A. A. BILYEU.

ROTARY STEAM ENGINE.

APPLICATION FILED OCT. 16, 1911.

1,039,353.

Patented Sept. 24, 1912.

3 SHEETS—SHEET 1.

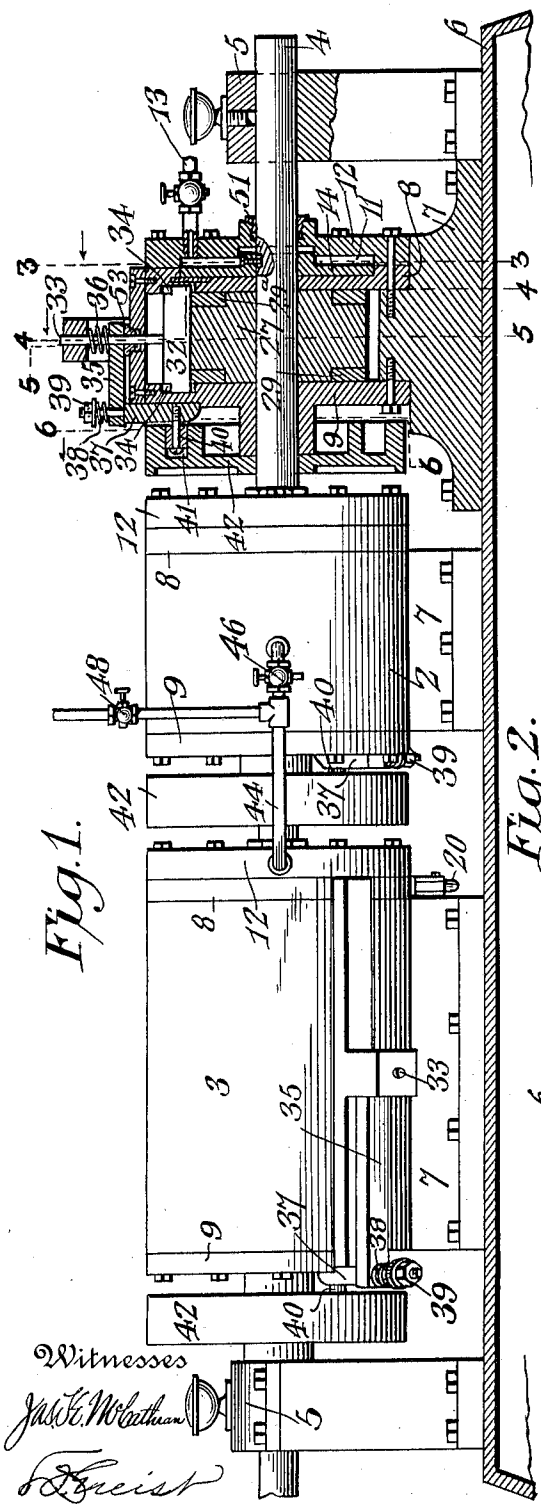

Fig. 1.

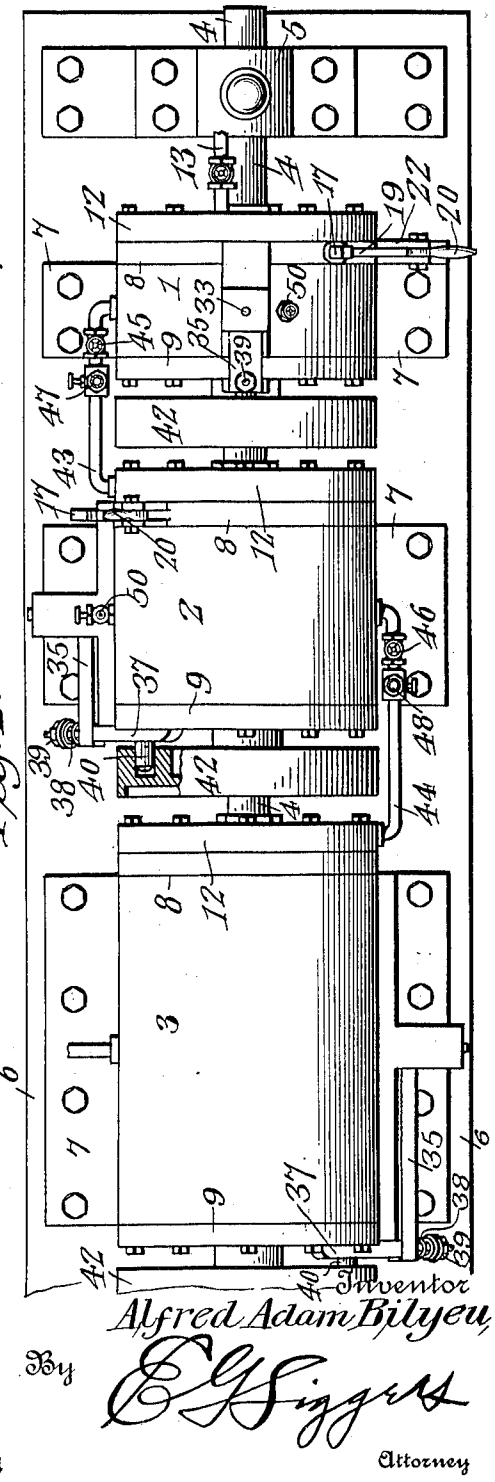

Fig. 2.

Witnesses

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Fig. 4.

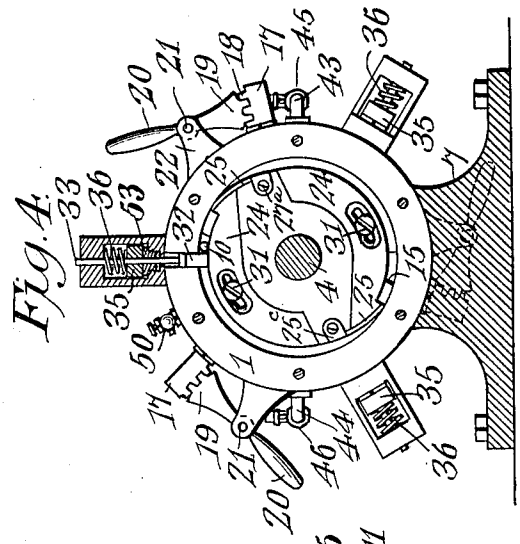


Fig. 6.

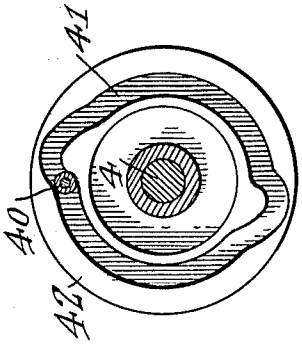


Fig. 7.

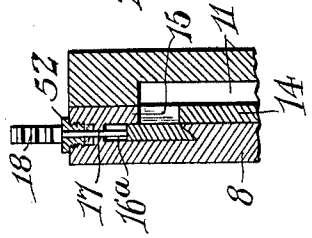


Fig. 8.

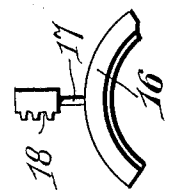


Fig. 3.

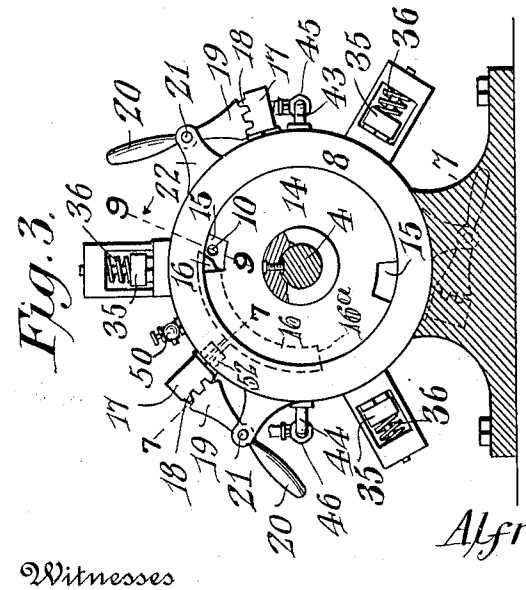
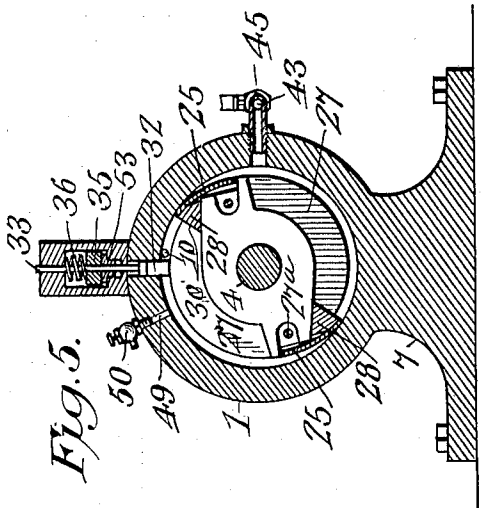


Fig. 5.



Witnesses

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3 SHEETS—SHEET 3.

Fig. 12.

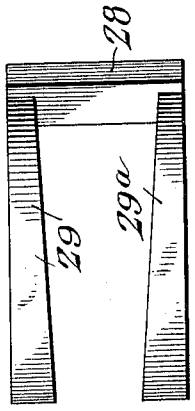


Fig. 13.

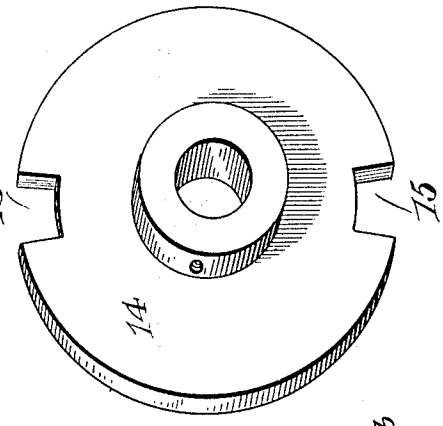


Fig. 14.

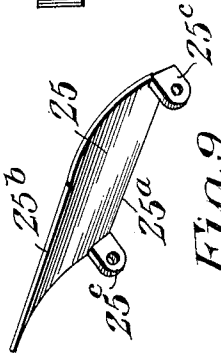


Fig. 9.

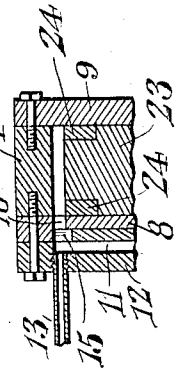


Fig. 15.

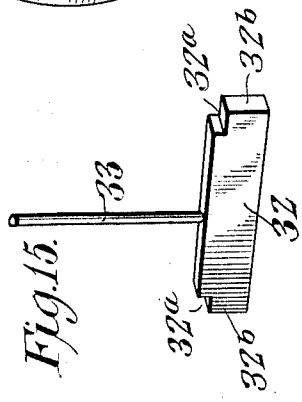


Fig. 10.

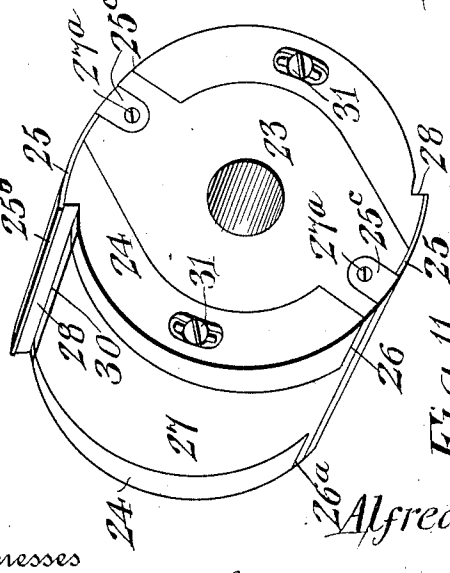
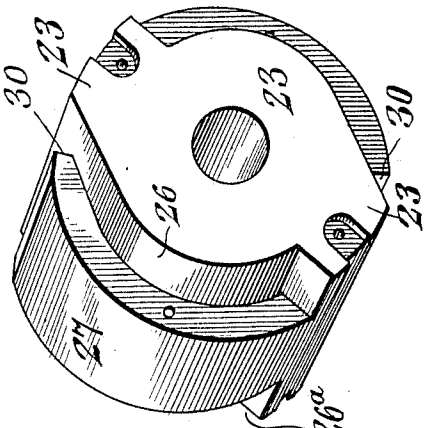


Fig. 11.



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UNITED STATES PATENT OFFICE.

ALFRED ADAM BILYEU, OF GRANBY, MISSOURI.

ROTARY STEAM-ENGINE.

1,039,353. Specification of Letters Patent. Patented Sept. 24, 1912.

Application filed October 16, 1911. Serial No. 654,928.

To all whom it may concern:

Be it known that I, ALFRED ADAM BILYEU, a citizen of the United States, residing at Granby, in the county of Newton and State of Missouri, have invented a new and useful Rotary Steam-Engine, of which the following is a specification.

This invention relates to rotary engines, and has for its primary object the provision of an engine having an improved form of piston characterized by its expansion under the pressure of motive fluid, so as to seal the space between said piston and the cylinder walls, whereby the fit may be made loose and undue friction avoided.

The invention also relates to the arrangement of an abutment for the pressure fluid, operated wholly by mechanical means, whereby exactitude is obtained and wear on the internal working parts of the engine materially reduced.

The invention also includes the novel arrangement of the starting valve, whereby the engine is more readily set in motion from any position of rest. Furthermore, the invention contemplates the coupling in tandem of a plurality of such units of diverse working pressure to constitute a multiple expansion compound rotary engine.

The construction of a preferred and advantageous form of embodiment of the invention is set out in detail in the following description, which is to be considered in connection with the accompanying illustrative drawings:—

In these drawings:—Figure 1 is a side elevation of a compound rotary engine, with the primary cylinder shown in vertical section. Fig. 2 is a top plan with a portion broken away to show the operative mechanism for the motive fluid abutment. Fig. 3 is a section on the line 3—3 of Fig. 1, showing the relation of the inlet valve and ports. Fig. 4 is a similar section on the line 4—4 of Fig. 1, showing the piston in elevation. Fig. 5 is a section on the line 5—5 of Fig. 1, showing the abutment in its relation to the piston head. Fig. 6 is a section on the line 6—6 of Fig. 1, showing the cam groove for the operation of the abutments. Fig. 7 is a fragmentary section on the line 7—7 of Fig 3, showing the starting valve in cross-section. Fig. 8 is a detail side elevation of the starting valve. Fig. 9 is a fragmentary section on the line 9—9 of Fig. 3 through the inlet port and starting channel. Fig. 10 is a perspective view of the piston complete. Fig. 11 shows in perspective the piston without the piston head. Fig. 12 is a similar view of the piston head. Fig. 13 is a perspective detail of the inlet valve; and Figs. 14 and 15 are detail perspective views of the packing plate and of the abutment, respectively.

The engine is illustrated as composed of three units, the primary high pressure unit 1, a secondary intermediate pressure unit 2, and a tertiary low pressure unit 3. The interior construction of each is similar, differing only in length and corresponding capacity of the cylinder, wherefore a detailed description of the interior working parts of one unit will suffice for all.

The units are mounted in tandem upon a common shaft 4, journaled in standards 5 supported by the bed plate 6, upon this shaft will be mounted the usual fly wheel and belt pulley (not shown). The casings forming the several cylinders are supported by pedestals 7, likewise carried by the bed plate 6.

The primary or high pressure cylinder 1 has a peripheral wall and also two side walls 8 and 9. The wall 8 contains the steam inlet port 10, leading from the valve chamber 11 formed between the wall 8 and an outer plate 12. The inner opposing faces of the wall 8 and the plate 12 are recessed, the latter more deeply around its outer border to form a slightly coned face, the deeper annular portion serving as a steam chest, which receives the motive fluid from the boiler, or other source through the pipe 13.

Within the recessed portion of the wall 8 is arranged a rotary slide valve 14, having marginal notches 15 which traverse and thereby control the steam inlet port 10, the valve 14 being fixed to the shaft 4 and rotating therewith to admit pressure fluid to the cylinder twice during each rotation as the notches 15 come into register with the port 10.

To provide for starting the engine in case the same is at rest, with neither one of the notches 15 in register with the inlet port, the recessed face of the wall 8 is provided with a groove extending from the port 10 through an arc of about 120 degrees, which groove will be traversed by the

notches 15 of the valve 14, placing the inlet port in communication with the steam chest, even though the notches 15 and the port 10 are not in register. This groove or channel is normally closed by a segmental valve 16, mounted for radial movement in a slot 16ª formed in the wall 8, and provided with a stem 17 projecting outwardly beyond the wall and formed as a rack having teeth 18 in engagement with the teeth of a segmental rack 19, carried by an operating lever or handle 20, fulcrumed at 21 upon a projection 22 of the casing.

In the example shown, there being three cylinders operating together, the starting valves of the three cylinders are displaced at an angle of substantially 120 degrees, so that by means of its levers that one of the cylinders whose feed valve 14 is in such position as to be brought into communication with the inlet port through the starting channel 16, can be utilized to start the engine as a whole by the actuation of its valve 16 to open such emergency starting channel. The engine being in operation, all the starting valves are closed and the inlet port is supplied with motive fluid only when the notch of its valve is in register therewith.

The piston is composed of three parts, the body portion 23, the piston head 24 and the packing plate 25. The body portion or core 23 is keyed to the shaft 4 and is provided with two diametrically opposed heads for the giving of two impulses during each rotation. The piston is made to fit more loosely within the cylinder than is usual with rotary engines, whereby to avoid in large measure the excessive friction, which has often been found to be an objection pertaining to this type of engine, and depending for the prevention of leakage of the pressure fluid upon the peculiar features of construction, which will now be explained.

The piston appearing in my invention is arranged to expand both radially and laterally under the pressure of the motive fluid, so as to effectually seal the interspace between it and the cylinder walls. The opposite sides of the piston body are cut away at 26 and 26ª, leaving between said cut-away portions a wedge-shaped portion 27 widening gradually in the direction of rotation. The piston head is a yoke-shaped member having a shoulder 28 and two arms 29 and 29ª, the arms having parallel outer edges and their inner edges inclined in such manner that the said arms complement the wedge-shaped portion 27 to form the outer face of the cylindrical piston, the shoulder 28 bearing against the forward end 30 of the wedge. The piston head is held in place by a bolt 31, passing through the two arms and the wedge. The hole formed in one of the parts, preferably the arms, being elongated so as to allow a slight movement of the arms along the wedge, the heads of the bolt being counter-sunk in the arms and limiting the extent of the expansion of the arms under the action of the wedge.

The packing plate 25 is formed as a stirrup and hinged by its downwardly turned ears 25ᶜ to the piston body by bolts 27ª. The forward edge 25ª rests within a recess formed in the face of the piston while its rear edge 25ᵇ overlies the forward edge of the shoulder 28, which is beveled to correspond to the curvature of the packing plate 25. It will thus be seen that as the motive fluid is introduced to the cylinder and presses against the shoulder 28, the piston head will move slightly forward and its arms 29 and 29ª will be forced outwardly by the wedge 27, increasing the effective width of the piston at this point and sealing the lateral space between it and the side walls of the cylinder. Also this slight forward movement of the piston head will tilt the packing plate 25 upon its hinge 27ª pressing the edge 25ᵇ against the inner peripheral wall of the cylinder effectually sealing the space at this point.

Adjacent to the inlet port is arranged the usual abutment 32, notched at 32ª and guided by its stem 33 for reciprocating radial movement in the wall of the cylinder. The abutment 32 is preferably made slightly longer than the interior width of the cylinder, so that its extremities 32ᵇ move in slots 34 formed in the inner faces of the side walls 8 and 9, as shown in Fig. 1. The stem 33 is secured to an arm 35 and is pressed downwardly by a spring 36. The other end of this arm 35 is adjustably secured to a second arm 37 by means of a spring 38 and an adjusting nut 39. The arm 37 carries a roller 40, which travels in a cam groove 41, formed in the face of a rotary plate 42 secured to the shaft 4 and rotating therewith. The action of this cam by means of these connections with the abutment is to raise the abutment at each revolution so as to clear the head and packing plate of the piston, while by means of the spring 36 it is held firmly in contact with the face of the piston during the effective action of the steam, or other motive fluid.

The spent pressure fluid is exhausted from the cylinder at the usual place, either directly or, where running as a compound engine, into the steam chest of the secondary cylinder through the pipe 43, which in turn will exhaust either directly or into the steam chest of the tertiary cylinder through the pipe 44, two-way cocks 45 and 46 being provided in the connection between the cylinders, permitting of this optional operation. Provision is also made for the leading of live steam direct from the boiler to either of the units in the series under control of the valves 47 and 48, which provision is espe-

cially advantageous when it is desired to operate any one or more cylinders to the exclusion of the others, or when the supply of exhaust steam is desired to be supplemented by additional fresh steam.

In order to vent any steam which by any chance might leak past the abutment and cause counter pressure, an opening 49 is provided back of the abutment and controlled by the waste cock 50.

By the improved constructional features of the piston parts to seal the interspaces, and the location and form of the feed and starting valves, and the reciprocatory mounting of the abutment within the cylinder heads, the possibility of leakage is greatly reduced and the necessity of packing minimized. However, as a precautionary measure, packing glands will be advantageously provided for the shaft on the steam chest side of the cylinder at 51, for the starting valve stem at 52 and for the stem of the abutment at 53, while other packing boxes may be inserted wherever found to be desirable under conditions of use.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. In a rotary engine, a cylinder having peripheral and side walls, a piston mounted to rotate loosely therein and arranged to expand laterally under pressure of motive fluid to seal the interspace between the piston and the cylinder walls.

2. In a rotary engine, a cylinder having peripheral and side walls, a piston mounted to rotate loosely therein and comprising a body portion, and a piston head, the head arranged to expand laterally under pressure of motive fluid to seal the interspace between the head and the cylinder walls.

3. In a rotary engine, a cylinder having peripheral and side walls, a piston mounted to rotate loosely therein and comprising a body portion, and an expansible piston head, the piston head mounted to allow for limited forward movement relative to the piston body under the action of the pressure fluid, and a wedge connection between the head and piston body, whereby such forward movement under the action of pressure fluid will cause the head to expand to seal the interspace between the said head and the cylinder walls.

4. In a rotary engine, a cylinder having peripheral and side walls, a piston mounted to rotate therein and comprising a body portion and an expansible piston head, the head and body having wedge-shaped complementary parts coöperating to expand the head as it is acted upon by the pressure fluid.

5. In a rotary engine, a cylinder having peripheral and side walls, a piston mounted to rotate therein and comprising a body portion and a piston head, one of the members being cut-away to form a wedge and the other formed with a wedge-shaped opening to receive the wedge, whereby the action of pressure fluid upon the piston head will cause the wedge surfaces of the parts to co-act to expand the piston head and seal the interspace between the piston and the cylinder walls.

6. In a rotary engine, a cylinder having peripheral and side walls, a piston mounted to rotate therein and comprising a body portion and a piston head, the body portion having its face cut away to leave a wedge enlarging in the direction of rotation and the piston head formed as a yoke with arms lying on each side of and embracing the wedge, whereby the pressure of motive fluid on the head will cause the arms to ride up the wedge and expand laterally to seal the interspace between the piston and cylinder walls.

7. In a rotary engine, a cylinder having peripheral and side walls, a piston mounted to rotate loosely therein and comprising a body portion and an expansible piston head, the piston head mounted to allow for limited forward movement relative to the piston body under the action of the pressure fluid, a wedge connection between the head and piston body, whereby such forward movement under the action of pressure fluid will cause the head to expand to seal the interspace between the said head and the cylinder walls, and a packing plate mounted on the piston and overlying the piston head and arranged to be forced by the head under pressure of motive fluid outwardly against the inner periphery of the cylinder to seal the interspace.

8. In a rotary engine, a cylinder having peripheral and side walls, a piston mounted to rotate loosely therein and comprising a body portion and an expansible piston head, the piston head mounted to allow for limited forward movement relative to the piston body under the action of the pressure fluid, a wedge connection between the head and piston body, whereby such forward movement under the action of pressure fluid will cause the head to expand to seal the interspace between the said head and the cylinder walls, and a packing plate mounted on the piston and overlying the piston head in wedged relation thereto and arranged to be forced by the forward movement of the head under pressure of motive fluid outwardly against the inner periphery of the cylinder to seal the peripheral interspace.

9. In a rotary engine, a cylinder having peripheral and side walls, a piston mounted to rotate therein and comprising a body portion and a piston head, the piston head mounted to allow for limited forward move-

ment relative to the piston under action of pressure fluid, a packing plate hinged to the piston and overlying the piston head in wedged relation thereto so as to be forced by the forward motion of the head outwardly against the inner periphery of the cylinder.

10. In a rotary engine, a cylinder having peripheral and side walls, a piston mounted to rotate therein and comprising a body portion and a piston head, the piston head mounted to allow for limited forward movement relative to the piston under action of pressure fluid, a packing plate formed as a stirrup with the ears hinged to the piston, the forward edge of the plate embedded therein and the rear edge overlying the piston head and arranged to be forced by the forward movement of the head outwardly against the inner periphery of the cylinder.

11. In a rotary engine, a cylinder having peripheral and side walls, a piston mounted to rotate loosely therein and comprising a body portion and an expansible piston head, the piston head mounted to allow for limited forward movement relative to the piston body under the action of pressure fluid, a wedge connection between the head and piston body, whereby such forward movement under the action of pressure fluid will cause the head to expand to seal the interspace between the said head and the cylinder walls, and a packing plate formed as a stirrup with the ears hinged to the piston, the forward edge of the plate embedded therein and the rear edge overlying the piston head and arranged to be forced by the forward movement of the head outwardly against the inner periphery of the cylinder to seal the peripheral interspace.

12. In a rotary engine, the combination with a fluid inlet port, and a valve controlling the same, of an emergency channel for the pressure fluid leading to the said port from a point controlled by the said valve but at a distance from said port, and means to open and close said emergency channel.

13. In a rotary engine, the combination with a fluid inlet port, and a feed valve controlling the same, of a normally closed emergency channel for the pressure fluid leading to the said port from a point controlled by the valve but at a distance from said port, and means to establish communication through said channel at will.

14. In a rotary engine, a cylinder, a valve chamber having a port leading to said cylinder, a rotary feed valve in the chamber controlling said port, a wall of the chamber having formed therein an emergency channel extending as an arc to the port from a distance and traversed by the valve, and a correspondingly shaped starting valve fitting within the channel, and means to operate said valve.

15. In a rotary engine, a cylinder, a circular valve chamber having a port leading to the cylinder, a rotary feed valve in the chamber and controlling said port, the wall of the chamber having formed therein an emergency channel extending as an arc to the port from a distance and traversed by the valve, and a correspondingly shaped starting valve fitting within the channel, a stem connected with the valve and formed as a rack, and a handle operatively connected to the stem, the handle being formed as a lever carrying a segmental rack meshing with the teeth of the stem.

16. In a rotary engine, a cylinder, a circular valve chamber having an inlet port to the cylinder, a rotary feed valve in the chamber and provided with two ports adapted to register with the inlet port, the wall of the chamber having formed therein an emergency channel extending as an arc to the inlet port from a distance and traversed by the ports of the slide valve, a starting valve fitting within the emergency channel and guided for radial movement into and out of said channel, the stem of said valve formed as a rack, and an operating lever formed as a segmental rack meshing with the teeth of the stem.

17. In a rotary engine, a cylinder, a rotary piston therein, an abutment guided for reciprocating radial movement, yielding means to force the abutment inwardly against the piston, an arm projecting from the abutment, a cam rotating with the piston, and an adjustable connection between the cam and the arm whereby to operate the abutment.

18. In a rotary engine, a cylinder, a rotary piston therein, an abutment guided for radial reciprocating movement, a spring bearing on the abutment to force it inwardly upon the piston, an arm projecting from the abutment, a cam rotating with the piston, and an adjustable connection between the cam and the arm, whereby to operate the abutment.

19. In a rotary engine, a cylinder, a rotary piston therein, an abutment guided for radial reciprocating movement, a spring bearing upon the abutment to force it inwardly upon the piston, an arm projecting from the abutment, a grooved cam rotating with the piston, a roller traversing said groove, and an adjustable connection between the roller and the arm, whereby to operate the abutment.

20. In a rotary engine, a cylinder, a rotary piston therein, an abutment guided for radial reciprocating movement, a spring bearing on the abutment to force it inward upon the piston, an arm projecting from the

abutment, a grooved cam rotating with the piston, a roller traversing the cam groove, an arm carrying the roller and passing through the first arm, a spring connecting the two arms, and an adjusting nut bearing upon the spring.

21. In a rotary engine, a plurality of high and low pressure units coupled in compound tandem relation, valve chambers for each of the cylinders, each chamber having an inlet port leading to its cylinder, a rotary valve in the chamber controlling said port, the wall of the chamber having formed therein a normally closed emergency channel extending to the port from a distance and traversed bv the valve, and a starting valve to establish communication through said emergency channel at will, the starting valves of the respective units being displaced relative to each other.

22. In a rotary engine, a plurality of high and low pressure units coupled in compound tandem relation, each unit comprising a cylinder, a rotary piston therein, an inlet valve, a starting valve, and an abutment, the valves and abutments of the several units being angularly displaced to facilitate the starting and operation of the engine.

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

ALFRED ADAM BILYEU.

Witnesses:
JOHN H. SIGGERS,
EDITH L. BROWN.