H. HOLZWARTH.

GAS TURBINE.

APPLICATION FILED OCT. 13, 1911.

1,043,768. Patented Nov. 5, 1912.

Fig. 1

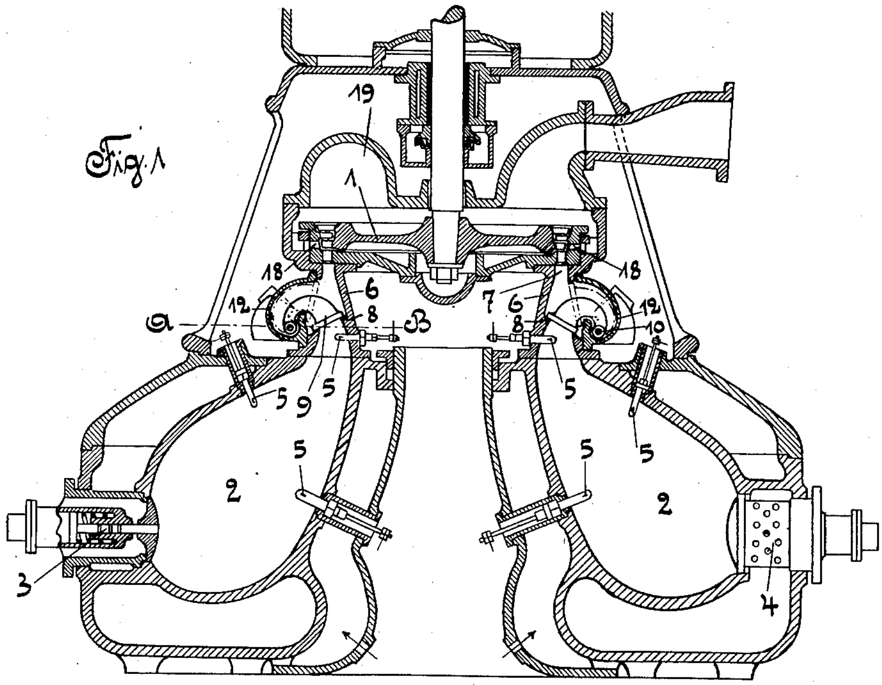


Fig. 3

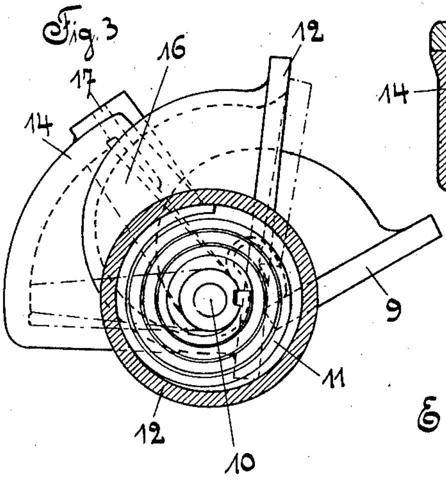
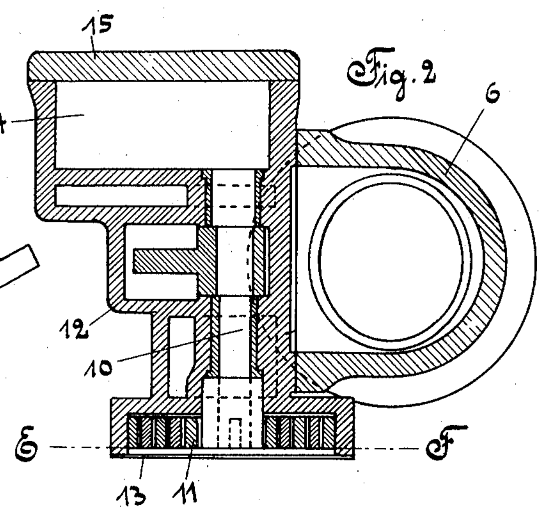


Fig. 2



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UNITED STATES PATENT OFFICE.

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GAS-TURBINE.

1,043,768 Specification of Letters Patent. Patented Nov. 5, 1912.

Application filed October 13, 1911. Serial No. 654,486.

To all whom it may concern:

Be it known that I, HANS HOLZWARTH, a subject of the German Emperor, residing at Mannheim, in the Empire of Germany, have invented certain new and useful Improvements in Gas-Turbines, of which the following is a specification.

This invention relates to gas turbines of the kind in which a combustible gaseous mixture is periodically exploded in separate chambers (combustion chambers) provided for that purpose, the resulting gases then flowing with expansion into the actual turbine, whereupon the explosion chamber is again filled with the combustible mixture, preferably after having been first scavenged with air, which has a cooling action.

The invention relates more particularly to a special formation of the outlet from the combustion chambers to the actual turbine, or rather of the nozzles, first as regards the size of this outlet as compared with the cubical contents of the combustion chamber, and then also as regard the closing and controlling of the outlet.

Efforts have hitherto been made to make the working of gas turbines as similar as possible to those of steam turbines and that working has been held to be the best working in which the hot gaseous products of combustion pass into the actual turbine in an unbroken uniform current. Others who recognized that a continuous, uniform combustion and a continuous outflow of the gases are not practicable on account of the high temperatures resulting therefrom, which no material used in the construction can stand, attempted to keep the outlets from the combustion chamber and the nozzles so small that the explosion pressure in the combustion chamber was maintained to a certain extent at least for a period and did not fall off too rapidly. It has even been suggested to artificially contract the nozzles during the commencement of the discharge and gradually to open them wider as expansion proceeds, so that the gases should flow into the actual turbine for a long time as uniformly as possible.

Now this invention suggests the opposite method of working and makes the outlet as wide as possible, much wider than has ever been previously attempted or proposed. Thorough investigation and experiments made by the inventor have in fact shown that it is of the greatest importance for the efficiency of working of a gas turbine that the temperature of the mixture intended for combustion should be low, that is to say, lie as little as possible above the temperature of the external air, and also that this initial temperature of the mixture is largely influenced by the temperature of the walls of the combustion chamber and, further, that the duration of the contact of the products of combustion with these walls plays the greatest part in determining the temperature of the walls, and, finally, that increase of the pressure in the explosion chambers beyond a certain limit must be avoided, because otherwise in place of the regular combustion, explosive effects which have a deleterious action, are produced.

In order to allow of the invention being better understood it will now be explained in the following specification, reference being made to an example of construction shown in the accompanying drawings, of which:—

Figure 1 is an axial section of a gas turbine with vertical shaft; Fig. 2, a section on the line A—B of Fig. 1, of the member closing the outlet of the combustion chambers; and Fig. 3, a section on the line E—F of Fig. 2, Figs. 2 and 3 being on a larger scale than Fig. 1.

The combustion chambers, several of which are located adjacent different parts of the periphery of the running wheel 1, are indicated by 2. They are provided with inlet valves 3, for air, and 4, for gas, and also with ignition devices 5 of any suitable kind, such for instance as sparking plugs, and of any suitable number. A body 6, which contains the nozzles 7 through which the combustion gases expand before reaching the running wheel 1 of the turbine, connects with the outlet side of the combustion chambers 2. A seat 8 is provided in the body 6 for a valve 9 which can close the passage from the combustion chambers 2 to the nozzles 7. The areas of the sections of the passage at different points have of course a certain relationship to one another determined by the condition of the flowing gas in each section in view of the continuity of the flow. Preferably the area of the section of the passage at the seat 8 of the valve 9, the area of the narrowest section or throat of the nozzle and the area of that section which the gas jet passes immediately before escaping, are in the proportion of 4:1:2, the lowest admissible value, for the ratio of the first two areas being 4.

Now in accordance with this invention the smallest nozzle section is at least 5/1000 of the volume of the hollow space of the explosion chamber, divided by the diameter of a sphere of a volume equal to that of the explosion chamber. The other sections are wider in accordance with the above mentioned considerations, all the sections being thus of substantially greater area than has hitherto ever been proposed or used. The body 6 preferably contains all the outlet passages for the separate explosion chambers 2 and all the nozzles 7, and is then made as a single ring which is mounted on the base of the machine, which base contains the combustion chambers 2. The valves 9 are each revoluble on a shaft 10 lying out of the way of the hot gases of combustion and may, as shown in dotted lines in Figs. 1 and 3, move so far aside when the outlet passage is opened, that they no longer impede the flow. They are preferably made self-closing, so that they are pressed on to their seats by means of a spring or the like 11 and may be lifted off their seats against the pressure of the spring, by the pressure of the combustion gases. A helical or spiral spring, such as the spring 11, is provided in a recess in the valve casing 12, one end being connected with the spindle 10 of the valve 9, while the other end is secured in the casing 12. The spring and its casing may be closed on the outside by means of a cover 13. The casing 12 forms, as particularly shown in Fig. 1, a separate body which is placed at the side of the body 6.

In order that the closing valve may be controlled, for instance in order to maintain it in an opened condition, even after the pressure of the gases of combustion has considerably decreased, a separate chamber 14 is provided in the casing 12 and closed on the outside by a cover 15. In this chamber is arranged a closely fitting rotary piston 16 which is mounted on the spindle 10 of the valve 9. Any suitable fluid under pressure, for instance oil, may be admitted behind the piston 16 through a passage or channel 17 (Fig. 3) so as to propel the piston into the position shown in chain dotted lines in Fig. 3, so that the valve 9 assumes the position shown in chain dotted lines in Fig. 3.

The details of the invention as regards its construction can of course be carried out in various ways. It is particularly important to give large dimensions to the outlet aperture from the combustion chambers. It is of especial advantage as regards this to form the closing member of this outlet as a flap valve instead of a mushroom valve, whereby a larger section of passage without substantial change of direction is provided for the combustion gases passing through it, and without the disadvantage that the operating parts must be placed in the path of the hot gas.

A further advantage of the controlled closing member hereinbefore described is that the dimensions of this closing member and the parts belonging thereto may be kept comparatively small in spite of its wide opening, so that the valve gear may be affixed easily and without interfering with the appearance of the engine as a whole, and the closing member with the parts serving for operating it may be easily removed for the purpose of attention.

The object of keeping the initial temperature of the exploded mixture low, is also substantially assisted by a further improvement which will now be described.

In gas turbines of the kind previously described air is preferably sent through the gas turbine as a cooling medium in the same course as that which the propelling gases take. This is effected by admitting air to the combustion chambers 2 through the air inlet valve 3 in the intervals between the separate explosions, and discharging it through the nozzles 7 when the nozzle closing member 9 is opened. For imparting motion to this cooling air, of course, only as small a drop of pressure as possible should be employed for practical reasons. This drop of pressure should, however, suffice to convey the air through the same course which the expanding gas jet has previously taken. The expanding gas jet, however, moves at a very high velocity and the air jet at a very low velocity in consequence of the fall in pressure being only small, and the passages between the blades of the wheel 1 must be of such dimensions that they afford no appreciable resistance to the passage of the gas jet. Now the shapes, dimensions and relative positions of the vanes can not also correspond to the low speed of the air current and therefore they oppose great resistance to the movement of this current.

Now in accordance with this invention, a sufficient discharge for the cooling air is afforded in an improved manner without affecting the cooling action, by outlet apertures 18 for the air being provided in proximity to the first ring of blades on the running wheel, which apertures allow the air to escape from the space between the nozzle and the first ring of blades directly to the space 19 beyond the turbine wheels, avoiding the passages between the blades of the turbine. In consequence of the radiating action of the running wheel not only is the running wheel itself sufficiently cooled, without the cooling air passing through its vanes, but also by the centrifugal action the conveyance of the air is considerably facilitated. The passages 18 are preferably made as wide as possible and they extend so far over the periphery that they approach one another as closely as possible. The partitions separating them are preferably tapered toward the inlet apertures and also toward the chamber 10.

I declare that what I claim is:—

1. A gas turbine comprising combustion chambers, inlet members leading the gas for combustion to said chambers, inlet members leading scavenging air to said chambers, outlet members leading both the products of combustion and the scavenging air from the said chambers to the running wheel, the outlet members being so formed that their smallest area of section is greater than 5/1000 of the volume of the combustion chamber divided by the diameter of a sphere having a volume equal to that of the combustion chamber.

2. A gas turbine comprising combustion chambers, inlet members for the gas intended for combustion, outlet members for the products of combustion and controlled closing members for said outlet members, the outlet members being so formed that their smallest area of section is greater than 5/1000 of the volume of the combustion chamber divided by the diameter of a sphere having a volume equal to that of the combustion chamber.

3. A gas turbine comprising combustion chambers, inlet members for the gas intended for combustion, outlet members for the products of combustion and controlled flap valves for said outlet members, the outlet members being so formed that their smallest area of section is greater than 5/1000 of the volume of the combustion chamber divided by the diameter of a sphere having a volume equal to that of the combustion chamber.

4. A gas turbine comprising combustion chambers, inlet members for the gas intended for combustion, outlet members for the products of combustion, and controlled spring loaded flap valves for said outlet members, the outlet members being so formed that their smallest area of section is greater than 5/1000 of the volume of the combustion chamber divided by the diameter of a sphere having a volume equal to that of the combustion chamber.

5. A gas turbine comprising combustion chambers, inlet members for the gas intended for combustion, outlet members for the products of combustion, flap valves for closing said outlet members, and coiled springs acting upon said flap valves, the outlet members being so formed that their smallest area of section is greater than 5/1000 of the volume of the combustion chamber divided by the diameter of a sphere having a volume equal to that of the combustion chamber.

6. A gas turbine comprising combustion chambers, inlet members for the gas intended for combustion, outlet members for the products of combustion, flap valves for closing said outlet members, coiled springs acting upon said flap valves, and hydraulic means for controlling said flap valves, the outlet members being so formed that their smallest area of section is greater than 5/1000 of the volume of the combustion chamber divided by the diameter of a sphere of a volume equal to that of the combustion chamber.

7. A gas turbine comprising combustion chambers, inlet members for the gas intended for combustion, outlet members for the products of combustion, said outlet members being so formed that their smallest area of section is greater than 5/1000 of the volume of the combustion chamber divided by the diameter of a sphere having a volume equal to that of the combustion chamber, flap valves closing said outlet members, coiled springs acting upon said flap valves, rotary pistons connected with said flap valves, and hydraulic means for controlling the movements of said pistons.

8. A gas turbine comprising combustion chambers, inlet members for the gas intended for combustion, outlet members for the products of combustion, said outlet members being so formed that their smallest area of section is greater than 5/1000 of the volume of the combustion chamber divided by the diameter of a sphere having a volume equal to that of the combustion chamber, flap valves for closing said outlet members, means for pivotally supporting said flap valves, said means being arranged out of the path of flow of the products of combustion, coiled springs acting upon said flap valves, rotary pistons connected with said flap valves, and hydraulic means for controlling said pistons.

9. A gas turbine comprising combustion chambers, inlet members for the gas intended for combustion, outlet members for the products of combustion, said outlet members being so formed that their smallest area of section is greater than 5/1000 of the volume of the combustion chamber divided by the diameter of a sphere having a volume equal to that of the combustion chamber, flap valves for closing said outlet members, means for pivotally supporting said flap valves, said means being arranged outside the path of flow of the products of combustion, coiled springs acting upon said flap valves, rotary pistons connected with said flap valves, hydraulic means for con-

trolling said pistons, and an integral member forming the casing for a valve with its spring and piston.

10. A gas turbine comprising combustion chambers, inlet members for the gas for combustion, outlet members for the products of combustion, the outlet members being so formed that their smallest area of section is greater than 5/1000 of the volume of the combustion chamber divided by the diameter of a sphere having a volume equal to that of the combustion chamber, and a lateral continuation of the outlet passages being formed in front of the blades of the turbine, flap valves closing the outlet members, coiled springs acting upon said flap valves, rotary pistons connected with said flap valve, hydraulic means controlling said pistons, means for pivotally supporting said flap valves, said means being arranged outside the path of the products of combustion, and an integral member forming the casing for a flap valve with its spring and piston.

11. A gas turbine comprising combustion chambers, inlet members for the gas for combustion, outlet members for the products of combustion, valve seats arranged in said inlet members, the outlet members being so formed that the area of section at the valve seat is greater than 2/100 of the volume of the explosion chamber divided by the diameter of the sphere having a volume equal to that of the explosion chamber, flap valves adapted to co-act with the said seats, coiled springs acting upon said flap valves, rotary pistons connected with said flap valves and hydraulic means controlling said pistons.

12. A gas turbine comprising combustion chambers, inlet members for the gas for combustion, outlet members leading the products of combustion from said chambers, said outlet members being so formed that their smallest area of section is greater than 5/1000 of the volume of the combustion chamber divided by the diameter of a sphere having a volume equal to that of the combustion chamber, nozzles formed in the outer ends of said outlet members, and delivering the products of combustion to the running wheel, a fixed casing surrounding the running wheel, said casing having laterally extending openings adjacent to the nozzles.

13. A gas turbine comprising combustion chambers, inlet members for the gas for combustion, outlet members leading the products of combustion from said chambers, nozzles fromed in the outer ends of said outlet members and delivering the products of combustion to the running wheel, a fixed casing surrounding the running wheel, said casing having laterally extending openings adjacent to the nozzles.

14. A gas turbine comprising combustion chambers, inlet members for the gas intended for combustion, outlet members for the products of combustion, flap valves for closing said outlet members, means for pivotally supporting said flap valves, said means being arranged outside the path of flow of the products of combustion, coiled springs acting upon said flap valves, rotary pistons connected with said flap valves, hydraulic means for controlling said pistons, and an integral member forming the casing for a valve with its spring and piston.

15. A gas turbine comprising combustion chambers, inlet members for the gas intended for combustion, outlet members for the products of combustion, flap valves for closing said outlet members, means for pivotally supporting said flap valves, said means being arranged out of the path of flow of the products of combustion, coiled springs acting upon said flap valves, rotary pistons connected with said flap valves, and hydraulic means for controlling said pistons.

16. A gas turbine comprising combustion chambers, inlet members for the gas intended for combustion, outlet members for the products of combustion, flap valves closing said outlet members, coiled springs acting upon said flap valves, rotary pistons connected with said flap valves, and hydraulic means for controlling the movements of said pistons.

In witness whereof, I have hereunto signed my name this 18th day of September, 1911, in the presence of two subscribing witnesses.

HANS HOLZWARTH.

Witnesses:
JOSEPH HEIFFER,
S. H. SHANK.