A. E. GREENE.
ROTARY ENGINE.
APPLICATION FILED FEB. 26, 1909.

984,904.

Patented Feb. 21, 1911.

2 SHEETS—SHEET 1.

Fig. 1.

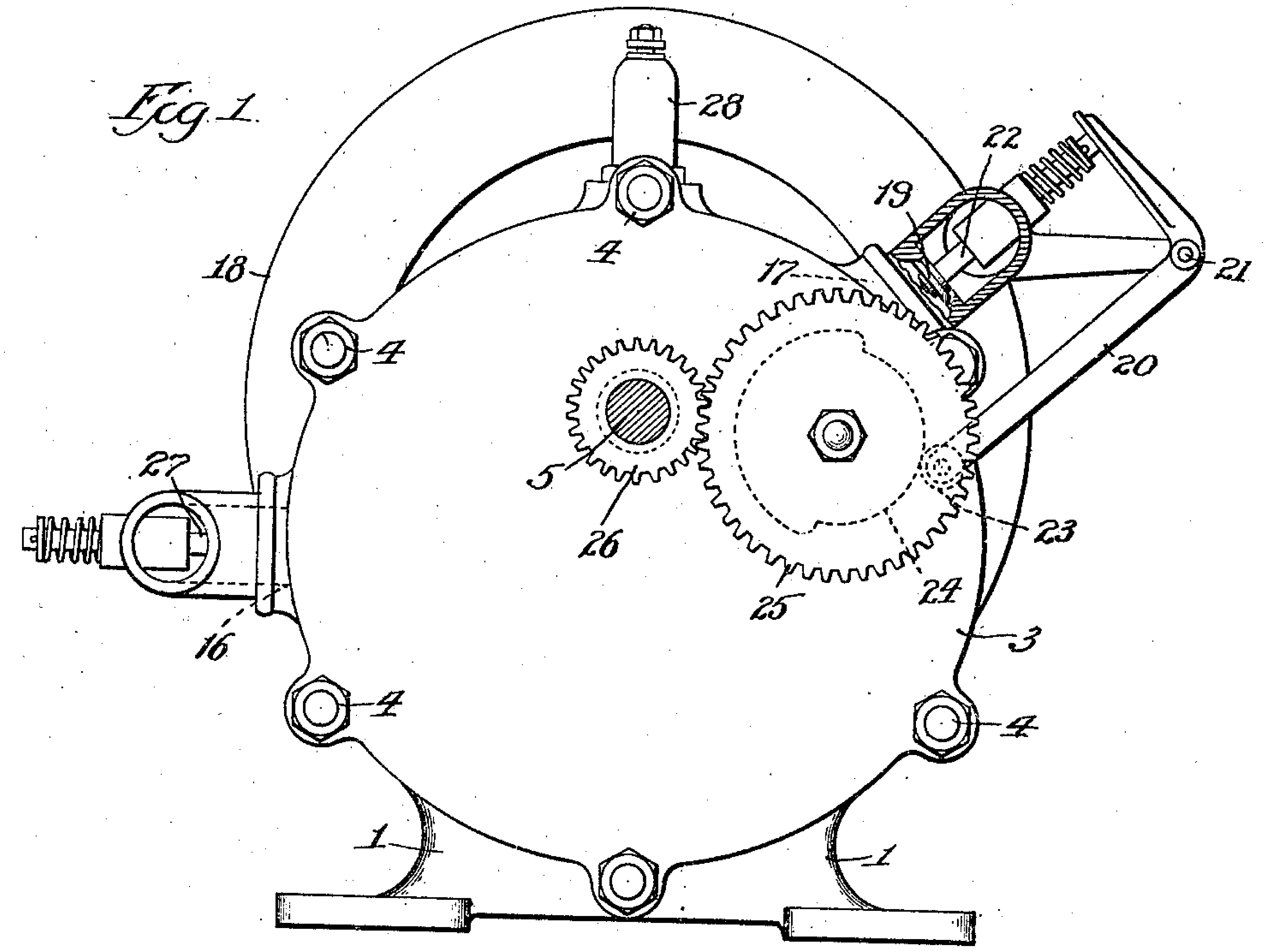
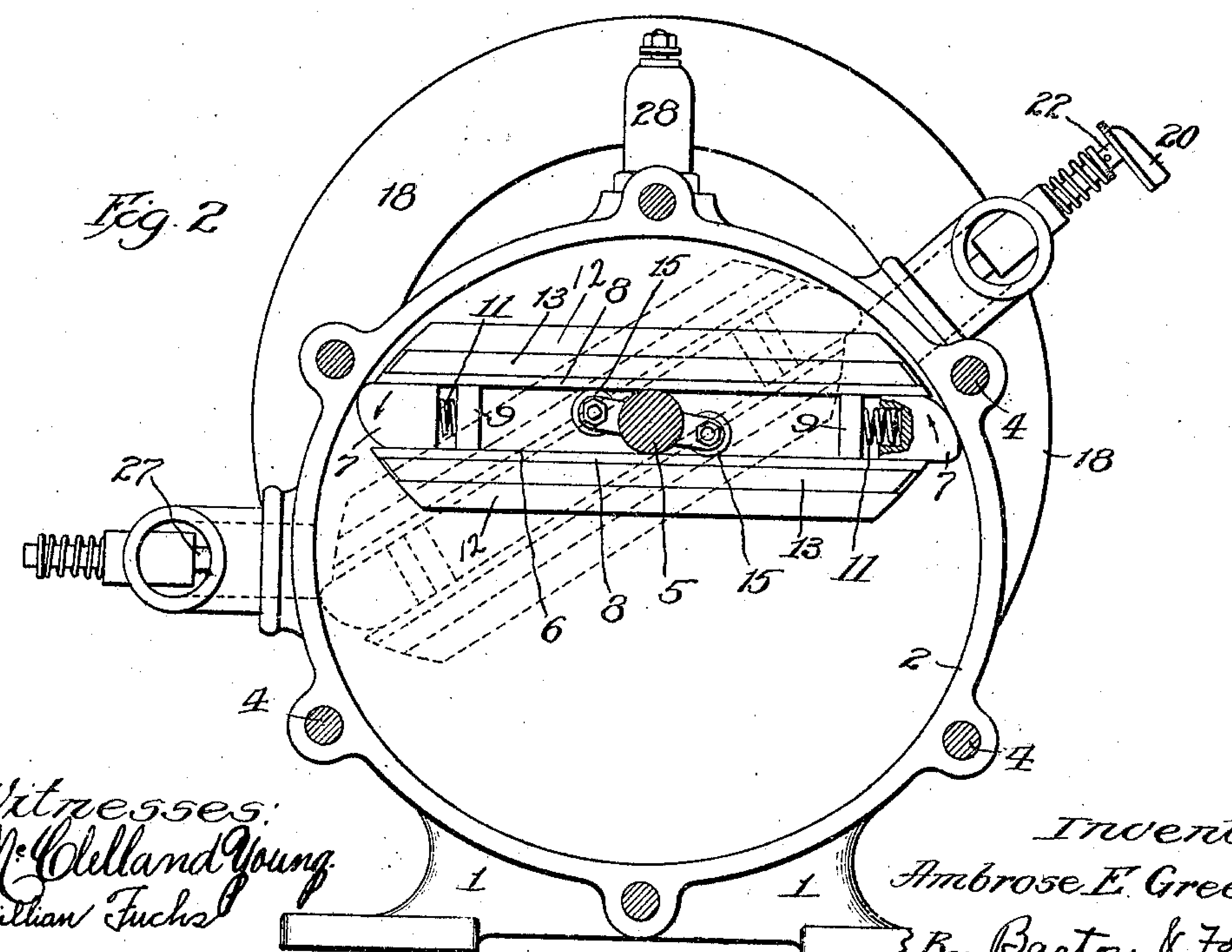


Fig. 2



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2 SHEETS—SHEET 2.

Fig. 3.

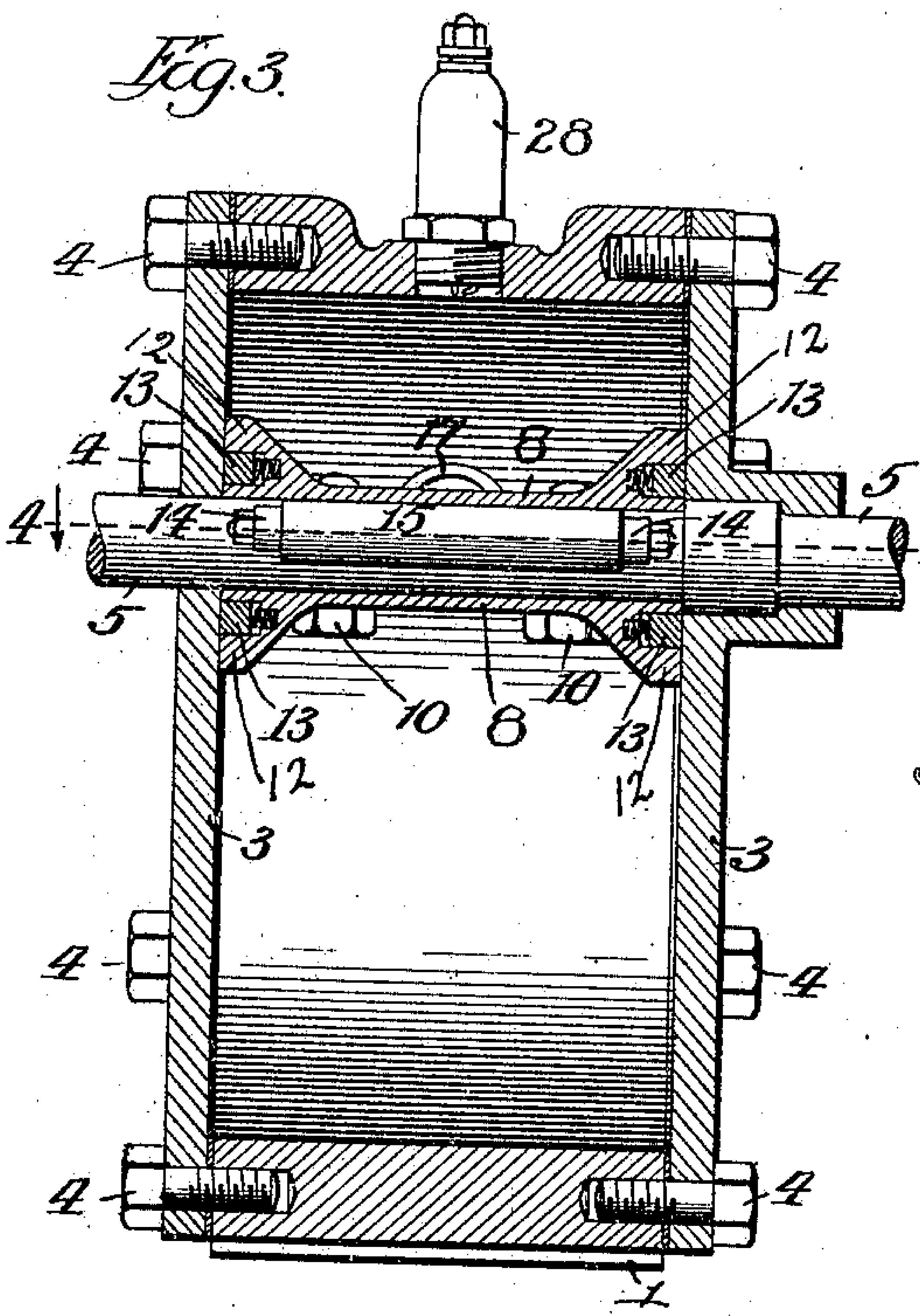


Fig. 4.

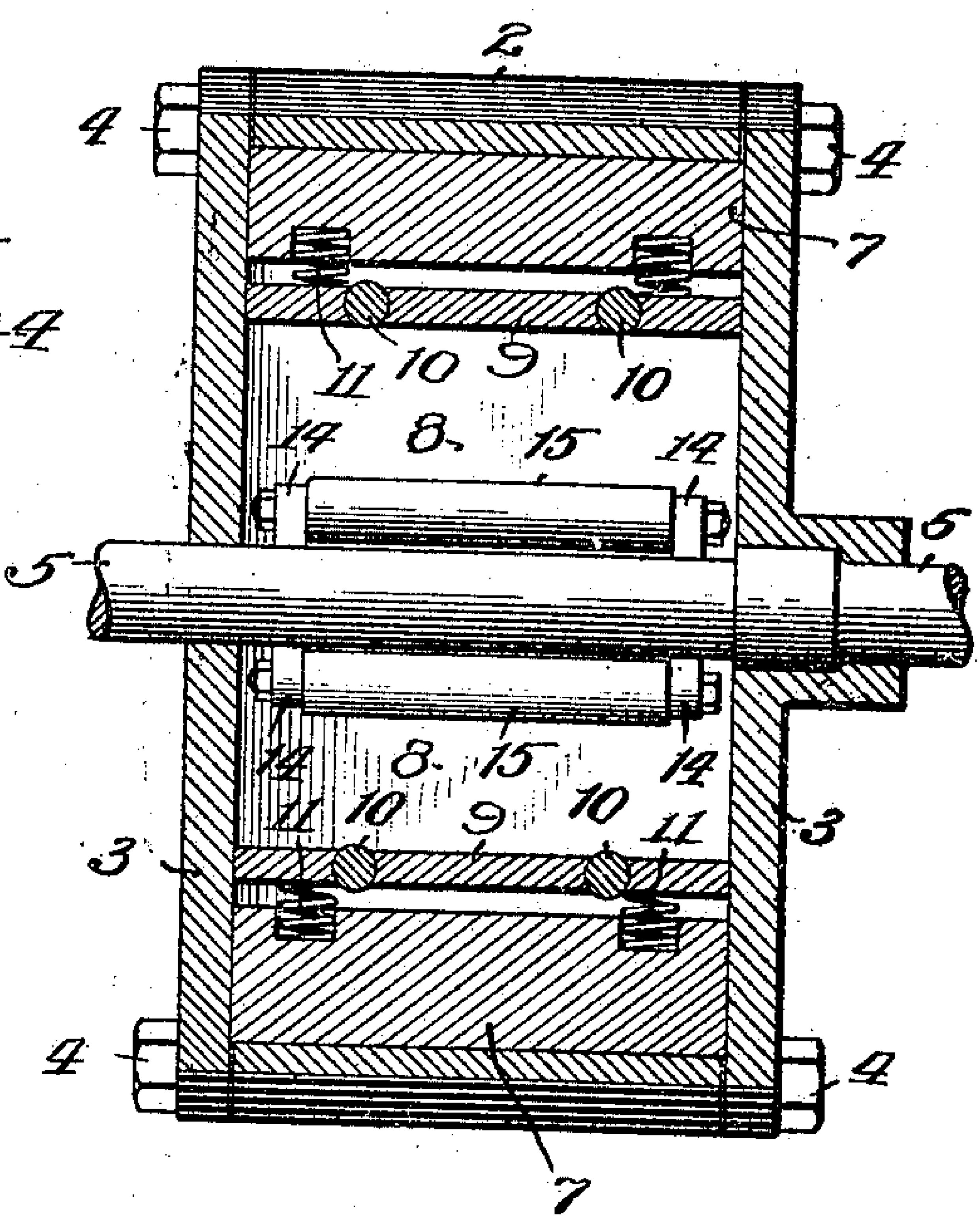


Fig. 5.

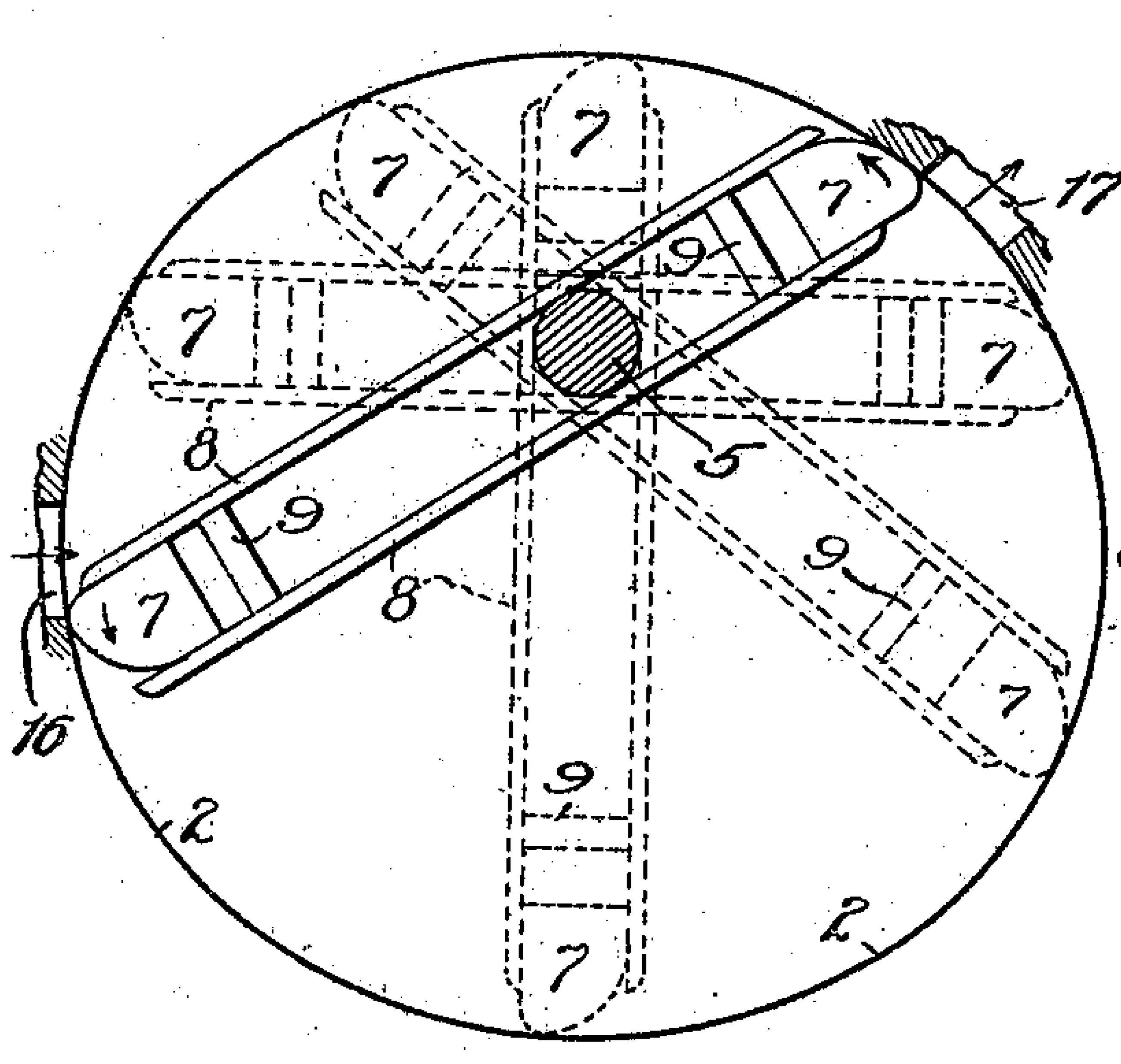
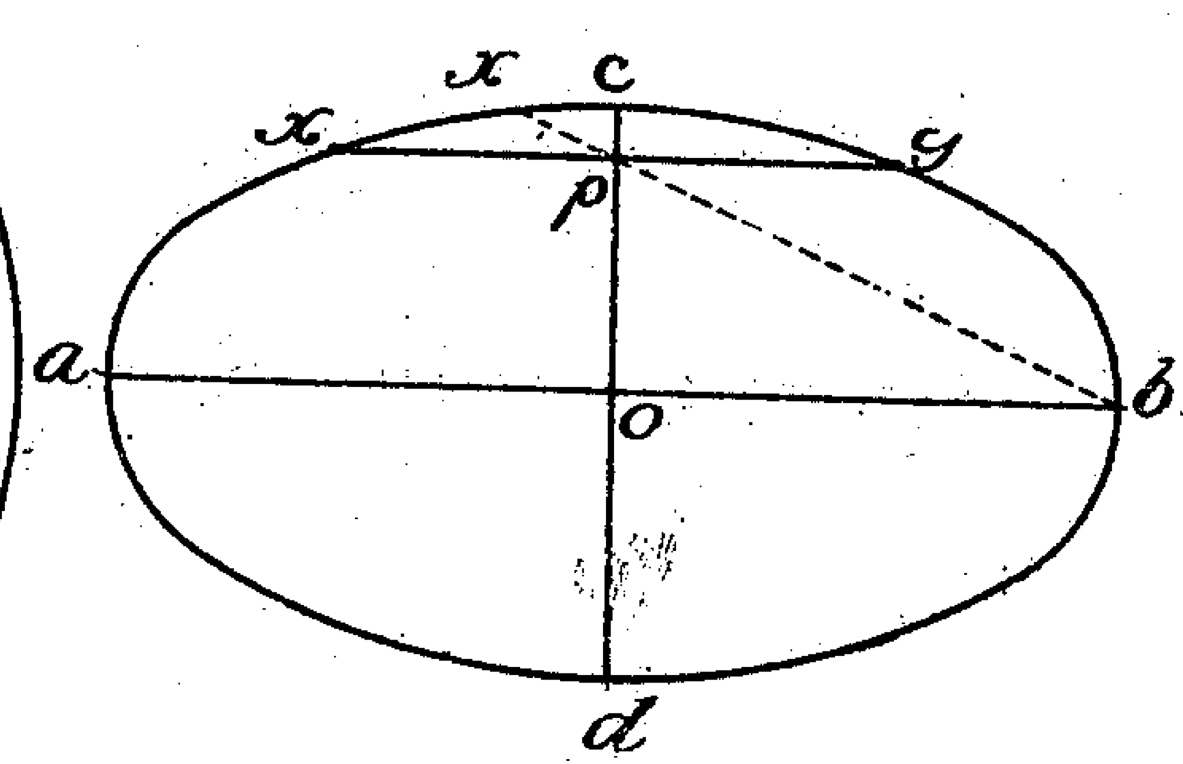


Fig. 6.



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UNITED STATES PATENT OFFICE.

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ROTARY ENGINE.

984,904. Specification of Letters Patent. Patented Feb. 21, 1911.

Application filed February 26, 1909. Serial No. 480,262.

To all whom it may concern:

Be it known that I, AMBROSE E. GREENE, a citizen of the United States, residing at Pueblo, in the county of Pueblo and State of Colorado, have invented a certain new and useful Improvement in Rotary Engines, of which the following is a full, clear, concise, and exact description.

My invention relates to rotary engines, and its object is to provide an engine having increased efficiency, which is of simple and compact structure, and which can be manufactured at a comparatively low cost.

My invention comprises a rotary engine having a cylinder of elliptical or approximately elliptical cross-section, a rotary shaft which is located eccentrically of the ellipse, on the minor axis thereof approximately at a point at which a chord equal in length to the minor axis and drawn perpendicular thereto intersects said minor axis, and a rotary piston blade having a length equal to the length of the minor axis of the ellipse, said blade being slidably mounted on said shaft to rotate therewith.

One feature of my invention relates to the particular construction of the piston blade and to the means by which it is slidably secured to the rotary shaft.

A further feature of my invention relates to certain structural details whereby the invention is capable of being embodied in an internal combustion engine.

These and other features of the invention may be more readily set forth in connection with the accompanying drawings, in which,

Figure 1 is a front end elevation of a gas-engine embodying my invention; Fig. 2 is a vertical section of the engine shown in Fig. 1, said section being taken on the plane of the inner face of the cylinder head, so as to show the interior construction of the engine; Fig. 3 is a central longitudinal vertical section of the engine; Fig. 4 is a section on the line 4—4 of Fig. 3; Fig. 5 is a diagrammatic view showing different positions assumed by the piston blade; and Fig. 6 is a diagrammatic view illustrative of the advantage resulting from locating the rotary shaft in accordance with my invention.

Similar reference characters designate similar parts throughout the several figures.

The engine is supported upon a suitable base 1. The engine casing consists of a hollow cylinder 2 of elliptical or approximately elliptical cross section, the ends of which are closed by cylinder heads 3, 3, clamped by bolts 4 to the ends of the cylinder. A rotary shaft 5 extends longitudinally through the cylinder and has suitable bearings in the cylinder heads 3. Said shaft 5 is located eccentrically of the elliptical bore of the cylinder. By reference to Fig. 2, it will be noted that the shaft 5 lies in the plane of the minor axis of the ellipse and at the point therein at which a chord of the ellipse equal in length to the minor axis and drawn perpendicular thereto intersects said minor axis.

Mounted to rotate with the shaft 5, but slidable transversely or radially thereof, is a rotary piston blade 6. Said piston blade has a length approximately equal to the length of the minor axis of the ellipse, and a width corresponding to the length of the interior of the cylinder. Since the shaft is located in the cylinder in the position above described, it follows that when the piston is in the horizontal position, as shown in Fig. 2, and also when in a vertical position, at right angles to the position shown in Fig. 2, it exactly fits the cylinder, the ends of the piston contacting with the curved interior surface of the cylinder. Owing to the particular location of the axis of rotation of the piston blade the differences in length of chords drawn through said axis are reduced to a minimum. Take for example the ellipse shown in Fig. 6, the ratio of whose major *ab* to the minor axis *cd* is approximately ten to six, in which the eccentricity of the ellipse is obviously considerable, and the two perpendicular chords drawn through the center *o* of the ellipse have a difference in length of over half the minor axis.

If a point *p* on the minor axis be located in the manner above described, that is so that the chord *xy*, perpendicular to the axis *cd* at the point *p* is equal to axis *cd*, it will be found that none of the chords of the ellipse drawn through such point *p*, as for example the chord *xb*, will have a difference in length of more than approximately one-sixth of the minor axis. As the eccentricity of the ellipse decreases, this difference in length of chords drawn through said point still further diminishes. For example in an ellipse in which the major and minor axes have a ratio of 10 to 9, such as is approximately the case in the elliptical cylinder shown in Fig. 2, the differences in length of the chords drawn through the selected axis are so slight as to be almost negligible. Hence by making the piston blade 6 of a length equal to the length of the minor axis, said piston will approximately fit said cylinder at every position of rotation of the piston blade.

In order to provide for any slight differences in length of the chords of the ellipse extending through the axis of rotation of the piston blade and also to take up any wear of said blade, each end of the piston blade is preferably provided with a spring pressed packing strip 7 forming the contacting end surface of the piston.

The piston 6 is preferably formed of two parallel plates 8, 8, spaced apart by blocks 9, 9 near each end thereof, said plates being clamped against said spacing blocks by bolts 10. A hollow rectangular opening or slot is thus left between the plates 8, 8, and the blocks 9, 9, the width of said slot being sufficient to receive the shaft 5 and its length being sufficient to permit such reciprocation of the piston 6, as it rotates, that the packing strips 7, 7, always remain in contact with the inner surface of the cylinder 2.

The spaced apart ends of the plates 8, 8 form sockets at the outer sides of the blocks 9, which sockets receive the packing strips 7, as shown most clearly in Fig. 2. Springs 11, are interposed between the blocks 9 and the packing strips 7 to press the latter out into intimate contact with the cylinder. The outer ends of the strips 7 are preferably shaped as shown in Fig. 2, that is the face turned toward the direction of rotation is considerably curved while the opposite face is comparatively straight. This gives a contour best adapted for riding over the sharper curves of the ellipse, and also gives a desirable contour to that end of the piston blade which it is desired shall receive the full effect of any motive fluid that may be employed to rotate said blade.

Each of the plates 8, 8, is preferably in the form of a channel-iron, that is they are provided with flanges 12, 12 at the sides thereof, which engage with the cylinder heads 3, as shown most clearly in Figs. 2 and 3. Said flanges have longitudinal grooves formed therein adapted to receive spring pressed packing strips 13, which are thus pressed into intimate engagement with the cylinder head and insure a tight, but elastic fit between the sides of the piston and the cylinder heads.

Two pins 14, 14 project diametrically through the shaft 5, preferably at points near the ends of the cylinder, and the projecting ends of said pins form bearings for cylindrical rollers 15, 15. The piston 6 is thus rotatably secured to the shaft 5, while at the same time the rollers 15 facilitate the sliding or reciprocation of the piston.

The cylinder is provided with an inlet port 16 and an outlet or exhaust port 17, situated upon opposite sides of the shaft 5, and preferably so located that as soon as one end of the piston in its rotation passes the exhaust port the opposite end of the piston will have passed the inlet port, as indicated in dotted lines in Fig. 2.

The usual fly-wheel 18 may be carried by the shaft 5 for reasons well understood.

The structure thus far specifically described sets forth the preferred embodiment of my invention whatever be the use to which the engine is put. For example, the invention may be embodied in a pump for pumping air, water, or other fluids, or in a steam engine, or in an internal combustion engine, and the additions which may be necessary in order to adapt the invention to the intended use will in general be well understood by one skilled in the art.

Assume that the piston is rotating counter clockwise, or in the direction indicated by the arrows in Figs. 2 and 5. Assume further that the space below the piston, when the piston is in the position indicated by full lines in Fig. 5, is filled with a fluid. It is obvious that as the piston rotates, and at the same time reciprocates on the shaft 5, as indicated in dotted lines in Fig. 5, the space to be occupied by said fluid decreases in volume and said fluid is either compressed, or, in case the exhaust port is open, is forced through the exhaust port. By the time the end of the piston has made a half-revolution and has again assumed the position shown in full lines in Fig. 5, though with its ends reversed, the fluid has been for the most part forced through the exhaust port 17, or, in case said port has been closed, is compressed in the space above the piston. Meanwhile the piston in its rotation has sucked in a fresh supply of fluid through the inlet port 16, which fresh supply of fluid now occupies the space below the piston. From the foregoing description it is obvious how the piston during its rotation sucks in fluid on one side of the piston through the inlet port and tends to compress on its opposite side or to force through the outlet port the fluid previously drawn into the cylinder.

From the foregoing description, it is believed the adaptation of my invention to use as a pump is obvious and needs no further description. Hence in the drawings I have shown an embodiment of the invention which is not so obvious, and will now describe certain parts which coöperate with those previously described to render my invention particularly adapted to use as an internal combustion engine.

The exhaust port 17 is controlled by a spring seated valve 19, which is adapted to be held open at predetermined periods by a bell-crank lever or tappet arm 20, pivoted at 21 upon a suitable support carried by the engine. The upper end of the tappet arm extends over the end of the valve rod 22. The lower end of said tappet arm is provided with a roller 23 which rides over a cam wheel 24, carried upon the shaft of a gear wheel 25, which meshes with a similar gear wheel 26 secured upon the shaft 5. The teeth upon the intermeshing wheels 25 and 26 are such that a two to one gear is provided, that is the gear 25 and its cam wheel 24 make one revolution for each two revolutions of the shaft 5 and gear 26. The cam has a depression extending over one-half of its periphery and hence is so shaped that during one half of its own revolution, or one complete revolution of the piston blade, it maintains the tappet arm 20 in position to hold open the valve 19. During the other half-revolution of the cam and the second complete revolution of the piston blade the tappet arm is held in position to permit the closure of said valve 19.

The inlet port 16 may be controlled by a well known type of spring pressed valve, 27, adapted to be opened in the usual manner by suction created in the engine cylinder.

Opening into that portion of the cylinder into which the gases are compressed is the usual type of spark plug 28, which may be timed and operated in the usual well-known manner to explode the compressed charges at desired intervals.

The operation of the gas-engine shown in the drawings may now be described as follows: Assume that the piston is in the position shown by dotted lines in Fig. 2 with a compressed charge above the piston and fresh or uncompressed charge below the same. In such position of the piston, the arm of the piston extending to the left, in Fig. 2, from the shaft 5 is longer than the opposite arm. Beginning with the conditions above assumed a complete cycle of operations of the engine occupies four half-revolutions of the piston. These four portions of the cycle may be described as follows:

(1.) The spark plug is so timed that the charge is exploded at the moment the conditions assumed have occurred. The greater force of the expansive power of the exploded gases is exerted, of course, upon the longer arm of the piston and hence the piston is propelled in the direction indicated by the arrows. During the first half-revolution of the piston the cam 24 is turned so that the valve 19 is closed. Hence the fresh charge is compressed into the space at the top of the cylinder.

(2.) At the beginning of the second half-revolution the piston extends in its initial direction across the cylinder, but with its ends reversed. During the first half-revolution the pressure of the exploded gases held the inlet valve 27 closed, and hence the space below the piston is now occupied solely by spent gases. The cam 24 has now turned so that the valve 19 is open and will remain open during the second half-revolution of the piston. The compressed charge is now exploded and during this second half-revolution the previously exploded gases are exhausted through the exhaust port 17.

(3.) At the beginning of the third half-revolution, the space below the piston is filled with spent gases resulting from the previous explosion, but there is, of course, no compressed charge above the piston. During this third half-revolution of the piston the suction created by the piston draws in a fresh charge behind the same, and meanwhile, the exhaust port being held open by the cam 24, the gases from the last explosion are exhausted.

(4.) At the beginning of the fourth half-revolution there is an uncompressed charge below the piston but no charge above the same. During this half-revolution the cam 24 is turned so as to hold the valve 19 closed, and hence during this last half-revolution of the cycle of operations, one charge of gas is being compressed upon one side of the piston and another charge is being drawn in on the other side. At the end of the fourth half-revolution there is, therefore, a compressed charge above the piston and an uncompressed charge below the same, the conditions assumed at the beginning of the cycle.

It will be observed therefore, that a gas engine embodying my invention has a cycle comprising four half-revolutions or strokes of the piston. During the first half-revolution there is an explosion on one side of the piston and compression on the other side; during the second half-revolution there is explosion and exhaust; during the third half-revolution, suction and exhaust; and during the fourth half-revolution suction and compression. It furthermore appears, in the operation of the gas-engine shown and described, that the cam 24 is so rotated that during one complete revolution of the piston-blade the valve 19, which controls the exhaust port, is in a closed position and during the succeeding complete revolution of the piston blade said valve is in an open position, such open and closed position of the valve alternating for each complete revolution of the piston-blade.

I claim:

1. In a rotary engine, the combination with an engine cylinder comprising a hollow shell

of elliptical cross-section and cylinder heads secured to the ends of said shell, of a rotary shaft having bearings in said cylinder heads, said shaft being located eccentrically of said cylinder in a line in which a chord equal in length to the minor axis and drawn perpendicular thereto intersects said minor axis, and a piston-blade having a length approximately equal to the length of the minor axis of the ellipse, said blade being mounted on said shaft to rotate therewith and at the same time to reciprocate transversely thereof.

2. In a rotary engine, the combination with a cylinder, of a rotary shaft located eccentrically of said cylinder, and a rotary piston-blade carried by said shaft and mounted to reciprocate transversely thereof, said piston-blade comprising two plates spaced apart to provide a slot extending longitudinally of the blade for receiving said shaft, and a spring pressed packing strip projecting from each end of said blade.

3. In a rotary engine, a rotary piston-blade comprising two plates, spacing blocks secured between said plates near each end thereof, thereby providing a longitudinally extending slot between said plates intermediate said blocks and also providing sockets at each end of the blade, packing strips mounted in said end sockets, and cushioning means interposed between said packing strips and said spacing blocks.

4. In a rotary engine, a rotary piston blade comprising two plates in the form of channel irons, the flanges of said channel irons being provided with longitudinally extending grooves, spacing blocks secured between said plates near each end thereof, thereby providing a longitudinally extending slot between said plates intermediate said blocks and also providing sockets at each end of the blade, and packing strips mounted in said end sockets and in the grooves of said flanges.

5. In a rotary engine, the combination with a cylinder; of a rotary shaft located eccentrically of said cylinder; a rotary piston blade comprising two plates, spacing blocks secured between said plates near each end thereof, thereby providing a longitudinally extending slot between said blocks for receiving said shaft and also providing a socket at each end of the blade, and packing strips mounted in said sockets; and means provided on said shaft and piston blade and for permitting a reciprocating movement of said blade on said shaft.

6. In a rotary engine, the combination with a cylinder, of a rotary shaft located eccentrically of said cylinder, a piston-blade having a longitudinal slot for receiving said shaft and for permitting a transverse reciprocation of said blade on said shaft, and a pair of cylindrical rollers mounted upon opposite sides of said shaft within said slot.

7. In a rotary engine, the combination with an engine cylinder comprising a hollow shell of elliptical cross-section and cylinder heads secured to the ends of said shell; of a rotary shaft having bearings in said cylinder heads, said shaft being located eccentrically of said cylinder in a line in which a chord equal in length to the minor axis and drawn perpendicular thereto intersects said minor axis; a rotary piston blade comprising two plates, spacing blocks secured between said plates near each end thereof, thereby providing a longitudinally extending slot between said blocks for receiving said shaft and also providing a socket at each end of the blade, and packing strips, mounted in said sockets; and a pair of cylindrical rollers mounted upon opposite sides of said shaft within said slot, whereby said piston blade is mounted to rotate with said shaft and also to reciprocate transversely thereof.

8. In an internal combustion engine, the combination with a cylinder having an inlet and an exhaust port and valves for controlling said ports, of a rotary shaft located eccentrically of said cylinder, a rotary piston-blade carried by said shaft and mounted to reciprocate transversely thereof, and means for maintaining the valve which controls the exhaust port alternately in a closed position for one complete revolution of the piston-blade and in an open position for a succeeding complete revolution thereof.

9. In an internal combustion engine, the combination with a cylinder having an inlet and an exhaust port and valves for controlling said ports, of a rotary shaft located eccentrically of said cylinder, a rotary piston-blade carried by said shaft and mounted to reciprocate transversely thereof, a two-to-one gear operated from said rotary shaft, a rotary cam carried by said gear, said cam having a depression extending over one-half of its periphery and a bell-crank lever having one of its ends in engagement with said cam and the other end in position to control the operation of the valve of said exhaust port.

10. In an internal combustion engine, the combination with a cylinder having an inlet and an exhaust port and valves for controlling said ports, of a rotary shaft located eccentrically of said cylinder, a rotary piston-blade carried by said shaft and mounted to reciprocate transversely thereof, and means for controlling said valves so as to provide for a cycle of operations covering four half-revolutions of the piston-blade and comprising an explosion of gases on one side of said piston and a compression of a charge on the other side thereof during one-half revolu-

tion, an explosion and an exhaust during the succeeding half-revolution, the admission of a fresh charge and the exhaust of the previously exploded charge during the succeeding half-revolution, and the admission of a fresh charge and the compression of the previously admitted charge during the final half-revolution of the cycle.

In witness whereof, I hereunto subscribe my name this 23rd day of February, A. D. 1909.

AMBROSE EVERTS GREENE.

Witnesses:
GEORGE E. FOLK,
ALFRED H. MOORE.