C. W. WEISS.

INTERNAL COMBUSTION TURBINE.

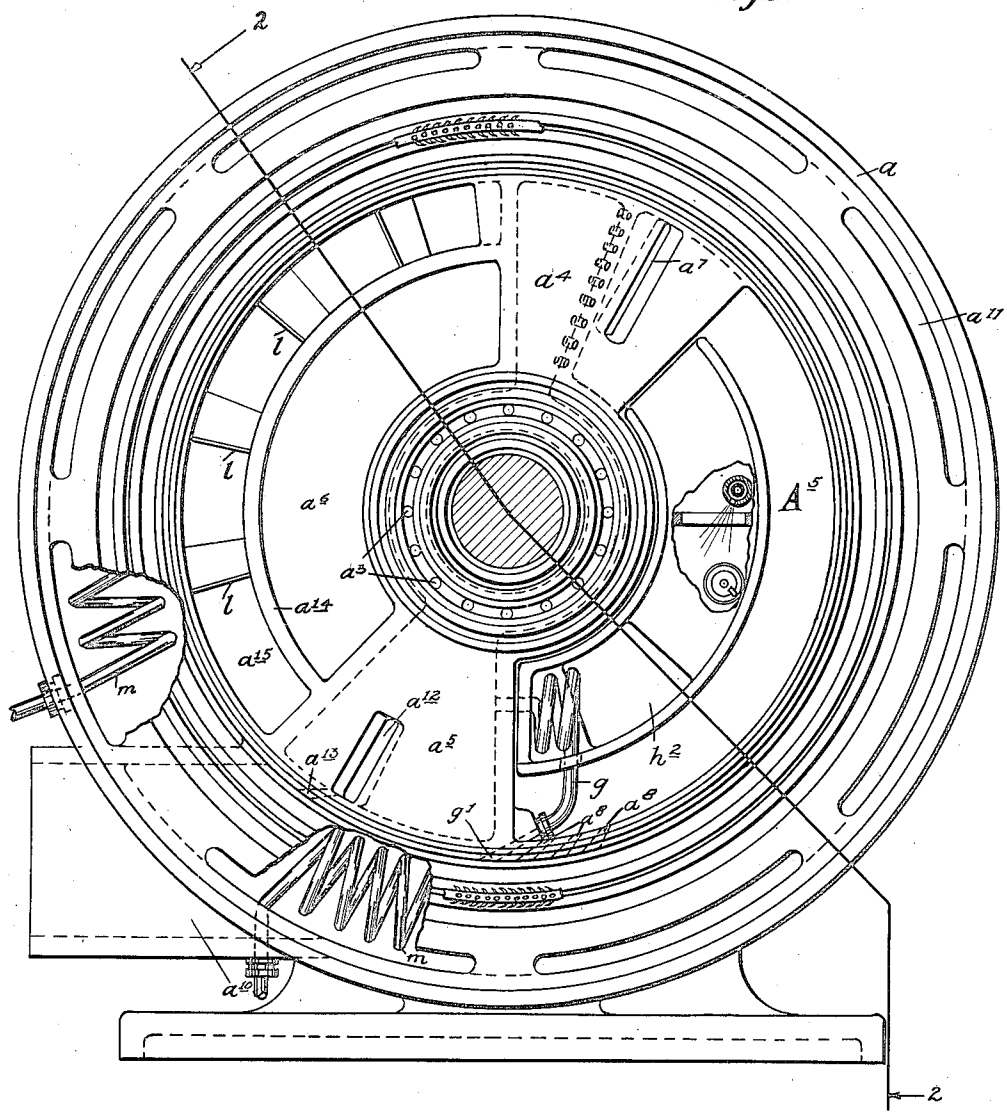
APPLICATION FILED FEB. 21, 1917.

1,284,841.

Patented Nov. 12, 1918.

5 SHEETS—SHEET 1.

Fig. 1.



INVENTOR.

Carl W. Weiss

BY Redding Ernst & Bartlett

ATTORNEYS.

ATTEST

H. F. Franklin

C. W. WEISS.

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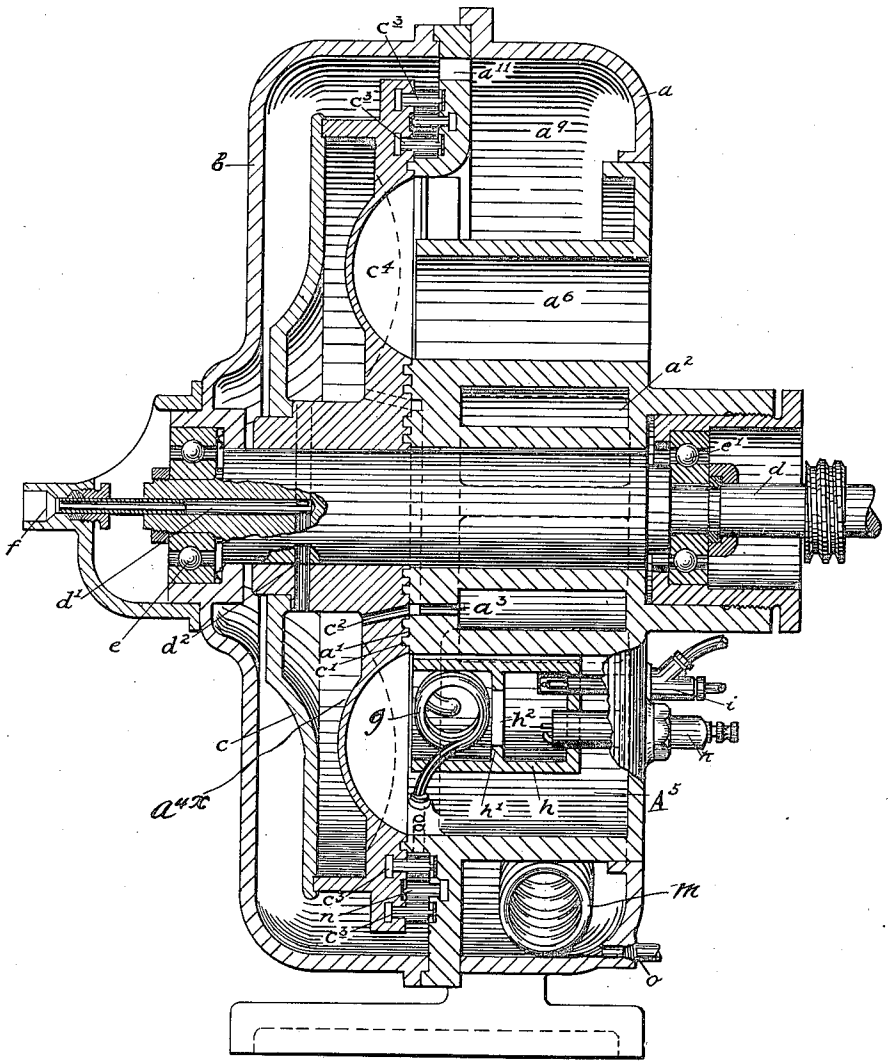
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5 SHEETS—SHEET 2.

Fig. 2.



ATTEST

H. F. Franklin.

INVENTOR.

Carl W. Weiss

BY

Redding Gurley & Geddes

ATTORNEYS.

C. W. WEISS.

INTERNAL COMBUSTION TURBINE.

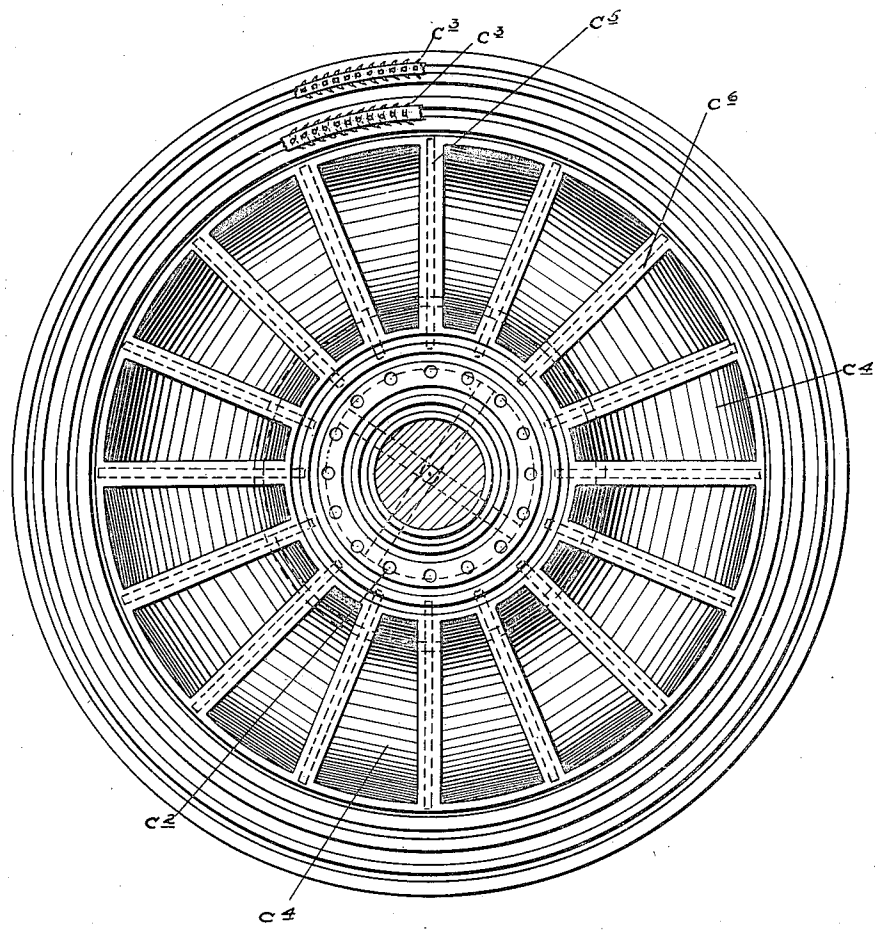
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5 SHEETS—SHEET 3.

Fig. 3.



INVENTOR.

Carl W. Weiss

BY

Redding Ensley & Burdett

ATTORNEYS.

ATTEST

H. F. Franklin.

C. W. WEISS.

INTERNAL COMBUSTION TURBINE.

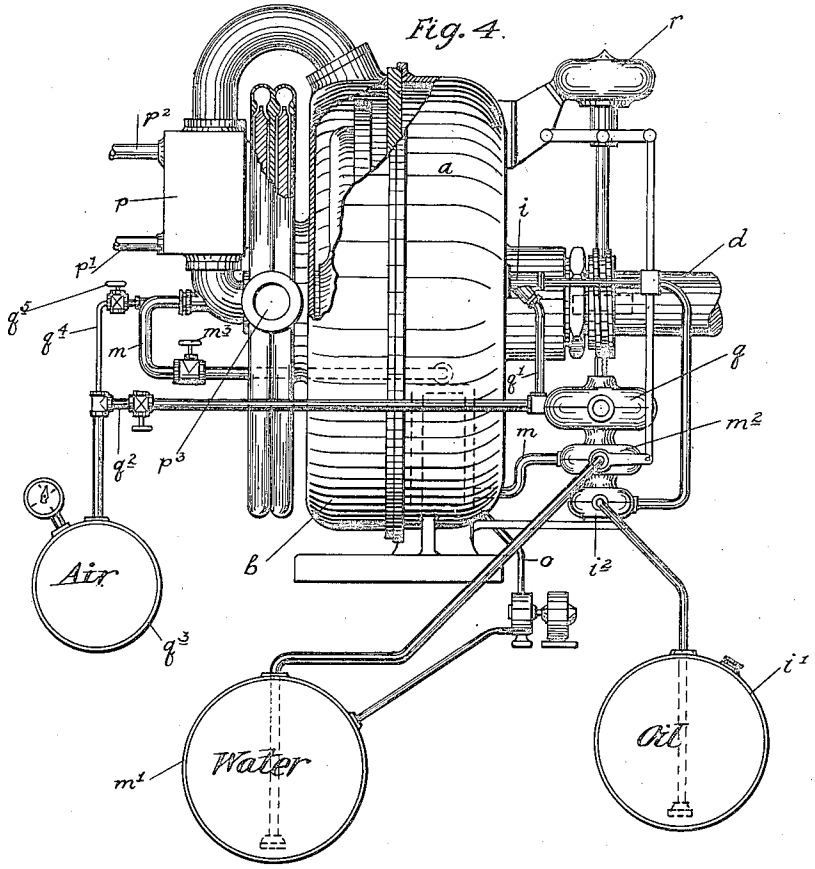
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5 SHEETS—SHEET 4.

Fig. 4.



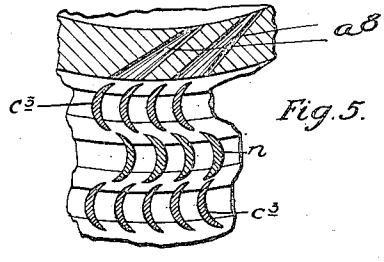


Fig. 5.

ATTEST.

H. F. Franklin

INVENTOR.

Carl W. Weiss

BY

Redding Ensley & Bordlett

ATTORNEYS.

C. W. WEISS.

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5 SHEETS—SHEET 5.

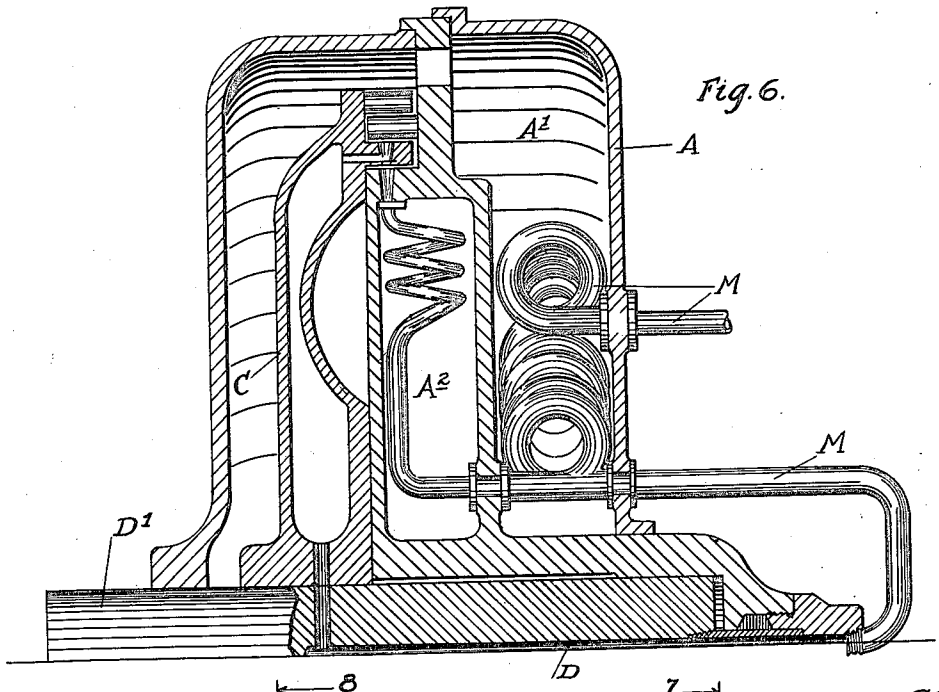


Fig. 6.

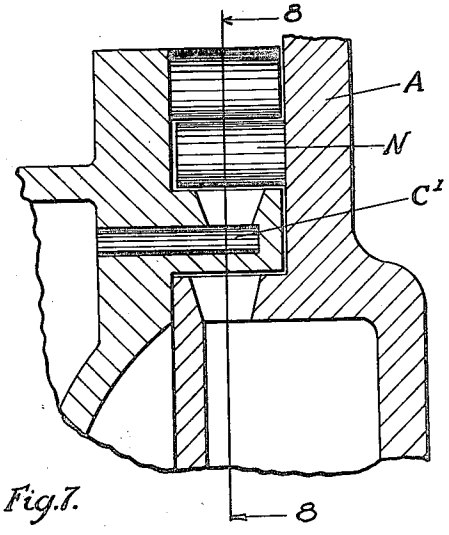


Fig. 7.

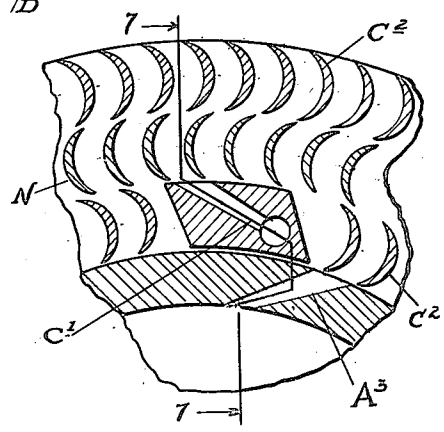


Fig. 8

INVENTOR.

Carl W. Weiss

BY

Reading, Emby & Goodlett

ATTORNEYS.

ATTEST.

H. F. Franklin

UNITED STATES PATENT OFFICE.

CARL W. WEISS, OF BROOKLYN, NEW YORK.

INTERNAL-COMBUSTION TURBINE.

1,284,841. Specification of Letters Patent. Patented Nov. 12, 1918.

Application filed February 21, 1917. Serial No. 150,142.

To all whom it may concern:

Be it known that I, CARL W. WEISS, a citizen of the United States, residing in the borough of Brooklyn of the city of New York, in the State of New York, have invented certain new and useful Improvements in Internal-Combustion Turbines, of which the following is a specification, reference being had to the accompanying drawings, forming a part hereof.

This invention relates to internal combustion turbines in which products of combustion are delivered at high velocity through suitable nozzles against the rotor so that by impact or reaction or by both impact and reaction the rotor is driven at high speed. In machines of this type in which the efficiency is dependent upon the temperature and pressure of the gases it is evident that the parts must be maintained, for best results, at about what might be termed the critical temperature, below which power will be lost and above which mechanical troubles will follow. It is the object of the present invention to provide a gas turbine in which a thermo medium of suitable properties, such as steam, is employed for maintaining the parts at about this critical working temperature after recovering from the spent gases and returning the waste heat to the machine in some form available for useful work. A further object of the invention is to provide a thermo medium of the character described which shall be available as a lubricant for the rotating parts and shall itself be employed as a propulsive force for the rotor. Still another object is to increase further the efficiency of a gas turbine by providing in combination with the exhaust chamber therefor condenser means by which a partial vacuum in said chamber may be created to establish a negative pressure at one side of the rotor blades while they are subjected at the other side to a positive pressure. In this way the differential propulsive effort is materially increased. Another feature of the invention has to do with the construction and relative disposition of the rotor pockets with relation to the ports in the fixed casing whereby a constant supply of fresh air to the combustion chamber through displacement of the air in the pockets and the products of combustion in the chamber, is insured, and whereby a corresponding mutual displacement of the waste gases in the pockets and fresh air is secured at the exhaust port. Another feature is the superheater placed in the combustion chamber to utilize the high temperature of combustion to better advantage by absorbing a portion of this heat by a second working medium to be returned to the rotor in a jet of high velocity. Other objects of the invention having to do generally with improved structural features of the constituent parts of the machine and the provision of an improved combination formed by the association with the turbine of various auxiliary devices including oil, water and air pumps and reservoirs and a governor therefor, will appear from the detailed description of the accompanying drawings, in which—

Figure 1 is a view in elevation of the inner face of the casing with the rotor removed.

Fig. 2 is a view in section taken on the irregular plane indicated by the line 2—2 of Fig. 1 and looking in the direction of the arrows.

Fig. 3 is a view in elevation of the face of the rotor.

Fig. 4 is a general view, somewhat diagrammatic, of a plant showing the improved turbine with its auxiliary units.

Fig. 5 is a fragmentary detail view showing the relation of the nozzle and blades of the embodiment of Fig. 1.

Fig. 6 is a fragmentary detail view in transverse section through a casing and rotor of a gas turbine of somewhat modified construction.

Figs. 7 and 8 are fragmentary detail views in section on an enlarged scale taken along the plane indicated by the corresponding numbers in the respective figures and showing particularly the relation of the blades, nozzles and casing of the embodiment of Fig. 6.

The improved turbine comprises generally a casing *a* having a cover *b* inclosing a hollow rotor *c* which is secured on the turbine shaft *d*, journaled in suitable bearings *e*, *e'*, one of which *e'* may be adjustable axially for the purpose of changing the relation of the rotor to the casing for compensation for wear or expansion, etc. The proximate faces of the rotor *c* and the casing *a* engage with a free but substantially gas-tight working fit and are provided as usual with coöperating annular ribs and grooves *a'*, *c'*, for known reasons.

The shaft d at one end is channeled, as at d', for communication with a water and air feed pipe f, and this channel communicates with the interior of the hollow rotor c through radial ducts d^2 passing through the shaft and the hub of the rotor. In the body of the annular casing is formed an annular chamber a^2 which communicates through an annular series of ducts a^3 with a corresponding annular series of ducts c^2 extending through the face of the rotor and leading to the chamber therein, this communication between the annular chamber a^2 and the hollow rotor c being established through a groove a^{4x} common to said ducts during rotation of the rotor. The annular chamber a^2 in the casing a terminates in two radially extending cored chambers a^4, a^5, one of which a^5 discharges into a coiled pipe g which is disposed within the arcuate combustion chamber A^5 hereinafter to be described. The pipe g leads to a nozzle g' inclined at an angle to the blades c^3 on the face of the rotor adjacent its periphery.

As thus far described it will be clear that water is introduced into the annular chamber in the rotor c through the pipe d' and ducts d^2 and is converted into steam in the rotor from which it passes through the conduits c^2, a^3 into the chambers a^2, a^4, a^5, and thence through the coiled pipe g' from which it is discharged against the blades of the rotor to add thereto its propulsive force. This steam in passing from the rotor to the annular chamber a^2 flows, to a limited extent, into the clearance space between proximate faces of the casing and the rotor so as to form a lubricating film therebetween and prevent the deposit of carbon from the burning gases now to be referred to.

At one side of the casing a and immediately outside of the chamber a^2 is formed the arcuate combustion chamber A^5 in which is mounted an arcuate flame box h. Into this flame box extends an oil burner i, to which is supplied air and oil and alongside of this burner is supported an igniter k for the combustible. The flame box is preferably divided into two compartments by a web h', this construction facilitating the flow of air and gas within the chamber in the most advantageous manner for the action and functions desired. The oil burner and igniter are preferably disposed in one of these compartments while the steam coil g passes through the other. These two compartments, however, communicate through a port h^2 which aids in directing the currents of air and gas through the combustion chamber in the most advantageous manner.

The means for supplying fresh air to the combustion chamber for continuous and complete combustion will now be described. On the opposite side of the casing a from the combustion chamber A^5 there is provided an arcuate air inlet port a^6 of considerable length. On the inner face of the rotor c are formed a great number of radial pockets c^4 which move successively across the air inlet port a^6 and the combustion chamber A^5. With the rotor moving in a clockwise direction each pocket c^4 filled with fresh air passes on to the face of the casing a, thereby trapping the air in the pocket and on toward the combustion chamber A^5. At the end of the combustion chamber nearest the port a^6 communicating with said chamber there is formed a nozzle a^7 which is inclined in the direction of movement of the rotor so that the air which is heated, expanded and has its pressure raised in the combustion chamber A^5 above that in each relatively cool pocket before it is fully exposed to the heat in the combustion chamber may expand through the nozzle a^7 into the body of fresh air within the pocket c^4 and equalize the pressures and add, by reason of the inclination of the nozzle, a propulsive effort by its reaction in the pocket. The complete discharge of fresh air into the combustion chamber is insured by the centrifugal force impressed thereon at high speeds. At the end of the combustion chamber A^5 remote from the point where the fresh air is introduced and where the temperature and pressure of the products of combustion are greatest, there is formed in the peripheral wall of the chamber a series of inclined nozzles a^3 so disposed as to direct the expanding gas against the blades c^3 of the rotor with the maximum driving effort.

The exhaust chamber a^9 of the turbine is annular in form and preferably extends entirely around the casing a terminating in an exhaust outlet a^{10} which may open to atmosphere. The rotor chamber is nominally separated from the exhaust chamber a^9 by the face plate of the casing but, in fact, communicates with the exhaust chamber through a series of arcuate ports a^{11} so that the waste gases and steam discharged into the rotor chamber from the outermost series of vanes c^3, pass freely into the exhaust chamber a^9 and thence out of the outlet a^{10}. The waste gases carried by the pocket c^4 from the combustion chamber A^5 must also be disposed of. These gases, however, before being exhausted are permitted to expand into a secondary nozzle by which they are directed against the vanes c^3 to spend their force usefully. The gases pass through an opening a^{12} in the face of the casing a and thence through the inclined nozzle a^{13} and impinge upon the juxtaposed vanes c^3 on the rotor. This expansive effort leaves the gases within the pockets at about atmospheric pressure. Concentric with the air inlet port a^6 and juxtaposed thereto but separated therefrom by a guard wall a^{14}, is

an arcuate exhaust port a^{15} which communicates with the annular exhaust chamber a^9. In this port a^{15} are mounted a series of spaced radial deflector plates l to maintain the waste gases in regular streams and facilitate their flow from the pockets c^4 into the exhaust chamber. As soon as the pockets c^4 come into communication with the air inlet port a^6 and the exhaust port a^{15}, the centrifugal force acting on the waste gases within the pockets tends to throw outward the gases through the port a^{15}, while the air which enters through the port a^6, while also subjected to some centrifugal force after it enters the pockets, really has impressed on it an inductive effort by the outflowing waste gases, since the entering fresh air is nearer the axis of rotation and therefore subjected to a lesser centrifugal force. The net result is that most desired, to wit, the continuous and certain discharge of all waste products at atmospheric pressure into the exhaust chamber and the continuous and complete replenishing of the traveling pockets with fresh air for transfer to the combustion chamber.

For the recovery of waste heat from the machine and its return thereto in the form of available work there is disposed in the annular exhaust chamber a^9 what may be termed a regenerator m or heater coil through which passes the feed water before entering the channel d' in the end of the shaft d of the turbine. In its passage through this coil the feed water absorbs the heat from the exhaust products and the steam in these exhaust products which has absorbed its heat from the combustible in its passage through the superheater coil g returns the remaining portion of its heat to the water in the coil m, so that it may be said that the heat left in the exhaust is given up to the feed water which later must be converted into steam. All heat thus given to the feed water means, of course, a return to the machine of these heat units in a form which is available for useful work, the final heat of vaporization abstracted from the machine itself being relatively small.

The operation of the gas turbine as a unit will be described before taking up the auxiliary devices associated therewith and the modified forms of the turbine illustrated in the drawings. The feed water after being heated in the coil m by the waste products in the manner described passes through the pipe d' and the ducts d^2 into the hollow rotor c which is, in operation, highly heated by the combustible. The water in the jacket is converted into steam by the heat of the combustible and tends to spread over the inner surface of the chamber in the rotor, the cooling action of the steam on the walls of the rotor being to prevent its temperature from rising to an undesirable point, while maintaining the entire casing and the rotor at an even temperature. This cooling action may be enhanced by forming radial grooves c^5 in the inner faces of the partition walls c^6 between the pockets c^4. The steam flows from the rotor through the ducts c^2, a^3, into the annular chamber a^2 and the radial chambers a^4, a^5, from the latter of which it passes into the super-heater coil g. The clearance between the ducts c^2, a^3 and the proximate faces of the casing and the rotor is such as to permit the steam to spread like a film between the proximate faces and thoroughly lubricate them. In fact the steam spreads across the pockets and prevents the deposit of carbon from the combustible in these pockets as well as on the face of the rotor. This clearance is such that the quantity of steam permitted to escape for this purpose is kept within its proper proportions so that it will not dilute the air in the pockets to any detrimental extent. The steam in the superheater coil g is subjected to the direct heat of the combustible since this coil is preferably disposed in the flame box h and extends through the hottest part of the combustion chamber A^5. The expansive force and velocity of the steam liberated at the nozzle q^5 is increased by this superheating so that the impelling effort of the steam against the vanes is of very substantial proportions. During this circulation of the steam and the performance of its functions as a cooling, cleaning, lubricating and impelling medium, continuous combustion is carried on in the combustion chamber A^5. Each pocket c^4, as its webs pass the air inlet port a^6, carries a volume of pure air to the combustion chamber into which it is expanded at relatively high pressure. This continuous supply of pure air insures continuous and complete combustion of the fuel injected through the nozzle i so that maximum pressures and temperatures are maintained in the combustion chamber. Further, the relative disposition of the nozzle a^7 and the port h^2 in the flame box h is such as to insure a constant circulation of air and gas in the combustion chamber, the gas at greatest pressure and temperature being found at the remote end of the chamber whence it passes through the peripheral nozzles a^8 and its greatest expansive force is expended on the vanes c^3 of the rotor. As each pocket passes beyond the combustion chamber A^5 it carries with it a volume of gas at substantially the same pressure and temperature as that in the combustion chamber. This gas is immediately carried through the opening a^{12} and the secondary nozzle a^{13}, through which it expands against the blades c^3 of the rotor, the expansive effort lowering the pressure to about atmospheric, The remaining waste gases are delivered by centrifugal

force through the port a^{15} into the exhaust chamber a^9, their efflux inducing a charge of fresh air through the air port a^6 into the pockets. The steam and products of combustion directed through the various nozzles against the blades first act on the moving vanes c^3, then against the annular series of fixed vanes n on the casing a and then on an outer annular series of vanes c^3 on the rotor arranged in juxtaposition to the vanes n, in a usual manner illustrated in Fig. 5. The spent products issuing through the various nozzles and expending their force against the vanes c^3 finally pass through the arcuate ports a^{11} into the exhaust chamber a^9 where they commingle with the waste gases discharged by the pockets c^4. The exhaust products in their passage toward the outlet a^{10} give up a great portion of their heat to the feed water in the coil m and this heat is returned to the machine by the heated water which is subsequently vaporized within the hollow rotor, all in a manner previously described. The steam in these waste products is condensed by the feed water coil m and made to collect at the base of the exhaust chamber and drip therefrom as water through a vent pipe o through which it is returned to the water reservoir.

It will be observed that by reason of the arrangement of the pockets c^4 of the rotor at a less radial distance from the axis of the rotor than the vanes c^3, the pockets have the relatively slow linear velocity which is desirable in order to permit the displacement of the fresh air from the pockets as they enter the combustion chamber and the replacement therein of the products of combustion, while the vanes have the relatively high linear velocity which is necessary to the propulsion of the rotor.

The actions, functions and advantages of the foregoing construction may be realized in equivalent devices, one of the most important forms of which now known is illustrated as a modification in Figs. 6, 7 and 8. In general the same elements are employed in much the same relation except that all of the steam or a portion of it generated in the rotor C is not passed through a superheater coil in the combustion chamber but, instead, all or a portion is discharged through nozzles C′ formed at the periphery of the rotor and acts directly on the vanes C^2, N, C^2, carried by the rotor and on the wall of the casing A. In this embodiment feed water passes through a coil M which is supported in the annular exhaust chamber A′ and from this coil some of the water is led to the axial channel D in the shaft D′ for discharge into the hollow rotor C, while another portion of the water in the regenerator is led into another coil in an annular chamber A^2 in the casing, which may or may not be the combustion chamber. This water is vaporized by the heat in the chamber and the steam is discharged through an inclined nozzle A^3 in one of the peripheral walls of the chamber A^2, against an inner annular series of vanes C^2 formed on the rotor in juxtaposition to the fixed vanes N. This jet through the nozzle A^3 not only serves as an additional impelling force but further cools the inner series of blades C^2 and prevents objectionable overheating by the combustion nozzles.

In a further modified form of the invention indicated in Fig. 4 condenser means p are applied to one of the exhaust spaces, that within the cover b of the casing a, while this space is separated from the other annular exhaust space a^9 by an imperforate wall. In the condenser illustrated, it is intended that cold water should flow into one of the pipes p' and out of another pipe p^2 so that the exhaust products might be condensed rapidly. In addition, a condenser pump p^3 may be applied for the purpose of further lowering the pressure within the exhaust space under the cover b. By the condenser means described it is sought to lower the pressure at the vanes c^3 within the exhaust space of the cover b to a relative minus compared to atmospheric pressure, while the pressure of the impelling gases and steam shall be greater and preferably a relative plus compared to atmospheric pressure. The effective impelling effort is, therefore, raised considerably and more efficient action is secured. In this modified form, the waste gas discharged by the pockets into the annular exhaust chamber a^9 passes out in the manner heretofore described, giving up its heat to the feed water in the coil m.

In the three embodiments of the turbine described as well as in any other altered forms in which the principle of the invention is retained, there may be associated with the turbine various auxiliary units shown most clearly in Fig. 4 for supplying the various mediums to the turbine under suitable manual control and any desired pressure. Referring now to Fig. 4, it will be seen that the oil which passes to the burner i is supplied from a reservoir i' from whence it passes through a pump i^2 before being delivered at the burner under pressure. The feed water is supplied from a reservoir m' from which it is drawn by a pump m^2 before being forced through the heating coil m and into the axial channel d' in the shaft d. The feed water pipe m may, in addition, be provided with a hand valve m^3 for cutting it off at will. The drip water derived from the condensed steam in the annular exhaust chamber a^9 is led back to the reservoir m' through the drip pipe o. Air for the burner i and for starting the turbine may be forced by a

suitable air pump q and be led through pipes q', q^2 to the burner i and to a suitable compressed air reservoir q^3, respectively. From the air tank q^3 the air may be discharged through a pipe q^4 controlled by a hand valve q^5 into the axial channel d' in the shaft d. Ordinarily, air through the pipe q^4 will be admitted only when the turbine is to be started, the practice being to permit the air under pressure to pass through the ducts and channels provided for the steam and react on the vanes c^3 for the purpose of impelling the rotor. As soon as the combustion takes place to an operative extent the air may be cut off at the hand valve, q^5. In addition to the auxiliary devices described there may be connected operatively with any one or more of the feed pipes for the various fluids a governor r which is driven from the turbine shaft d and may regulate automatically the flow of such fluids in proportion to the load, speed, temperature and other variable factors.

As indicated hereinbefore, the improved turbine derives its propulsive force primarily from the products of combustion, the steam employed being so controlled in its action as to coöperate with the working elements and the products of combustion to increase greatly the efficiency of operation of the machine and to recover and return a great portion of the heat of the waste products to the machine in available form for work. Other modifications than those hereinbefore disclosed may be made by one skilled in the art without departing from the spirit of the principle employed, all such departures being within the scope of the invention provided the means recited in the appended claims are employed in any one of the stated combinations.

I claim as my invention:

1. An internal combustion turbine having a casing, a rotor mounted therein, an exhaust chamber into which the waste products of combustion pass, means to supply a thermal medium to abstract heat from such products of combustion and return it to the turbine in form available for useful work, means to direct said medium into driving relation to the rotor, and means to lead a portion of the medium between the proximate faces of the casing and the rotor.

2. An internal combustion turbine having a casing, a hollow rotor mounted therein, an exhaust chamber into which the waste products of combustion pass and a pipe passing through the exhaust chamber for leading water into the hollow rotor.

3. An internal combustion turbine having a casing, a hollow rotor mounted therein, an exhaust chamber into which the waste products of combustion pass, a pipe passing through the exhaust chamber for leading water into the hollow rotor, and a superheater coil in the casing through which the steam from the rotor passes before discharging into the exhaust chamber.

4. An internal combustion turbine having a casing, a hollow rotor mounted therein, an exhaust chamber, a combustion chamber, a conduit for leading water into the hollow rotor, and a superheater coil in the combustion chamber through which the steam from the rotor passes before discharging into the exhaust chamber.

5. An internal combustion turbine having a casing, a hollow rotor mounted therein and provided with vanes, an exhaust chamber, a combustion chamber, a pipe for leading water into the hollow rotor, a superheater coil in the combustion chamber through which the steam from the rotor passes and a nozzle through which the steam from the coil is directed against the vanes before discharging into the exhaust chamber.

6. An internal combustion turbine having a casing, a hollow rotor mounted therein, an exhaust chamber, a combustion chamber, a pipe passing through the exhaust chamber for leading water into the hollow rotor, and a superheater coil in the combustion chamber through which the steam from the rotor passes before discharging into the exhaust chamber.

7. An internal combustion turbine having a casing, a hollow rotor mounted therein, an exhaust chamber, a combustion chamber, a pipe passing through the exhaust chamber for leading water into the hollow rotor, a superheater coil in the combustion chamber through which the steam from the rotor passes and a nozzle through which the steam from the coil is directed against the vanes before discharging into the exhaust chamber.

8. An internal combustion turbine having a casing, a hollow rotor mounted therein, an exhaust chamber, a combustion chamber, a pipe passing through the exhaust chamber for leading water into the hollow rotor, communicating ducts in the proximate faces of the rotor, a casing to lead the steam in the rotor therefrom and permit the escape of a limited quantity of steam into the clearance space between the faces, and a superheater coil in the casing through which the steam from the rotor passes before discharging into the exhaust chamber.

9. An internal combustion turbine having a casing, a hollow rotor mounted therein, an exhaust chamber, a combustion chamber, a pipe passing through the exhaust chamber for leading water into the hollow rotor, communicating ducts in the proximate faces of the rotor and the casing to lead the steam in the rotor therefrom and permit the escape of a limited quantity of steam into the clearance space between the faces, a superheater coil in the combustion chamber to which the

steam through the ducts passes, and a nozzle through which the steam from the coil is directed against the vanes before discharging into the exhaust chamber.

10. An internal combustion turbine having a casing, a rotor provided with pockets on its face and driving vanes, the pockets having a less radial distance from the axis and a slower linear speed than the driving vanes, and the driving vanes having a greater radial distance from the axis and a higher linear speed than the pockets, a combustion chamber into which air is carried by the pockets of the rotor and from which the products of combustion are carried by said pockets, a fuel burner in the combustion chamber, and nozzles by which products of combustion from the combustion chamber are directed against the driving vanes for adding to the rotor a propulsive effort.

11. An internal combustion turbine having a casing, a rotor provided with pockets on its face and vanes, a combustion chamber, a burner therein, an air port from which air is carried by the pockets to the combustion chamber, a forwardly directed nozzle in the wall of the combustion chamber through which the heated working fluid is directed into successive pockets to equalize the pressure of the fresh air therein with that in the combustion chamber.

12. An internal combustion turbine having a casing, a rotor provided with pockets on its face and vanes, a combustion chamber, a fuel burner therein, an air port from which air is carried by the pockets to the combustion chamber, a forwardly directed nozzle in the wall of the combustion chamber through which the heated working fluid is directed into the successive pockets to equalize the pressure of the fresh air therein with that in the combustion chamber and peripheral nozzles at the remote end of the combustion chamber through which the products of combustion are directed against the vanes.

13. An internal combustion turbine having a casing, a rotor provided with pockets on its face and vanes, a combustion chamber, a fuel burner in the combustion chamber, an air port from which air is carried by the pockets to the combustion chamber, primary nozzles through which the products of combustion are directed against the vanes, and a secondary nozzle formed in the face of the casing beyond the combustion chamber to direct the expansive effort of the heated gases in the successive pockets against the vanes.

14. An internal combustion turbine having a casing, a rotor provided with pockets on its face, an arcuate exhaust port in the face of the casing, an arcuate air inlet port concentric therewith but nearer the center of the casing, the pockets communicating with both of said ports, whereby the efflux of spent gases from each pocket is accompanied by the influx of fresh air and a guard plate between the ports.

15. An internal combustion turbine having a casing, a rotor provided with pockets on its face, an arcuate exhaust port in the face of the casing, an arcuate air inlet port concentric therewith but nearer the center of the casing, the pockets communicating with both of said ports, whereby the efflux of spent gases from each pocket is accompanied by the influx of fresh air, a guard plate between the ports and deflecting webs mounted in the exhaust port.

16. In combination with an internal combustion turbine, air, water, and oil pumps to force the respective fluids to the turbine and a governor connected operatively to the turbine to control the discharge from said pumps.

17. An internal combustion turbine having a casing, a hollow rotor mounted therein, an exhaust chamber into which the waste products of combustion pass, a pipe passing through the exhaust chamber for leading water into the hollow rotor and radial grooves on the inner wall of the rotor to receive water to cool the rotor.

18. In combination with an internal combustion turbine, air, water, and oil pumps to force the respective fluids to the turbine and a governor connected operatively to the turbine to control the discharge from said pumps including a condenser pump having a rotor on the shaft of the turbine.

This specification signed this 15th day of February, A. D. 1917.

CARL W. WEISS.