No. 876,860. PATENTED JAN. 14, 1908.

H. I. CROMER.

TURBINE ENGINE.

APPLICATION FILED MAY 3, 1906.

Fig. 1.

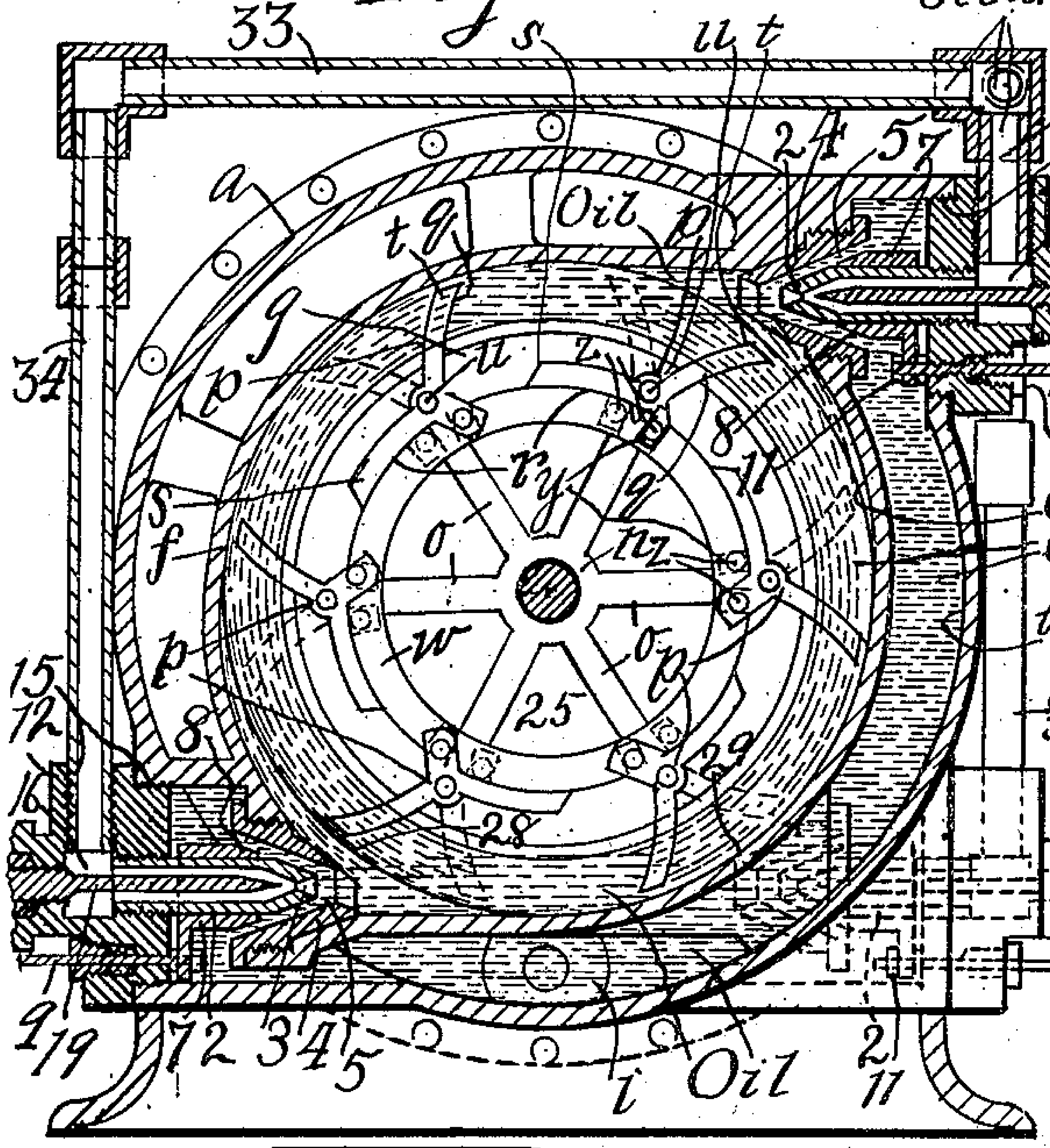


Fig. 2.

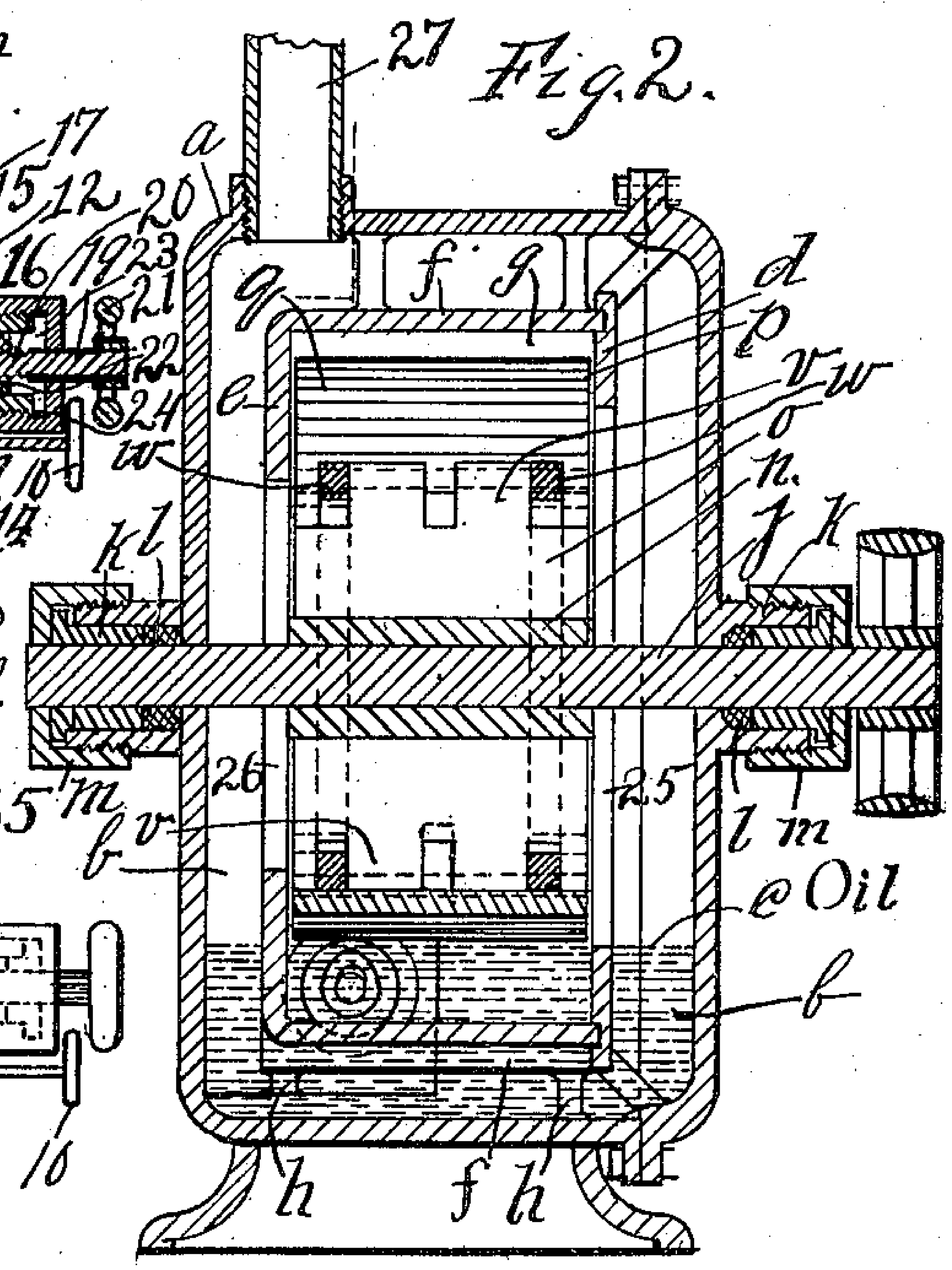
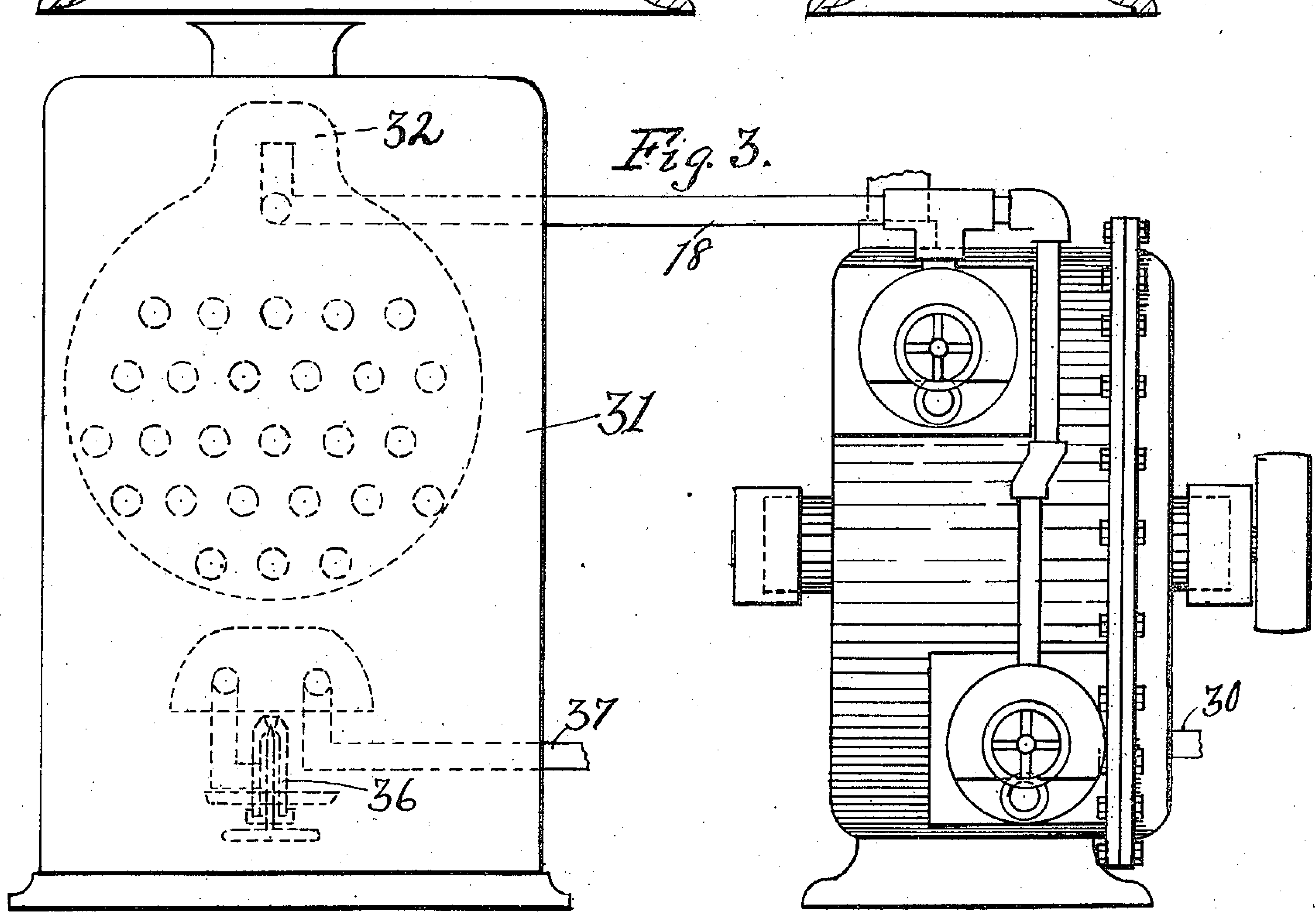


Fig. 3.



Witneses.
Adolphus G. Scott
Ethel M. Jones

Inventor.
Harry I. Cromer.

UNITED STATES PATENT OFFICE.

HARRY I. CROMER, OF CHICAGO, ILLINOIS.

TURBINE-ENGINE.

No. 876,860. Specification of Letters Patent. Patented Jan. 14, 1908.

Application filed May 3, 1906. Serial No. 315,013.

To all whom it may concern:

Be it known that I, HARRY I. CROMER, a citizen of the United States, residing in Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Turbine-Engines, of which the following is a specification.

In the art to which this invention relates, it is well known that power may be produced by means of the expansion of a compressible fluid such as gas, air or steam; also that such compressible fluid or fluids may be caused to impinge against mechanism to be operated thereby so as to produce power which results principally from the speed of movement of the current rather than from the mere expansion thereof. Non-compressible fluid or liquid such as water, has also been employed in producing power resulting from its speed of movement independently of the expansive quality of compressible fluids. It is found in practice, however, that the method of producing power which consists in forming a current or currents of compressible fluid and causing the same to impinge against mechanism to be operated thereby possesses serious disadvantages which it is very desirable to overcome in a practical and efficient manner. One of these disadvantages is that compressible fluid when used by the known methods is either in the form of a current or currents having a speed in excess of that which is most desirable, or else such compressible fluid is employed in the form of separate charges adapted to operate reciprocating or rotary pistons by the expansion of the fluid. When the fluid is employed so as to produce power by its expansion, the mechanism or engines to be driven are required to be of objectionable size and weight relatively to the power produced, and vibrations or objectionable pulsations are also produced, all of which should be overcome. When compressible fluid alone is used by any known method in the form of a current so as to afford power principally by reason of its speed of movement, the speed of such current is required to be excessively high at the point of contact with the mechanism to be operated. This necessitates the driving of the turbine wheel, or similar mechanical device, at a correspondingly high and objecjtionable peripheral speed, and requires a wheel of excessively large diameter, or the driving of a wheel of less diameter at an excessively high speed of rotation. This excessive speed of the current of fluid at the point of contact with the wheel and the consequent objectionable speed of rotation of the wheel, is injurious to the mechanism or engine and results in waste of energy often requiring increased gearing either in the form of reduction gears or interchangeable speed gears.

A method of producing motive power which requires the use of water or other liquid in large quantities is objectionable, and one of the objects of this invention is to obtain the advantages which result from using liquid while dispensing with the use of an excessive quantity of liquid,—in other words to obtain the desired results with a minimum quantity of liquid.

It is very desirable to provide a method of producing motive power which will enable the speed of rotation of a turbine or motor wheel or similar device to be controlled and varied as desired, and also to enable such engines or motors to be economically operated at a lower speed than is practicable when power is produced and applied through the medium of compressible fluid by known methods. It is also desirable to provide a method of producing power which will enable the maximum power to be obtained and utilized relatively to the weight of the engine or motor to which such power is applied.

The principal object of the invention is to provide a simple, economical and efficient rotary or turbine engine.

A further object is to provide a turbine engine or motor adapted to be operated by means of a current or currents of intermixed compressible fluid and liquid passing tangentially into engagement with the wheel, with means for intermixing such fluid and liquid in such a manner as to produce a current of greater weight relatively to its speed than a current of compressible fluid alone without condensing the compressible fluid or steam before it comes in contact with the wheel and adapted to minimize the noise caused by the escaping steam and without producing objectionable back pressure.

A further object is to provide, in a turbine engine or motor having a rotatable wheel, suitable and efficient means for introducing a current of intermixed fluid and liquid into operative engagement or contact with such rotatable wheel, and to provide means for enabling the same liquid to be continuously kept in motion and heated and repeatedly or continuously intermixed with the constantly renewed current of compressible fluid and forced therewith into contact with the engine or motor wheel, and adapted to enable such continuously moving liquid to be separated from the compressible fluid in a simple, economical and efficient manner by the action of centrifugal force.

A further object is to provide a turbine engine or motor wheel adapted to be reversed and operated in either direction as desired at varying rates of speed, thus enabling reversible gears and interchangeable high and low speed gears to be dispensed with.

A further object is to provide a turbine engine with suitable means for introducing a current or currents of compressible fluid and intermixing liquid therewith in such a manner that a continuous current of liquid may be caused to encircle the wheel to be operated and intermixed with a portion of the compressible fluid which is moving toward the wheel, also adapted to enable the liquid to be separated from the compressible fluid by means of centrifugal force in such a manner as to operate upon the wheel continuously or repeatedly in combination with renewed compressible fluid, and without such loss of power as would result from permitting the liquid to become stationary.

Other and further objects of the invention will appear from an examination of the drawings and the following description and claims.

The invention consists in the features, combinations and details of construction hereinafter described and claimed.

In the accompanying drawings, Figure 1 is a sectional elevation of a turbine engine or motor constructed in accordance with my improvements; Fig. 2, a central sectional elevation taken on line 2 of Fig. 1 looking in the direction of the arrow and showing the wheel in end elevation, and Fig. 3, a view in elevation showing the engine and a boiler operatively connected therewith.

The improvements in the apparatus herein described relate particularly to rotatory or turbine engines or motors and the means for enabling such engines or motors to be driven by means of a current or currents of intermixed compressible fluid and liquid in such a manner that the rotatable wheel may be economically driven at a lower peripheral speed than it is practicable to economically drive such wheels by means of a current of compressible fluid or fluids without intermixing liquid therewith.

As already suggested it is well known that turbine engines or motors which are operated by means of a current or currents of compressible fluid, such as air, steam or gas, can only be economically operated at an excessively high peripheral speed. It is also well known that such engines or motors are not adapted to be controlled or operated in an economical manner at any desired rate of speed, or to enable the power to be increased to the desired extent with relation to the speed.

In constructing an engine or motor in accordance with my improvements adapted to overcome these objections, I provide a casing *a* formed of metal or of any suitable material having the required strength to withstand the stresses and strains to which it is subjected in use. This casing is provided with a liquid supply chamber *b* which is partially filled with liquid preferably having a higher boiling point than pure water. The liquid may be in the form of brine, but on account of freedom from causing corrosion of the mechanism, a mineral oil which also has the desired high boiling point is ordinarily preferable. An inner casing portion having end walls *d* and *e*, and wheel-encircling walls *f* forms a wheel-containing and operating chamber *g* which is also provided with a quantity of liquid *c*. The liquid contained in the operating chamber and in the liquid supply chamber *b* should in fact be capable of being heated to a temperature as high as that of the steam with which it is intermixed without such liquid or oil coming to a boil or evaporating.

Inner walls *h* together with the outer casing form liquid inlet passages through which the liquid or oil is adapted to pass from the liquid supply chamber *b* into the operating chamber and into contact with the turbine or motor wheel contained in such operating chamber. The liquid supply chamber communicates with the operating chamber and is adapted to receive the surplus or excess of liquid therefrom during the operation of the apparatus and afford a supply of liquid for such operating chamber. Openings *i* in the walls *h*, preferably at the bottom of the engine, permit the liquid to be drawn from the liquid supply chamber *b* through the passages formed by the walls *h* and forced into contact with the wheel in the manner hereinafter described. A main shaft *j* is mounted in suitable bearings *k* in the engine frame or casing. These bearings are provided with packing rings *l*, and securing caps *m* which may be of any ordinary and well known type. A turbine or motor wheel *n* having blades *o* is mounted upon the main engine or driving shaft and secured in fixed relation thereto inside the operating chamber. Each of the blades *o* is provided with a movable or tiltable outer portion *p* pivotally mounted at its outer end, and each of these pivotal blade portions is provided with concave surface portions *q* and *r* which are adapted to face in opposite directions when in extended position and receive the impact of the operating fluid for turning the wheel in either direction as desired. The concave surface portions *r* are adapted to be presented in position to receive the impact of the operating fluid when the wheel is being driven in one direction, and the surfaces *q* receive the impact for operating in the opposite direction. These pivotal blade portions are each provided with preferably two integral arm portions *s* and *t* which extend outward at an angle with relation to each other from pivots *u* which form the pivotal points for the several pairs of such integral pivotal or tiltable blade portions. These pivots are mounted in suitable lug portions *v* of the main supporting arms or blades of the wheel and extend through suitable perforations in the pivotal wing or blade portions, and the inner edges of the pivotal blade portions are recessed to form securing lug portions. The recessed portions also swing into engagement with the supporting arm or blade portions so as to hold the wings in position to be readily tilted in one direction and yet firmly and rigidly resist the pressure of the operating fluid against the blades. By this arrangement when either arm is moved to extended position so as to receive the impact of the current of operating fluid, the other arm of each pair will extend substantially parallel with the movement of the wheel and in the direction of movement of the liquid, the convex face of the extended arm or blade being in the direction of movement of the wheel, and its concave surface being at the proper angle and in position to receive the impact of the operating fluid.

In order to enable all of the pivotal members to move together in position to present the desired arm in extended position and prevent their movement separately, connecting rings *w* are mounted inside the pivotal blade portions and provided with slots *y* which engage studs *z* on the pivotal wings in such a manner that the movement of one pair of wings in either direction will cause the movement of all of the others to corresponding position. The connecting rings thus serve to lock all of the pivotal blade portions in the desired position corresponding to the direction of movement of the wheel, and when the direction of the pressure fluid is reversed it will impinge against the convex or extended sides of the pivotal members throwing the extended arm or blade portion inward and the inner arm or blade portion outward to extended position so as to receive the reverse current of fluid upon the convex sides of such extended pivotal blade portions.

One or more compressible fluid inlet nozzles 2 are provided and arranged in position to project a current of compressible fluid into the operating chamber tangentially with relation to the turbine or motor wheel and operating chamber, causing such current of fluid to impinge against the blades of the wheel so as to rotate it in the direction corresponding to the direction of such current. The inlet apertures 3 of these nozzles are arranged at a sufficient distance from the periphery of the wheel to permit the liquid to be intermixed with the compressible fluid to pass between the blades and such apertures. The liquid is caused to pass in a preferably continuous current into the path of the compressible fluid and is thus intermixed with a portion of the current of compressible fluid which is moving toward the blades of the wheel and before such portion of the compressible fluid impinges against the wheel. It is also desirable that the liquid while converging with the current of compressible fluid and immediately before striking or entering such current, should be moving in the direction corresponding as nearly as practicable with the direction of movement of the compressible fluid so that the intermixed fluid and liquid shall have the maximum force relative to the speed of such current,—in other words, so that the force of the current of compressible fluid will not be impaired by constantly overcoming the inertia of liquid having little or no movement favorable to the operation of the wheel. In order to accomplish this, an aperture or liquid nozzle 4 is provided for each of the compressible fluid nozzles forming a liquid inlet passage 5 which converges with the adjacent pressure fluid passage or inlet and is adapted to introduce the liquid into the path of movement of the current of compressible fluid while both liquid and fluid are passing toward the wheel.

The inner peripheral surfaces 6 of the encircling walls of the operating chamber have portions which are preferably parallel with the path of movement or periphery of the wheel and another portion or portions which gradually converge toward the periphery of the wheel or the lateral edges of its blades in opposite directions from the respective inlet nozzles. In other words the inner peripheral wall of the operating chamber is preferably so constructed that a portion of such wall diverges from the periphery or path of movement of the wheel outward toward the adjacent inlet nozzle so as to cause the liquid on the inside of the operating chamber to pass outward laterally beyond the periphery of the wheel just before entering the current of compressible fluid, and to enter such current while passing at a slightly oblique angle to the current of compressible fluid in the general direction of the peripheral movement of the wheel and the moving current of compressible fluid. The liquid is thus enabled to have a speed as nearly as possible equivalent to the speed of the current of compressible fluid immediately before and at a point of converging therewith. A sleeve valve 7 is provided and slidably mounted upon each of the compressible fluid nozzles having a tapered surface portion 8 which is adapted to engage the walls of the liquid inlet passage 5 or liquid inlet nozzle and open or close such passage to any desired extent. Each of these sleeves is provided with a threaded operating rod 9 having a hand wheel 10 on its outer end and secured at its inner end by means of nuts 11, to the sleeve 7. This rod is in threaded engagement with a plug 12 through which it passes and is provided with a suitable packing 13 and plug 14 for preventing the escape of operating fluid. The plugs 12 are each provided with a threaded portion 15 in threaded engagement with the main casing of the engine and the compressible fluid inlet nozzles 2 are mounted in this plug so as to form passages which communicate with the fluid chamber 16 in the plug and direct the currents of compressible fluid projected therefrom inward tangentially with relation to the operating chamber and wheel.

The end or flat wall portions of the operating chamber extends inward toward the axial center of the wheel a sufficient distance to retain the desired quantity of liquid in the operating chamber and are provided with perforations for permitting the escape of compressible fluid or steam from the operating chamber after the liquid has been separated therefrom by the action of centrifugal force. The liquid being heavier than the compressible fluid retains its position at or laterally beyond the periphery of the wheel and forms a continuous current entirely encircling the wheel and sufficient to immerse and engage the peripheral edge portions of its blades. The fluid chambers in the plugs 12 are connected with the source of compressible fluid supply by means of pipes 17 and 18. A needle 19 extends through the plug 12 and into the fluid inlet nozzle and is adapted to open and close or control the size of the pressure fluid inlet opening and thereby regulate the volume of compressible fluid. Each of these needles is provided with a threaded portion 20 in threaded engagement with a plug 12, and with a hand wheel 21 upon its outer end by means of which the needle or spindle is adapted to be rotated. A suitable packing or bearing ring 22 and plug 23 are held in place by means of a cap 24 so as to form a suitable bearing adapted to prevent the escape of fluid.

In Fig. 1 two forward driving nozzles are shown which are adapted to rotate the wheel in one direction, and one reversing backward driving nozzle is shown at the bottom right hand corner of the figure. Any desired number of both forward and rearward driving nozzles may be employed, and all may be substantially of the same construction. The description of one therefore applies to all and it is deemed unnecessary to describe each individually. The reversing nozzle is disposed so as to introduce or supply a current of compressible fluid and cause liquid to be intermixed with such compressible fluid after it leaves the compressible fluid nozzle and is adapted to direct such intermixed current in the direction opposite to that of the current or currents formed by the other two nozzles shown in said figure. The liquid inlet of this nozzle may be opened or closed as desired in the manner already described. When the reversing nozzle is in operation the forward driving nozzles are closed but when the forward driving nozzles are in operation the liquid passage of the reversing nozzle may be left open or closed as desired so as to permit liquid to be drawn by centrifugal force through such liquid passage from the operating chamber into the passage formed between the walls *h* which lead to the upper driving nozzle or nozzles. When the liquid passage of the reversing nozzle is closed, however, the liquid contained in the operating chamber may be permitted to remain therein until it reaches the desired quantity, being maintained by centrifugal force at or outward beyond the periphery of the wheel so as to form an endless current of liquid constantly converging with a constantly renewed portion of the current of compressible fluid and passing therewith into operative contact with the blades of the wheel.

The wall *d* of the operating chamber is provided with a large axial opening 25 through which the liquid which is in excess of the desired amount to be maintained in the operating chamber may escape into the liquid supply chamber *b*. The opposite wall is provided with a similar opening 26, and through these axial openings in the end walls of the operating chamber the compressible fluid is caused to escape by being driven toward the center as a result of the superior weight of the liquid and the action of centrifugal force thereon. The compressible fluid is permitted to escape from the chamber *b* through an outlet passage or exhaust pipe 27 which may lead to another operating chamber when a plurality of wheels in separate operating chambers are to be employed. The forward driving nozzles may be upon one side of the vertical or transverse center of the wheel and the reversing nozzle or nozzles may be on the opposite side of such center so as to cause fluid therefrom to impinge against the curved surface portion 28 of the inner operating chamber wall while passing the adjacent forward driving nozzle. The fluid projected from the forward driving nozzle adjacent to such reversing nozzle impinges against and passes over the curved surface portion 29 adjacent to the reversing nozzle and flows parallel with the periphery of the wheel for any desired distance corresponding with the pitch of the curve of the inner wall portion of the operating chamber.

The curve of the inner face of the operating chamber wall may be at any desired angle with relation to the periphery of the wheel at the points of intersection with the nozzles. By this means the current is permitted to diverge from the periphery of the wheel just before being intermixed with the current of compressible liquid, and upon being intermixed with such current or currents of compressible liquid the intermixed liquid is maintained in the proper direction and position to efficiently engage and operate the periphery of the wheel. It passes parallel with the path of movement of the wheel for the desired distance expending its force thereon and being separated from the compressible fluid by the action of centrifugal force and retained in the operating chamber. The liquid in an endless current thus operates continuously and repeatedly in connection with a constantly renewed and continuous current or currents of compressible fluid. An oil supply pipe 30 is provided which communicates with a suitable source of liquid supply, preferably oil, and which is adapted to enable the liquid to be introduced in a convenient manner. The liquid may be supplied to the operating chamber until a sufficient quantity is reached to produce the desired effect and the liquid inlets or nozzles leading into such operating chamber may then be closed if desired while continuing the introduction of compressible fluid, the liquid remaining substantially continuously in the operating chamber and being constantly intermixed with such compressible fluid and caused to impinge against the blades of the wheel when intermixed in the manner already described. When it is desirable to employ a constantly renewed current of liquid, the liquid passages of the nozzles may remain open to the desired extent so as to constantly supply liquid in addition to that contained in the operating chamber and cause a constant flow of both liquid and compressible fluid into and out of the operating chamber.

It is desirable that the liquid intermixed with the compressible fluid should be maintained at a high temperature preferably above the boiling point of water. In order to accomplish this, in an efficient manner and to provide means for supplying compressible fluid under pressure to be intermixed with such liquid and forced therewith into operative engagement with the turbine or motor wheel, a boiler 31 is provided which may be of any ordinary and well known form having a compressible fluid supply pipe 18 already described, forming a steam supply passage leading from the dome or steam chamber 32 of the boiler through the pipes 33, 34, 35, and 17 into the steam chambers 16 in the plugs 12, and thence to the respective compressible fluid supply nozzles and the operating chamber. The boiler here shown is provided with an oil burner 36 which may be of any ordinary and well known type, and is provided with an oil supply pipe 37 which communicates with a suitable source of oil or compressible fluid supply.

In operation compressible fluid for operating the engine is forced in a continuous current or currents toward the blades of the engine or motor wheel and the heated liquid is intermixed with a portion of such current or currents while moving toward the wheel and after being projected from the nozzle or nozzles is as dry a condition as possible. The liquid is caused to flow in a preferably continuous current which encircles the wheel to be operated thereby, and is separated from the compressible fluid by centrifugal force which causes the liquid to force the steam toward the center of the wheel and permitting it to pass out of the operating chamber, thus separating the compressible fluid and liquid.

A turbine engine or motor constructed as above described is adapted to run efficiently at a relatively slow peripheral speed and is very efficient as a portable engine, and is capable of sustaining the shocks and vibrations which would in a short time injure or destroy an engine which is required to run at the high peripheral speed required when compressible fluid alone is used. An engine so light as to be handled manually may have high power in proportion to its weight and therefore be very efficient in use for many purposes familiar to those skilled in the art. It should also be noted that the intermixing of the liquid with the compressible fluid in the manner above described, serves to muffle or reduce the noise caused by the escaping steam without causing back pressure or reducing the efficiency of the steam. This results from reducing the speed of the steam before it strikes the mechanism to be operated and is very desirable, especially for automobiles and other portable engines or motors.

I claim:

1. In a turbine engine the combination of a rotary wheel having peripheral blades, a casing forming an operating chamber in which such wheel is mounted and provided with compressible fluid and liquid inlet passages communicating with separate sources of supply and leading tangentially into the chamber, said chamber having imperforate end wall portions extending from the peripheral wall of the chamber inward past the periphery of the wheel and adapted to retain an annular revolving current of liquid in the operating chamber, and having a compressible fluid outlet leading from the chamber at a point toward the axial center of the wheel from the outer annular water-containing portion of the chamber.

2. In a turbine engine, the combination of rotary wheel mechanism having lateral

blades, and a casing forming a chamber in which such wheel mechanism is mounted provided with a compressible fluid nozzle and a liquid inlet nozzle leading tangentially into the chamber in position to discharge intermixed currents of compressible fluid and liquid against the wheel mechanism for rotating it, said chamber having an annular centrally perforated end wall adapted to retain a revolving annular current of water in the chamber and permit the escape of compressible fluid and thereby separate the compressible fluid from the liquid in the said chamber.

3. In a turbine engine, the combination of rotary wheel mechanism provided with peripheral blades, a casing forming an inner annular operating chamber in which the wheel mechanism is mounted, and an outer water containing chamber forming a water passage which partly encircles the operating chamber and wheel and opens into the operating chamber at a tangent with relation to the wheel mechanism, said operating chamber having an end wall extending from the peripheral wall of said chamber inward past the periphery of the wheel mechanism toward the axial center thereof and adapted to retain a revolving annular current of water in the operating chamber, said end wall having an opening inside the outer annular water retaining portion thereof adapted to permit the escape of compressible fluid from the chamber and thereby separate the said compressible fluid from the liquid in the chamber, and a compressible fluid inlet nozzle mounted adjacent to the inlet opening of the liquid passage in position to discharge a current of compressible fluid into the liquid and tangentially into the operating chamber.

4. In a turbine engine, the combination of a casing forming an annular inner operating chamber and a lateral water containing passage which partly encircles and leads tangentially into the operating chamber, a fluid inlet nozzle communicating with a compressible fluid supply passage and opening into the liquid inlet passage in position to discharge a current of compressible fluid through the liquid passage and tangentially into the operating chamber, wheel mechanism having peripheral blades mounted in the operating chamber, means for permitting the escape of compressible fluid from the operating chamber and retaining a revolving annular current of water in said chamber, thereby separating the compressible fluid from the liquid in said chamber, and means for permitting the escape of compressible fluid from and retaining the liquid in the lateral water containing chamber or passage.

5. In a turbine engine, the combination of a casing having inner peripheral and end wall portions forming an annular inner operating chamber adapted to retain an annular current of water and provided with a central outlet opening in the end wall portion of the operating chamber for permitting the escape of compressible fluid from the chamber, a wheel rotatably mounted in the chamber and provided with radial blades having their outer peripheral edges extending laterally beyond the outer edge of the outlet opening of the operating chamber, a liquid inlet nozzle opening into the operating chamber tangentially with relation to the wheel, and a fluid inlet nozzle opening into the operating chamber tangentially with relation to the wheel and communicating with a compressible fluid supply passage.

6. In an engine, the combination of a casing provided with an operating chamber and having a compressible fluid inlet passage and a liquid inlet passage leading into such chamber, rotatable wheel mechanism mounted in such chamber in position to be rotated by the compressible fluid and liquid from such passages and means for separating the compressible fluid from the liquid in the operating chamber substantially as described.

7. In an engine, the combination of a casing provided with an operating chamber and having a compressible fluid inlet passage and a liquid inlet passage leading into such chamber, rotatable wheel mechanism mounted in such chamber in position to be operated upon by the compressible fluid and liquid from such passages, valve mechanism for opening and closing the compressible fluid inlet passage and means for separating the compressible fluid from the liquid in the operating chamber and permitting the escape of the compressible fluid therefrom, substantially as described.

8. In an engine, the combination of a casing provided with an operating chamber and having a compressible fluid inlet passage and a liquid inlet passage leading into such chamber, rotatable wheel mechanism mounted in such chamber in position to be operated upon by the compressible fluid and liquid from such passages, valve mechanism for opening and closing the compressible fluid inlet passage, means for opening and closing the liquid inlet passage means for separating the compressible fluid from the liquid in the operating chamber, and means for permitting the escape of the compressible fluid from the casing and retaining the liquid therein, substantially as described.

9. In an engine, the combination of a casing provided with an operating chamber and having a compressible fluid inlet passage and a liquid inlet passage leading into such chamber and provided with a liquid containing chamber with which the liquid passage communicates, rotatable wheel mechanism

mounted in such operating chamber in position to be operated upon by the compressible fluid and liquid from such passages, a nozzle for such compressible fluid inlet passage, means for opening and closing the compressible fluid inlet passage means for separating the compressible fluid from the liquid in the operating chamber and permitting the escape of the compressible fluid, and means for permitting the escape of the compressible fluid from the casing and retaining the liquid, substantially as described.

10. In an engine, the combination of a casing provided with an operating chamber having a compressible fluid inlet passage and an inlet passage for liquid, a nozzle for each of such passages, valve mechanism for opening and closing such passages respectively, power translating mechanism mounted in such chamber in position to be impinged and operated by the compressible fluid and liquid from such passages means for retaining an annular current of liquid in the operating chamber and permitting the escape of compressible fluid therefrom, and means for permitting the escape of compressible fluid from the casing and retaining the liquid, substantially as described.

11. In an engine, the combination of a casing provided with an operating chamber containing liquid, a rotatable wheel mounted in such chamber and adapted to be entirely encircled by such liquid when in operation, means for forcing compressible fluid into such chamber through the liquid and into engagement with such rotatable wheel and means for forcing the compressible fluid inward through the wheel encircling liquid on the inside of the operating chamber and permitting it to escape therefrom, substantially as described.

12. In an engine, the combination of a casing provided with a liquid containing chamber, a wheel rotatably mounted in such liquid containing chamber and provided with blade portions having their outer edges immersed in such liquid, means for forcing a current of compressible fluid into such chamber through the liquid and into engagement with the blade portions of such wheel and means for causing the liquid to pass repeatedly into the path of movement of the portion of the compressible fluid passing into the chamber and toward the wheel and into driving contact with the wheel, substantially as described.

13. In an engine, the combination of a casing provided with an operating chamber, a wheel rotatably mounted in such operating chamber, a compressible fluid inlet passage provided with an inlet aperture opening into the operating chamber, means for introducing liquid between such aperture and the rotatable wheel and means for confining the desired portion of the liquid in the operating chamber and separating and permitting the escape of compressible fluid therefrom substantially as described.

14. In an engine, the combination of a rotatable wheel, a casing provided with a chamber in which such wheel is rotatably mounted, and having a compressible fluid inlet passage provided with a mouth opening into such operating chamber, such chamber being provided with revolving annular current of liquid extending between the mouth of such compressible fluid passage and the rotatable wheel, substantially as described.

15. In an engine, the combination of a rotatable wheel, a shaft on which the wheel is mounted, a casing provided with an operating chamber in which such wheel is rotatably mounted, and having a compressible fluid inlet passage opening into such operating chamber, such chamber being provided with liquid entirely encircling the wheel and extending between it and the inlet opening of the compressible fluid passage, and having an axial opening through which the shaft extends adapted to permit the escape of compressible fluid from the operating chamber, substantially as described.

16. In an engine, the combination of a casing provided with an operating chamber having a compressible fluid inlet passage communicating therewith, and provided with a liquid supply chamber communicating with the operating chamber, means for opening and closing the compressible fluid inlet passage, a wheel mounted in the operating chamber in position to be operated upon by the compressible fluid and liquid, such operating chamber being provided with an opening for permitting the escape of compressible fluid therefrom and having end walls extending from a point beyond the periphery of the wheel inward toward the axial center thereof for retaining the desired quantity of liquid in such operating chamber, substantially as described.

17. In an engine, a rotatable wheel provided with pivotal blade portions each having a pair of arms extending at an angle with relation to each other and provided with curved surface portions, and means for operatively connecting a plurality of such blade portions.

HARRY I. CROMER.

Witnesses:
ETHEL M. JONES,
THOS. M. POYNTON.