No. 752,603. PATENTED FEB. 16, 1904.

E. F. TAYLOR.

ROTARY ENGINE.

APPLICATION FILED OCT. 9, 1903.

NO MODEL.

Fig. 1

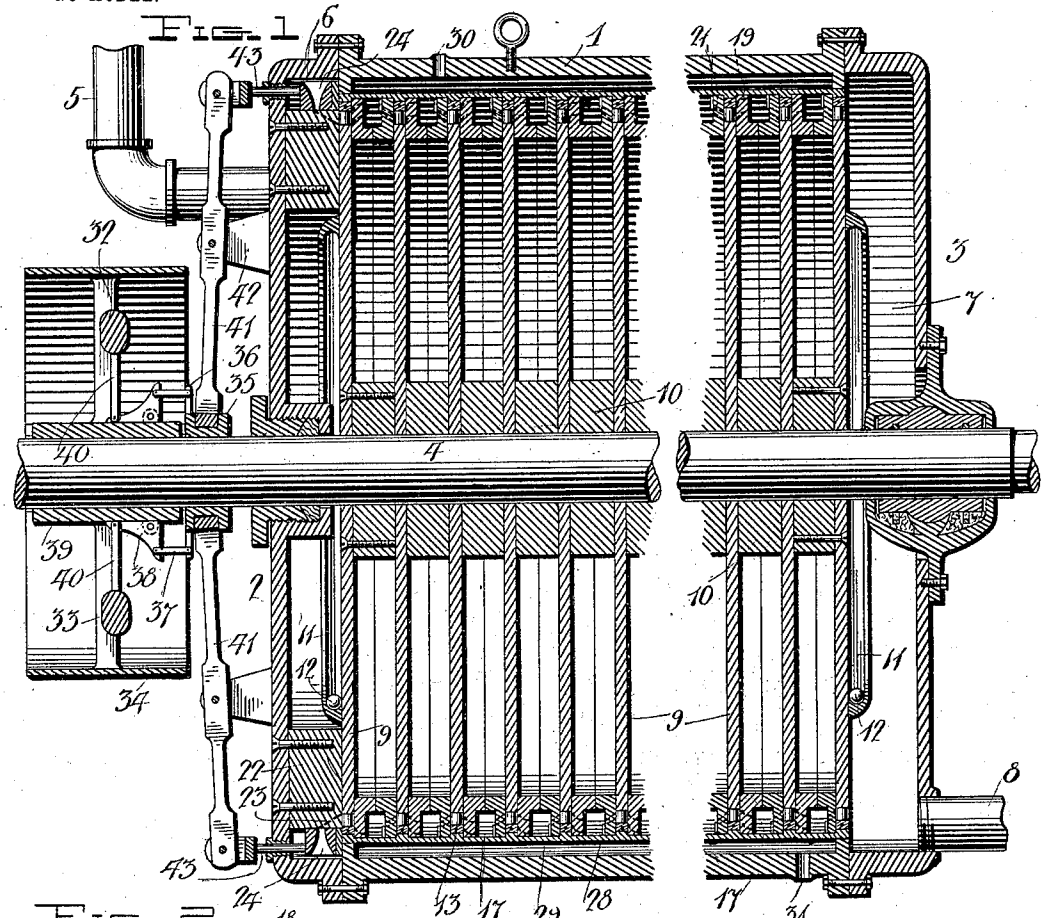


Fig. 2

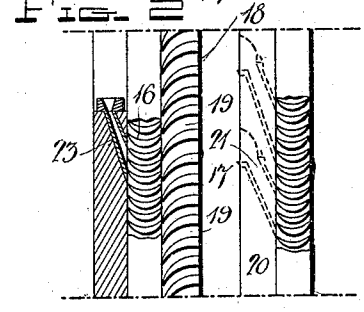


Fig. 3

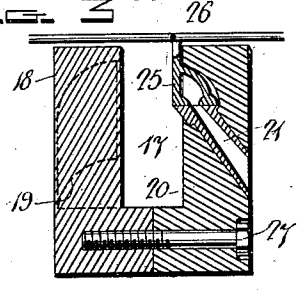
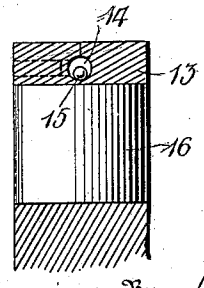


Fig. 4



Witnesses

Inventor

E. F. Taylor

By

his Attorneys

No. 752,603. Patented February 16, 1904.

UNITED STATES PATENT OFFICE.

EDWIN F. TAYLOR, OF NEW DECATUR, ALABAMA.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 752,603, dated February 16, 1904.

Original application filed August 22, 1902, Serial No. 120,718. Divided and this application filed October 9, 1903. Serial No. 176,368. (No model.)

To all whom it may concern:

Be it known that I, EDWIN F. TAYLOR, a citizen of the United States, residing at New Decatur, in the county of Morgan and State of Alabama, have invented certain new and useful Improvements in Rotary Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention, which relates to rotary engines, is a division of the invention forming the subject-matter of an application filed by me August 22, 1902, Serial No. 120,718.

The present invention is set forth in detail in the following description and fully illustrated in the accompanying drawings, the description and drawings disclosing the engine in its preferred form of embodiment. It will be understood, however, that the construction shown and described may be variously modified without exceeding the scope of the concluding claims.

In the drawings, Figure 1 is a vertical longitudinal sectional view, partly broken away, of a rotary engine embodying my invention. Fig. 2 is an enlarged plan view of portions of the wheel peripheries and intervening steam-chambers. Fig. 3 is an enlarged cross-sectional view of one of the intervening steam-chambers. Fig. 4 is an enlarged cross-sectional view of one of the wheels at the rim portion.

The principle of the present engine is similar, generally speaking, to the principle set forth with reference to the engine which forms the subject-matter of my other application for patent above referred to, the main difference being that in lieu of a single wheel acted upon by flanking nozzles a series of wheels are employed, together with a series of separate intervening chambers from which expanded steam is impacted against the wheels successively or step by step with an initial ratio of expansion, each chamber having a pressure of steam which is a perfect ratio with the preceding one, so that throughout the range of chambers the steam is expanded adiabatically through sections of a diverging nozzle or nozzles, whereby the velocity is controlled from one chamber to another, resulting in a complete transformation of the energy into mass and velocity from the maximum to minimum pressures, yet not exceeding at any time the theoretical velocity of nine hundred feet a second.

Referring to the drawings by numerals, the construction includes a cylindrical casing 1, having heads 2 3, through which extends a shaft 4.

5 is the steam-supply pipe, leading to a steam-chamber 6 at one end of the cylinder, and at the other end of the cylinder is an exhaust-chamber 7, from which leads an exhaust-pipe 8. Keyed to the shaft are wheels 9 9, preferably twenty in number, for a purpose presently to be explained, though the drawings show a less number, Fig. 1 being partly broken away. The wheels are spaced apart by sleeves 10 10, and the end wheels carry ball-races 11 11, which carry ball-weights 12 12. Each wheel carries a two-part rim 13, in which is a raceway 14, carrying ball-weights 15. The function of the ball-weights 12 and 15 will presently be described.

Each wheel 9 carries at its periphery radially-disposed vanes or buckets 16 16 of concave-convex form. Located between the wheels in the path of rotation of the vanes or buckets are a series of chambers 17 17, each having through one wall 18 admission-channels 19 19, the inlet ends of which are at the vanes or buckets, the other ends opening into the chambers. In the opposite wall 20 of each chamber are diverging nozzles 21, radial with and discharging against the vanes or buckets of the adjacent wheel 9. The inner wall of the steam-chamber 6 is formed by a ring 22, and diverging nozzles 23 in said ring convey partly-expanded steam from the chamber to the vanes or buckets of the first wheel of the series. A ring valve 24, provided with diverging openings, controls the inlet ends of the nozzles 23, said valve being connected with a governor, the construction of which will presently be described. Each of the nozzles 21 is provided with a similar controlling-valve

25, connected with the valve 24 to move therewith through the medium of rods 26, one of these rods being shown in Fig. 4.

The nozzles 21 23 each form a sectional part of a complete nozzle in which the steam is fully expanded adiabatically. Admitting steam at the average boiler-pressure of, say, one hundred and twenty pounds absolute by the pipe 5 into the chamber 6 and thence through the nozzles 23, an adiabatic partial expansion of the steam is effected in said nozzles to one hundred pounds pressure, and having attained through such expansion a velocity of nine hundred feet a second the steam gives up its energy to the vanes or buckets of the wheel by impact upon them, moving the wheel at a peripheral speed of four hundred and fifty feet a second. The steam reacting from the vanes or buckets into the channels 19 arrives in the first chamber with one hundred pounds pressure, but practically at rest. From this chamber the exit of the steam is regulated by the diverging nozzles 21, which are of such size that the expanded steam from the first chamber can escape in quantities sufficient only to maintain a constant pressure in the chamber and yet again attain a velocity of nine hundred feet a second through the second series of nozzles, in which there is an adiabatic partial expansion to one-hundred one-hundred-and-twentieths, or 1.2, the volume of the first chamber. The expanded steam discharges from the nozzles against the vanes or buckets of the second wheel and from thence enters the second chamber with a pressure of eighty-three and one-third pounds. This operation is repeated throughout the series of wheels and chambers, each succeeding pressure being one-hundred one-hundred-and-twentieths of the preceding one, giving a constant ratio of expansion of 1.2 its volume from one chamber to the adjacent one. The steam finally exhausts at 8, as above stated. Thus the steam is controlled to limit the velocity of the expansion, whereby each wheel receives an impact from a volume of steam having a velocity of nine hundred feet a second. As there is always obtained the same weight of steam at the same velocity, the same amount of energy is exerted by way of impact from each chamber upon each wheel. The number of the series is determined by dividing the maximum by the minimum practical pressure. For instance, to expand from the maximum pressure above stated to three pounds absolute, forty expansions are required, (one hundred and twenty divided by three,) and as the ratio of expansion is 1.2 its volume, which is approximately the twentieth power of the above, it requires twenty expansions to obtain the results above stated.

The nozzles in the intermediate stages, as well as in the chamber 6, are, as described, located radial with and discharge against the vanes or buckets of the adjacent wheels, the outlet ends inclining slightly toward the axis. In explanation of the operation if an adiabatic partially-expanded fluid is discharged obliquely in a direct right-line tangent to the revolving part the complete effect of the impact through the change in entropy is partially destroyed by the centrifugal force of said revolving part warding off the impact thereby created and resulting, consequently, in a considerable loss in efficiency. If, however, the outlets of the nozzles are slightly inclined below the tangent line toward the axis, the impact will rebut the centrifugal force of the revolving part, with no tendency to glance off, with the result of a complete absorption of the energy.

By reference to Fig. 3 it will be observed that the nozzles 21 are formed to be removably inserted in openings in the chamber-wall, whereby nozzles of larger internal diameter may be substituted if additional power is required. Preferably the chamber-walls are formed separately and secured together by bolts 27. An inner concentrically-arranged cylindrical casing 28 incloses the chambers and wheel-rims and provides between it and the outer casing 57 a steam chamber or "jacket" 29, having its inlet at 30 and its outlet at 31. The steam chamber or jacket increases the efficiency of the engine, and by connecting a steam-trap with the drip-outlet 31 a uniform temperature may be maintained in the chamber or jacket. This steam chamber or jacket acts as a reheater for the working fluid in the series of chambers 17 17, which it surrounds. In expanding the fluid adiabatically from one hundred and twenty pounds to one hundred pounds, for example, through change in entropy following such expansion, about 20° of temperature is utilized in doing work. Consequently the temperature of the fluid in the second chamber is 20° lower than in the first chamber. To prevent any loss in temperature through condensation before the next adiabatic partial expansion is created, I incase the chambers in the steam chamber or jacket in order to maintain the walls of the chambers at a temperature equal to or above the temperature of the fluid contained in said chambers. By reason of the short length of time allowed for contact of the fluid with the heated walls between the successive adiabatic expansions no appreciable rise in temperature is created, yet accumulation of moisture and condensation is prevented, allowing a complete series of adiabatic partial expansions to be made without any isothermal expansion of the fluid being effected.

The channels 19 in the chamber-walls 18 are formed, preferably, by a series of divisions made by the circumference of two arcs starting from a common point and intersecting each other at the side adjacent to a wheel, whereby said channels have each a diverging

form. The channels are angular to the vanes or buckets, so that the steam from the nozzles after impact thereon and reflection therefrom at one-half its velocity reacts in the channels before admission to the chambers, thereby effecting a reactive action on the wheels. The number of these channels 19 are not equal to the number of vanes or buckets of a wheel, but are so proportioned that the pressure of steam from a chamber will react for the purpose of equalizing pressure on both sides of the vanes or buckets, thereby overcoming all end thrust of the shaft.

The steam expansions are each attended with a low pressure, and it requires, therefore, a proportionately larger cross-section or diameter of nozzle or a greater number of the same size to give the same velocity and maintain the ratio of pressure from each chamber. Thus at no time is the maximum velocity above that required for the highest efficiency of the engine.

The efficiency of the engine is maintained minus the friction throughout its range of capacity by connecting the valves to be commonly operated for consecutively opening or closing the nozzles through the series either separately or in groups with reference to the work required from the engine. Thus with a light load the majority of the nozzles are automatically closed, preventing an abnormal amount of steam in proportion to its load passing through the engine.

It will be observed that the engine is entirely free from parts which have rubbing contact, and is therefore especially adapted for superheated steam.

One object of my invention is to obtain a peripheral speed of the wheels approximating four hundred and fifty feet a second, and to accomplish this with safety, secure perfect running, and permit the use of the common type of bearing I provide the described ball-weights, which being free to move in the grooves or raceways are acted upon by gravity or by centrifugal force, dependent upon which force prevails. The velocity obtained is much above what is known as the "critical" speed, (three hundred feet a second,) which when reached changes the rotation of the revolving body from the mechanical or geometrical axis to its axis of gravity. Below the critical speed, should there be any difference of weight in the make-up of the body or wheel, there is a tendency of the heavier part to move from the shaft; but when the critical speed is reached the heavier part has a tendency to move inwardly toward the axis and the lighter part leaves the mechanical axis to revolve about the axis of gravity. By the use of the automatically-shifting weights, which in the revolution of the wheel find their proper positions to compensate for variations in the weight of the different parts of the wheel, the axis of gravity is after the critical speed is reached brought into coincidence with the mechanical or geometrical axis, and thus is maintained an even and uniform balance of the wheel, permitting the employment of the ordinary type of bearings without the necessity of providing the usual cushioning means or other expedient to overcome the danger and imperfect operation attending the revolution of a wheel at a velocity above the critical point.

Any suitable type of governor may be employed to move the valves and control the engine, though I prefer the type shown, which consists of weights 32 33, carried by arms pivoted to the spokes of a pulley 34 and connected together by a rod, and of a spring operating to retract the arms and weights. The weights are moved from the axis of the revolving pulley by centrifugal action against the action of the spring, and such movement is transmitted to the valves by the following means: Loose on the shaft is a collar 35, projecting from which are ears 36 36, each connected by a link 37 with one arm of a bell-crank lever 38, pivoted on the pulley-hub 39. The other arms of the bell-crank levers are connected by links 40 40 with the weights 32 32. The collar 35 is provided with an annular groove in its periphery, which receives the forked inner ends of levers 41 41, pivoted to ears 42 42, projecting from the casing ends. The other or outer ends of the levers 41 are connected by rods 43 43 with the adjacent valve 24, the rods passing through openings in the casing-head 2, at which are stuffing-boxes. The movement of the valves to the left to close the nozzles is coincident with the outward movement of the governor-weights; but it will be understood that the series of valve-openings are of gradually-increasing size, whereby the nozzles are successively closed to cut off the steam-supply. The first opening is approximately the size of a valve-opening, and the sizes of the other openings increase in such proportion as to effect the successive opening or closing of the nozzles by the movement of the valves, whereby the maximum pressure of steam which, as before stated, is present in the steam-chamber always exists at the inlets of the uncovered nozzles regardless of their number. The engine is therefore self-governing, and this advantage is obtained without in any way affecting a loss of energy of the steam and a consequent impaired efficiency in the engine. With a maximum steam-pressure in the steam-chamber and the governing means acting directly at the inlets of the nozzles a constant speed is maintained regardless of the load within its rated capacity, and all of the energy of the steam is directed on the moving part. It will be understood that the governing device acts in conjunction with the valves to open or close the nozzles accordingly as the load varies and that no expansion of the steam takes place until it enters the nozzles, where-

upon the steam is expanded adiabatically, as above explained.

I claim as my invention—

1. In a rotary engine of the character described, a series of wheels driven by the impact and reaction of a continuously adiabatically expanded motive fluid, and means effecting an equal amount of energy of the fluid at each of said wheels.

2. In a rotary engine of the character described, a series of wheels carrying impact-surfaces, and a series of chambers between the wheels at said impact-surfaces, each chamber having in one wall a section of a diverging passage arranged to direct adiabatic partially-expanded fluid against the impact-surfaces of the adjacent wheel, and having in its opposite wall reacting fluid-channels.

3. In a rotary engine of the character described, a series of wheels carrying impact-surfaces, a series of chambers between the wheels at said impact-surfaces, and a series of nozzles at said chambers effecting step by step a continuous adiabatic expansion of the motive fluid, said nozzles adapted to maintain an equal velocity of the fluid at each wheel.

4. In a rotary engine of the character described, a series of wheels carrying impact-surfaces, a series of chambers between the wheels at said impact-surfaces and a series of nozzles removably inserted in the walls of said chambers and adapted to direct adiabatically-expanded fluid against said surfaces.

5. In a rotary engine of the character described, a series of wheels carrying impact-surfaces, a series of chambers between the wheels at said impact-surfaces, a series of nozzles at said chambers effecting step by step a continuous adiabatic expansion of the motive fluid, with an equal velocity of the fluid at each wheel, and means for maintaining an equal weight of the fluid at each wheel.

6. In a rotary engine of the character described, a series of wheels carrying impact-surfaces and a series of sections of an adiabatic nozzle each situated so as to deliver the motive fluid against the impact-surfaces of one of the wheels and all arranged to effect a continuous adiabatic expansion of the motive fluid.

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

EDWIN F. TAYLOR.

Witnesses:

F. A. BLOODWORTH,

W. R. HARE.