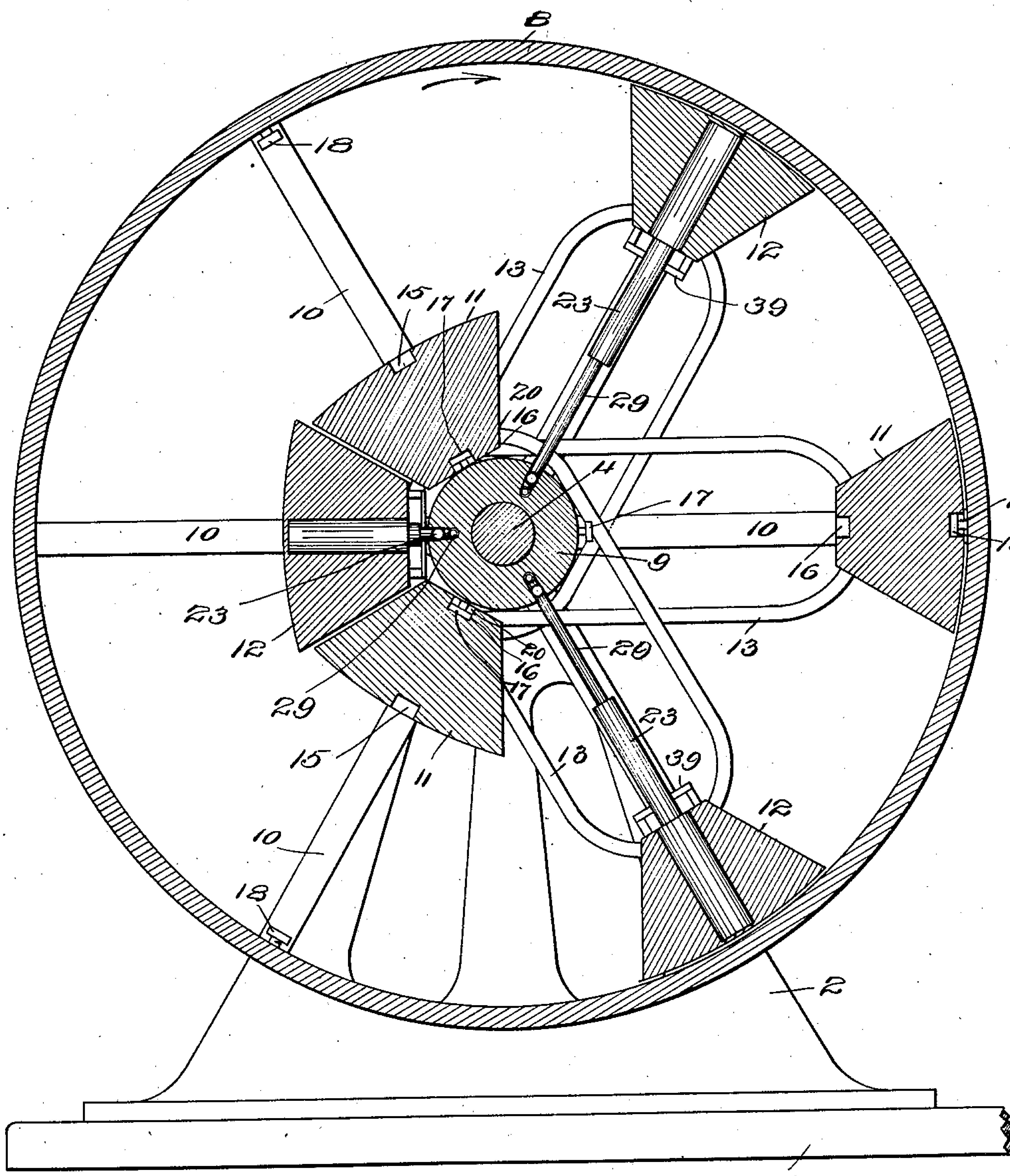

Fig. 3.

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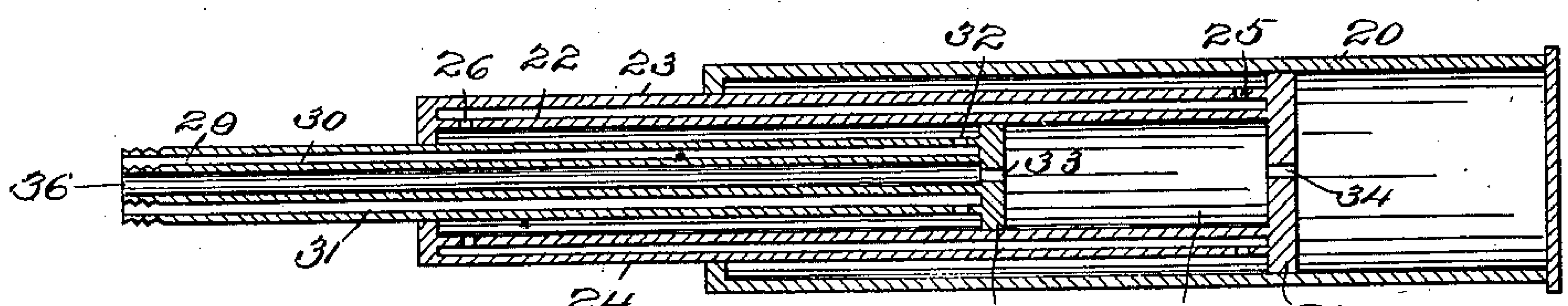


Fig.10

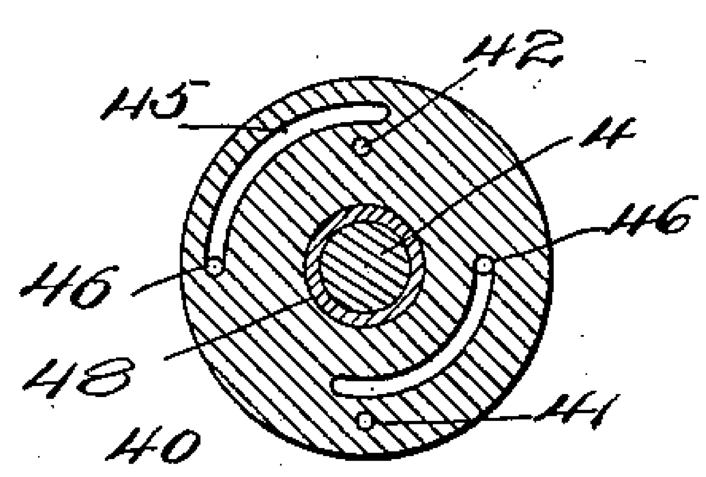


Fig.11

Fig.4

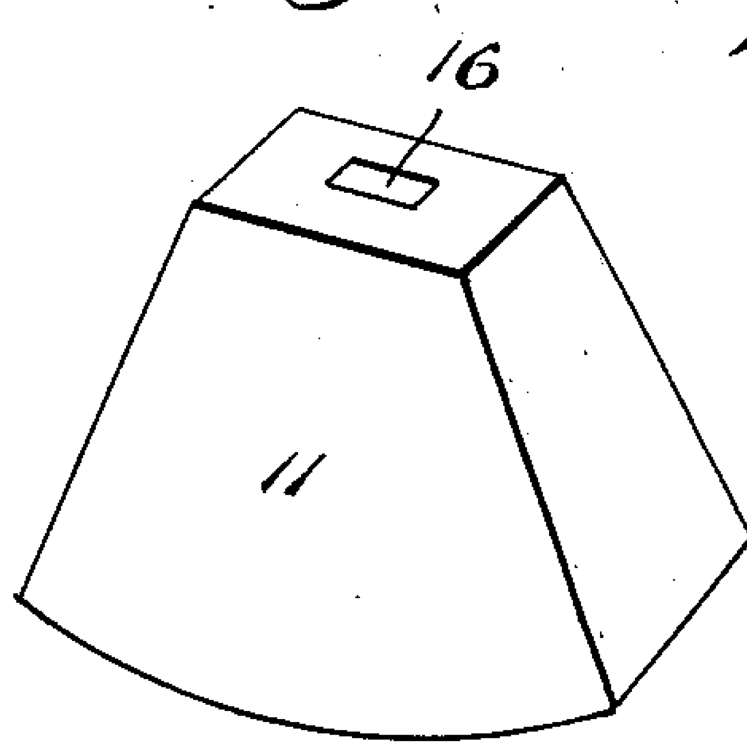
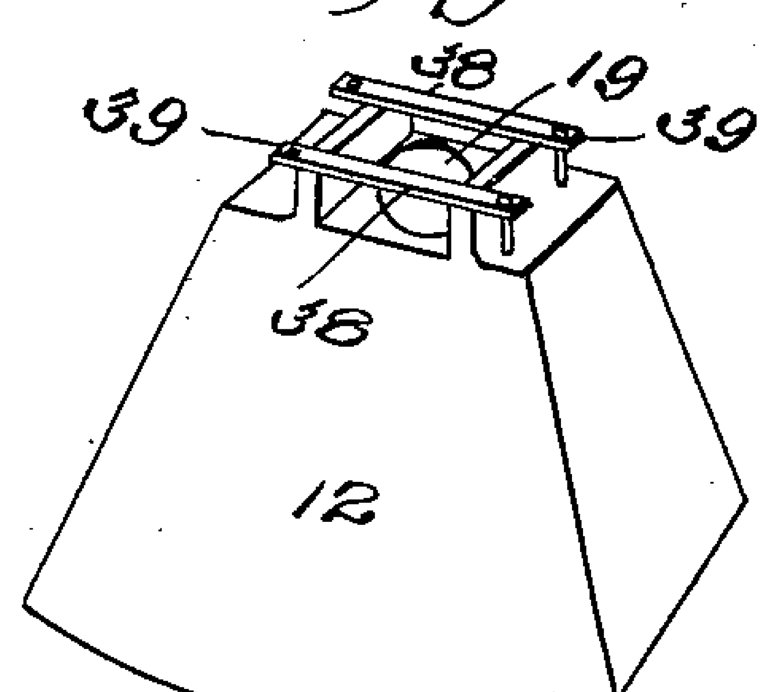


Fig.5.



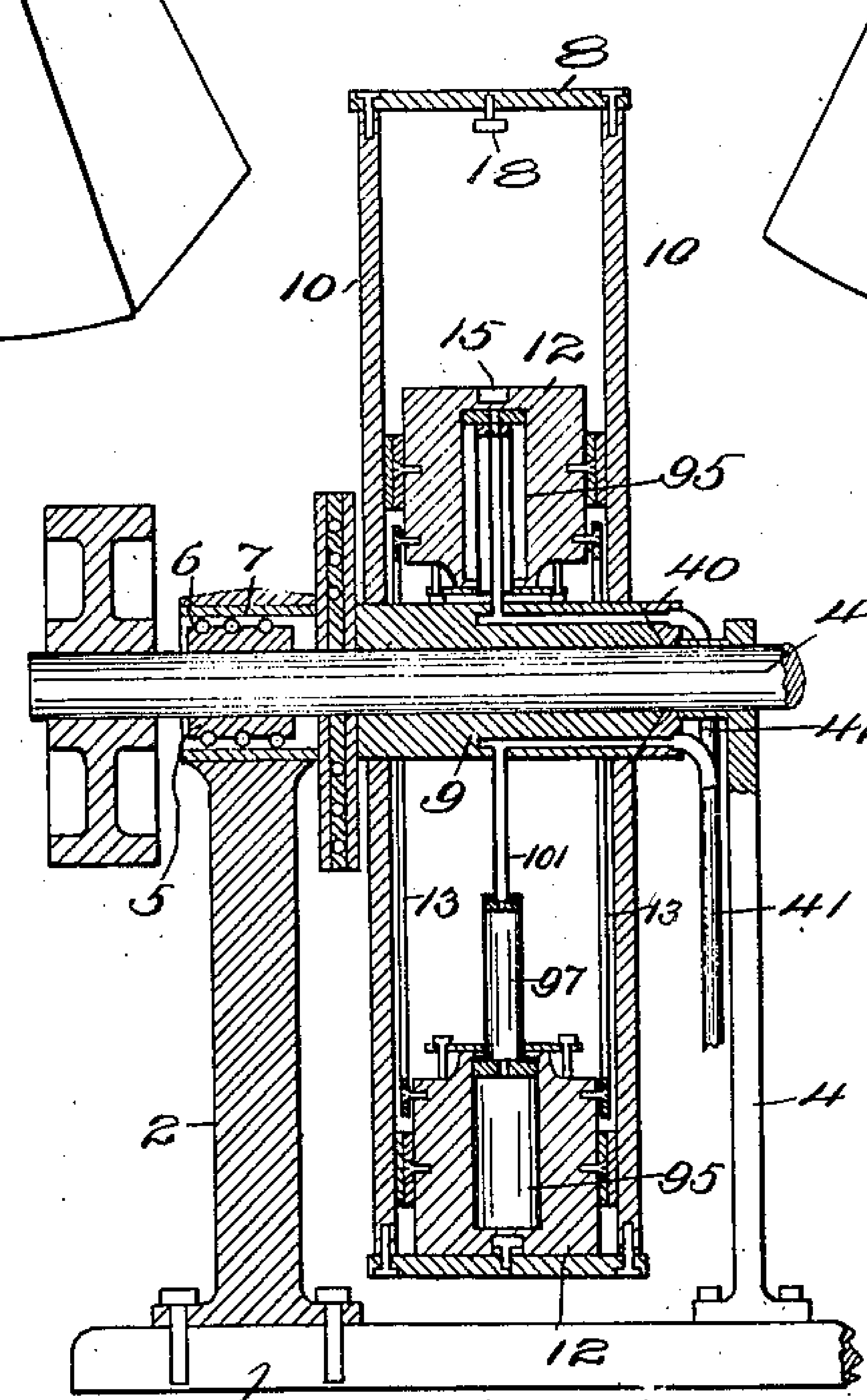


Fig.12.

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5 SHEETS—SHEET 5.

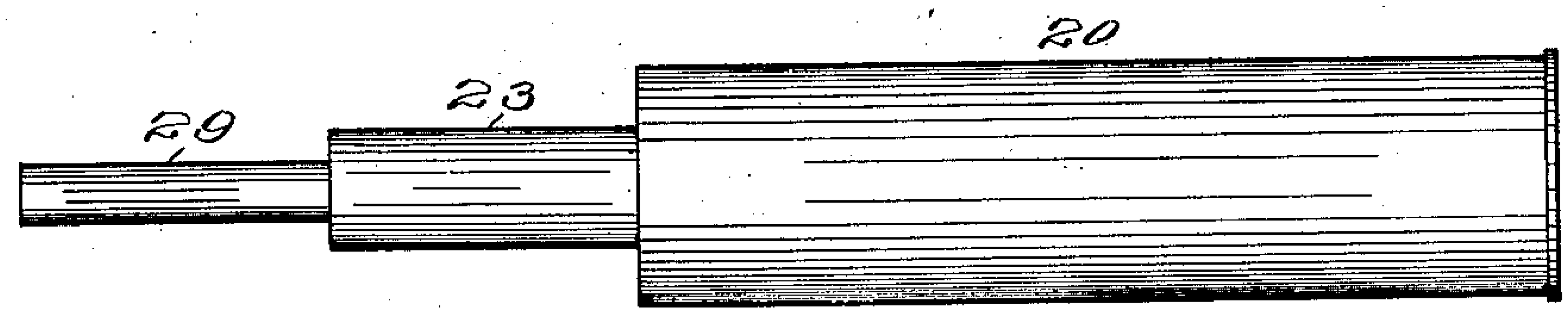

Fig. 6.

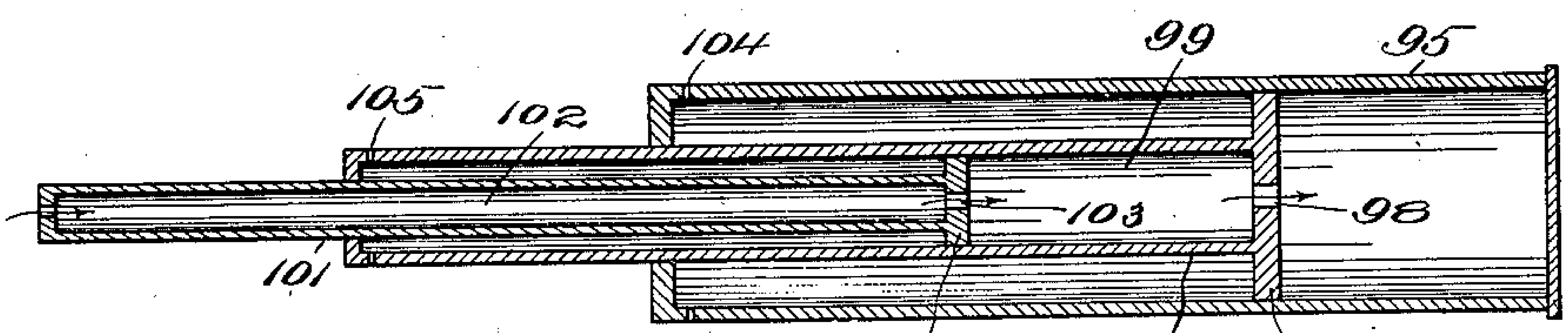

Fig. 7.

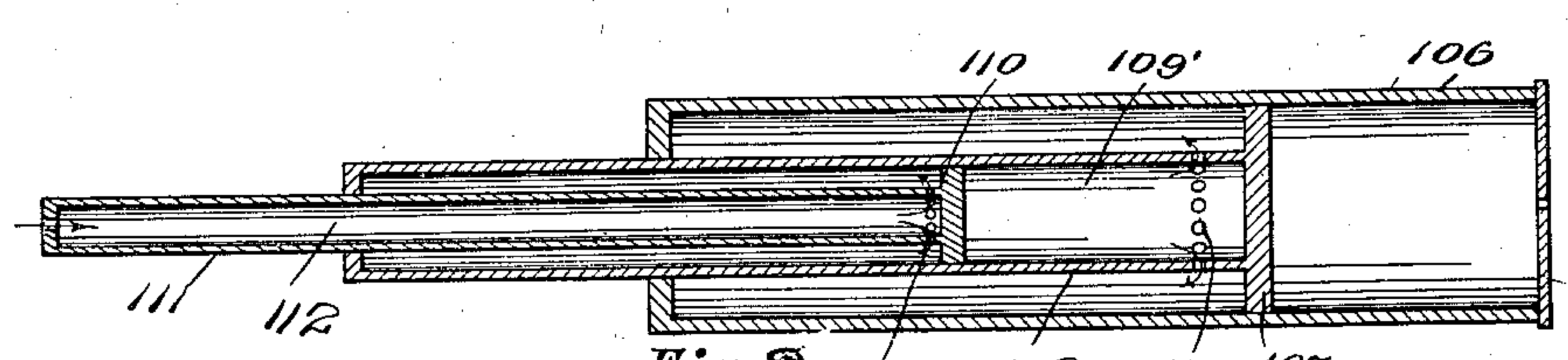

Fig. 8.

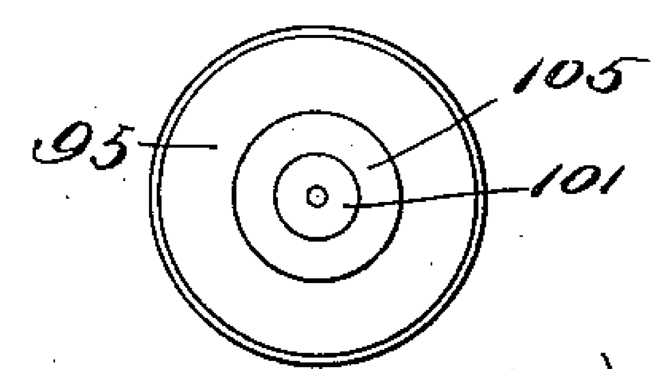

Fig. 9.

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UNITED STATES PATENT OFFICE.

EZRA OSCAR COCHRAN AND LOUIS HARRY COCHRAN, OF DENVER, COLORADO.

MOTOR.

No. 874,303. Specification of Letters Patent. Patented Dec. 17, 1907.

Application filed March 16, 1906. Serial No. 306,227.

To all whom it may concern:

Be it known that we, EZRA OSCAR COCHRAN and LOUIS HARRY COCHRAN, citizens of the United States, residing at Denver, in the county of Denver and State of Colorado, have invented certain new and useful Improvements in Motors; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to compressed air motors, and has for an object to provide a machine of the class embodying new and improved features of reliability, strength, utility and efficiency.

A further object of the invention is to provide a machine of the class embodying moving parts capable of continuing a machine in motion for a considerable length of time and to store energy during such operation for use at another time.

A further object of the invention is to provide a double acting cylinder and piston of improved form.

A further object of the invention is to provide a single acting cylinder and piston of improved form.

With these and other objects in view, the invention comprises certain novel constructions, combinations and arrangements of parts, as will be hereinafter fully described and claimed.

In the drawings:—Figure 1 is a view of the improved compressed air motor in end elevation and the air compressor in side elevation. Fig. 2 is a view of the improved compressed air motor partly in side elevation and partly in vertical section, and of the air compressor in end elevation. Fig. 3 is a transverse vertical sectional view of the improved compressed air motor. Fig. 4 is a perspective view of one of the weights operated by the cylinders and pistons. Fig. 5 is a perspective view of a different form of weight. Fig. 6 is a view in side elevation of one of the cylinders and pistons. Fig. 7 is a view in longitudinal section of one of the single acting cylinders and pistons of the expansion type. Fig. 8 is a view in longitudinal section of one of the single acting cylinders and pistons of the contracting type. Fig. 9 is a view of one of the single acting cylinders and pistons in end elevation. Fig. 10 is a longitudinal sectional view of one of the double acting cylinders and pistons. Fig. 11 is a transverse vertical sectional view of one of the port blocks taken on line 12—12 of Fig. 2. Fig. 12 is a longitudinal vertical sectional view through one of the wheels of the motor, using cylinders and pistons of the single acting type.

Like characters of reference designate corresponding parts throughout the several views.

The compressed air motor forming the subject-matter of this application, comprises a base 1, upon which any approved number of standards, as 2, are secured by any approved means, as the bolts 3, and accommodating at their upper ends alined bearings for the shaft 4 extending longitudinally of the machine. The bearings for the shaft 4 comprise each a collar 5 provided with one or more annular grooves forming races for the series of balls 6 and with bushing 7 surrounding and embracing the balls and upon which the said balls travel.

Upon the shaft 4 are mounted any approved number of wheels similar in construction and operation, the description of one of which will serve for the description of all. The said wheels comprise a peripheral band 8 and hub 9 with radial spokes 10 arranged in pairs parallel to each other, and spaced apart approximately the width of and secured to the outer edges of the rim 8. Upon alternate spokes 10 are mounted weights 11 and upon the intervening spokes are mounted weights 12 similar in external conformation. The weights 11 and 12 are rigidly connected by means of rods or bands 13 and are each provided with friction plates 14, bearing against the inner surface of opposite spokes 10, whereby the said connected weights are slidable upon the said spokes as guides simultaneously and diametrically of the wheel. The weight 11 is provided upon opposite sides with recesses 15 and 16 and the hub is provided with plungers 17 positioned to engage within the said recesses to form dash pots for cushioning the fall of the weight upon the hub. The peripheral band 8 is likewise provided with plungers 18 positioned to engage within the recesses 15 for like purposes. The weight 12 is provided with a bore 19 within which is mounted a cylinder 20. Within the cylinder 20 is mounted to reciprocate a piston 21 having a piston rod composed of double walls 22 and 23 defining an annular chamber 24 opening externally, at 25, into the cylinder 20 and internally, at 26, into the central bore 27 of the piston. Within the central bore 27 of the piston is mounted a second piston 28 similarly formed with spaced walls 29 and 30, defining an annular chamber 31 communicating externally, as at 32, with the bore 27, upon one side of the piston 28, and by means of an axial opening 33 with the bore 27 upon the opposite side. The piston 21 is also provided with an axial opening 34 forming communication between the bore of the piston 20 and the bore 27. The walls 29 and 30 of the inner piston rod are connected by means of screw-threads at their extremities with the hub 9 and the chamber 31 is in communication with the passage 35 formed in the hub, while the central bore 36 of the piston rod is in communication with the passage 37 adjacent to the passage 35. To properly retain the cylinder and its associated pistons within the socket 19 of the weight 12, bars 38 are provided engaging the said cylinder in any approved manner and secured to the weight 12 as by the screws 39. One end of the hub 9 is preferably formed conical and through the conical end of the said hub the passages 35 and 37 open. Upon the conical end of the said hub is engaged a collar 40 arranged to conform to and fit the said conical end and provided with inlet ports 41 and 42 diametrically opposite, but differently spaced relative to the center of the shaft 4 and communicating by means of a pipe 43 with the source of compressed fluid energy, as herein described. The collar 40 is also provided with segmental exhaust ports 44 and 45, differently spaced relative to the shaft 4, the said port 45 being spaced from the shaft at a distance equal to the inlet port 42, and the port 45 spaced at a distance equal to the distance of the inlet port 41. The exhaust ports 44 and 45 communicate by means of a pipe 46 with the storage reservoir which receives the compressed air used in the cylinders and stores it in condition for use in the next cylinders in series. To retain the collar 40 in operative position, relative to the hub 9, a standard 47 is rigidly secured to the base 1, and provided with an opening to embrace the shaft 4, and a sleeve 48 surrounding the said shaft and extending within the central opening of the block 40. Between the standard 47 and the collar 40 and embracing the sleeve 48 is disposed a coil spring 49 positioned to force the said collar into operative engagement with the conical end of the hub.

For the storage of compressed fluid energy a reservoir 50 is divided as at 51 and 52 into separate compartments with which the several wheels of the motor communicate in cases where a plurality of such wheels are used. As shown in Fig. 2 three such wheels are mounted upon a single shaft and the exhaust port of the first wheel in series communicates with one compartment of the storage reservoir 50, and the inlet port of the next in series communicates with the same compartment. The exhaust port of the second wheel in series communicates with the second compartment, and the inlet port of the third in series with the same compartment, while the exhaust port of the third in series communicates with the third compartment, which is arranged to discharge into the atmosphere or to the compressor, so that the said air may be compressed and again used.

In association with the motor a storage reservoir 53 is provided communicating by means of a pipe 54 with any approved form of compressor and by means of the pipe 55 with the inlet port of the first wheel in series. In operation the motor receives air from the reservoir 53 through the pipe 55 to the inlet ports 41 and 42 of the first wheel in series. The compressed air is supplied from the ports 41 and 42 by the passages 35 and 37 alternately. When the air enters the passage 35 it is conducted to the annular chamber 30 and through the ports 32 into the bore 27, between the pistons 28 and the extremity of the intermediate piston. The interior piston being rigid with the hub is immovable relative thereto and the intermediate piston by reason of the compressed air acting between the interior piston head and the immovable end of the said intermediate piston, forces the said piston toward the hub. At the same time the compressed air passes through the port 26 into the chamber 24 and through the port 25 into the interior of the piston 20 between the piston head 21 and the inner end of the said cylinder. The action of the compressed air upon the intermediate piston and the cylinder 20 forces the said piston and cylinder above the hub and carries with it the weight 12 and its rigidly connected opposite weight 11. The port 41 communicating with the said passage 35 is disposed at the extreme lower side of the collar 40 and air is admitted to move the said weights, as described, when the weight 12 is at its lower limit and in contact with the rim 8, and the weight 11 in contact with the hub. The introduction of the weight, as described, and the movement of the said weights, throw the weight 11 outwardly adjacent the rim 8 and draws the weight 12 into juxtaposition with the hub 9. The wheel moving in the direction of the arrow, in Fig. 3, by reason of the weights disposed adjacent its periphery overbalancing the weights adjacent the hub, the weight 11 thrown into the periphery, as described, is in position to continue the operation of the wheel. When, by reason of the revolution of the wheel, the weight 12 is uppermost, and the weight 11 lowermost, the port 42 is in communication with the passage 37, which, in turn, communicates with the central bore 36 of the piston, and by reason of the ports 33 and 34, air is admitted to force the weight 12 away from the hub and its oppositely connected weight 11 toward the hub, thereby throwing the next weight in series toward the periphery and its opposite weight toward the hub, whereby the rotary movement of the wheel is continued.

Instead of using the double acting cylinders, and pistons as shown in Fig. 11, each weight may be provided with a single acting piston as shown in Fig. 8. The said single acting piston consists of cylinders 95, within each of which is mounted a piston 96 having a hollow piston rod 97, the internal bore of which communicates with the interior of the piston 95 by a port 98. Within the interior bore 99 of the piston rod 97 is mounted a piston 100 having a hollow piston rod 101 provided with an interior bore 102 communicating with the interior bore 99 by means of a port 103. To prevent the imprisonment of compressed air within the cylinder 95, an opening 104 is provided and a similar opening 105 provided for a similar purpose in the hollow piston rod 97.

In operating with a single cylinder, only one inlet port is provided as the port 42, the port 41 serving as an exhaust port. When the weight fitted with a single acting expansion cylinder reaches the uppermost point of its rotary movement, air is admitted through the port 42 to the bore 102 of the inner piston rod and through the ports 103 and 98 to operate the piston and cylinder to move the weight radially outward to the periphery of the wheel, and its associate weight inwardly to the hub. As the port 42 is open to admit air to move the weights, as described, the port 41 is similarly opened to permit the exhaust of the air imprisoned within the opposite cylinder, whereby the said connected weights are simultaneously operated in manner similar to the operation with the double acting cylinder and piston. It is also desirable in some cases to employ a contracting cylinder and piston, as shown in Fig. 9, which said cylinder comprises a cylinder casing 106 within which is mounted to reciprocate the piston 107 provided with a hollow piston rod 108, which communicates with the piston 106 through the ports 109 at the side of the piston 107, next adjacent the hub. The piston rod 108 is provided with a central bore 109′ within which is mounted to reciprocate a piston 110 having a piston rod 111 formed with a central bore 112, which communicates with the bore 109′ by means of ports 113 opening upon the side of the piston 110 next adjacent the hub. For use in connection with the contracting cylinder, the ports 42 and 41 are likewise alternately exhaust and inlet ports, but the inlet port is now at the lower extreme and the exhaust port at the upper extreme. When air is admitted through the inlet port at the lower extreme of rotary movement, it is admitted to bore 112, and through the ports 113 and the bore 109′ of the piston rod 108 to move the said piston 107 toward the hub. When the piston 107 is moved a sufficient distance to uncover the ports 109, air is admitted to the cylinder 106 to move the said cylinder and its associated weight toward the hub. It will thus be seen that with the contracting cylinder, shown at Fig. 9, the movement is to lift the lower weight by means of compressed air introduced therein, while the air is exhausting from the upper weight rigidly connected therewith.

The air to start and operate the motor may be supplied to the reservoir from any improved source and after the motor has started, when the load is removed, or when for other reasons the inertia of the motor is exerting more energy than is required to operate the load, the compressor connected with the said shaft will supply compressed air to the reservoir.

What we claim is:—

1. In a machine of the class described, a wheel, a plurality of weights mounted in said wheels and to move in pairs diametrically thereof, cylinders and pistons carried by said weights, and means for admitting a fluid under tension to the said cylinders to move the pairs of weights alternately from the hub to the periphery of the wheel.

2. In a machine of the class described, a wheel provided with a plurality of radial spokes, a plurality of weights mounted to move upon said spokes as guides and connected in diametrical pairs, cylinders and pistons carried by said weights and connected with the hub, means for admitting fluid under tension to the hub, and means to control the flow of fluid to move the pairs of weights alternately from the hub to the periphery.

3. In a machine of the class described, a wheel provided with a plurality of radial spokes, weights equaling in number the spokes and mounted to move radially thereupon, means connecting opposite weights rigidly together, cylinders and pistons carried by one of each pair of the weights and connected with the hub and arranged to move the connected pair alternately in opposite directions, means carried by the hub for controlling the flow of fluid to the cyilnders to produce reciprocation of the weights, and means to cushion the impact of the weights in either or both directions.

4. In a machine of the class described, a wheel, a plurality of weights mounted to move radially upon the wheel, cylinders and pistons carried by the weights, and means for admitting fluid under compression to the said cylinders.

5. In a machine of the class described, a wheel, a plurality of weights movably mount-

ed upon the wheel, hollow telescoping members connecting the weights to the wheel, and means adapted to control the flow of fluid to and to actuate the telescoping members and the weights.

6. In a machine of the class described, moving parts, a cylinder connected to one moving part, a piston mounted to reciprocate within the cylinder, a hollow piston rod connected with said piston and extending through the end of the cylinder, a second piston mounted within the piston rod of the intermediate piston, a hollow piston rod for the internal piston extending through the end thereof, and connected with the other moving part, and with ports communicating from the bore of the hollow piston to their respective cylinders, and means adapted to control the flow of fluid to the cylinder and piston.

7. In a machine of the class described, moving parts, a cylinder connected with one moving part, a piston mounted within the cylinder, a hollow piston rod for said piston extending through the end of the cylinder and with ports formed in the hollow piston rod adjacent the piston, an interior piston mounted to reciprocate within the intermediate piston, a hollow piston rod rigidly connected to the interior piston and extending through the outer end of the intermediate piston, and connected with the other moving part, and provided with ports formed adjacent the intermediate piston, and means adapted to control the flow of fluid to the cylinder, and piston.

8. In a machine of the class described, moving parts, a cylinder connected to one of the moving parts, a piston mounted within the cylinder, a hollow piston rod rigidly connected with the piston and extending through the outer end thereof, and composed of spaced side walls, ports piercing the inner wall adjacent the outer end, and the outer wall adjacent the inner end, a piston mounted to reciprocate within the hollow piston rod, a hollow piston rod for the inner piston composed of spaced side walls and connected to one of the moving parts and having ports piercing the outer walls of the piston rod of the inner piston, said ports formed through the inner and intermediate piston heads, and means adapted to control the flow of a fluid to the cylinder and piston.

9. In a machine of the class described, a wheel, a plurality of weights movably mounted within the wheel, telescoping members for moving the weights, and means adapted to control the flow of a fluid to the telescoping parts.

In testimony whereof we affix our signatures in presence of two witnesses.

EZRA OSCAR COCHRAN.
LOUIS HARRY COCHRAN.

Witnesses:
CARLE WHITEHEAD,
ELIHU PALMER.