No. 869,560. PATENTED OCT. 29, 1907.

C. R. FRANCIS.

ROTARY ENGINE.

APPLICATION FILED MAY 7, 1907.

3 SHEETS—SHEET 1.

Fig. 1.

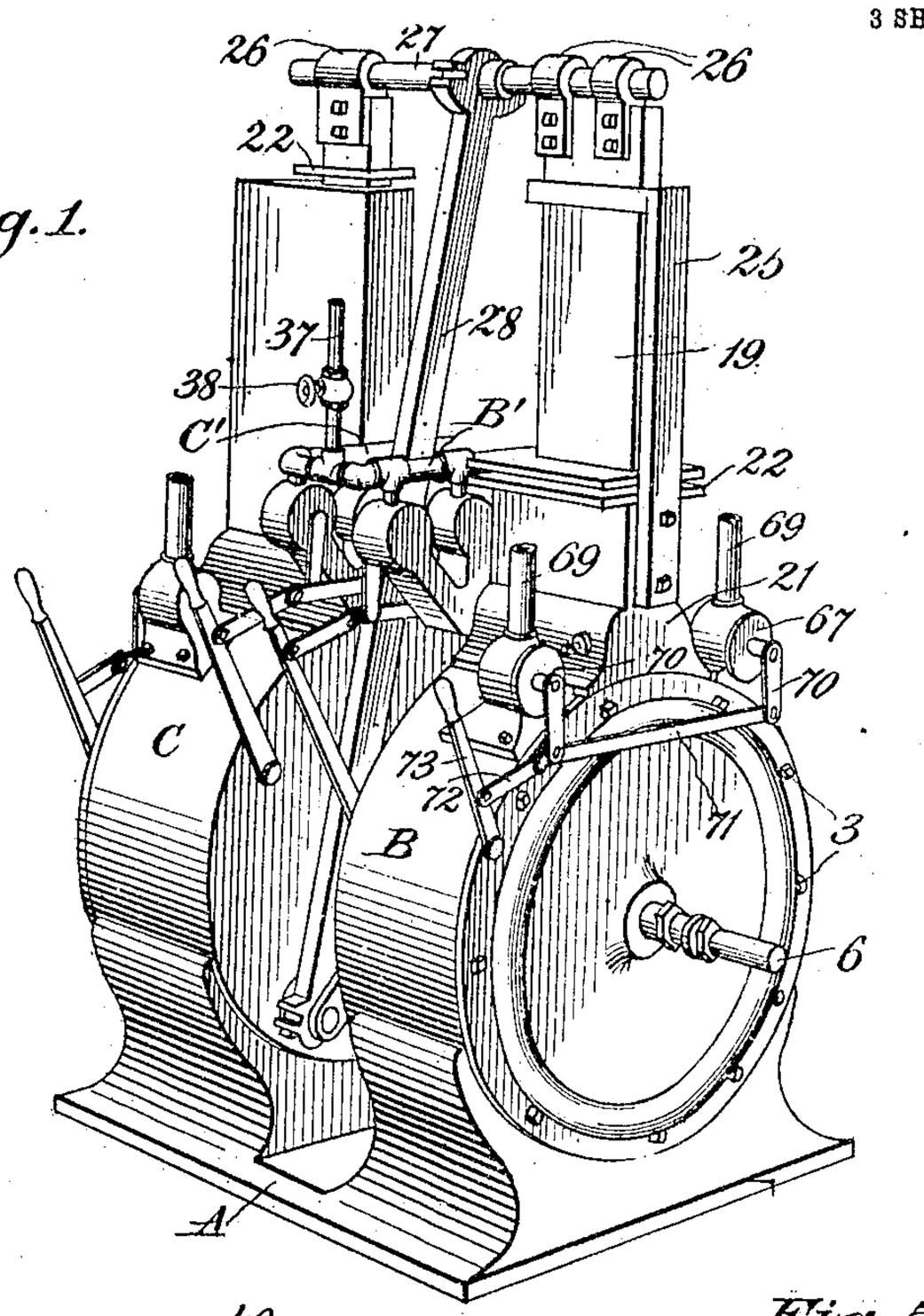


Fig. 4.

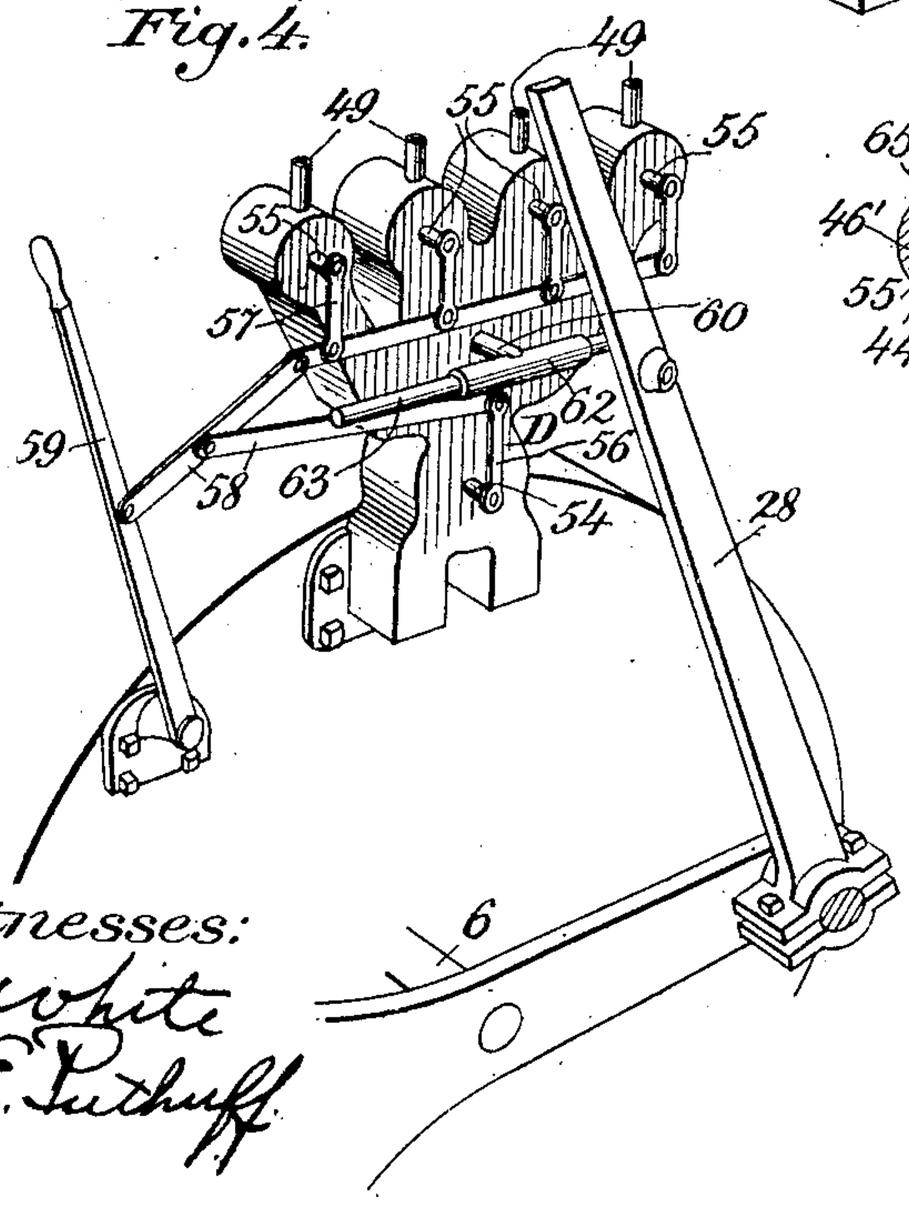
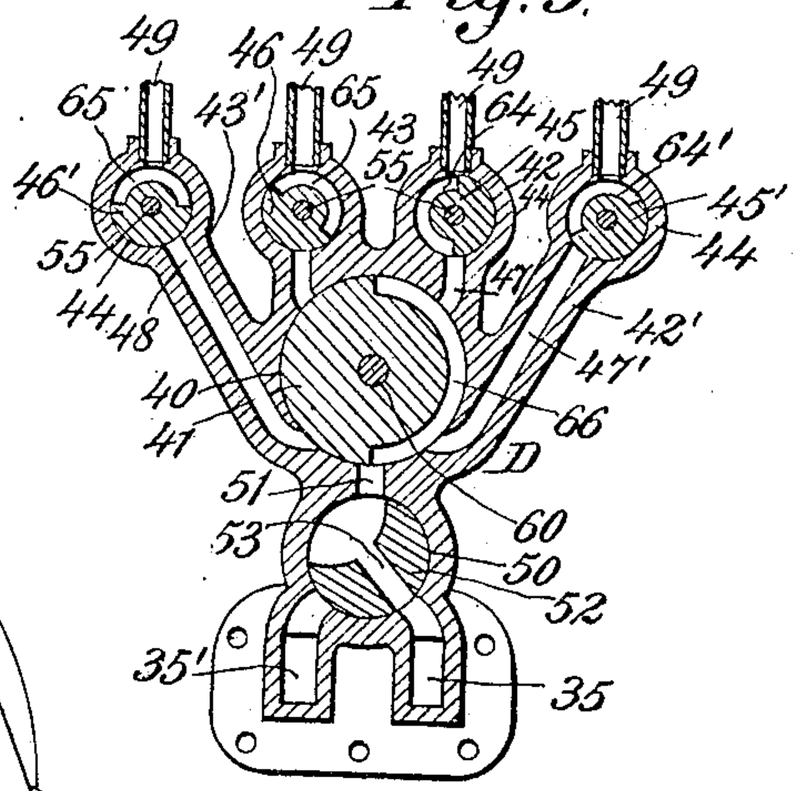


Fig. 5.



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3 SHEETS—SHEET 2.

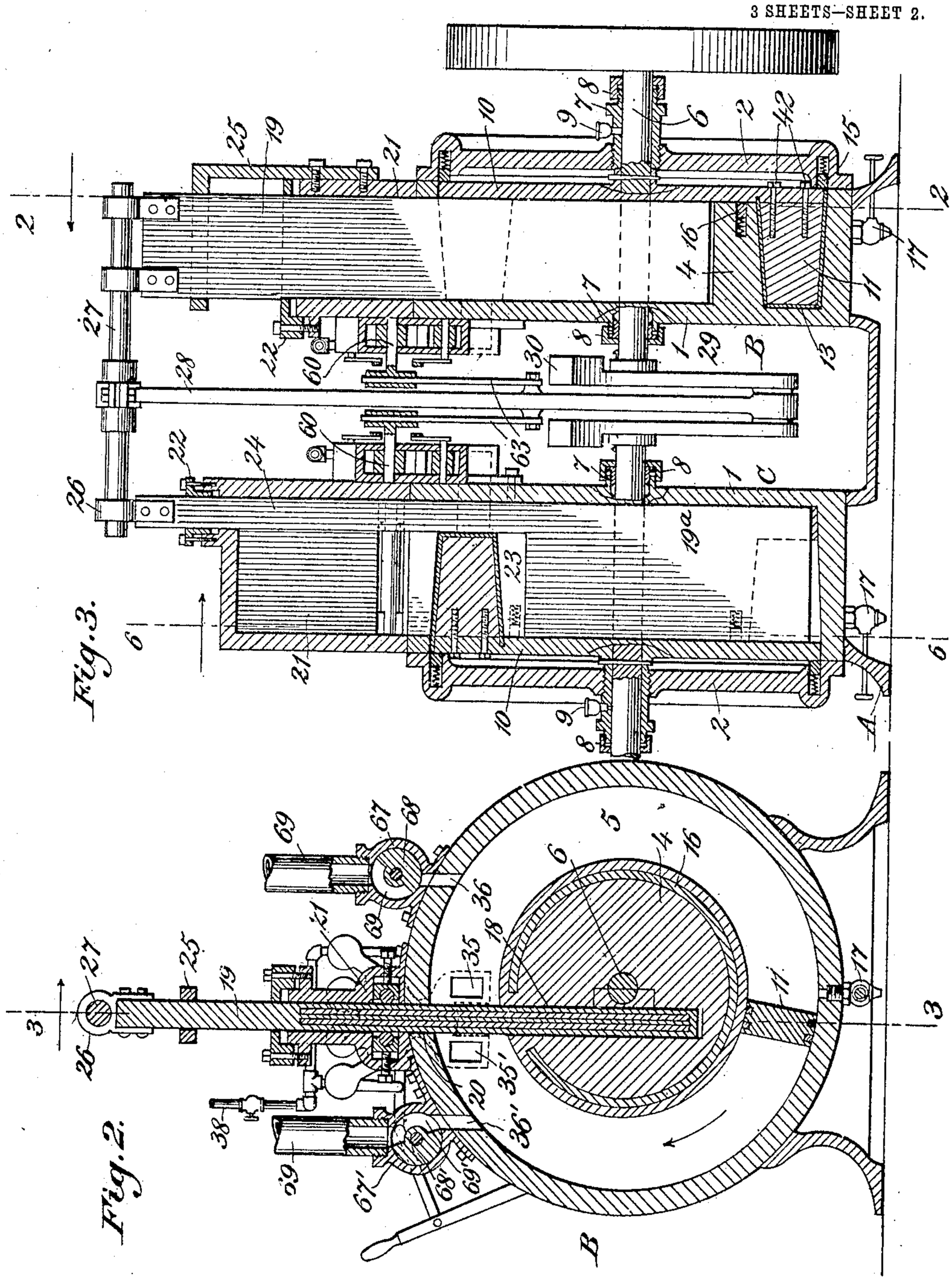

Fig. 3.

Fig. 2.

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3 SHEETS—SHEET 3.

Fig. 6.

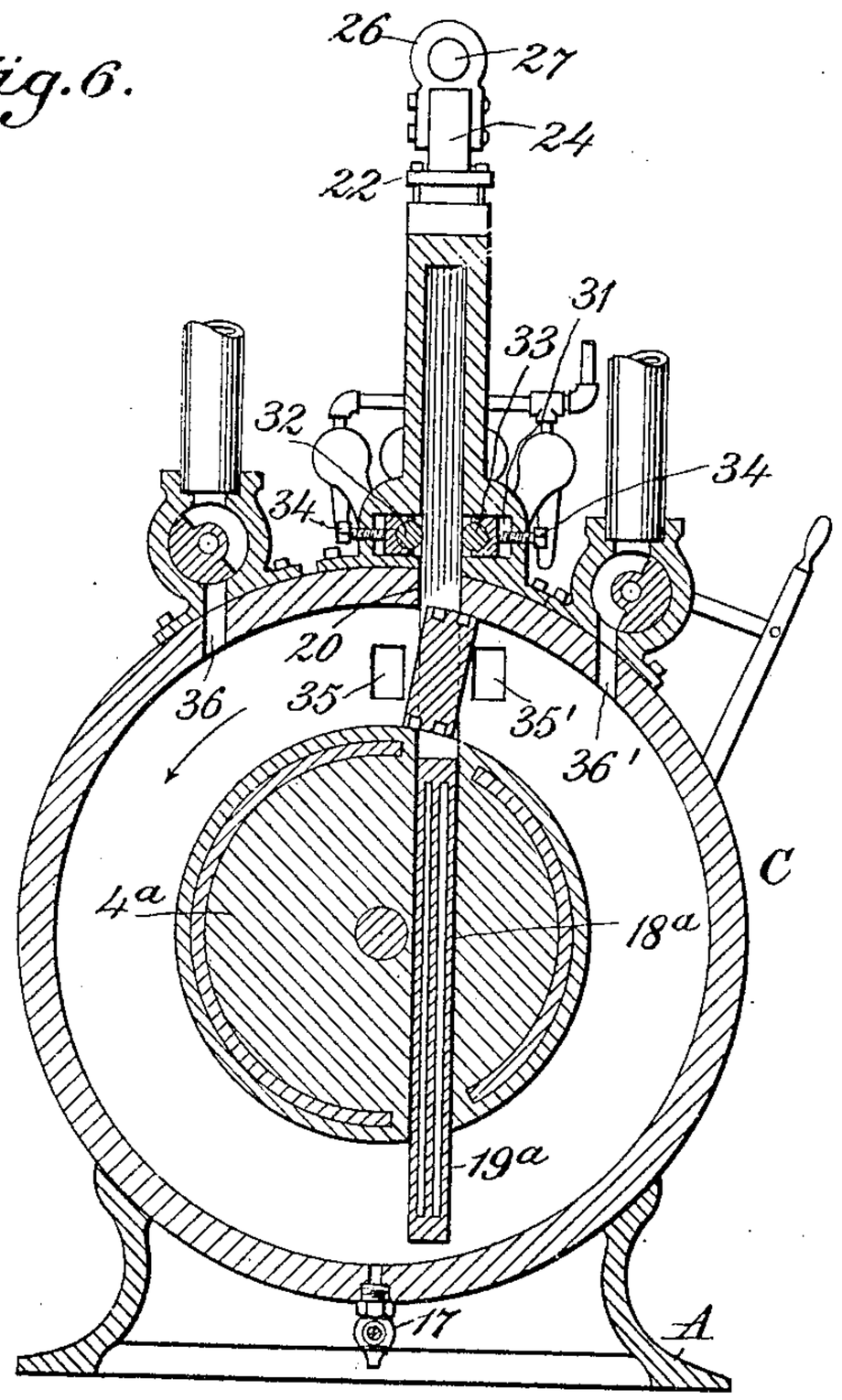
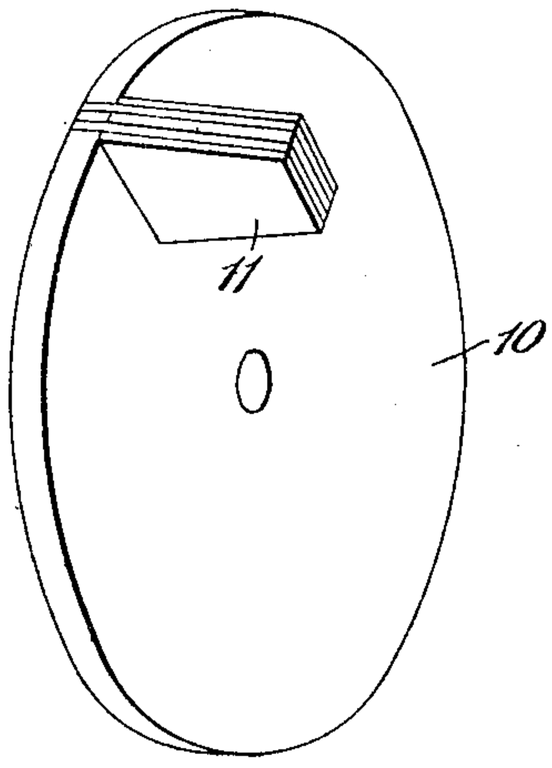


Fig. 7.



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UNITED STATES PATENT OFFICE.

CHARLES R. FRANCIS, OF WARSAW, MISSOURI.

ROTARY ENGINE.

No. 869,560. Specification of Letters Patent. Patented Oct. 29, 1907.

Application filed May 7, 1907. Serial No. 372,433.

To all whom it may concern:

Be it known that I, CHARLES R. FRANCIS, a citizen of the United States, residing at Warsaw, in the county of Benton and State of Missouri, have invented new and useful Improvements in Rotary Engines, of which the following is a specification.

This invention relates to that class of rotary engines which are driven by the expansion as well as by the direct impact of steam which is admitted into a chest or casing between a piston which is mounted upon a rotary member fixed upon the shaft that is to be driven and an abutment which is supported slidably in such a manner as to recede at the proper times for the passage of the piston.

The invention is applicable to engines of the single or multiple cylinder types of engines, its application to the multiple or two cylinder type being for the purpose of enabling the engine to be reversed, at will.

The objects of the invention are to simplify and improve the construction of the cylinder, the rotary piston carrying member, and the slidable abutment, and the arrangement and assemblage of these parts.

Further objects of the invention, which have special reference to the multiple type of engine, are to simplify and improve the valves, the reversing gear, and the means whereby the cut-off valve is automatically operated to control the admission of steam to the cylinder or steam chest from the source of supply.

Further objects of the invention are to simplify and improve the general construction and assemblage of parts of this class of engines.

With these and other ends in view which will readily appear as the nature of the invention is better understood, the same consists in the improved construction and novel arrangement and combination of parts which will be hereinafter fully described and particularly pointed out in the claims.

In the accompanying drawings has been illustrated a simple and preferred form of the invention; it being, however, understood that no limitation is necessarily made to the precise structural details therein exhibited, but that changes, alterations and modifications within the scope of the invention may be resorted to when desired.

In the drawing, Figure 1 is a perspective view illustrating a two cylinder engine constructed in accordance with the invention. Fig. 2 is a vertical sectional view taken on the plane indicated by the line 2—2 in Fig. 3. Fig. 3 is a vertical sectional view taken longitudinally of the main shaft on the plane indicated by the line 3—3 in Fig. 2. Fig. 4 is a perspective view enlarged, showing the valve casing and the valve gear. Fig. 5 is a vertical sectional view taken through the valve casing and the valves. Fig. 6 is a vertical transverse sectional view taken on the plane indicated by the line 6—6 in Fig. 3. Fig. 7 is a perspective detail view of the rotary piston carrying plate or member.

Corresponding parts in the several figures are denoted by like characters of reference.

Referring to Figs. 1 to 6 inclusive of the drawings (it being understood that Fig. 7 applied equally to the several forms of the invention), A designates a base upon which cylinders B and C are supported in axial alinement; each of said cylinders having a solid integral head 1 and a removable head 2, which latter is secured in the first named manner by stud bolts or lag screws 3; the removable heads being located, for convenience, at what may be designated as the outer ends of the cylinders. Each of the cylinders is provided with a centrally disposed boss, the bosses in the cylinders B and C being designated respectively 4 and 4^a, which is concentric with the walls of the cylinder and which in combination with the cylinder walls forms in each cylinder an annular space or passage which will be designated as the steam chest 5. The main shaft 6, which extends through the central bosses of the cylinders, is supported for rotation in suitably constructed boxes or bearings 7 that are connected with the cylinder heads and which may be of any well known construction that will permit slack caused by wear to be taken up at will; said boxes or bearings being provided with packing glands 8 wherever needed, with lubricators 9.

Fixedly mounted upon the shaft 6, adjacent to the removable cylinder heads 2 are the rotary piston carrying plates or members 10, each carrying a piston plate 11 which has been shown as being secured in position by means of stud bolts 12. These piston plates, which are disposed in diametrically opposite relation within the two cylinders, are preferably wedge shaped, as will clearly appear by reference to Figs. 3 and 7, the walls of the steam chest or space 5 being correspondingly inclined, as by this construction, a perfectly steam tight joint may be readily obtained; to further prevent leak of steam the pistons are provided with metallic packing strips 13 extending around the sides and inner ends of said pistons into contact or direct engagement with proximate walls of the steam chest by means of suitably arranged springs 14 which are disposed in grooves or recesses of the piston heads 10 into which the free ends of the packing strips extend. Spring actuated packing rings 15 and 16 are seated respectively in grooves in the detachable cylinder heads 2 and in the bosses 4 and 4^a, to engage the opposite sides of the rotary piston carrying plates for the purpose of preventing leakage of steam. Each of the cylinders is provided with a drain cup 17 through which water of condensation may be discharged.

The bosses 4 and 4^a of the cylinders B and C are provided respectively with a recess or pocket 18 and with a transverse slot 18^a, said pocket and slot being dis-

posed at one side of the aperture or bearing through which the shaft 6 extends for the accommodation of the slidable abutment plates 19 and 19ª, which extend through slots or apertures 20 in the walls of the cylinders, and through casings 21 having packing glands 22; the abutment plate 19ª being provided with an offset 23 to admit of the passage of the piston, and with a stem or shank 24. For the upper end of the abutment 19 a suitable guide 25 is provided. The upper extremities of the abutment 19 and of the stem 24 of the abutment 19ª are provided with clips or bearings 26 for a cross head 27, which latter is connected by a pitman 28 with a crank 29 upon the shaft 6, intermediate the cylinders B and C, the side members of said crank being provided with counterweights 30; by this construction, when the engine is in motion, a reciprocatory movement will be imparted to the abutments as will be readily understood. The casings 21 are provided with recesses 31 wherein are mounted boxes 32 carrying anti-friction rolls 33 that serve to steady the movement of the abutments so as to avoid vibration; said screws 34 being provided for the purpose of adjusting the boxes carrying the anti-friction rolls.

Each of the cylinders is provided in its back wall or inner head 1 with steam ports 35 and 35′ disposed adjacent to opposite sides of the abutment, and each cylinder is likewise provided with exhaust ports 36 and 36′ which are preferably formed in the walls of the cylinders at opposite sides of the abutments. Steam is supplied to the cylinders through a steam pipe 37 having a globe valve 38 and provided with branches B′ and C′ communicating respectively with the cylinders B and C. Each of said cylinders supports a valve casing D having a main bore or recess 40 wherein is seated a rotary valve 41. The casing D is provided with divergent branches 42—42′ and 43—43′ each provided with a bore or recess 44 wherein is seated an oscillatory or rocking valve, said valves being designated 45—45′ and 46—46′, respectively. Ducts or channels 47—47′ and 48—48′ connect the seats of the several valves 45—45′ and 46—46′ with the seat of the valve 41 at opposite sides of the axis of the latter. The seats or casings of the several valves 45—45′ and 46—46′ are connected by means of nipples or ducts 49 with the branches B′ and C′ of the main steam pipe; the valves contained in the casing D supported upon the cylinder B being connected with the steam pipe C′ as will be readily understood. Each of the casings D is also provided with a bore or recess 50 communicating through a port or duct 51 with a bore 40 in which the valve 41 is seated at a point intermediate the ducts 47—47′ and 48—48′ respectively, said bore 50 being in direct communication with the steam ports 35 and 35′ of the cylinder with which the casing D is connected; seated in the bore 50 of each casing D is a rocking or oscillatory valve 52 having a port or aperture 53, which, by proper adjustment of said valve, will serve to establish communication between the port 51 and either one of the steam ports 35 or 35′. The valve 52 will for convenience be designated the inlet valve; the valve 41 the cut-off valve and the valves 45—45′ and 46—46′ the throttle valves.

The stem 54 of the inlet valve and the stems 55 of the throttle valves project through the respective casings D and are provided respectively with cranks 56 and 57 which are connected by links 58 with a hand lever 59 whereby the several valves may be simultaneously oscillated and adjusted. The stem 60 of the cut-off valve 41 carries a sleeve 62 in which operates a sliding rod 63 which is pivotally connected with the pitman 28 which connects the crank of the main shaft with the slidable abutments, said cut-off valve being thus automatically rotated when the engine is in motion.

The valves 45 and 45′ are provided with arcuate ducts or passages 64 and 64′ which are so located with relation to the axes of said valves as to be capable of establishing communication between the live steam pipe and the ducts 47 and 47′ leading to the seat of the cut-off valve 41 at one side of the axis of the latter, either simultaneously or independently, according to the adjustment of said valves; in like manner the valves 46 and 46′ are provided with arcuate passages 65 and 65′ which by proper adjustment of said valves will connect the live steam pipe with the seat of the cut-off valve at the opposite side of the axis of the latter; under the construction shown in the drawings, however, only one of the valves 45—45′ or one of the valves 46—46′ is utilized at any one time, the other valve of each pair being reserved for auxiliary or alternate use. The rotary cut-off valve 41 has an arcuate duct or passage 66 extending around one half of its circumference. The inlet valve 52, which is operated by the hand lever 59 concurrently with the throttle valves may be rocked in its bearings so that the passage 53 in said valve will serve to connect the duct or port 51 with either one of the steam ports 35 or 35′. Under the construction plainly illustrated in Fig. 5 of the drawings the throttle valve 45 is open to the passage of steam while the throttles 45′, 46 and 46′ are closed, and the inlet valve 52 is in position to establish communication between the valve seat 40 and the steam port 35; when the throttles and the inlet valve are rocked or oscillated by the hand lever 59, the throttle 46 will be opened to the passage of steam while the throttles 45, 45′ and 46′ will be closed, and the position of the inlet valve will be reversed so that the latter will establish communication between the valve seat 40 and the steam port 35′, as will be readily understood. It will also be understood that as regards the two cylinders, the valve arrangement will be such that steam will be admitted into the two cylinders, simultaneously, through ports disposed at the same side of the axis of the main shaft.

The ports 36 and 36′ are connected with casings 67—67′ wherein are seated oscillatory or rocking valves 68—68′ having arcuate ducts 69—69′ adapted to establish communication between the ports 36—36′ and the exhaust pipes 69—69′, it being understood that when one of said valves is open to the passage of exhaust steam, the outer valve will be closed. The stems of the exhaust valves which project through the respective casings are provided with cranks 70 connected with each other by a link 71 which is connected by another link 72 with a hand lever 73 whereby the exhaust valves may be simultaneously rocked or oscillated in their seats for the purpose of reversing their positions. It is obvious that when an inlet port 35 or 35′ at one side of the abutment in either cylinder is open to the passage of steam the exhaust port on the opposite side of such abutment will be open to the passage of exhaust steam from the cylin-

der, while the exhaust port at the side of the abutment where the inlet port is open to the passage of live steam will be temporarily closed.

The operation of this invention and its advantages will be readily understood from the foregoing description taken in connection with the drawings hereto annexed by those skilled in the art to which it appertains.

Assuming the several valves to be in the position indicated in Fig. 5 of the drawings, live steam will pass by the throttle 45 to the valve seat 40, through the port or duct 51, through the port 53 in the inlet valve 52 and to the steam port 31, entering the steam chest or space 5, the operation of the rotary cut-off valve 41 being so timed as to admit steam through the port 35 directly when the piston operating in the steam chest connected therewith has passed the said port, the movement of the abutment 19 being likewise timed to obstruct the steam chest at precisely the same moment. The piston carrying head or plate 10 will thus be rotated by the direct impact of the steam until at a predetermined stage of its rotation, which is determined by the length of the arcuate duct in the cut-off valve 40, the steam supply is cut off, and the rotation of the piston carrying plate or head will be completed by the expansive power of the steam. When the rotating of the piston carrying plate has been almost completed, the exhaust port 36 will be passed, and the steam contained in the chest or space 5 will pass to exhaust. By the arrangement of the pistons at diametrically opposite sides of the shaft within the two cylinders, one of said pistons will at all times be exposed to the direct action of the steam, and the shaft upon which the piston carrying plates are mounted will thus continue without interruption. By operating the hand levers as herein described, the relative positions of the valves governing the admission of steam and the exhaust may be reversed at any time, thus reversing the direction of rotation.

Having thus fully described the invention, what I claim as new is:—

1. In a rotary engine, a cylinder having a concentric boss coöperating with the cylinder walls to form an annular steam chest, a detachable cylinder head, a piston carrying plate fixed upon the shaft for rotation therewith intermediate the boss and the detachable cylinder head, and spring actuated packing rings seated in grooves in the boss and in the detachable cylinder head in engagement with opposite sides of the piston carrying plate.

2. In a rotary engine, a cylinder having a concentric boss coöperating with the cylinder walls to form an annular steam chest, a detachable cylinder head, a concentric shaft supported for rotation in the cylinder, a piston carrying plate fixed upon the shaft for rotation therewith, a reciprocatory abutment operating transversely in the cylinder and the boss at one side of the shaft, a crank upon the shaft and a pitman connecting the crank with the abutment.

3. In a rotary engine, a cylinder having a concentric boss coöperating with the cylinder walls to form an annular steam chest, a shaft supported for rotation in the cylinder concentric therewith, a plate fixed upon the shaft for rotation therewith, a piston carried by said plate and operating in the annular steam chest, an abutment mounted for reciprocation at one side of the shaft, a crank upon the shaft, a pitman connecting the crank with the abutment, a movably supported valve controlling the admission of steam to the steam chest, a sleeve upon the stem of said valve, and a rod pivoted upon the pitman and disposed for slidable movement in the sleeve.

4. In a rotary engine, a cylinder having an annular steam chest, a shaft supported for rotation concentric with the cylinder, a plate fixed upon the shaft for rotation therewith, a piston upon said plate extending into the steam chest, an abutment supported for reciprocation through the steam chest, a crank upon the shaft, a pitman connecting the crank with the abutment, a movable valve having an axial supporting stem, and a slidable member connecting the valve stem with the pitman.

5. In a rotary engine, a pair of cylinders disposed in axial alinement and having annular steam chests, a shaft supported for rotation concentric with the cylinders, plates fixed upon the shaft for rotation therewith and having pistons extending into the steam chests, said pistons being disposed at diametrically opposite sides of the shaft, abutments supported for reciprocation through the steam chests to alternately obstruct adjacent portions of the steam chests in the two cylinders, a shaft connecting the abutments, a pitman connecting the cross-head with the crank, and means for controlling the admission of steam into the steam chests, and the exhaust steam from the steam chests of the two cylinders.

6. In a rotary engine, a pair of cylinders supported in axial alinement and having annular steam chests, detachable heads fixed upon the outer ends of the cylinders, an axial shaft supported for rotation in the cylinders and having a crank intermediate said cylinders, abutments mounted for reciprocation through the steam chests of the cylinders at one side of the shaft, said abutments being adapted to alternately obstruct adjacent portions of the steam chests in the two cylinders at diametrically opposite sides of the shaft, plates fixed upon the shaft for rotation therewith and having pistons extending into the steam chests of the cylinders, said pistons being disposed at diametrically opposite sides of the shaft, manually operable reversible throttles and inlet valves for controlling the admission of steam to the steam chests of the cylinders alternately at opposite sides of the abutments, movably supported cut-off valves having axial stems, sleeves upon said stems, means including a pitman for transmitting motion from the shaft to the abutments, and rods pivoted upon said pitman and slidably engaging the sleeves upon the stems of the movably supported cut-off valves.

In testimony whereof, I affix my signature in presence of two witnesses.

CHARLES R. FRANCIS.

Witnesses:
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E. M. WHITE.