J. W. TYGARD.

BALANCED REVERSING ROTARY ENGINE.

APPLICATION FILED JAN. 11, 1915.

1,272,876.

Patented July 16, 1918.

4 SHEETS—SHEET 1.

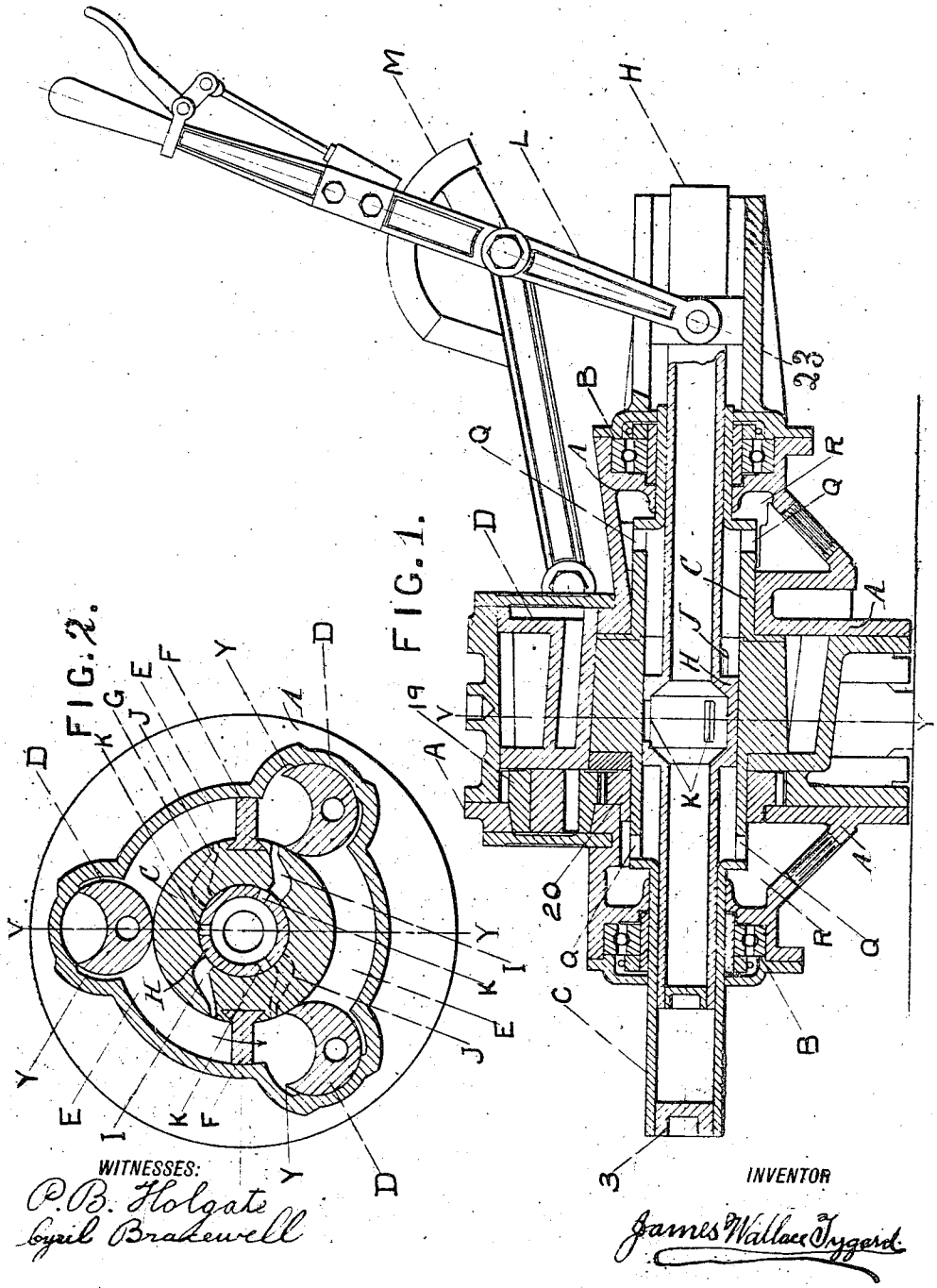


FIG. 1.

FIG. 2.

WITNESSES:

P. B. Holgate

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INVENTOR

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4 SHEETS—SHEET 2.

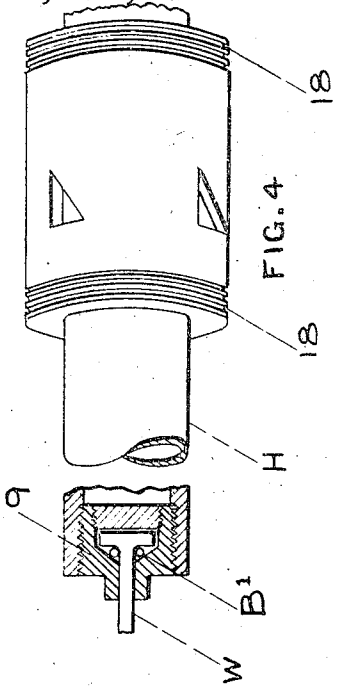


FIG. 4

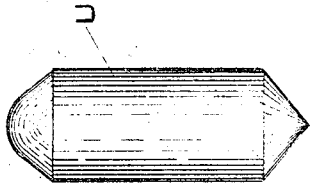


Fig. 6.

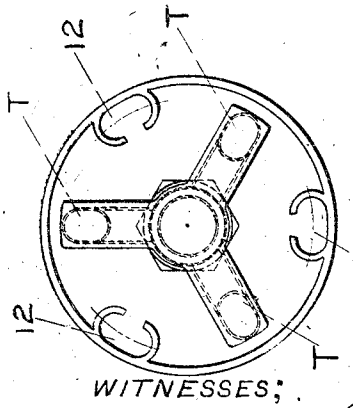


FIG. 5

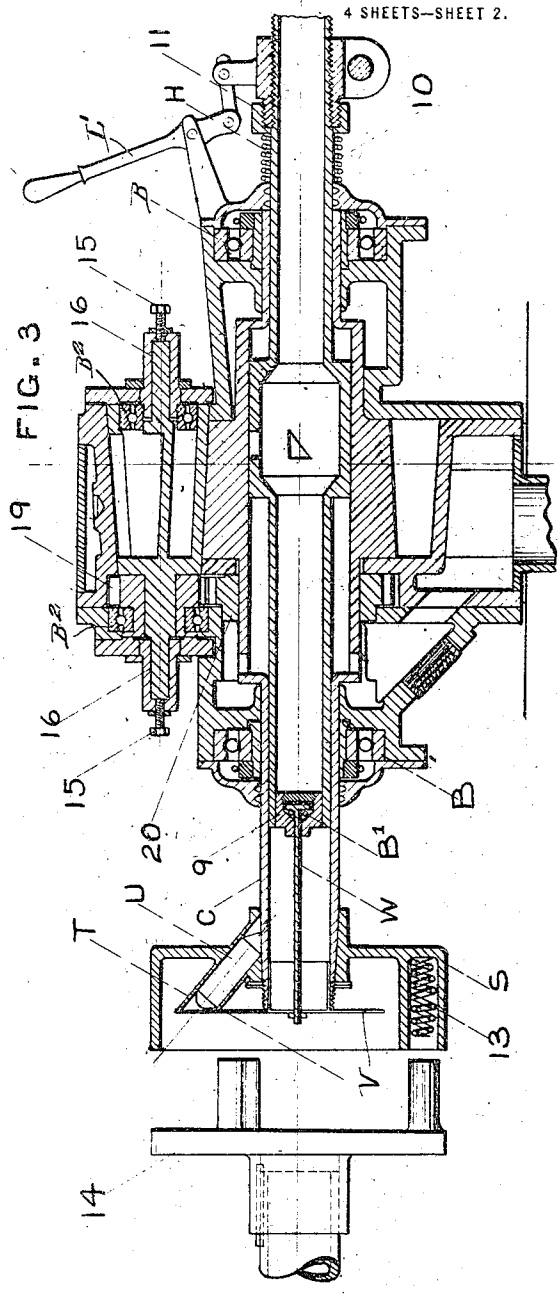


FIG. 3

WITNESSES;

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BALANCED REVERSING ROTARY ENGINE.

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4 SHEETS—SHEET 3.

FIG. 11

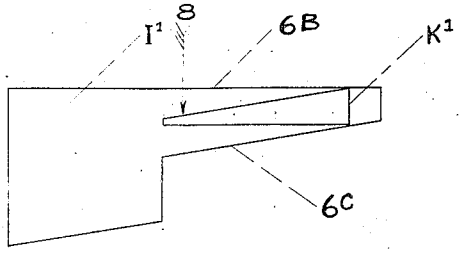


FIG. 9

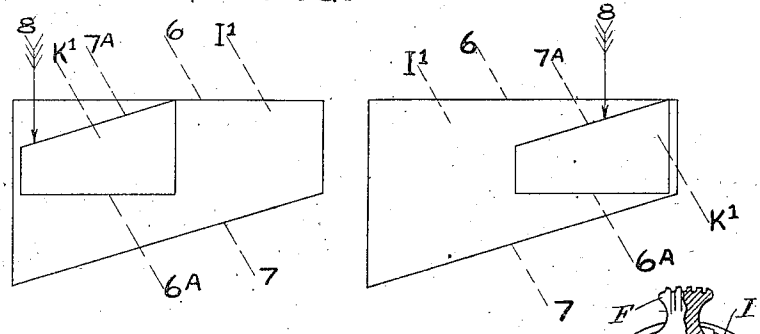


FIG. 6.

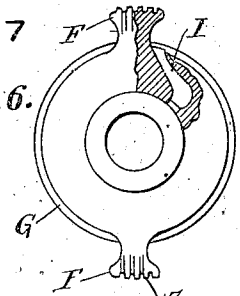


FIG. 10

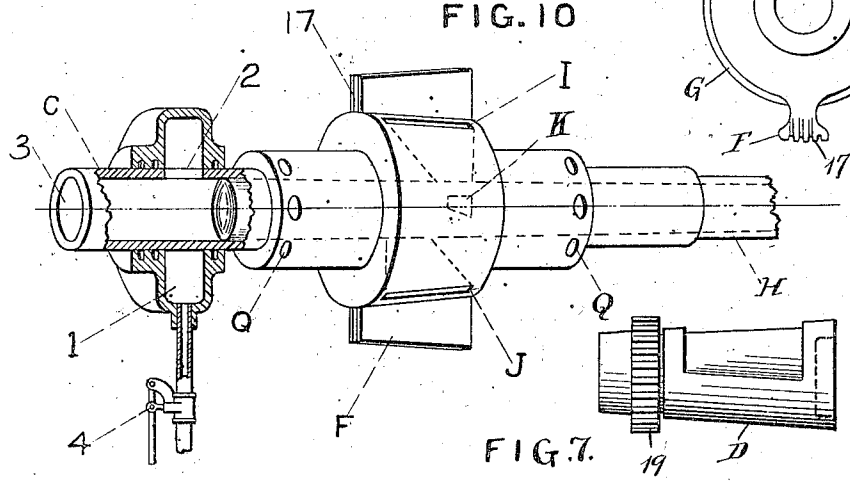


FIG. 7.

WITNESSES:

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BALANCED REVERSING ROTARY ENGINE.

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1,272,876.

Patented July 16, 1918.

4 SHEETS—SHEET 4.

Fig. 12.

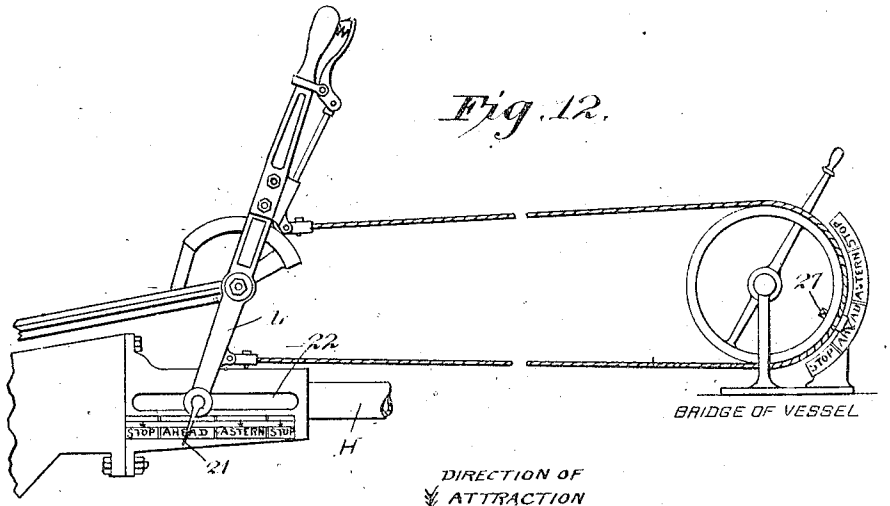
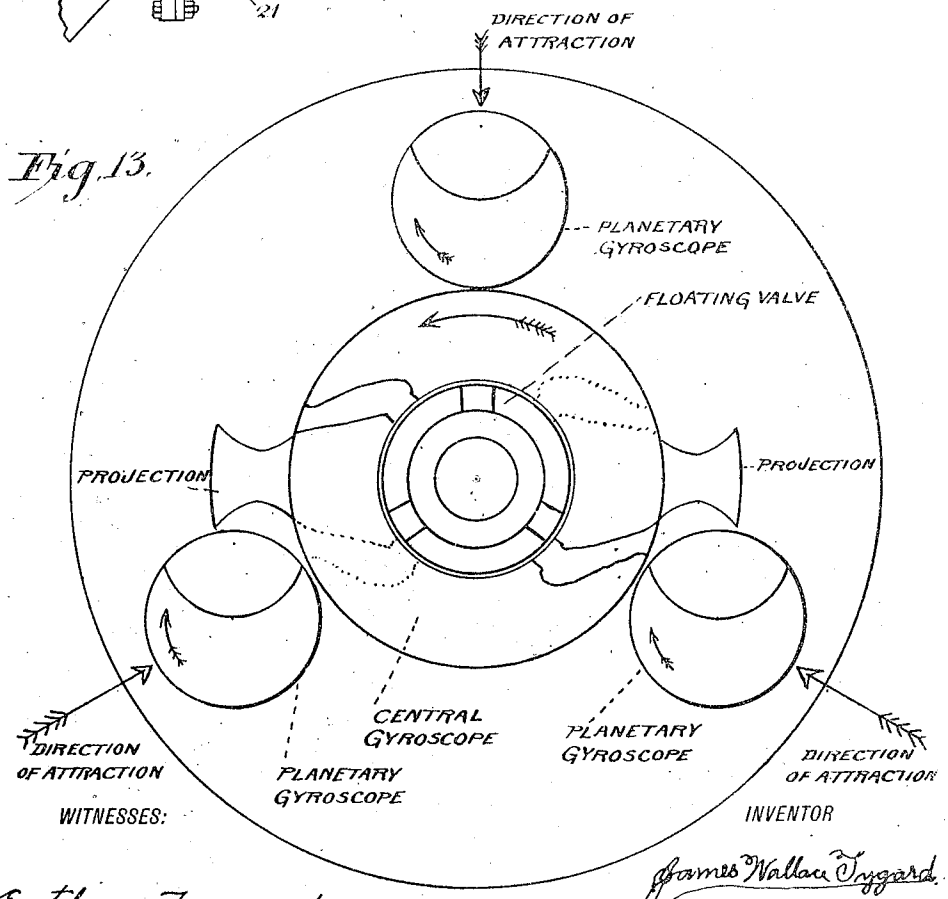


Fig. 13.



WITNESSES:

Esther Tygard.

Blanche Tygard.

INVENTOR

James Wallace Tygard.

UNITED STATES PATENT OFFICE.

JAMES WALLACE TYGARD, OF PLAINFIELD, NEW JERSEY.

BALANCED REVERSING ROTARY ENGINE.

1,272,876. Specification of Letters Patent. Patented July 16, 1918.

Application filed January 11, 1915. Serial No. 1,687.

To all whom it may concern:

Be it known that I, JAMES WALLACE TYGARD, a citizen of the United States, residing at Plainfield, in the county of Union and State of New Jersey, at the post-office address of 920 South avenue, in said city, have invented a new and useful Balanced Reversing Rotary Engine, of which the following is a specification.

My invention more particularly relates to the type of rotary engine described in United States Letters Patent No. 619,004, issued to J. W and P. L. Tygard for rotary internal combustion engine on February 7th, 1899, also No. 1,047,340 issued to James Wallace Tygard for rotary pump or motor on December 17th, 1912, and No. 1,060,039 issued to James Wallace Tygard for internal progressive combustion rotary motor on April 29th, 1913; and to provide a new and improved construction whereby said type of rotary engine may be adapted to other fields of use than described in these Letters Patent.

The objects of this invention are as follows:

To reduce the weight of an engine structure by increasing number of power impulses during each revolution.

To simplify the engine structure by reducing number of moving parts.

To provide means whereby vibration is entirely eliminated and a gyroscope effect attained in all the rotating parts of an engine structure.

To provide means whereby an instantaneous reverse may be secured without shock or jar irrespective of the speed at which engine is running, and at a point any distance from the engine structure, as from the bridge of a vessel.

To produce a variable cut-off valve mechanism which in combination with a governing device shall control the amount of steam or air entering the expansion spaces of the engine so as to maintain a uniform rate of rotation under varying conditions of load with the greatest economy of propulsive medium.

To reduce the condensation losses in a steam engine in two ways; by increasing the speed at which the propelling medium is passed through the engine, and by reducing the area of surface to which the heated propelling medium is exposed.

To render wrecking of engine by water impossible by providing an unobstructed passage from the exhausting side of the pistons to the atmosphere or condenser.

To render packing unnecessary by providing taper adjustments whereby clearances in the steam chambers can be reduced to a minimum without the revolving surfaces coming into rubbing contact.

To eliminate necessity of lubrication in the steam chambers of the engine by such arrangement of revolving parts that only the journals require lubrication.

To produce a shock absorbing device whereby when the engine and its load is suddenly reversed by shifting the steam from the forward to the reverse side of the pistons its inertia is absorbed and cushioned on the elastic pressure of the steam in the boiler.

To produce a most durable type of engine structure by providing that all wear shall come upon the journals of the four moving parts contained in the engine.

To provide an engine structure whereby steam at its most economical degree of superheat may be utilized in the expansion spaces of the engine due to the absence of rubbing parts.

To produce an engine for marine use which while capable of running at turbine speed can be suddenly reversed without damage.

To so arrange the parts of a rotary engine that the steam in the clearance spaces can be utilized to the fullest degree.

To vary the point of cutting-off the steam entering the engine spaces without producing the so-called "wire-drawing" effect by such arrangement of valve as will allow the rotation of the engine shaft ports across a stationary port to actuate the cut-off direct without the intervention of cams or dash pots and in such manner that movement of the fixed port will vary the point at which the cut-off of steam occurs.

To cushion the impulse vibration or shock effect upon the engine parts by interposing a film of steam of predetermined and regulatable thickness between the movable and stationary surfaces of the steam chambers.

To balance the steam inlet valve of a rotary engine in such manner that it shall be supported and float upon a thin film of steam or fluid under pressure of adjustable thick-

ness and can be moved with the same ease in either direction.

To provide an instantaneous emergency stop that may be operated at points distant from engine.

To utilize the gyroscopic effect combined with the three point support in a rotary engine in such manner as to effect a floating balance of the rotating gyroscopes and preserve an equalized contact of the three outer revolving gyroscopes with the central gyroscope.

To provide an engine of such flexibility and ease of control that for purposes of quick maneuvering all the operations of starting, stopping, and reversing may be effected from points as distant from the engine as the bridge of a vessel or the lookout upon the mast and with no more effort than is required under the present system to signal that the same may be done manually by an assistant.

To so balance the gyroscopes of a rotary engine that a floating, practically frictionless, vibrationless, revolving group of power transmitting members is produced.

To attain in a rotary engine a port and piston giving practically a turbine nozzle curve to the expanding jet of steam as it issues from the supply valve into the expansion chamber whereby both the impact or kinetic force, and the static or expansive force of the steam may be used at the same time uniting the advantages of both turbine and expansive systems of steam utilization.

Accompanying this specification are seven sheets of drawings which form part of this application.

Referring to said drawings in detail—

Figure 1.— is a central section elevation of my balanced rotary engine on line *V—Y* of Fig. 2.

Fig. 2.— is a cross section taken on line *V—Y* of Fig. 1.

Fig. 3.—is a side elevation section of my balanced rotary engine in combination with governor, manually operated variable cut-off, and angular ported steam valve.

Fig. 4.— is a side view of the steam valve removed.

Fig. 5.— is a view of the governor and coupling.

Fig. 6.— is a view of the piston partly in section to show the port.

Fig. 7.— shows the revolving cylinder head removed.

Fig. 8.— is an elevation of one of the weights of the governor.

Fig. 9.— is a plan view of the ports to secure veriable cut-off.

Fig. 10.— is a view of the emergency stop and reverse to be operated at a distance from engine.

Fig. 11.— is a plan view of a modification of port design to secure later cut-off.

Fig. 12.— is a plan view showing method of operating the reverse of my engine from the bridge of a battleship.

Fig. 13.— is a diagrammatic plan view illustrating the mutual attraction of gyroscopes revolving in proximity to each other and a central revolving mass.

Referring to the drawings illustrating the means and methods whereby I accomplish these the above recited objects of my invention; Figs. 1 and 2 show my balanced reversing rotary engine in which a fixed member (A) carries bearings (B) for a central piston shaft (C) and revolving abutments or cylinder heads (D) preferably three in number located at 120 degrees apart arranged in such manner as to divide the annular groove or channel (E) forming the steam chamber or piston pathway into separate compartments or expansion spaces.

The main shaft C has pistons (F) preferably two in number which fit in and work in said annular groove and with the piston disk (G) with which they are connected to the shaft (C) form the central wall of the annular steam chamber.

The revolving cylinder heads are suitably geared by pinions 19 and gear 20 to be driven by the shaft and are recessed so that as they rotate they permit each piston to pass, but separate said compartments at all other times.

Behind each piston is an opening or port (I) and in front of each piston is a similar port (J) leading through the piston disk toward the shaft center which is bored to receive a suitable supply valve (H) with three ports (K) adapted to co-act with one of the two ports leading from each piston to the central shaft bore. The inner ends of these ports I and J are offset from each other longitudinally of the shaft. The steam inlet valve (H) does not completely fill the shaft bore endwise. Side openings (Q) into this shaft bore communicating with suitable annular spaces (R) around the main shaft form a free and uninterrupted passage from the front of each piston to the atmosphere through the piston port J which is not in register with the stationary supply steam port K in the valve:

Thus the rotation of the engine causes one set of the shaft ports I leading to the rear of each piston to travel across the fixed supply port K and admit steam or other pressure successively into each of the steam chambers, or expansion spaces into which the annular chamber or piston pathway is divided by the rotary cylinder heads D, during a portion of the stroke or circular travel of each piston F.

As this steam admission begins to occur in each expansion chamber as soon as the piston has entered the chamber and the revolving cylinder head has closed the path-

way behind it, its duration is determined by the size of the port and cut-off at any part of the stroke may be attained and positive expansion in a closed chamber secured.

The operations of admission, cut-off, expansion and exhaust occurring continuously, successively, and in regular progressive sequence between the traveling pistons and the revolving abutments or cylinder heads are exactly similar to those occurring in a reciprocating slide valve engine, except in their number. As both pistons are operated upon simultaneously power is being delivered at all times; thereby obtaining several objects of my invention.

The exhaust or waste steam of each expansion is continuously forced from the front of each advancing piston through the port J in the piston disk to the annular space (R) surrounding the steam valve and out through the shaft openings (Q) into the atmosphere or condenser. This unobstructed passage or opening prevents damage to engine by water entering engine spaces or remaining condensed in pipes.

The steam supply ports I in the piston disk will trade functions and become exhaust ports should the stationary valve floating in the shaft bore be moved in a suitable endwise direction by suitable means, one of which is shown by the reversing lever and quadrant (L, M), and the former exhaust ports in the piston disk become steam supply or receiving ports; reversing the engine's rotation.

Inertia of the moving parts of the engine and its load is effectually absorbed, upon reversal by the elastic cushion of the boiler pressure, suddenly transferred to the opposite side of the advancing pistons, preventing all shock or jar regardless of speed at which engine is running or reverse is effected.

A modification of my invention in which an instantaneous reverse, or stop, may be attained for use in emergencies, in addition to the regular reverse gear, in which the steam or other suitable pressure may be utilized is shown in Fig. 10, in which steam or other pressure is introduced from a suitable annular chamber (1) encircling the shaft (C) through a suitable side port (2) in said shaft into the central shaft bore closed by the plug (3) in which the steam supply valve (H) is located.

A suitable gate or other valve (4) upon being opened manually, or by any suitable electrical or mechanical means, allows the steam or other suitable pressure to enter the shaft bore and move the steam supply valve H to the position opposite to that shown in Fig. 1, reversing the engine, or by suitable adjustment suddenly stopping the same.

It will be readily seen that this auxiliary emergency reverse, and stop, can be operated at points distant from the engine room; as from the look-out upon a vessel, or the interior of a railroad train, or by wireless electrical methods from a signal tower, etc.

To provide for arranging the parts so that the steam in the narrower spaces can be utilized to the fullest degree and secure a variable cut-off of the steam entering the engine, a port construction similar to that described in my United States Letters Patent on double-action piston and valve, No. 1,123,039, patented Dec. 29, 1914, Serial No. 140,903, and further illustrated in detail in a diagram plan view in Fig. 9, may be used in which a traveling receiving port (I^1) is formed in the piston disk (G) with its opening line or edge (6) substantially parallel to the shaft axis and its closing line or edge (7) substantially at an angle to the said axis adapted to move across a stationary or supply port (K^1) of shorter length, located in a suitable valve (H) fixed as regards the revolution or travel of the receiving port (I^1) across it and movable by suitable means in a direction parallel to the shaft axis with opening and closing edges (6^A and 7^A) substantially parallel and angular to the shaft axis and arranged in such manner that the two lines of the opening edges will meet on a line parallel to the shaft axis and close on a line angular to said shaft axis and that endwise movement of the stationary supply valve (H) will vary the point at which the angular port edges (7^A and 7) will meet or close as they travel past during the shaft's rotation in the direction indicated by the arrows (8).

A diagram plan view of this type of port opening is shown in Fig. 9, in which the moving receiving port (I^1) with its opening edge (6) and its angular or closing edge (7) sweeping past the supply port (K^1) in the direction of the arrow (8) is indicated in the position of latest and earliest cut-off. This may be obtained within the limits shown without "wire-drawing" the steam by moving the valve (H) containing the supply ports, preferably three in number, in a direction parallel to the axis of the shaft in any suitable manner, either by the governing device shown or manually by means of the lever (L) in which suitable notches in the quadrant may be arranged to hold the valve in any desired position of cut-off.

It is manifest that these ports may be any desired proportion of size to each other and that either the receiving or supply port may be the larger in area. This angular port feature constitutes in part divisional matter from my Patent No. 1,123,039.

A modification of the receiving port is shown in the diagram plan view in Fig. 11 in which the traveling port (I^1) has its closing angular edge (6^C) so formed that it will admit steam during full stroke while valve

containing steam supply port (K^1) is at one position of its longitudinal movement and cut-off steam at various points of the stroke as it is moved to other positions of its longitudinal travel. This form is useful to give great starting torque as when a vessel or train is getting under way after which the point at which the cut-off occurs may be regulated to give the best results. In variable cut-off engines using this type of angular ported valve the exhaust steam does not pass out through both ends of the shaft; but may be discharged as shown in Fig. 3 into the annular space formed by a hoop, No. 23 surrounding the engine casing and from it discharge to the atmosphere or condenser; or if preferred exhaust ports may be cut through suitable points in the casing wall through which the advancing side of the pistons will continuously force it to the atmosphere or condenser. It is not deemed necessary to illustrate this manner of arranging the exhaust ports.

In engines requiring close regulation under varying conditions of load and boiler pressure as in the generation of electricity, the manufacture of textile fabrics, etc., it is preferable to connect this angular ported supply valve with a suitable governor which by centrifugal action shall maintain the valve in a state of unstable equilibrium; moving it to a position to vary the point of cut-off to maintain uniform speed of shaft rotation under varying conditions of load and in my improved balanced rotary engine the six impulses of steam received during each shaft revolution allows three times as close regulation to be attained as in the reciprocating engine.

While any ordinary type of centrifugal governor may be used, the preferred form is shown in Fig. 3, in which a casing (S) is keyed to the power end of the shaft (C) forming also the female part of a coupling by which the engine is flexibly connected to its work. Three suitable openings (T) are formed in this casing placed at such suitable angles to the shaft center as to form guides for suitable weights (U) adapted to move outward under the action of centrifugal force and impinge against a suitable three pronged washer (V) attached to the stationary steam valve (H) by means of a rod (W) and a ball bearing (B^1) located in the plug (9) in the valve end in such manner as to reduce the amount of steam supplied to the engine and control its speed.

A suitable spring (10) on the outer end of the valve (H) with an adjusting nut (11) placed between the bearing and the adjusting nut (11) opposes the centrifugal force of the weights and returns the valve to such position as will cause the valve to remain open.

The nut (11) may be adjusted while engine is running to give the speed desired.

I do not claim this governor in detail herein as it is the subject for a divisional application, and I reserve the right to present it in that manner.

The casing (S) is formed with suitable recesses (12), preferably three in number, adapted to receive suitable concave ended spiral springs (13) between which the arms of a three pronged spider (14) attached to the work driven by the engine, are placed; the springs forming elastic pads between the spider and the casing (S) providing an elastic coupling between the engine and its work. These conical ended springs (13) are placed parallel to the shaft axis in the recesses and the pressure of the engine is upon their sides instead of their ends forming a flexible and durable shock absorber.

A modification whereby a manually operated variable cut-off may be secured while engine is running under control of the governor is shown in Fig. 6, by the handle L^1, by means of which a greater or less compression of the governor valve spring 10^a is temporarily secured. The cylindrical governor weight "U" may be replaced by the globular form in the manually operated variable cut-off type of engine as shown in Fig. 6 if desired.

The taper form of the moving surfaces within the steam spaces is an important means of regulating the clearances or thickness of the film of steam which obviates the necessity of flexible packing in an engine, and prevents the moving surfaces from coming into actual rubbing contact within the steam chambers of the engine. The clearances of the revolving cylinder heads and piston disk G are adjustable by means of the regulating screw (15) placed in the ends of the cylinder head journals (16); suitable ball bearings (B) are placed in housings in the engine casing supporting the piston shaft of the engine and upon the ends of the revolving cylinder heads as shown at B^1 in Fig. 3. The pistons are conical upon their outer diameter and are a close running fit within the conical chamber in which they travel. Water grooves (17) (Fig. 14) are formed to minimize leakage of steam past them. Similar grooves (18) are formed upon the central steam valve (H), and also upon the shaft bearing "Z" in Fig. 3, and a corresponding labyrinth groove ring "Z^1" is found by which a frictionless packing tending to accomplish the seventeenth and eighteenth objects of my invention is provided.

It is found that the film of steam interposed between the moving surfaces forms a shock absorbing medium preventing vibration under varying pressure of the steam impulses. I thus reduce the friction and

wear to a minimum and confine it entirely to the journals of the revolving parts, which are preferably lubricated by force-feed systems.

This type of engine may be arranged to be operated in a vertical position as when direct connected to an electrical generator, or a rock drill, etc.

I attain the gyroscopic effect of my invention above described by arranging three cylinder heads or gyroscopes around the central shaft of such proportionate diameter to each other that the central revolving or shaft mass is approximately twice that of the revolving cylinder head mass and they are spaced at the equidistant points of an equilateral triangle intersecting their centers of gyration; in other words this construction is used to offset the attraction of gravitation tending to draw all weights toward the center of the earth, thereby producing in my type of engine a practically perfect balance of the rotating elements and an almost entire absence of frictional loss due to their weight in their bearings.

I have shown a pointer (21) upon the steam valve (H) which pointer moves along the edge of the slot (22) in the sleeve valve guide (23) of the variable cut-off engine. It is evident that a suitably marked scale placed along the pathway of this pointer will indicate exactly the point at which cut-off in the engine space is occuring.

A similar indicator may be placed upon the reversing or marine type of engine to indicate the point at which the valve is set to give forward, reverse, or neutral action in the engine structure.

While I have described the action of the engine and its valve and reversing features as applied to the use of steam, its advantages are equally apparent when arranged to utilize compressed air as for rock drills, pneumatic tools, engines for propulsion of torpedoes, military aeroplanes, etc., and particularly for propulsion of submarines in which the air, compressed by suitable types of my complete expansion divided action oil or coal-dust engines before submergence is utilized in the balanced reversing rotary engine for propelling the submarine after its submergence, the expanded air issuing from the exhaust of the rotary engine directly into the interior of the submarine to furnish air for the breathing of its crew.

This latter type will be made the subject of another patent application.

Having thus described my invention what I desire to claim and secure by Letters Patent is:

1. In a rotary steam engine the combination of a fixed member; a rotary member mounted in the fixed member and carrying a plurality of pistons adapted to travel in a chamber within the fixed member; revolving abutments actuated by the rotary member; having cut-away portions adapted to allow the passage of the pistons across their axis and to close the piston pathway after such passage; a central supply valve mounted in a bore in the rotary member and movable back and forth in said bore; ports in the valve adapted to co-act with ports in the rotary member leading to one side of the pistons; ports in the rotary member leading from the opposite side of the pistons to the shaft bore; ports leading from the shaft bore to exhaust passages in the fixed member; means whereby movement of the supply valve in the bore will cause the valve ports to register alternately with either set of piston ports or to such position as to register with neither set of piston ports allowing a single movement of the valve to stop, start and reverse the engine; means whereby the products of exhaust are continuously expelled from the engine, and means whereby the rotation of the rotary member will cause the admission of pressure into the spaces between the moving pistons and the abutment closed piston pathway at such times as to produce a continuous rotative effort of the rotary member.

2. In a rotary engine the combination of a fixed member; a rotary member mounted in the fixed member and carrying a plurality of pistons adapted to travel in a chamber within a fixed member; revolving abutments actuated by the rotary member having cutaway portions adapted to allow the passage of the pistons across their axis and to close the piston pathway after such passage; a central supply valve mounted in the bore of the rotary member and adapted to move back and forth in said bore; ports in the valve adapted to co-act with the ports in the rotary member leading to one side of the pistons, the ports formed in such manner that their co-acting edges will open on a line parallel with the axis of the rotary member and close on a line angular to the axis of the said rotating member so as to cause their opening edges to co-act with each other at the same point in each revolution of the rotary member and their closing edges to co-act or meet at such time in the revolution of the rotary member as may be determined by the position of the valve in the shaft bore and the relation of the unequally sized ports to each other; means whereby the valve may be caused to change its position in the shaft bore to govern the amount of steam passing through the said ports; and ports in the fixed member adapted to form a passage in combination with the revolving cylinder heads for the exhaust products.

3. In a rotary engine the combination of

a central valve; a power shaft inclosing the valve; pistons carried by the power shaft; revolving cylinder heads with cutaway portions adapted to pass the pistons through them; gears adapted to connect the power shaft and the rotary cylinder heads and cause their cutaway portions to allow the pistons to travel through the cylinder heads; a frame or body adapted to receive the shaft bearings and form the chamber in which the pistons travel; pistons carried by the shaft and traveling in the chamber; a piston disk integral with the shaft and in which the pistons are fastened; ports in the valve located in the shaft bore and adapted to cause the valve to float in the shaft; a passage or bore leading from the steam supply to the ports in the valve; an enlarged central portion of the valve in which the steam ports are located adapted to fill the shaft bore at the enlarged portion and leave an annular space at either side of the enlarged portion; a lever adapted to move the valve along the shaft bore and cause the valve ports to change their relative positions with the piston ports; ports in the piston disk leading from the shaft bore to the sides of the piston faces; ports in the shaft bore leading into the annular exhaust passage in the frame member; annular spaces in the frame adapted to inclose or surround ports in the shaft; exhaust passages in the frame connected with the annular spaces in the frame; bearings carried by the frame and adapted to receive the power shaft; a quadrant attached to the frame and adapted to carry the valve lever and hold it in position all for the purpose set forth and described.

4. A rotary engine comprising a frame; bearings in the frame; a steam chamber in the frame, with its circumference tapering and its side walls at right angles to the shaft axis; a combined piston disk and power shaft, the disk formed with a taper circumference; taper pistons carried by the disk and adapted to travel in a taper steam chamber; a bore or passage along and through the shaft; a valve located in the bore; rotary tapered cylinder heads located in taper bearings in the frame and adapted to contact with the tapered surface of the piston disk; a gear mounted upon the shaft and engaging pinions; tapered cylinder heads mounted in bearings in the frame; cut-out portions in the tapered surfaces of the cylinder heads; the cylinder heads adapted to receive the pinions meshing in the shaft gear and to rotate the cylinder heads in such manner as to allow the cut-out portions to pass the pistons, carried by the disk, through them or across the axis of the head's rotation; means by which the taper cylinder heads can be adjusted to vary the clearance or rolling contact of the heads upon the disk; a steam passage in the valve; a central enlargement near its middle; ports in the enlarged portion of the valve; ports leading from the shaft bore to the circumference of the piston disk and adapted to co-act with the valve ports and with the annular spaces in the shaft bore; ports from the shaft bore to the annular passages in the frame and means whereby the annular passages are united in a common discharge and with the shaft adapted to receive the bearings carried by the frame.

5. A balanced rotary engine comprising a fixed member and a rotary member; ports in the fixed member and ports in the rotary member; three revoluble conical abutments, with means for their longitudinal adjustment, driven by the rotary member, mounted on ball bearings and having a cutaway portion; taper pistons carried by the rotary member and traveling without friction in a central chamber within the fixed member; a ported supply valve, mounted and floating within a central bore, located in the rotary member; and means to vary the position of its ports and to produce the floating mounting without friction or appreciable leakage; ball bearings housed within the fixed member and carrying the rotary member, to allow a nearly frictionless movement of the conical abutments and the traveling pistons within the fixed member; a taper disk carrying the taper pistons and forming the central part of the rotary member; the conical abutments adapted to revolve with their taper surfaces in close but not rolling contact with the taper piston carrying disk; and means whereby this proximity of revolving surfaces are made adjustable; preventing leakage without contact of the surfaces for the purpose set forth.

6. A reversing rotary engine comprising four gyroscopes; the central gyroscope mounted in bearings located within a fixed member; the remaining planetary gyroscopes grouped at the points of an equilateral triangle surrounding the central gyroscope, and driven by it; their bearings housed within the fixed member; a floating valve located within the central bore of the main gyroscope; ports in the valve and in the central gyroscope and in the fixed member whereby their co-action will allow the supply of actuating medium to enter the spaces formed by the planetary gyroscopes, the central gyroscope and its projections, and the fixed member, and by its imprisonment within the said spaces enlarge the same; thereby revolving the group of gyroscopes, and after expansion escape from the fixed member; and means whereby the movement of the floating valve will cause a reversal of the movement of the actuating medium in the said space in such manner as to reverse the rotation of the gyroscopes for the purpose set forth.

7. In a rotary marine engine comprising

a fixed member inclosing a rotary member; the fixed member housing supporting bearings for the rotary member; three revolving taper cylinder heads, with their bearings carried by the fixed member adjustable longitudinally; a gear carried by the rotary member and pinions carried by the rotary cylinder heads whereby the rotary member revolves the cylinder heads; an inclosed chamber in the fixed member; traveling pistons carried by a ported disk on the rotating member; and adapted to rotate within the inclosed chamber in close contact with the revolving cylinder heads; cut-out portions in the revolving cylinder heads through which the pistons pass; a central bore through the rotary member; a ported supply valve located and floating within the bore; means to move the supply valve within the bore; a slotted supporting guide or sleeve for the valve carried by the fixed member through which one end of the valve enters the bore; a pointer mounted near the outer end of the supply valve and visible through the slot in the supporting guide and a scale marked upon the slot to indicate, in connection with the pointer, the position of the valve's travel within the bore; ports leading from both sides of the pistons through the disk to the bore in which the valve is located and adapted to co-act with the valve ports and outlet ports near the ends of the central rotary member adapted to discharge into passages through the fixed member; means whereby the movement of the valve may be attained at points remote from the engine in such manner as to secure instantaneous starting, stopping or reversing of the same.

8. In a rotary steam or compressed air engine the combination of a fixed member containing central chambers, and three longitudinal tapered chambers intersecting both central chambers at equidistant points; bearings at the ends of the tapered chambers; a central shaft journaled in the fixed member; a bore through the shaft; a conical or taper piston disk carried by the shaft; pistons carried by the disk; the top of the pistons taper and adapted to travel closely along the surface of one of the central chambers in the fixed member; water grooves cut along the top and ends of the pistons and curved or concave surfaces formed on the front and rear of the pistons; curved nozzles or ports leading from the curved piston faces through the disk to the shaft bore; a gear mounted upon the central shaft in the central chamber adjoining the piston disk; three taper abutments or cylinder heads carrying pinions adapted to mesh with the central gear; cut-out portions or recesses in the taper abutments adapted to permit the pistons' passage across their axis; the abutments adapted to revolve within the tapered chambers upon the journals or bearings in the fixed member; adjusting screws by which the clearance of the taper abutments within their tapered chambers is regulated; a multi-ported supply valve adapted to float within the shaft bore and to be manually or mechanically moved back and forth within the shaft bore; discharge ports leading from the shaft bore to passages through the fixed member; a side port leading to the shaft bore beyond its inner end; an annular chamber encircling the shaft end and this port and a valve to control the entrance of actuating medium; a plug in the shaft end adapted to form a closed chamber between the valve end and the shaft end into which an actuating medium can be introduced to suddenly move the valve in the shaft bore and fixed member; and cords or chains by which the manually operated lever handle can be operated from a distance without signal to engine room operator all in the manner and for the purpose described.

9. In a rotary engine, the combination with two members, one rotatable relatively to the other, said members being provided with admission and exhaust ports, of a supply valve having ports therethrough adapted to register with the admission ports of the rotating member periodically as that member rotates, and means for introducing a fluid under pressure into contact with the end of said valve and moving it in one direction for the purpose of bringing its admission port out of registration with the admission port of the rotary member to stop the engine.

10. In a rotary engine, the combination with two members, one rotatable with respect to the other, said members being provided with admission and exhaust ports, of a supply valve having ports adapted to register with the admission ports of the rotating member, and having an end fitting a bore in the rotary member, said rotary member being provided with a port beyond the valve, and means for introducing a fluid under pressure through said ports into contact with the end of the valve for moving the valve to vary the registration of its port with said admission port.

11. In a rotary engine the combination with a stationary member and a rotary member, said members being provided with ports for the admission and exhaust of gas or vapor, of a supply valve mounted at the center of said members and capable of reciprocating axially therein, said valve having ports therein adapted to register with the ports of the rotating member periodically as that member rotates, means for reciprocating said valve to bring the ports of the valve into and out of registration with the ports of said rotary member, said operating means comprising a governor, and means for introducing pressure at the end of said valve to

move it in one direction for the purpose of stopping the engine, said means being capable of being controlled from a distance.

12. In a rotary engine the combination with a stationary member and a rotary member, said members being provided with ports for the admission and exhaust of gas or vapor, of a supply valve mounted at the center of said members and capable of reciprocating axially therein, said valve having ports therein adapted to register with the ports of the rotating member periodically as that member rotates, means for reciprocating said valve to bring the ports of the valve into and out of registration with the ports of said rotary member, said valve having an end fitting a bore in the rotary member, said rotary member being provided with a port beyond the valve, and means for introducing steam or pressure through said port into contact with the end of the valve for forcing the valve longitudinally.

13. In a rotary engine, the combination with a cylinder, a supply valve therefor inclosed therein, said cylinder and valve being adapted to rotate relatively to perform the functions of admission and exhaust, and each having an admission port, said ports adapted to register with each other at a point during the rotation, the opening edges of the two ports being parallel with the axis of rotation, and the closing edges being parallel with each other and at an angle to the axis of rotation, said cylinder and valve being relatively adjustable along the axis of rotation to vary the point at which the angular closing edges will meet to cut off the admission, of means for longitudinally moving said adjustable element a greater distance to stop or reverse the engine.

14. In a rotary engine, the combination of two relatively rotatable members having contiguous conical surfaces, one having a plurality of conical recesses each having bearings at its ends only, a plurality of conical rotary abutments rotatable in said recesses and supported at their ends solely by said bearings, just out of actual contact with the recesses to admit a film of gas or vapor between their surfaces, and means for adjusting said abutments longitudinally for regulating the clearance.

15. In a rotary engine the combination of two concentric members, one stationary and the other rotary, said members having conical contiguous surfaces, the stationary member being provided with a plurality of rotary abutments of conical form fitting in conical recesses therein, bearings in said recesses for supporting said abutments therein to hold their surfaces out of contact with the recesses and admit a film of gas or vapor between said surfaces to reduce wear, means for adjusting said abutments longitudinally to take up wear and control the intimacy of contact, and means for holding them in their adjusted positions.

16. In a reversible rotary engine, the combination of an outer and an inner member, one stationary and the other rotatable and one having a pair of pistons, an axially reciprocable valve member located in the center of the inner of said members having admission and exhaust ports, said inner member having two pairs of ports, one pair serving as admission and exhaust ports when said valve is in one position and the other pair when it is in another position, the admission port of one pair leading to one side of a piston and the admission port of the other pair to the other side of the same piston, whereby reversal is secured and the inertia of the moving parts is effectually absorbed by the elastic cushion thus provided on the other side of the piston.

17. In a rotary steam engine, the combination of a stationary annular outside member, an inner rotary piston member, a central valve, said inner member having a space surrounding the valve, and having openings leading into said space to conduct the exhaust thereto in all positions thereof, whereby damage to the engine by water entering the engine spaces or remaining condensed in the device is prevented, and whereby back pressure from the exhaust side of the piston is eliminated.

18. In an engine, the combination of an annular outside member, an inner piston member, one of said members being rotary, a central valve, said inner member having a space surrounding the valve, and having leading into the said space an exhaust port whereby damage to the engine by water entering the engine spaces or remaining condensed in the device is prevented.

19. In an engine, the combination of an annular outside member and an inner piston member, one of which is rotary, a central valve, there being a space surrounding the valve, and the piston member having openings leading into said space to conduct the exhaust thereto in all positions thereof, whereby back pressure from the exhaust side of the piston is eliminated, the piston member having constantly open openings for conducting the exhaust from said space.

In testimony whereof I have hereunto set my hand, in the presence of two subscribing witnesses.

JAMES WALLACE TYGARD.

Witnesses:
L. W. RANDOLPH,
LEONARD M. RANDOLPH.