No. 871,523. PATENTED NOV. 19, 1907.

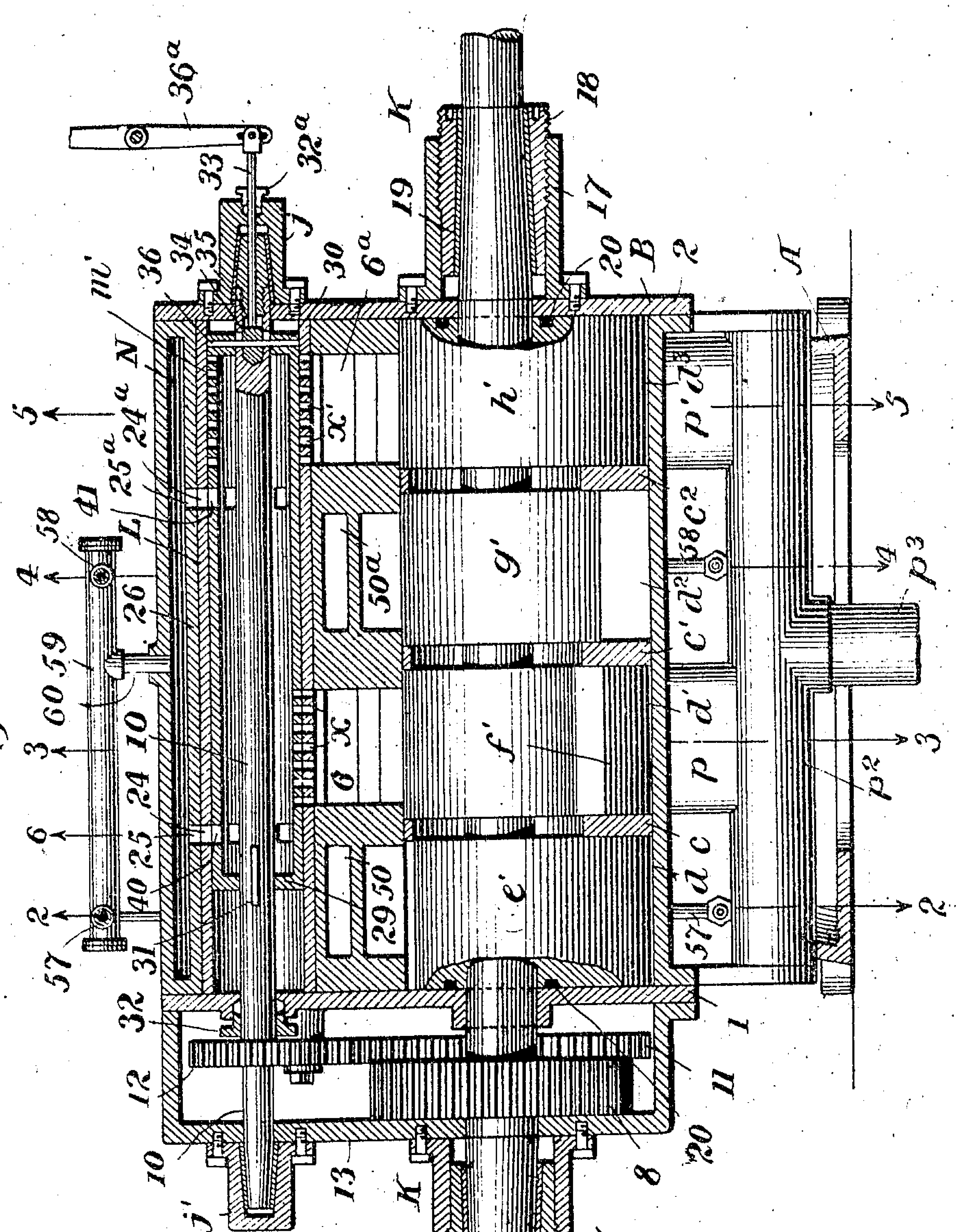
J. POLLOCK & W. F. LEIBENGUTH.

ROTARY GAS ENGINE.

APPLICATION FILED MAY 17, 1907.

4 SHEETS—SHEET 1

Fig. 1.



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4 SHEETS—SHEET 2.

Fig. 2

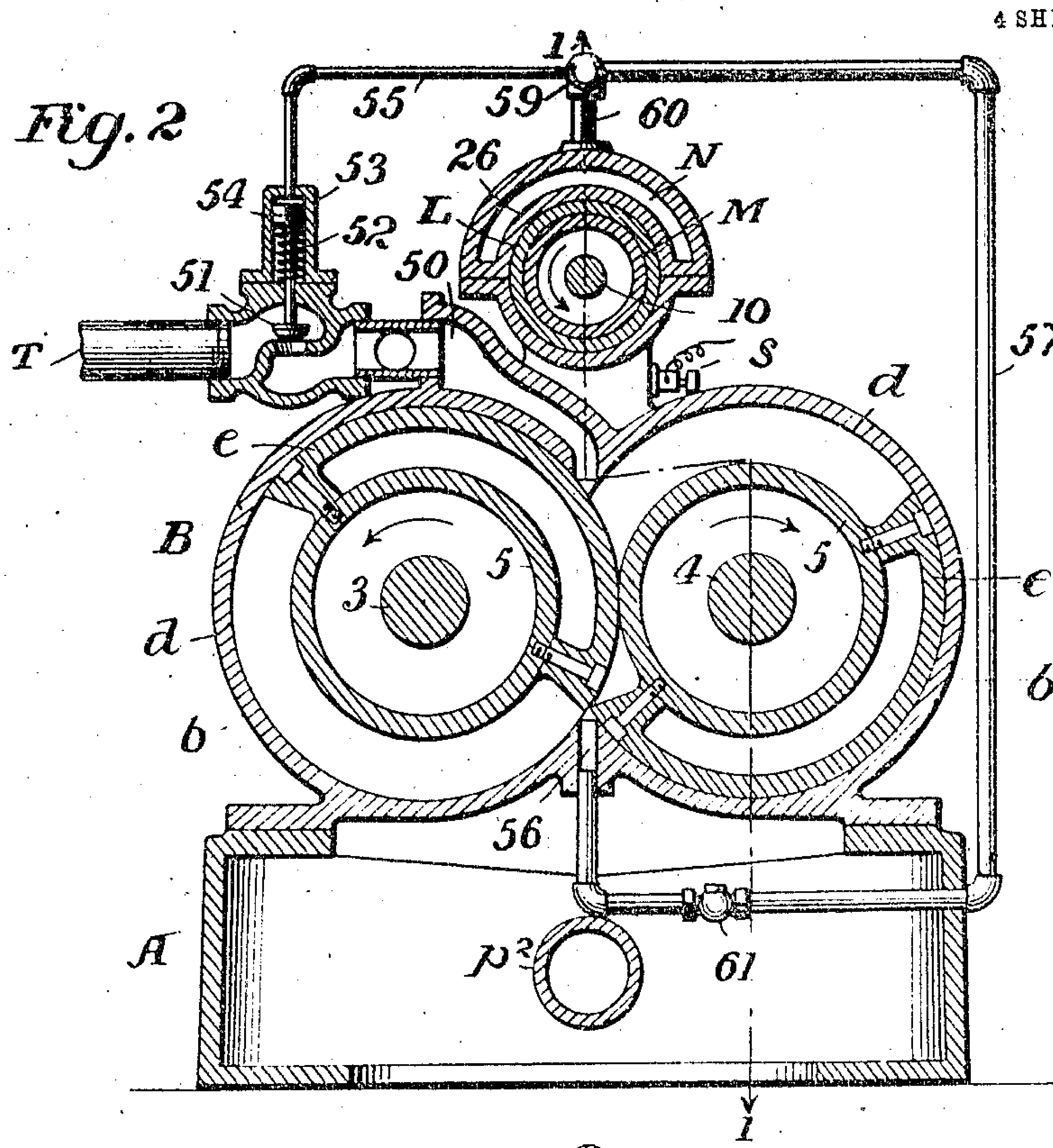
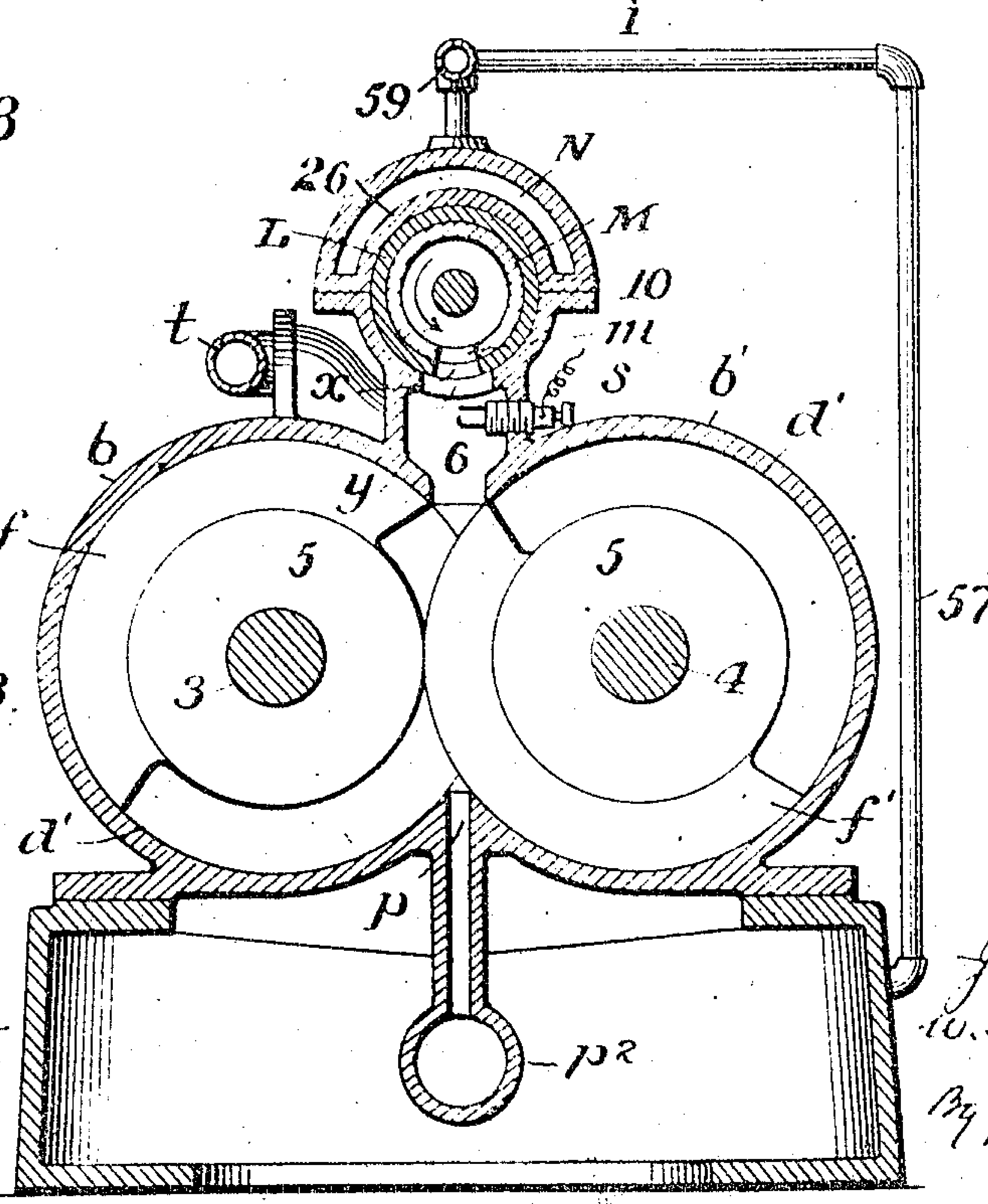


Fig. 3



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4 SHEETS—SHEET 3.

Fig. 4

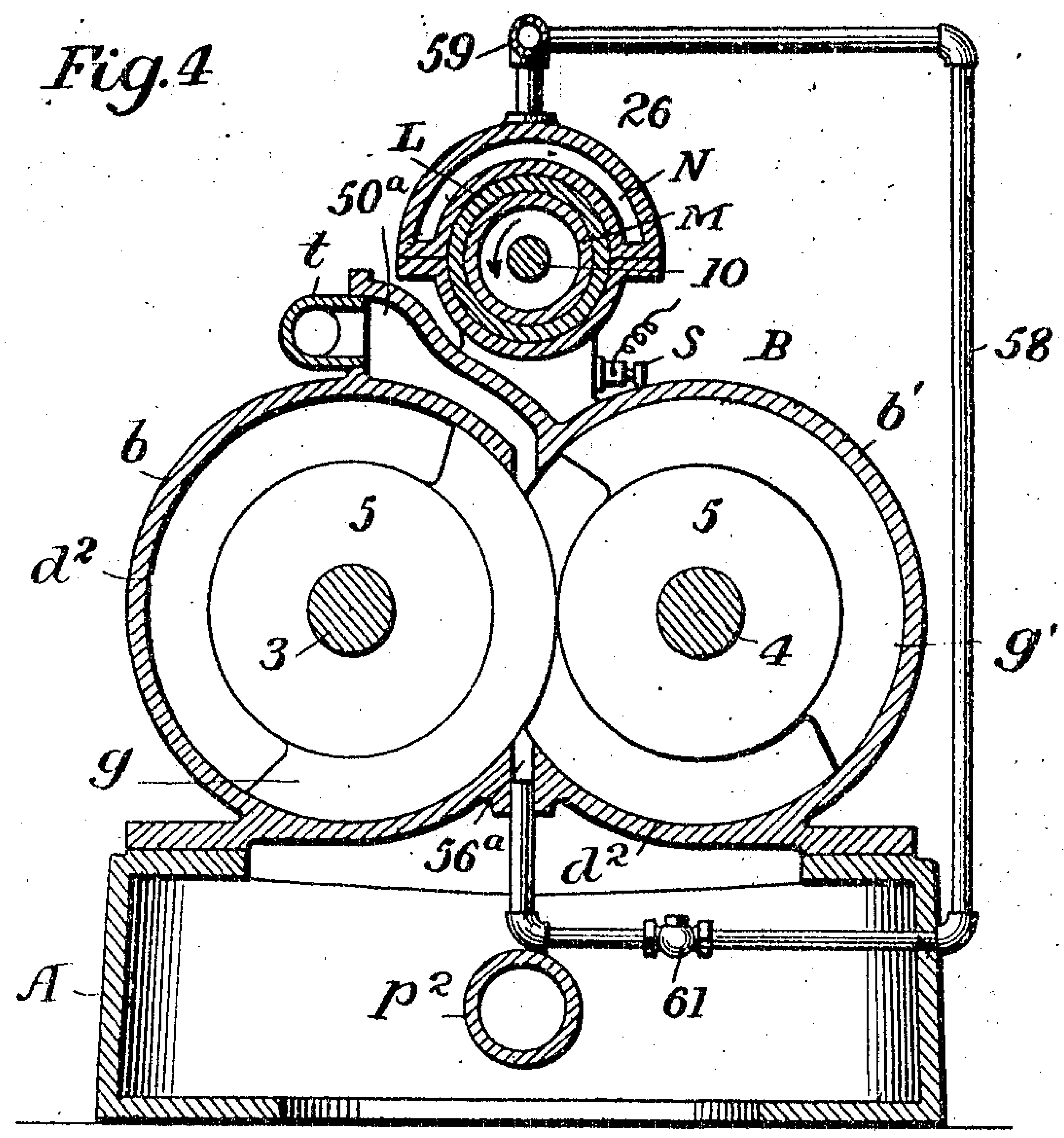
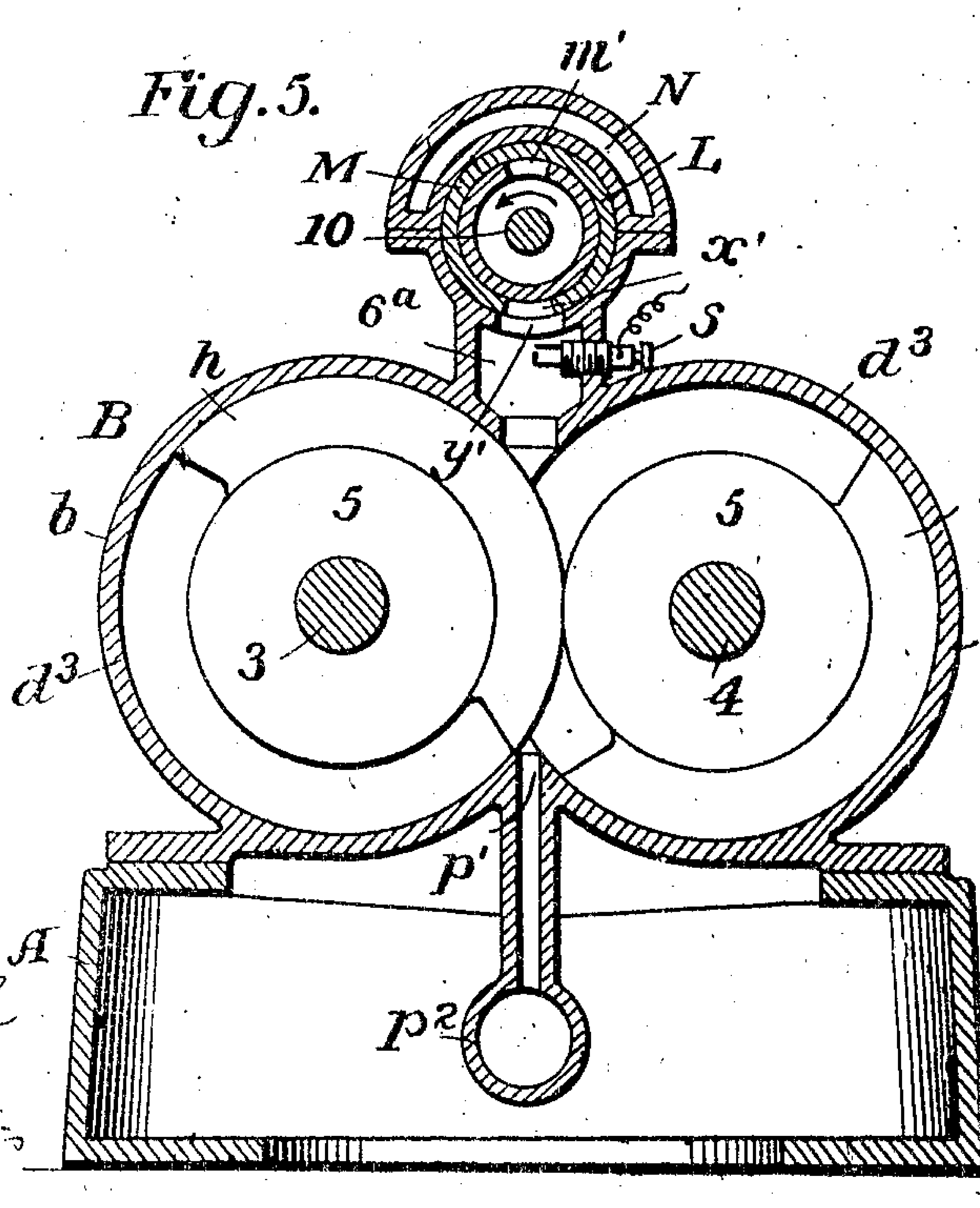


Fig. 5.



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4 SHEETS—SHEET 4.

Fig. 6.

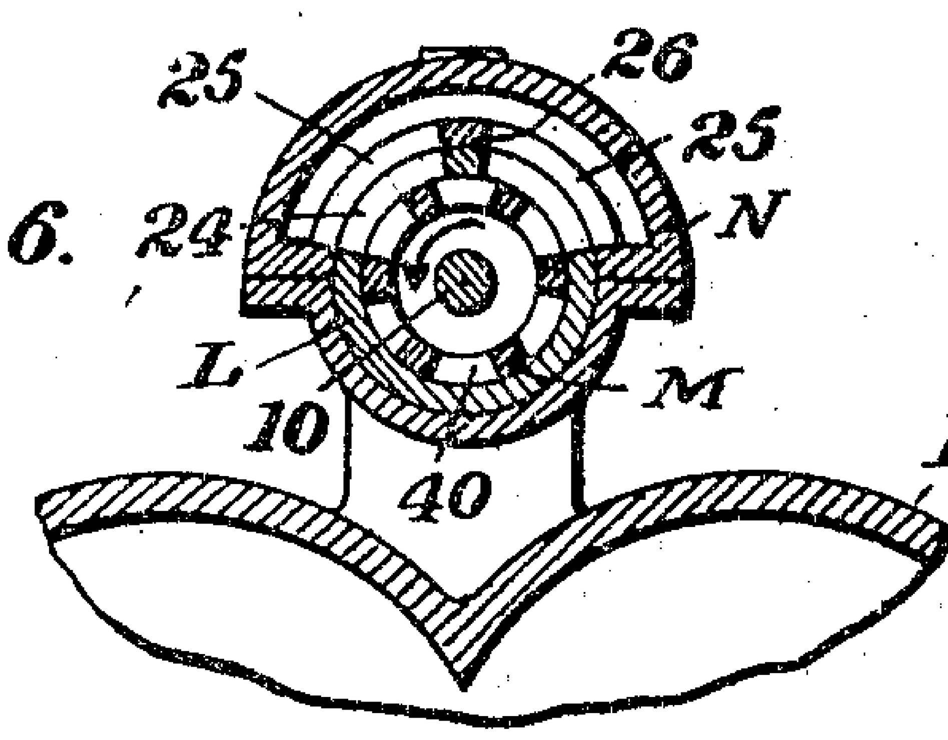


Fig. 7.

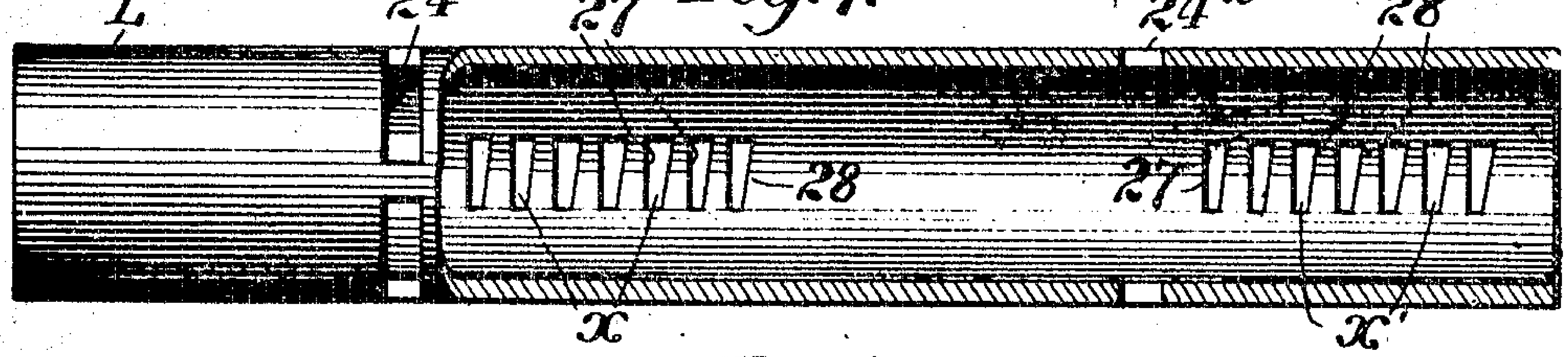


Fig. 8.

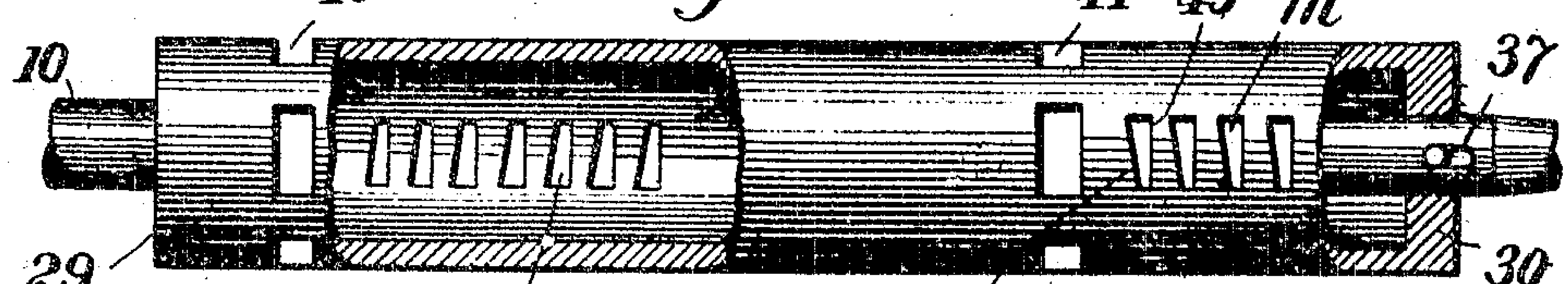


Fig. 9.

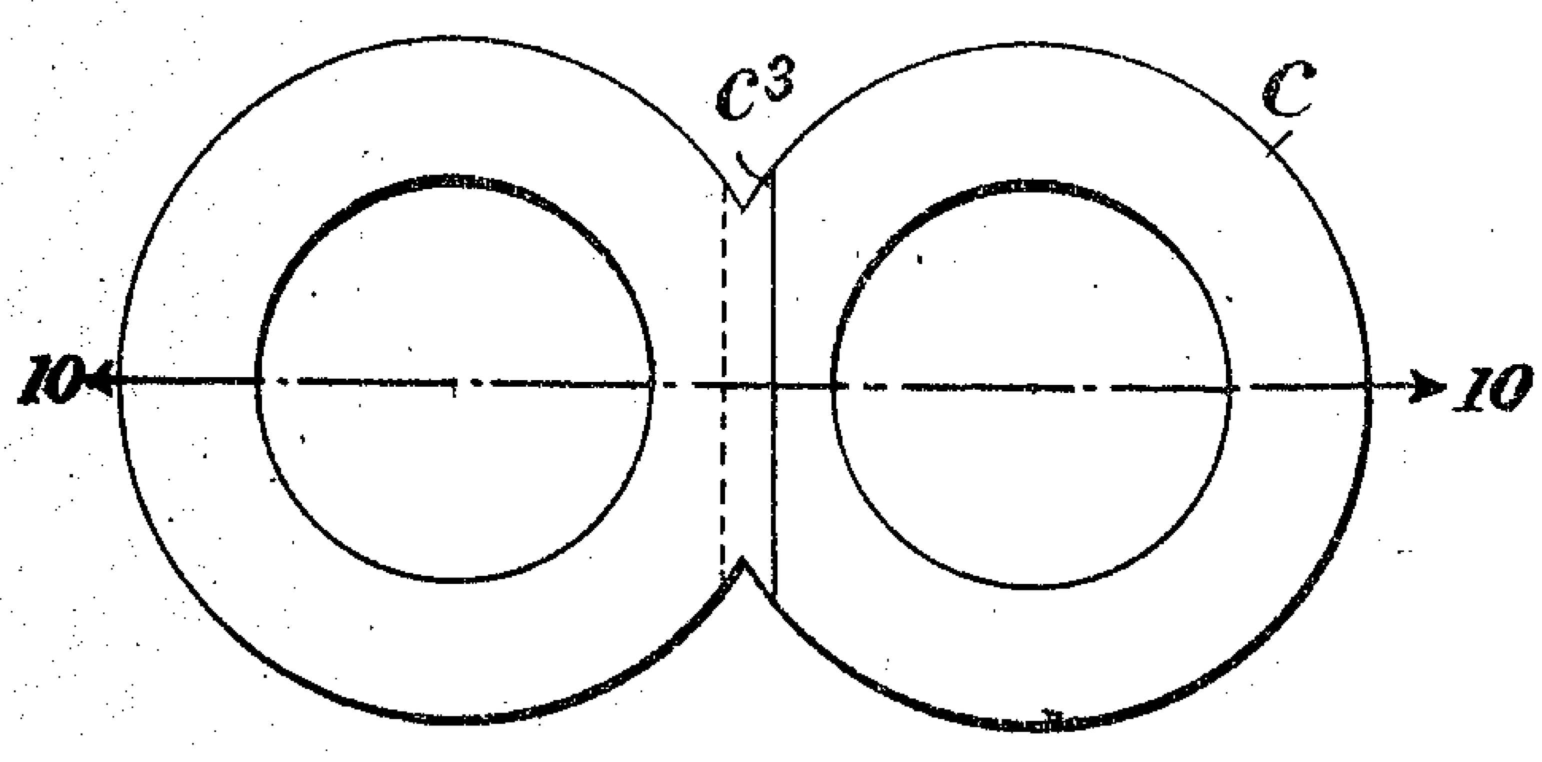


Fig. 11.

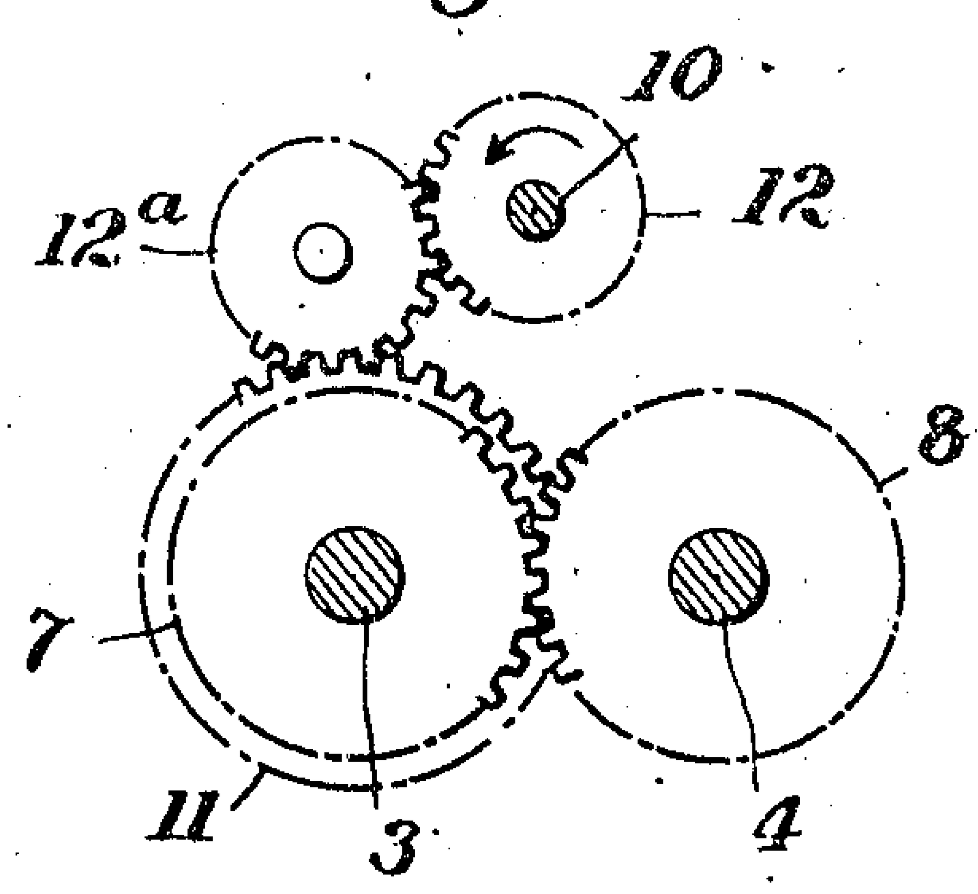
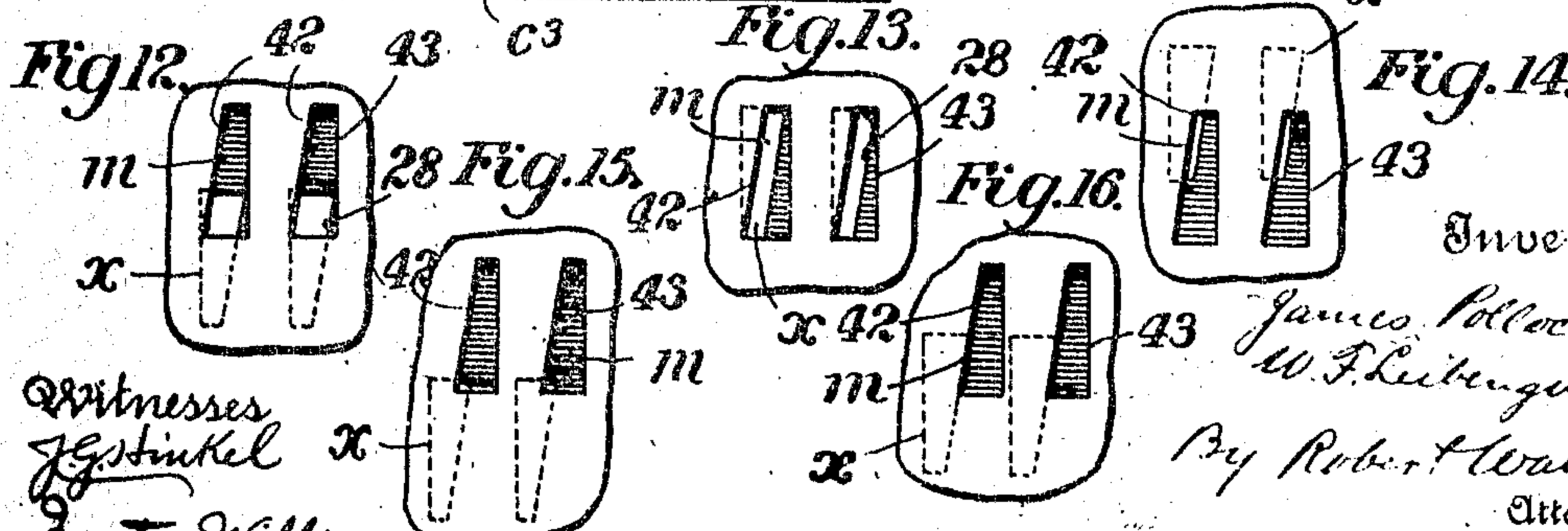


Fig. 10.

Fig. 12. Fig. 13. Fig. 14. Fig. 15. Fig. 16.



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UNITED STATES PATENT OFFICE.

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ROTARY GAS-ENGINE.

No. 871,523. Specification of Letters Patent. Patented Nov. 19, 1907.

Application filed May 17, 1907. Serial No. 374,229.

To all whom it may concern:

Be it known that we, JAMES POLLOCK and WALTER F. LEIBENGUTH, citizens of the United States, residing at Wilkes-Barre and Dorranceton, respectively, in the county of Luzerne and State of Pennsylvania, have invented certain new and useful Improvements in Rotary Gas-Engines, of which the following is a specification.

This invention comprises improvements in explosive engines having rotary pistons of the type illustrated in the patent to Walter F. Leibenguth No. 773,401, dated October 25th, 1904.

In the present invention a series of pairs of segmental pistons are arranged in compartments of an engine cylinder and equally spaced around the shafts so as to preserve the balance and act in succession, and the pistons in one or more of these compartments serve as pumps to compress the gas or mixture into a valve chamber, from whence it is admitted in regulated quantities at proper intervals to the explosion chambers of the remaining compartments and there exploded against the pistons therein. The valve mechanism regulates the quantity of explosive mixture passing from the valve chamber into the explosion chambers, and a pressure-controlled valve regulates the admission of the mixture to the pump compartments of the engine.

In the accompanying drawing, Figure 1 is a vertical section through the engine, taken on the line 1—1 of Fig. 2, the pistons being shown in side view, partly broken away; Fig. 2 is a section on the line 2—2 of Fig. 1; Fig. 3 is a section on the line 3—3 of Fig. 1; Fig. 4 is a section on the line 4—4 of Fig. 1; Fig. 5 is a section on the line 5—5 of Fig. 1; Fig. 6 is a section through the admission valve and casing taken on the line 6—6 of Fig. 1; Fig. 7 is a plan view of the valve casing partly in central horizontal section; Fig. 8 is a similar view of the admission valve; Fig. 9 is a side view of one of the partitions in the engine cylinder; Fig. 10 is a section on the line 10—10 of Fig. 9; Fig. 11 is a side elevation of the gears which connect the shafts of the engine, and Figs. 12 to 16, inclusive, are detail views illustrating the operation of the admission valve.

Referring to the drawing, A indicates a suitable base and B indicates the engine frame or casing which comprises a double cylinder, consisting of the two connected halves, b and b', having heads 1 and 2 at their ends and having transverse partitions c, c' and c^2 which divide the cylinder into four compartments d, d', d^2, and d^3. The cylinder is provided with a suitable water jacket, not shown. Parallel shafts 3 and 4 extend longitudinally through the cylinder and upon these shafts, within the compartments, are arranged pairs of coöperating semi-circular segmental pistons, e—e', f—f', g—g' and h—h'. Each piston is mounted upon a cylindrical hub 5, which is secured to the shaft. The pistons of each pair are arranged relatively to one another so that the periphery of one of the pistons will always be almost in contact with the hub of the other.

The pairs of pistons f—f' and h—h' in the compartments d' and d^3, which are the explosion compartments of the engine, are arranged respectively 90 degrees apart on the shafts, and the pairs of pistons e—e' and g—g' in the compartments d and d^2 are arranged 90 degrees apart, the arrangement being such as to preserve a good mechanical balance. Valve mechanism, hereinafter described, is arranged to admit explosive mixture into combustion chambers 6 and 6^a (Figs. 1, 3 and 5), alternately at each quarter revolution of the piston shafts 3 and 4. Gears 7 and 8 (Figs. 1 and 11) of equal diameters are secured to the shafts 3 and 4, respectively, and these gears mesh with one another, so that the shafts rotate in unison and keep the pistons in fixed relation to one another. A valve shaft 10 is turned at twice the speed of the shafts 3 and 4 by means of a gear 11 upon the shaft 3 which drives a gear 12 upon the valve shaft, through an intermediate gear 12^a. These gears are all inclosed within a suitable gear casing 13. The piston shaft 4 is mounted in bearings K, one of said bearings being secured to the cylinder head 2 and the other being secured to the gear casing. The piston shaft 3 is mounted in similar bearings, not shown in the drawing, and the valve shaft is mounted in bearings j and j' secured to the piston head 2 and the gear casing, respectively.

Each of the bearings K for the piston shafts comprises an outer sleeve 17, secured to the frame, and an inner sleeve 18, which is threaded into the outer sleeve. The inner sleeve has a lining 19 of anti-friction metal. The portions of the shafts within the bearings are made tapering, as shown, the inner sleeve being correspondingly tapering. It is important to provide accurately fitting bearings in an engine of this class, in order to keep the pistons in close relation to the adjacent parts without friction. The inner sleeve may be adjusted longitudinally in order to take up general wear in the bearings, or, if a bearing should wear more at one point than another, the sleeve may be turned so as to present another portion of its surface at the point of greatest wear.

No packing is used on the pistons except on those faces of the pistons which adjoin the cylinder heads 1 and 2, where rings 20 are fitted into the piston faces.

A storage chamber N is suitably secured upon the top of the cylinder, and between the storage chamber and the cylinder is arranged a cylindrical valve casing L, having long circumferential slots 24, 24ª (Figs. 1, 6 and 7) which register with slots 25, 25ª, respectively, of corresponding length, in the lower curved wall 26 of the storage chamber. The valve casing remains stationary, its ends abutting against the heads 1 and 2, which are extended above the cylinder, as shown in Fig. 1. The valve casing has in its lower wall, over the explosion chambers 6, 6ª, two series of circumferentially extending wedge shaped slots or ports x, x', each slot having one side, 27, in a plane at right angles to the axis of the cylinder, and the opposing side 28 at an angle to the axis of the cylinder.

Within the valve casing is arranged a valve M, consisting of a hollow cylinder having suitable openings in its ends 29 and 30 for the valve shaft 10 to extend through. The valve is connected to the valve shaft by a key 31 so as to rotate with the shaft, but it is free to move longitudinally on the shaft. The valve shaft is held against longitudinal movement by the conical bearings j' and j, and stuffing boxes 32, 32ª are provided to prevent the escape of gas from the valve casing.

The valve stem 33 extends through the stuffing box 32ª and into an axial opening in the adjacent end of the valve shaft and is connected to a crosshead 34 arranged within a cavity 35 in the shaft. A pin 36 extends through the crosshead and through a slot 37 in the shaft and into the head 30 of the valve cylinder, so that a longitudinal movement of the valve stem 33 will cause the valve to slide along the valve shaft. The outer end of the valve shaft has a pin and slot connection with one arm of an operating lever 36ª, which may be connected to a suitable governor, or moved by hand.

The valve has two circular series of ports, 40 and 41, which are in line with the ports 24 and 24ª in the valve casing, respectively, when the valve is at the left hand limit of its movement, as shown in Fig. 1, so that the gas can pass directly from the storage chamber or reservoir N through the ports in the valve casing and valve into the interior of the valve at all times except when the valve is at the right hand limit of its movement, when the ports 40 and 41 will be out of the line with the ports in the valve casing. At intermediate positions of the valve the admission of gas through the ports 40 and 41 will be more or less throttled. The valve also has two series of outlet ports, m, m' arranged to admit gas from the interior of the valve through the ports x, and x' in the valve casing and thence through the ports y, y' in the cylinder into the explosion chambers 6, 6ª of the several compartments alternately. The outlet ports in the valve are wedge-shaped and of the same size and form as the outlet ports in the valve casing, but reversely arranged; that is, the slots in the valve diverge circumferential in the opposite direction from the slots in the valve casing, as will be noted by comparing the slots x in Fig. 7 with the slots m in Fig. 8, or by comparing the slots x and m in Figs. 12 to 16, and the slanting walls 42 of the slots in the valve are at the left while the walls 43 which are at right angles to the axis of the valve are at the right, whereas in the valve casing the inclined walls 28 are at the right and the walls 27 which are at right angles to the axis are at the left.

The valve rotates within the valve casing in the direction indicated by the arrows and the two series of outlet ports in the valve are arranged 180 degrees apart around the cylinder, so that as the valve rotates one series of outlet ports in the valve will come opposite one series of outlet ports in the valve casing at each half revolution of the valve. As the valve rotates twice for each revolution of the piston shafts, gas is admitted to each explosion chamber of the cylinder twice during each revolution of the piston shafts. Thus referring to Figs. 3 and 5, when the ports m in the valve come opposite the ports x in the valve casing gas is admitted to the explosion chamber 6 of the cylinder and exploded against one of the pistons, f, in the compartment d'. After the piston shafts have turned through one-fourth of a revolution, or an angle of 90 degrees, the piston, h, in the compartment d^3 will be in position to be acted upon, and by this time the valve will have made one-half of a revolution, and gas will pass from the ports m' through the ports x' into the explosion chamber 6ª. After the shafts have made another one-fourth of a revolution and the valve another one-half of a revolution, gas is again admitted through the ports m and x into the chamber 6, and the piston f' will then be in position to be acted upon, and after the piston shafts have made another one-fourth of a revolution and the valve has made another half revolution, the piston h' will be in position to be acted upon, and gas will be admitted to the chamber 6^a through the ports m' and x'. The four pistons, f, h, f' and h' are thus successively acted upon by the explosions during each revolution of the piston shafts. Spark plugs s are arranged in the explosion chambers and connected to a suitable electric generator and timing device, unnecessary to illustrate.

The spent gases are carried around between the ends of the segmental pistons and discharged through exhaust ports p, p' into exhaust pipes p^2 and p^3 leading to the atmosphere.

The gas or explosive mixture is carried to the engine through a supply pipe T which is connected to an inlet port or passageway 50 in the upper part of the engine casing, midway between the piston shafts, leading into the compartment d of the engine. A branch pipe t leads from the supply pipe to a corresponding passageway 50^a for admitting the mixture to the compartment d^2. In the main supply pipe T is arranged a valve 51 which is normally held open by a spring 52, arranged within a casing 53 beneath a piston or a plunger 54 which is secured to the valve stem. A pipe 55 leads from the casing or cylinder 53 to the storage chamber or reservoir N, the arrangement being such that the gas pressure in the storage reservoir will regulate the position of the throttle valve 51, and thus the supply of mixture to the compression compartments of the cylinder will be regulated by the pressure in the storage chamber.

As the engine rotates the pistons in the compression compartments d and d^2 draw in the gas or explosive mixture through ports 50 and 50^a and force it through ports 56 and 56^a, respectively, from whence the mixture is carried through pipes 57 and 58 to a trunk pipe 59 above the reservoir N. This trunk pipe is connected by a branch 60 to the reservoir. In the positions of the pistons represented in Figs. 2 and 4, a charge of gas is being drawn into the compartment d by the piston e', and a charge is being carried around to the exhaust port 56 by the piston e; the piston g' is commencing to draw in a charge from the inlet port 50^a and is forcing a charge out through the exhaust port 56^a, and the piston g is carrying a charge around to the exhaust port.

While we have referred to the chamber N as a storage reservoir, it will be understood that the pipes leading from the check-valves 61 to said chamber, and also the hollow valve M, which is normally in communication with said chamber may be considered parts of the reservoir for storing gas or explosive mixture under pressure.

It is not essential to the successful operation of our invention to make the outlet ports in the valve casing L^2 and valve M wedge-shaped, but we preferably make them wedge-shaped because with this construction a closer regulation of the amount of gas passing through the ports is obtained than if the ports consisted of straight slots.

The operation of the valve M is illustrated by the detail views, Figs. 12 to 16 inclusive, in which a portion of the valve M is indicated as moving in the direction of the arrows over the ports x in the valve casing. Figs. 12, 13 and 14 illustrate successive relative positions of the outlet ports in the valve and casing when the valve is in the left hand position shown in Fig. 1, in which the ports are in register, and Figs. 15 and 16 illustrate successive relative positions of said ports when the valve has been shifted to the right in Fig. 1 by the action of a governor or by hand.

As shown in Fig. 12, when the valve is in its left hand position, as the valve rotates the wider ends or bases of the slots m in the valve approach and pass over the wider ends or bases of the slots x in the valve casing, the wider ends of the slots m extending entirely across the slots x, forming wide rectangular openings through the ports, at the commencement of the movement, which admits a free flow of gas. As the valve moves to the position indicated in Fig. 13, wherein, the ends of the ports in the valve and valve casing are coincident, the openings for the admission of gas to the cylinder through said ports become gradually longer and narrower, but still have large areas. As the valve moves from the position shown in Fig. 13 to that shown in Fig. 14, it will be noted that the valve gradually throttles the gas, the openings through the ports becoming narrower as the inclined sides 42 and 28, respectively, of the ports approach one another, and shorter as the narrower ends of the ports or slots m approach the narrower ends of the ports x. In the left hand position of the valve, therefore, gas is admitted throughout the entire movement of a series of outlet ports in the valve past the coöperating series of outlet ports in the valve casing. When the valve is moved to the right of Fig. 1, to a greater or less extent, the inlet ports 40 and 41 in the valve move out of register with the ports 24 and 24^a, respectively, in the valve casing, thus throttling gas entering through said ports into the interior of the valve. At the same time the outlet ports m in the valve are shifted laterally relatively to the outlet ports l in the valve casing.

In Fig. 15, the valve M is represented as having been shifted to nearly the limit of its movements to the right, and it will be noted that as the ports *m* pass over the ports *x* only a small opening is left for the passage of gas through said ports when they first overlap, and as the valve moves onward to the position indicated in Fig. 16, the openings through the ports become longer and narrower until in the latter position, the gas is cut off entirely, the inclined sides of the ports in said latter figure being in line with one another. It will be seen therefore that in this right hand position of the valve, only a small quantity of gas is admitted when the ports first overlap and that the gas is cut off at or before the time when the ports in the valve have moved halfway past the ports in the valve casing.

Owing to the peculiar form and arrangement of the ports in the valve and valve casing, the openings through said ports, in any position of the valve, grow longer and narrower and are then closed by the approach of the inclined sides of the ports, and when the valve is moved from its extreme left hand position, the gas is cut off before the ports in the valve have passed beyond the ports in the valve casing, the point of cut off being regulated by the position of the valve which in turn is regulated by the load on the engine and the speed, when an automatic governor is used.

As the valve rotates at a relatively high rate of speed, it may be moved longitudinally with very little frictional resistance and as there are a large number of outlet ports in the valve and valve casing, a very slight movement of the valve causes a comparatively large increase or decrease, as the case may be, in the combined areas of the outlet openings through the valve and casing. At the same time, the admission of gas through the inlet ports to the interior of the valve is varied by the position of the valve, and it will be seen that this valve mechanism makes the engine sensitive to very slight adjustment of the valve. Any suitable form of centrifugal governor may be used to operate the valve, or it may be operated manually when the engine is used on automobiles or for other purposes where a governor is not required.

If the admission valve M is moved to reduce the supply of compressed gas flowing from the reservoir to the explosion compartments of the engine, the increased pressure in the reservoir will cause the pressure controlled throttle valve 51 to move towards its seat thus throttling the supply of gas flowing to the compression compartments, so that a smaller quantity of gas will be forced into the reservoir, and when the valve M is moved to admit a greater quantity of gas to the explosion compartments, the reduction in pressure in the reservoir will allow the valve 51 to open wider and admit more gas to the compression compartments. Thus a practically constant gas pressure is automatically maintained in the reservoir.

All the parts of the engine are accurately fitted. The partitions between the pistons, each, as shown in Figs. 9 and 10, consist of two similar parts having a lap joint c^3 between them. The hubs 5 for the pistons are preferably cast hollow, as shown in Fig. 2, and are accurately turned, and the pistons are accurately turned on their inner faces to fit the hubs and bolted thereto by countersunk bolts. The arrangement of the pistons on the shafts gives the engine a perfect mechanical balance, and this, with the admission of gas to the four pistons in succession during each revolution makes the engine run smoothly.

What we claim is—

1. In a rotary gas engine a cylinder, a pair of parallel piston shafts extending therethrough and geared together, a pair of coöperating semi-circular pistons upon said shafts, a reservoir, means for compressing gas into said reservoir, and a rotary valve geared to one of said shafts and having ports arranged to admit gas from said reservoir into said cylinder twice during each revolution of the piston shafts.

2. In a rotary gas engine, a cylinder having several explosion compartments, a pair of parallel shafts extending through said compartments and geared together, a pair of coöperating semi-circular pistons on said shafts in each compartment, the pairs of pistons in said compartments being arranged in different angular positions on the shafts, means for storing a supply of gas under pressure, and a rotary valve geared to one of said shafts and having ports arranged to admit gas from said storage means to the explosion compartments of the engine, successively, twice during each revolution of the shafts.

3. In a rotary gas engine, a cylinder having an explosion compartment and a compression compartment, a pair of parallel shafts extending through said compartments and geared together, a pair of coöperating semi-circular pistons on said shafts in each of said compartments, a storage reservoir for gas connected to the exhaust port of said compression compartment, and a rotary valve geared to one of said shafts and having ports arranged to admit gas from said reservoir to said explosion compartment twice during each revolution of the shafts

4. In a rotary gas engine, a cylinder having several explosion compartments and a compression compartment, a pair of parallel shafts extending through said compartments and geared together, a pair of coöperating semi-circular pistons on said shafts in each compartment, the pairs of pistons in the explosion compartments being arranged

in different angular positions on the shafts, a storage reservoir for gas connected to the exhaust port of said compression compartment, and a rotary valve geared to one of said shafts and having ports arranged to admit gas from said reservoir to said explosion compartments, successively, twice during each revolution of the shafts.

5. In a rotary gas engine, a cylinder having a plurality of explosion compartments and a plurality of compression compartments, a pair of parallel shafts extending through said compartments and geared together, a pair of coöperating semi-circular pistons on said shafts in each compartment, the pairs of pistons in the explosion compartments being arranged in different angular positions on the shafts, a storage reservoir for gas connected to the exhaust port of each compression compartment, and a rotary valve geared to one of said shafts and having ports arranged to admit gas from said reservoir to said explosion compartments, successively, twice during each revolution of the shafts.

6. In a rotary gas engine, a cylinder having an explosion compartment and a compression compartment, a pair of parallel shafts extending through said compartments and geared together, a pair of coöperating semi-circular pistons in each of said compartments, a storage reservoir for gas connected to the exhaust port of said compression compartment, valve mechanism arranged to admit gas from said reservoir to said explosion compartment twice during each revolution of the shafts, a supply conduit leading to the inlet port of the compression compartment, a normally open valve in said conduit, and connections for moving said normally open valve toward closed position by the gas pressure in the reservoir.

7. In a rotary gas engine, a cylinder having an explosion compartment and a compression compartment, a pair of parallel shafts extending through said compartments and geared together, a pair of coöperating semi-circular pistons in each of said compartments, a storage reservoir for gas connected to the exhaust port of said compression compartment, a valve arranged to admit gas from said reservoir to said explosion compartment twice during each revolution of the shafts and adjustable to vary the quantity of gas admitted, a supply conduit leading to the inlet port of the compression compartment, a normally open valve in said conduit, and connections for moving said normally open valve toward closed position by the gas pressure in the reservoir.

8. In a rotary gas engine, an explosion compartment, a compression compartment, a reservoir connected to the outlet port of the compression compartment, a valve adapted to regulate the supply of gas from said reservoir to the explosion compartment, a throttle valve for controlling the admission of gas to the compression compartment, and means for regulating the position of said latter valve according to variations in the pressure in the reservoir.

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

JAMES POLLOCK.
WALTER F. LEIBENGUTH.

Witnesses:
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