

Feb. 19, 1929.

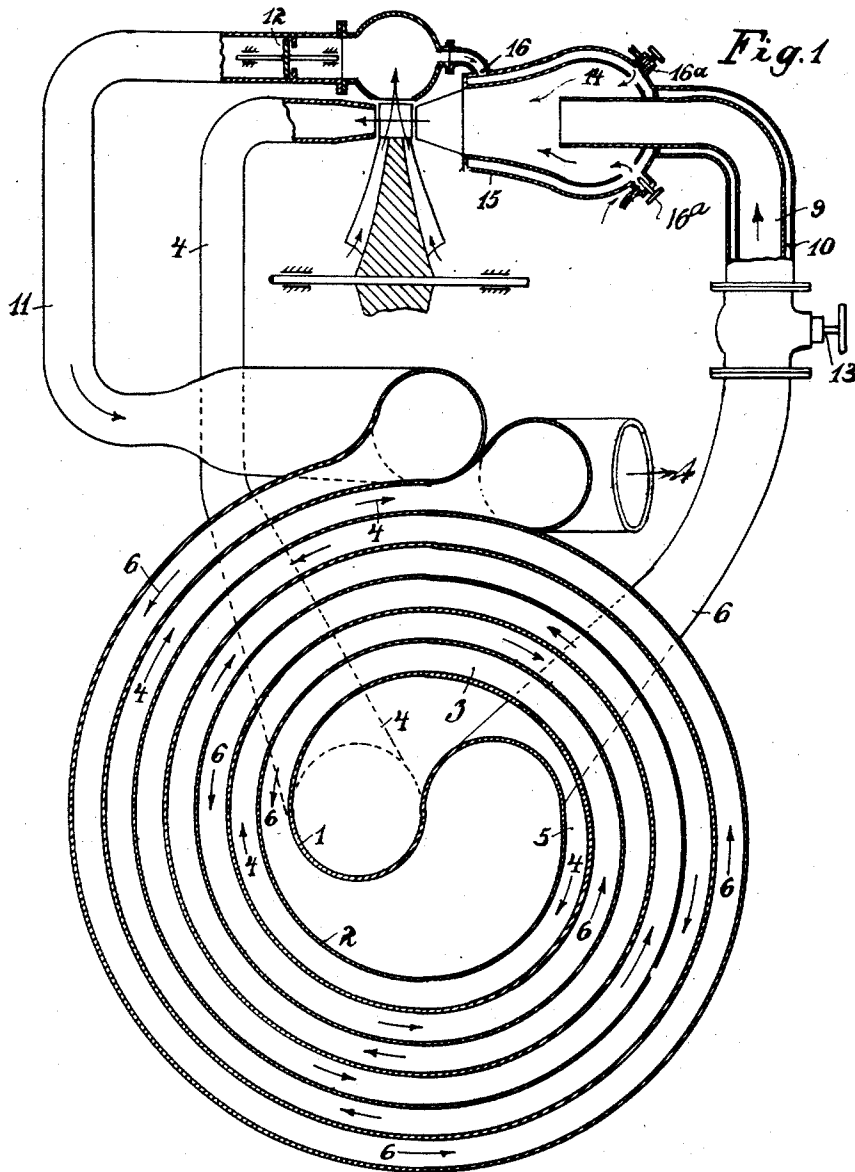
1,702,264

C. LORENZEN

GAS TURBINE

Filed Oct. 4, 1923

3 Sheets-Sheet 1



Inventor:

Christian Lorenzen

Feb. 19, 1929.

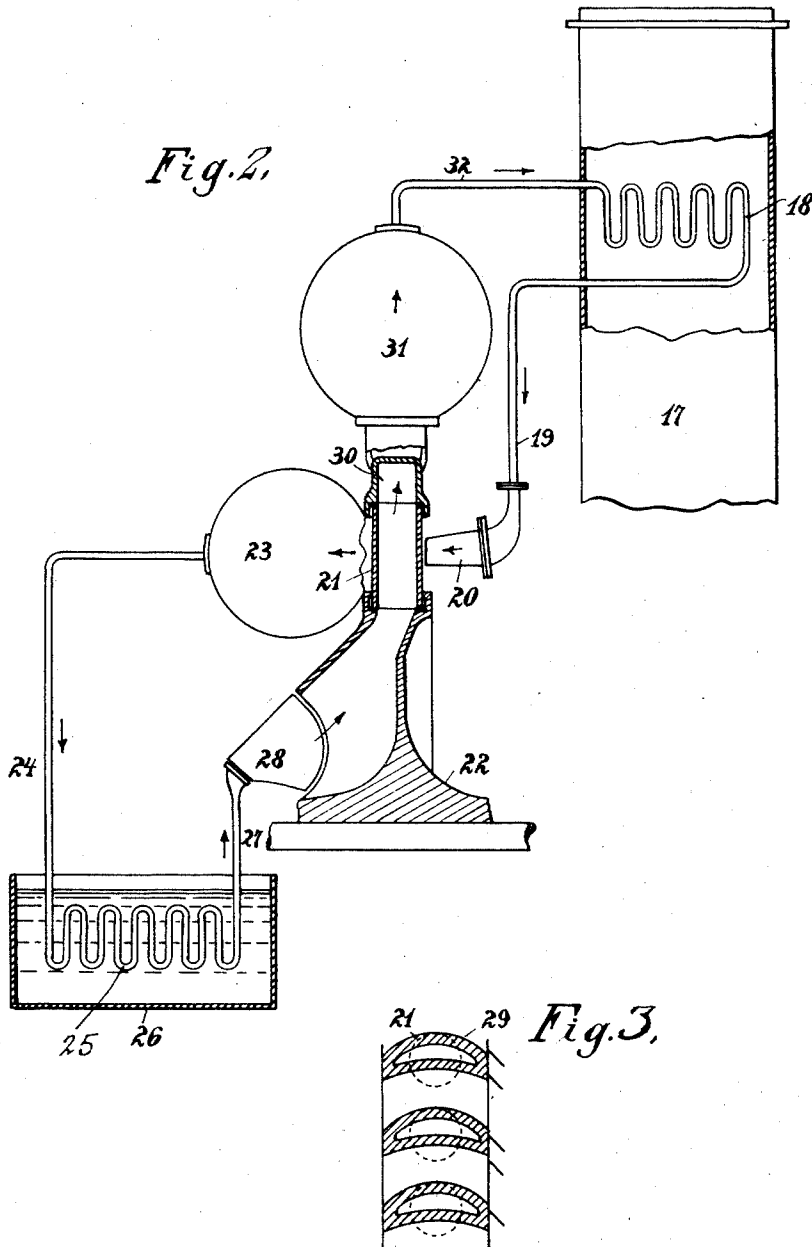
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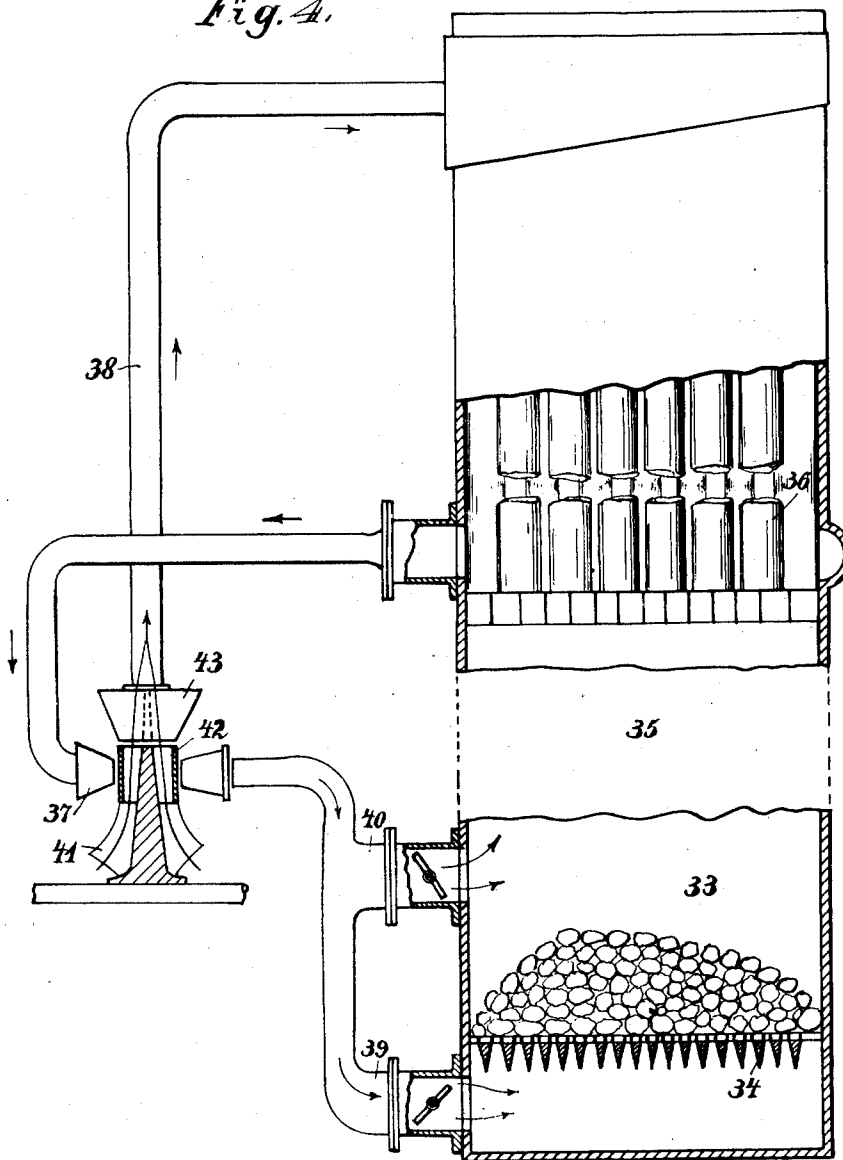
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Fig. 4.



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GAS TURBINE.

Application filed October 4, 1923, Serial No. 666,648, and in Germany November 27, 1922.

The present invention relates to gas turbines of the type shown in my copending application Serial No. 50,274, filed August 14, 1925, and in my Patent 1,640,784 of August 30, 1927, wherein a cooling agent, such as air, is passed through radial channels in the turbine blades, and is compressed by the cooperation of the rotating blades and a peripheral receptacle or diffuser.

An object of the invention is to obtain a high degree of efficiency and a thorough utilization of the heat content of the motive fluid.

In one form of the invention, the motive fluid is heated by the combustion of fuel in a combustion chamber, from which it passes to the turbine blades to impel them. The power output of the turbine is derived almost solely from the kinetic energy of the motive fluid, which is caused to pass through the turbine at an effective driving velocity by transferring heat thereto in a heat-exchanger and in the combustion chamber. The output of the turbine can be readily regulated by varying the fuel supply admitted to the combustion chamber, or by varying the pressure of the air entering the combustion chamber to support combustion therein.

The present invention can be most advantageously employed with a low-speed turbine-compressor having comparatively large blades, to which the motive fluid is supplied in larger volume, but at lower velocity than in the ordinary turbine. The decrease in speed of the turbine lessens the stresses to which the moving parts are subjected, while the increase in the cross-sectional area of the blades facilitates cooling thereof, so that the cooling air, in passing through the blades does not reach a temperature approximating that of the power gases, and it is therefore possible to effect a further heat-exchange between the two fluids. The invention also comprises a heat-exchanger for effecting such further heat-exchange.

In a modified form of the invention, the air is circulated through a closed circuit which comprises a heater, a cooler, and the turbine-compressor.

The invention is illustrated by way of example in the drawings, in which

Fig. 1 is a diagrammatic view of the turbine-compressor and the heat-exchanger;

Fig. 2 shows a modification wherein the motive fluid passes through a closed circuit;

Fig. 3 is a cross-sectional detail of the turbine blades; and

Fig. 4 is a further modification.

The heat-exchanger, shown in Fig. 1, is formed of two parallel sheets 1, 2, wound spirally, and spaced apart to form two paths 3, 5, for conducting the cold and hot gases respectively in opposite directions, as indicated by arrows 4, 6. Radiation losses are minimized by first conducting the air to be heated around the exchanger, thereby forming an insulating jacket. Pipe 9, which conducts the heated air from path 3 to the combustion chamber 14, is also surrounded by a jacket 10 forming a heat insulation. The air in jacket 10 is preferably exhausted to enhance the heat-insulating properties of the jacket.

The heat-exchanger may also serve as a reservoir for air under pressure to be used in starting the turbine. For this purpose, a one-way valve 12 is placed in pipe 11, and a manually operable valve 13 is placed in pipe 9. When the turbine is to be started, valve 13 is opened, allowing compressed air to flow from the heat-exchanger to the turbine to start it rotating. At the same time, the fuel valves 16^a are opened.

As ignition would not occur under the foregoing conditions, a small duct 16 is provided, to lead the compressed air from the blades, back through jacket 15 of the combustion chamber, and into the combustion chamber at the fuel nozzles 16^a, where it mingles with the fuel to support its combustion. The air is compressed by centrifugal action, as it passes outwardly in the direction indicated by the arrows, through compressor channels in the turbine rotor. The initial ignition of the fuel is effected by introducing a match through an opening (not shown) or in any other well-known or approved manner. Combustion begins at the fuel-nozzles 16^a, sufficient air entering through 16, and a further supply of air (which is heated) issues from the outlet of pipe 9, so that a thorough combustion is effected. Of course, the compressor and other parts are so proportioned that the air will be forced through against any back pressure due to the heating of the air.

When the turbine begins to operate, the pressure in the heat-exchanger has dropped and the pressure caused by the turbine blades has increased, so that valve 12 is automatically opened, allowing the compressed air

to pass through pipe 11 to the heat-exchanger to be heated.

Referring to Fig. 2, at a point subjected as continuously and intensively as possible to the source of heat, for example, in the stack 17 for conducting off the heating or combustion gases of a technical plant, is located a pipe system 18. Air flows through this pipe system. The air enters in cold condition and with a certain speed of flow into the pipes, and is heated by the source of heat referred to. The air thus heated flows through a piping 19 into the nozzle system 20, and out of the nozzles 20 into the blades 21 of the turbine rotor 22. After striking the turbine blades the air flows into a collecting chamber 23, from which, passing through a conduit 24, it reaches a pipe system 25 built into a cooling device, for example a feed water pre-heater 26. The air, which has already partially employed its energy of flow and its heat in the turbine, here discharges the remainder of its heat. After passing through the pipe system 25 the air is sucked through a conduit 27 into the compressor 28, and forced through the passages 29 of the turbine blades 21 and the guide vane ring 30 into a collecting chamber 31, from which, proceeding through a conduit 32, it again reaches the pipe system 18.

Figure 4 shows a modified form of the invention, in which 33 represents a furnace having a grate 34 over an air induction means (not shown). Above the furnace 33, which is fed with fuel of any desired kind, is located the point of utilization 35 of the plant, from which, for example, is fed a boiler, a chemical plant or the like. The waste gases from the plant pass over the point of utilization 35 through a pipe system 36 into the stack. With the plant is connected a turbine 37. This turbine is connected with the plant 33—36 by a conduit system 38, which passes in the direction of the arrow through the turbine into the top of the heat compensator of the plant 33—36. From the heat compensator the conduit proceeds towards the turbine, and out of the turbine continues through one or two inlets 39, 40 into the furnace.

The working method of this plant is as follows: The furnace 33 is first set into operation in the customary manner. The inlets 39 and 40 are closed. The waste gases from the furnace flow off through the heat compensator 36. The air located around the pipes of the heat compensator is thereby warmed. The normal air inlet for the combustion air for the furnace is now closed and the openings 39 and 40 are opened. The furnace now sucks in the necessary combustion air through these openings. It thereby sets into operation the turbine 37, the details of which are contained in Figs. 3 and 4, and the above-described cycle of operations is developed, whereby the combustion air is sucked through the compressor

41, flows through the hollow turbine blades 42 and the diffuser 43 into the conduit 38, which conveys it to the heat compensator 36. From here the air, substantially heated, reaches the turbine, and strikes against the blades thereof. The air loses in this manner a proportion of its heat, which is again subsequently attained in the form of compressed air. The majority of the heat remains in the discharge air, and reaches the furnace with the discharge air of the turbine through the openings 39 and 40. The temperature of same is thereby correspondingly increased, and the temperature accordingly increases at the point of utilization. In like manner the temperature of the waste gas is also increased. This, however, results in the fact that the fresh air in its circulation through the heat compensator is pre-heated to a substantial degree, i. e., enters with greater heat into the turbine, and after leaving the turbine sends a greater heat through the openings 39 and 40 into the furnace.

In this manner the temperature at the utilization point of the furnace is continuously increased. This natural increase attains a limit at the point when the radiation losses equalize the increase in temperature.

Certain features of my invention disclosed but not specifically claimed herein are claimed in my Patent 1,601,402, granted September 28, 1926, and for which an application was filed February 14, 1922, under Serial No. 536,562.

What I claim is:

1. A gas turbine comprising a combustion chamber for supplying power gas to the rotor of said turbine, hollow blades on said rotor to permit the passage of a cooling agent therethrough, means associated with said rotor for compressing said cooling agent, a heater having one path to receive the exhaust gas from the turbine and another path to receive said cooling agent from said compressing means, a pipe for conducting said cooling agent to said heater, a second pipe for conducting said cooling agent from said heater to said combustion chamber, an automatic valve in said first pipe, and a manually controlled valve in said second pipe, whereby the cooling gas may be retained under pressure in said heater for subsequently starting said turbine.

2. In a gas turbine, a rotor, a combustion chamber for supplying a motive fluid to the rotor, blades on said rotor provided with radial passages, said passages being open at their inner ends to receive a cooling medium, the blades thereby forming a centrifugal compressor for said medium, a receiver communicating with the outer ends of said radial passages to receive the compressed cooling medium, a conduit extending between said receiver and said combustion chamber, a heat-exchanger in said conduit, a valve be-

tween said receiver and heater, and a second valve between said heater and combustion chamber, said valves being adapted to retain said cooling agent under pressure in said heat-exchanger for starting the turbine.

3. In a gas turbine, a rotor, a combustion chamber for supplying a motive fluid to the rotor, blades on said rotor provided with radial passages, said passages being open at their inner ends to receive a cooling medium, the blades thereby forming a centrifugal compressor for said medium, a receiver communicating with the outer ends of said radial passages to receive the compressed cooling medium, a conduit extending from said receiver to said combustion chamber, a heat-exchanger in said conduit for transferring heat to said cooling agent, a one-way valve in said conduit between said receiver and said heat-exchanger, and a manually operable valve between said heat-exchanger and said combustion chamber.

4. A gas turbine comprising a combustion chamber for supplying power gas to the rotor of said turbine, hollow blades on said rotor to permit the passage of a cooling gas therethrough, means associated with said rotor for compressing said cooling gas, a heater having two paths for the cooling gas and the exhaust gas respectively, a conduit for conducting the exhaust gas from said rotor to one of said paths, a second conduit for conducting the cooling gas from said compressing means to the other of said paths, a third conduit leading from said heater to said combustion chamber to supply heated compressed air thereto, and valves placed in said second and third conduits whereby the cooling gas may be retained under pressure in said heater for subsequently starting said turbine.

5. In a gas turbine, a rotor, a combustion chamber for supplying a motive fluid to the rotor, blades on said rotor provided with radial passages, said passages being open at their inner ends to receive a cooling medium, the blades thereby forming a centrifugal compressor for said medium, a receiver

communicating with the outer ends of said radial passages to receive the compressed cooling medium, a heat-exchanger having two paths, a conduit between said receptacle and one of said paths, a one-way valve in said conduit, a second conduit between the same path and the combustion chamber, a second valve in said second conduit, a normally open duct leading from said receptacle to said combustion chamber, and a conduit for conducting the exhaust motive fluid from said rotor to the other path of said heat-exchanger.

6. A gas turbine comprising a combustion chamber for supplying power gas to the rotor of said turbine, said rotor being air cooled and provided with means to compress the air used for cooling it, a receptacle having an inlet opening adjacent the periphery of said rotor to receive compressed air from said rotor, a conduit leading from said receptacle to said combustion chamber for supplying compressed combustion air thereto, a heater in said conduit, means for shutting off communication between said heater and said combustion chamber, and a duct leading directly from said receptacle to said combustion chamber.

7. A gas turbine comprising a rotor having hollow blades permitting the passage of cooling gas therethrough, a combustion chamber for supplying power gas to said rotor, means associated with said rotor blades for compressing said cooling gas, a conduit connecting said means to said combustion chamber, a portion of said conduit forming one path of a heat exchange device, a conduit receiving the exhaust gases from said rotor and having a portion forming the other path of said heat exchange device, and valves in said first mentioned conduit for shutting off the said portion from the remainder thereof.

In testimony whereof I have affixed my signature.

CHRISTIAN LORENZEN.