W. FENNELL.

TURBINE ENGINE.

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954,946.

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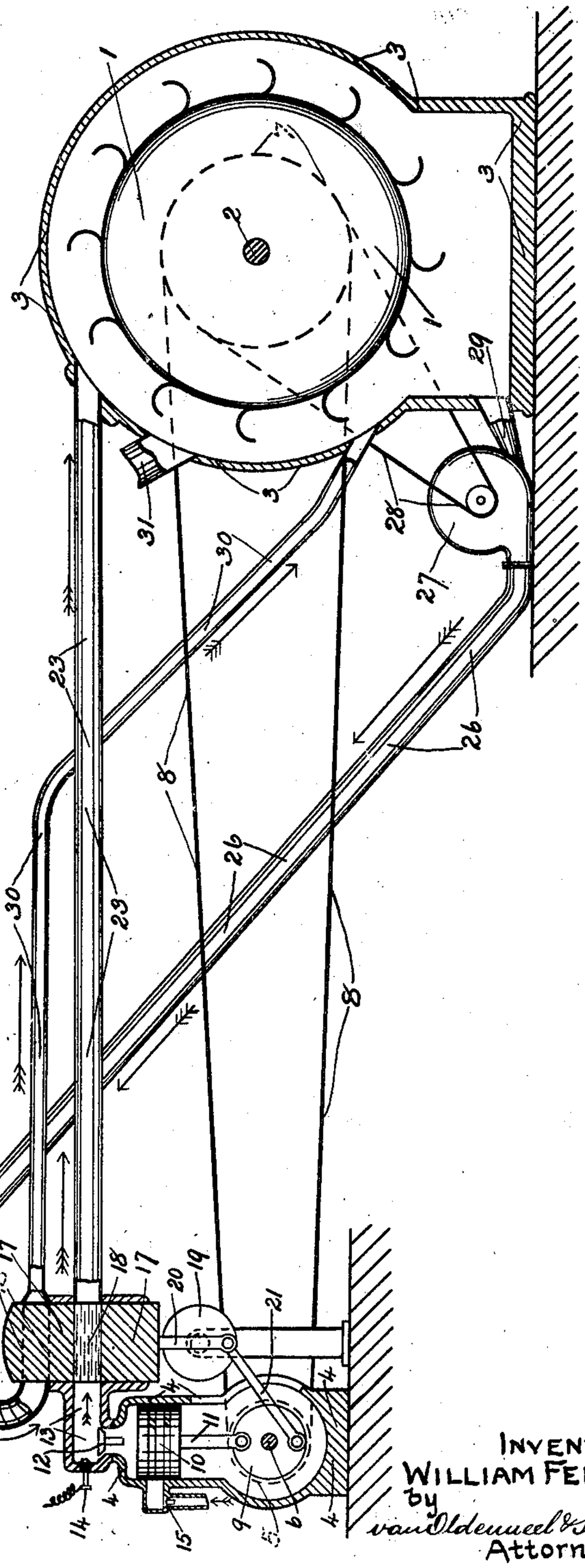

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UNITED STATES PATENT OFFICE.

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TURBINE-ENGINE.

954,946. Specification of Letters Patent. **Patented Apr. 12, 1910.**

Application filed March 21, 1903. Serial No. 422,455.

To all whom it may concern:

Be it known that I, WILLIAM FENNELL, a subject of the King of Great Britain, residing at Clarkson Road, Wednesbury, in the county of Stafford, England, have invented a new and useful Turbine-Engine; and I do hereby declare the following to be a full, clear, and exact description of the same.

This invention relates to heat engines of the class using gases as the working agent to produce rotation directly without aid of reciprocating motion commonly known as steam or gas turbines.

Hitherto there have been two great difficulties in the way of designing efficient turbines. (1) In turbines of the reaction type the rotating parts or wheels have been subject to high temperatures and where ignited gas is the working agent these temperatures are so high that practical working conditions are almost unattainable. (2) in the "impulse" turbines where the working gas is so high that a wheel cannot be run at the necessary peripheral speed (viz), half that of the issuing gas to secure economy. This again is particularly the case with "gas turbines."

The velocity of the expanded gases may easily be over 5000 ft. per second, yet no turbine wheel has hitherto been run at a peripheral speed of more than 1,500 ft. per second, and at this speed the limit of safety has been reached, if not exceeded. As a matter of practice 750 ft. per second is the limiting safe speed of a wheel carrying vanes or blades. In the case of "gas turbines" of the impulse type a further difficulty occurs that the stream of gas must in the ordinary way be continuous, as the rotating wheel cannot allow the varying velocities of the gases, if the gases issue in a series of puffs. This prevents economical use of the advantage of the explosion action.

Heretofore it has been proposed to drive turbine wheels by a "working fluid" and a "driving fluid" each of which is admitted into an expansion tube by a separate annular valve with small ports; but in such there is great difficulty in admitting a definite quantity of such fluids as slight variations of speed will greatly alter the relative quantity of the light and heavy fluids as will also fluctuations of pressure forcing such fluids through valves especially in the case of the heavier or driving fluid; and moreover the form of valve admission tends to split up the working fluid into a spray if any rapid inlet of working fluid is attempted and thus cools the driving fluid and reduces the efficiency. Such proposals would not however achieve the desired object of giving to the fluid before impinging on the wheel a final definite velocity properly proportioned to the velocity of the wheel to be driven though they are alleged to do so. It has also been proposed to partially fill a chamber with water by suction arrangement by cooling products of combustion remaining therein from a previous explosion by means of a spray. The chamber is rotated until it comes opposite a combustion chamber which has been provided with compressed gas as a result of the previous explosion acting upon an auxiliary piston. In this case the result is as before—uncertainty as to the amount of water in the chamber, as this depends upon the amount of suction available, or in other words upon the heat of the exhaust gases, and also variation in the compression of the new gas as it depends upon the strength of the previous explosion. Indeed one missfire will cause the apparatus to stop work as the gas left in the fluid chamber would be cool and there would be no filling action, and there would be no compression of the new gas.

According to this invention I overcome the difficulties enumerated above, by preventing the free egress of the compressed gases, interposing between definite measured quantities of the expanding gases and the point of the outflow, a plug or stopper of water or other fluid of definite weight, which fluid has been previously measured into a chamber. The gases are released in a series of puffs in definite quantities, and such portion of expanding gas is caused to drive before it the definite measured plug or stopper of fluid along an expansion pipe, at the outer end of which the fluid issues in the form of a jet, and is caused to give its energy, say by impinging upon the turbine wheel. The expanding gases also follow the water jet and may in turn do useful work. This plug of water or the like acts as a free piston and attains a definite velocity proportional to the mass. I am thus enabled to obtain any desired jet velocity by proportioning the weight of the water to the energy, which can be obtained from the expanding gas. The velocity may of course be made enormously lower than that

at which the gases would travel if allowed free egress.

This invention may be generally described as the means for rotating a turbine wheel by a series of plugs of fluid rapidly discharged onto a wheel by means of an expansion tube, these plugs being fed into a position between a driving fluid admission and the expansion tube; the said plugs consisting of a definite amount of fluid "delivered" to the necessary discharge position, as distinguished from the previous attempts in which the fluid has been allowed to flow into the expansion tube or has been allowed to partially fill a chamber with the disadvantages previously stated. I arrange by suitable mechanism that a succession of charges of gas and water are presented to the expansion tube in rapid succession, so maintaining a continual action.

Referring to the drawings, the Pelton wheel 1 is mounted on its axle 2 in suitable chamber 3 and is driven in manner now described. Arranged at a suitable distance from this wheel is a compressor 4 having a pulley 5 on its crank axle 6 whereby it is driven from the pulley 7 on Pelton wheel axle 2, by the driving belt 8; though any other suitable driving means or engine may be employed for operating said compressor. On the crank axle 6 is a crank disk 9 whereby the piston 10 is operated through the piston rod 11 for the purpose of compressing the explosive mixture admitted through the valve 15. Upon compression, the mixture is forced through the valve 12 into the explosion cylinder or chamber 13 where it is exploded by the sparking plug 14, or high compression or other suitable means.

Adjacent to the explosion chamber is a cylindrical or other suitable shaped fluid or water feeder 17 having a water cylinder or a chamber 18 designed to register with the explosion cylinder when the feeder is in its lowest position. This feeder 17 is actuated from suitable crank disk 19 to which it is connected by piston rod 20, said crank disk being driven from the aforementioned disk 9 to which it is connected by the link 21. Thus, the compressor and the feeder work together, the piston being up, or at full compression when the feeder is in its lowest position *i. e.* with its cylinder 18 registering with the explosion cylinder.

In alinement with the explosion cylinder and in alinement with water cylinder 18 when same is in the position on the drawings, is an expansion tube 23 one end of which is against the feeder 17 while the other end enters the wheel casing 3 and is arranged to feed on to the buckets of the Pelton wheel.

Suitable proportions and pressures for the working of this engine are calculated to be, explosion cylinder and water cylinder of equal volume with the volume of the expansion tube twelve times as great as either; while the compressor is designed to compress the explosion mixture to 120 lbs. per square inch. Then assuming the engine to be in the position shown upon the accompanying drawings, the water cylinder 18 is filled with a suitable fluid, or the like, as water, and as same comes opposite the explosion chamber the previously compressed explosion mixture is ignited. The energy obtained by the expansion from the explosion is absorbed by the water plug in cylinder 18, as kinetic energy and the water plug is propelled through the expansion tube, and it impinges upon the buckets of the Pelton wheel, which is thereby driven. By making the parts of the proportions stated *i. e.* the total volume of expansion tube, water cylinder and gas cylinder of fourteen times the volume of the gas cylinder alone, it is calculated that when the water plug has left the expansion tube then the gas is at or near atmospheric pressure. Also I calculate that the velocity of the water as it issues will be about 300 to 350 ft. per second, so that the peripheral speed of the wheel need only be about 150 to 175 ft. per second, equal to about 1,000 revolutions per minute on a 3 ft. wheel. To show the importance of this invention I would state that, allowing free egress, the speed of gases would have been of the order of 5,000 ft. per second and to secure economy the wheel would be required to run at 2,500 ft. per second peripheral velocity, equal to 16,000 revolutions per minute on a 3 ft. wheel, a speed which is practically impossible. The gases in the expansion tube either follow the water plug and do useful work upon the wheel or are driven out by the next water plug with the same result.

The arrangement for successively feeding a plug of water to the expansion position as shown on the drawings consists of a feed pipe 26 with which the water cylinder 18 registers when in its highest position as shown by the dotted lines on the drawings. Water is forced through this pipe by the centrifugal pump 27 driven from the Pelton wheel by the belt 28, the feed to said pump being wholly or partially from the base of the wheel casing 3, by pipe 29. Thus when the water cylinder reaches its highest position it is filled by the feed pipe in manner described, and the overflow water and gas being drained back to the wheel casing by the pipe 30. An exhaust pipe 31 is provided for the discharge of the gas from the wheel chamber.

The following great advantages are obtained by this invention:—(1) A very thick expansion reducing the loss of heat to the expansion tube or cylinder and water plug.

(2) A high ratio of expansion by using a long expansion tube enabling me to use economically a high initial pressure without the disadvantage of increased cost met with in reciprocating engines. (3) A definite and fixed velocity of jet exactly proportional to the wheel velocity allowing the use, if desired, of the "explosion" or "puff" system. I do not confine the material of which the "plug" is made, to water, although I prefer to use it, but may use mercury or any other fluid or even semi-solids, or powders as mechanical considerations alone determine the material to be used.

This invention has no reference to any particular gases or to the means of producing the gas under pressure. I may apply it to steam or any other gases and may use the issuing plug or jet in any way to obtain the desired result and may use any number of such jets acting on one machine in order to produce an even turning moment.

The term "fluid plug feed chamber" means, throughout this specification, a chamber, or the like, of definite size, arranged to be placed in communication with a pipe, or a chamber, carrying the fluid for a sufficient time to become completely filled thereby. Thereupon, it is fed or moved to another position, whereat the definite quantity of fluid is to be forced or blown out, and the chamber afterward fed back to the filling position.

What I claim then is—

1. In a turbine engine, the combination of a driving wheel, means for delivering definite amounts of gas under pressure to a position for operating upon fluid, a fluid plug feed chamber for successively delivering plugs of fluid, of definite and measured quantity, to a position to be driven by said gas under pressure, means for completely filling said chamber with fluid, and means for conveying the fluid to the driving wheel.

2. In a turbine engine, the combination of a driving wheel, an expansion tube for conveying plugs of fluid to said wheel, a fluid plug feed chamber for successively delivering plugs of fluid, of definite and measured quantity, to be received by the expansion tube, means for completely filling said chamber with fluid, and means for supplying gas under pressure to drive the plugs of fluid, upon delivery as aforesaid, into and along said expansion tube to the wheel.

3. In a turbine engine, the combination of a driving wheel, an expansion tube for conveying plugs of fluid to said wheel, a fluid plug feed chamber for successively delivering plugs of fluid, of definite and measured quantity, to be received by said expansion tube, means for completely filling said chamber with fluid, means for supplying gas under pressure, and means for igniting said gas, to drive the plugs of fluid, upon delivery as aforesaid, into and along said expansion tube to the wheel.

4. In a turbine engine, the combination of a driving wheel, an expansion chamber, a fluid plug feed chamber, located between the expansion chamber and the wheel, for successively delivering plugs of fluid, of definite and measured quantity, to a position to be driven therefrom toward the driving wheel, means for completely filling the last-named chamber with fluid, and means for delivering gas to said expansion chamber.

5. In a turbine engine, the combination of a driving wheel, a fluid plug discharge apparatus for delivering plugs of fluid to said wheel, a fluid plug feed chamber for successively delivering plugs of fluid, of definite and measured quantity, to a position to be driven into said discharge apparatus, means for completely filling said chamber with fluid, and means for supplying an expansible driving fluid to propel each said plug from the chamber and into the discharge apparatus.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM FENNELL.

Witnesses:
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