Sept. 29, 1931. H. HOLZWARTH 1,824,893

EXPLOSION TURBINE

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Fig. 1

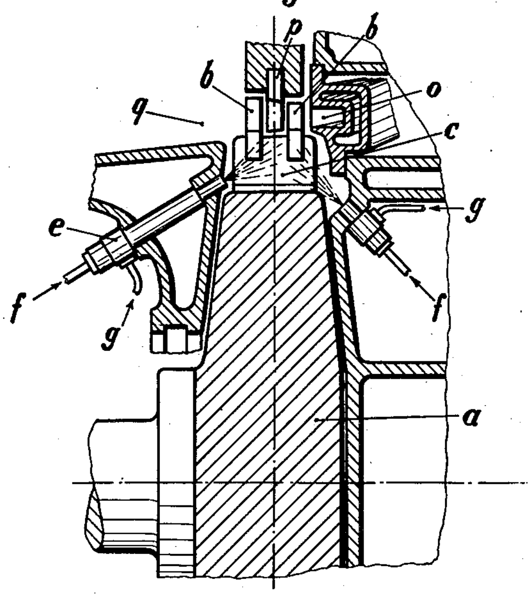


Fig. 2

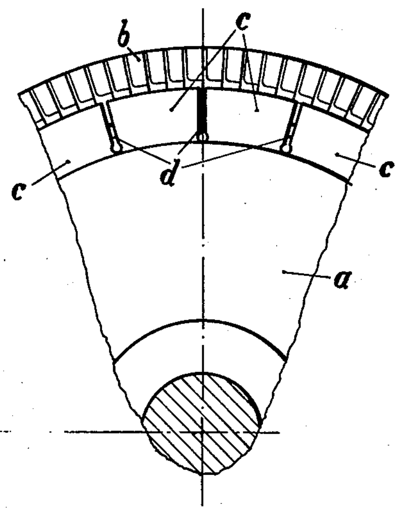


Fig. 3

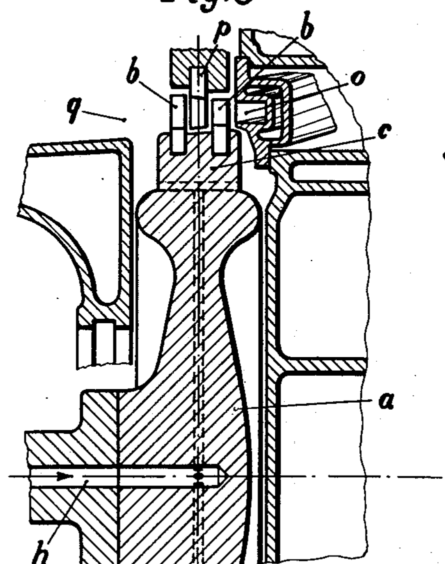
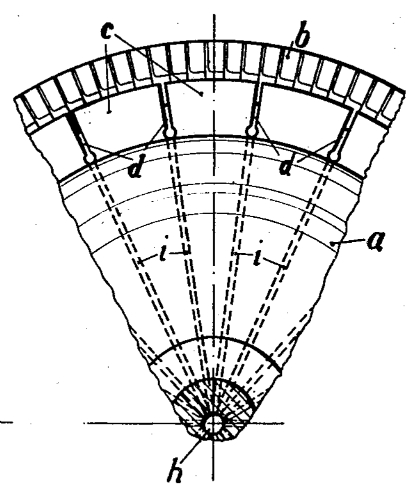


Fig. 4



Witness

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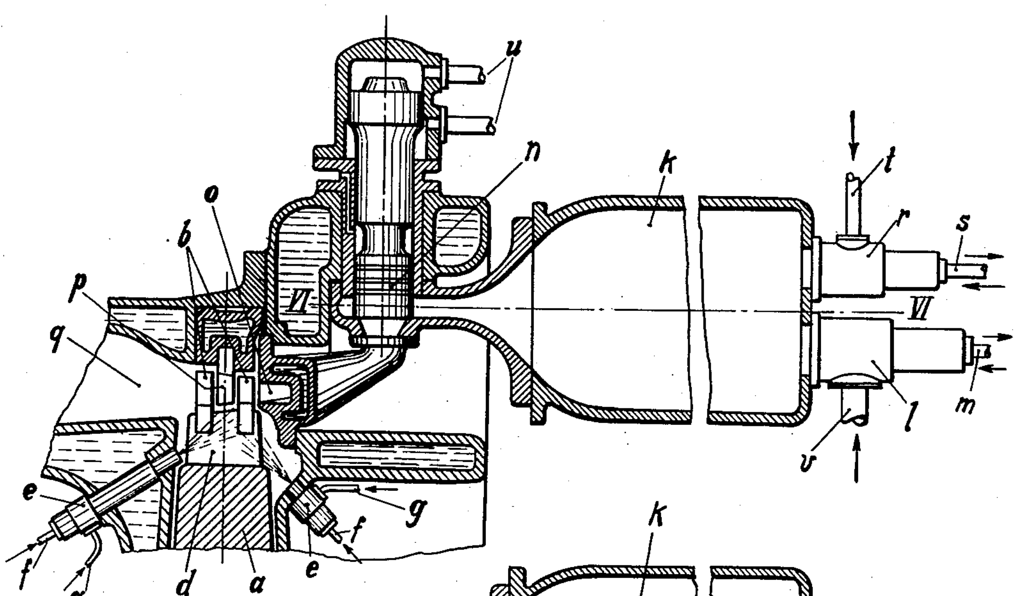
Fig. 5



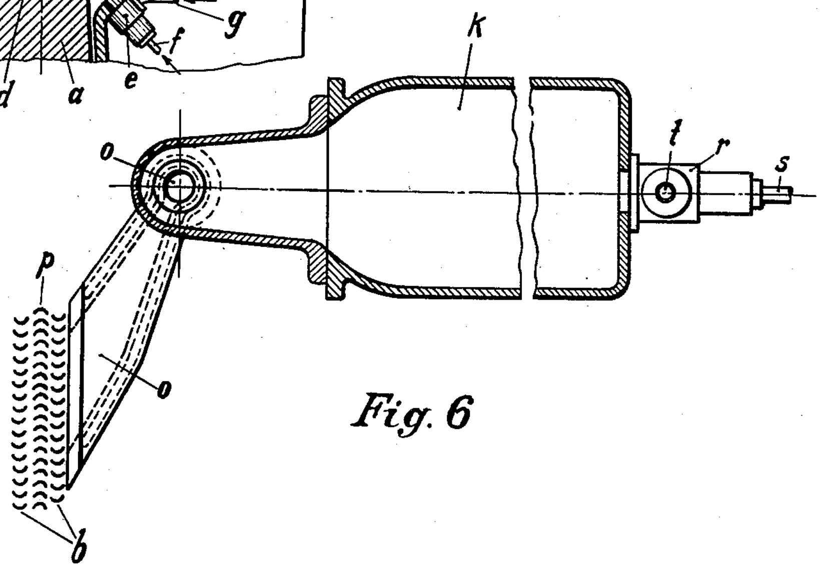


Fig. 6

Witness

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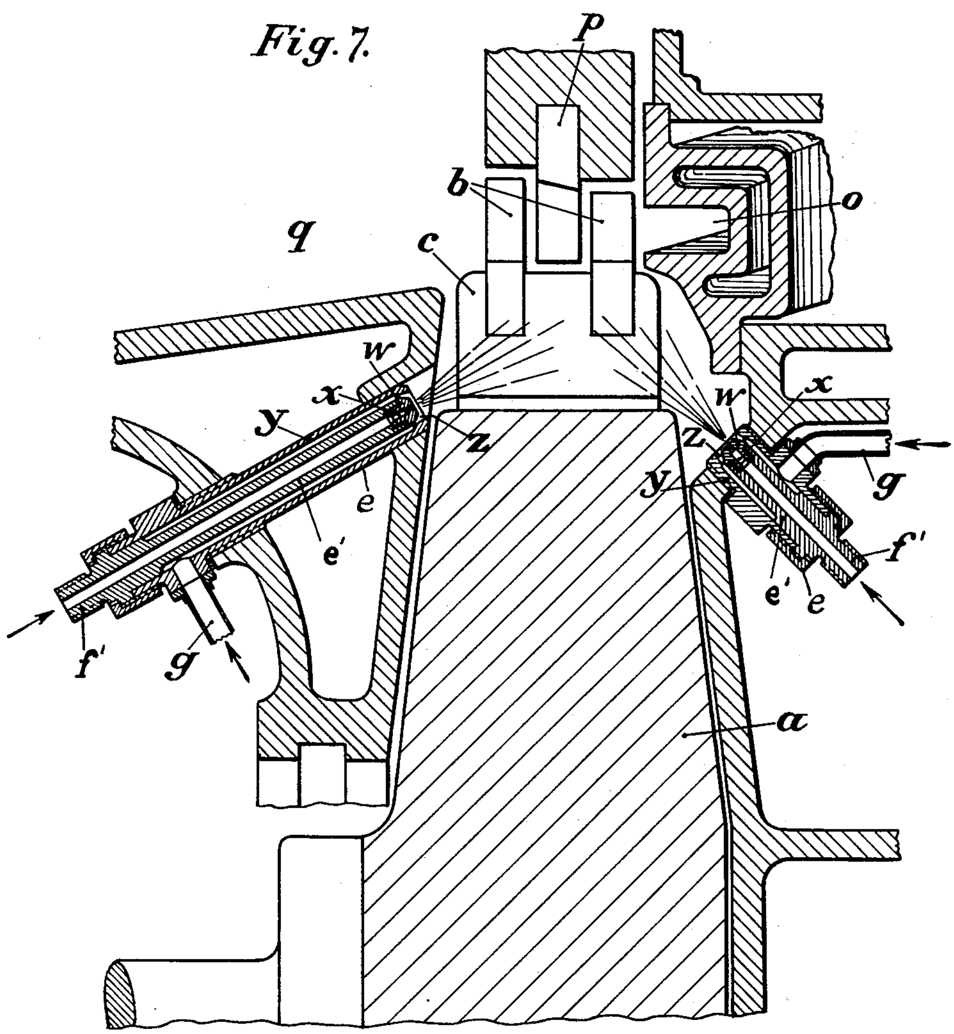
Fig. 7.



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Attorneys

Patented Sept. 29, 1931

1,824,893

UNITED STATES PATENT OFFICE

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EXPLOSION TURBINE

Application filed April 8, 1929, Serial No. 353,458, and in Germany April 21, 1928.

My invention relates to an explosion turbine, and more particularly to the construction of the rotor upon which the turbine blades are mounted.

The disc-shaped or drum-shaped rotor of explosion turbines is, in operation, subjected to stresses set up by the centrifugal forces resulting from its own weight and the weight of the inserted turbine blades. These stresses may reach considerable amounts, if the circumferential speed, which depends on the diameter of the rotor and the number of rotations per minute, reaches the high values usually desirable in practical operation.

The stresses set up by the centrifugal forces are, in the case of rotors of conventional construction for explosion turbines, further increased by additional internal stresses arising from differences in temperature between the central zone and the circumferential zone of the rotor. Such difference in temperature is produced and maintained by the continuous effect of the very hot gas jets operating on the turbine blades and imparting considerable quantities of heat to them and to the circumferential zone of the rotor, which is further heated by radiation. Unless special cooling means are provided, this continuous convection and radiation of heat raises the temperature in the circumferential zone of the rotor by a considerable amount above that prevailing in the central part thereof.

Any such large difference in temperature is very undesirable as it sets up radially and tangentially directed stresses in the rotor. This will easily be understood from the following consideration. The rotor may be considered as being built up of a number of annular elements in nested relation with and integral with each other. If the elements constituting the circumferential zone are heated, they tend to expand in circumference as well as in diameter, but are restrained from such expansion by action of the cooler inner elements integral with them. As a result, tangential and radial strains (thermal strains) are set up in the material which are superimposed on those caused by centrifugal forces. The total tension may easily assume excessive values which cannot be withstood even by the strongest materials of the highest quality available and are liable to cause fractures in the rotor.

The primary object of my invention is to provide a novel construction for the rotor of a gas turbine whereby excessive stresses therein are prevented. I have found that the injurious effect of the thermal stresses may be eliminated by providing radial slots in the peripheral zone of the rotor and by cooling such slotted peripheral zone of the rotor. These two means in combination tend to keep the unslotted portion of the rotor free from excess heat and heat strains so that it can be constructed as a rotor subjected to centrifugal forces only.

In a preferred embodiment, the rotor may be provided with one or more peripheral rings integral with or rigidly connected to the rotor and provided with radial slots. These rings serve as a support for the turbine blades and may be cooled in operation by suitable means. Due to the slots in the rings, tangential tensions caused by difference in temperature and the tensions arising from centrifugal forces, are eliminated or reduced to a negligible amount. The central non-slotted portion of the rotor is thus relieved from the thermal strains and is subjected substantially to the centrifugal tensions only. Preferably, the slotted ring carrying the turbine blades is cooled to such an extent that all of the heat imparted thereto by the gas jet and the heated blades is taken up by the cooling medium and is thus kept from the non-slotted portion of the rotor.

My invention is applicable to disc-shaped or drum-shaped rotors of any desired construction. Moreover, my invention is in no way limited to any particular method of cooling the slotted rings. A suitable cooling arrangement may consist in jets directing a cooling medium on to the rings, or the cooling medium may be conducted to the ring by way of suitable conduits extending from the rotor axle through its interior.

Further objects of my invention will appear from the description following herein after and the features of novelty will be pointed out in the claims.

In the accompanying drawings two preferred embodiments of my invention are illustrated.

Fig. 1 is a partial radial section through an explosion turbine equipped with a disc-shaped rotor and is taken along the vertical center line of Fig. 2, while

Fig. 2 is a partial elevation of the rotor;

Fig. 3 depicts a radial section through another embodiment, similar to Fig. 1, and shows another cooling arrangement for the rotor which is shown in partial elevation in Fig. 4;

Fig. 5 is similar to Fig. 1 and illustrates further elements of an explosion turbine to which my invention is primarily applicable.

Fig. 6 is the section on line VI—VI of Fig. 5;

Fig. 7 is an enlarged view illustrating the construction of a cooling fluid charging mechanism.

In Figures 1 to 4, *a* designates the rotor of the turbine which may be in the form of a disc having a reinforced rim as shown in Fig. 3 or may be flat as will appear from Fig. 1. The radial turbine blades *b* are mounted in the usual manner in a blade-carrying ring *c*. This ring is preferably integral with the body *a* as indicated in Figs. 1–4.

One feature of novelty resides in the provision of radial slots *d* in the ring *c*, such slots dividing the ring into individual arcuate pieces or sections which are cooled by suitable means, such as hereinafter described.

In the embodiment of Figures 1 and 2 the cooling means comprise jets or nozzles *e* arranged in the frame of the turbine and directed towards the ring *c* to impinge a cooling medium thereon, which is admitted through pipes *f*. Preferably, the cooling medium consists of a fluid atomized by compressed gases, such as compressed air, which may be admitted through pipes *g* from a suitable source, not shown. The atomization of the cooling liquid offers the advantage of easy regulation and of a smooth and uniform effect which could not be obtained in so satisfactory a way by a solid liquid jet directly impinged on the ring as such jet would be liable to chill the material in an undesirable manner.

In Figures 3 and 4 I have shown another way of cooling ring *c*. From an axial boring *h* in the rotor connected to a suitable source of atomized cooling liquid, radial branches *i* extend to the slots *d* to directly convey the atomized liquid to the surfaces of the individual sector-shaped blocks or projections constituting the ring. Thus, the heat imparted to the blocks by the heated blades and the hot gas jet is taken up by the cooling medium entering the slots *d* with the result that the non-slotted portion *a* of the rotor will have a substantially even temperature in all its parts and will be free from thermal stresses.

The construction of the other parts of my turbine does not form part of present invention and is shown and described in a number of prior patents and applications. To facilitate the easy comprehension of my invention, however, I have illustrated in Figures 5 and 6 the vital parts of my turbine and its operation will briefly be described hereinafter.

An explosive gas mixture is intermittently formed in the chamber *k* by admitting its constituents through conduits *t* and *v* controlled by valves *l* and *r* which are operated in a predetermined timed relation by means of pressure oil conducted to the valves through pipes *m* and *s*. When a sufficient pressure has been reached in the chamber *k*, its content is ignited by means not shown and simultaneously the nozzle valve *n* is opened to discharge the explosion gases into the nozzle *o*. Subsequently, chamber *k* is scavenged by air whereupon valve *n* is closed and the cycle of operations is repeated. Valve *n* is controlled by pressure oil admitted through pipes *u*. The jets of explosion gases issuing from nozzle *o* are impinged upon the first row of rotor blades *b* and then pass through stationary blades *p* to be diverted and directed to the second row of rotor blades *b* wherefrom they are discharged into a chamber *q* for any desired further use.

Fig. 7 shows an enlarged longitudinal sectional view through the nozzles *e*. Each nozzle consists of a hollow central member *e'* having a connection *f'* for attachment to a supply conduit for cooling water or other cooling fluid. The member *e'* is surrounded by a casing *y* in spaced relation thereto, the intervening annular space being connected by the conduit *g* to a source of compressed air. The member *e'* carries a discharging plug *w* provided with a fine bore *x*. The cooling water flowing through the bore *x* is caught up and atomized by the annular stream of air discharged through the tapered passageway *z*. The mixture of air and water so formed is charged against and between the blade ring segments *c* and effects the necessary cooling of the latter.

I claim:

1. In an explosion turbine, the combination of a rotor having a blade-carrying portion at its periphery, said blade-carrying portion being provided with slots which divide such portion into a plurality of sections and permit expansion of such sections, means for directing combustion gases against the blades of said rotor, and means for charging a cooling medium to cool said blade-carrying portion.

2. In an explosion turbine, the combination of a rotor having a blade-carrying por-

tion at its periphery, said blade-carrying portion being provided with slots which divide such portion into a plurality of sections and permit expansion of such sections, means for directing combustion gases against the blades of said rotor, and means for charging a mixture of compressed air and atomized water to cool said blade-carrying portion.

3. In an explosion turbine, the combination of a rotor, an annular blade-carrying portion upon the circumference of said rotor for supporting the rotor blades, said annular portion being provided with slots which divide such portion into a plurality of sections and permit expansion of such sections, means for directing combustion gases against the blades of said rotor, and means for charging a cooling medium to cool said slotted portion.

4. In an explosion turbine, the combination of a rotor, an annular blade-carrying portion at the circumference of said rotor integral with the body of said rotor, said blade-carrying portion being provided with slots which divide such portion into a plurality of sections and permit expansion of such sections, means for directing combustion gases against the blades of said rotor, and means for conducting a cooling medium to cool said blade-carrying portion.

5. In an explosion turbine, the combination of a rotor, a blade-carrying portion at the circumference of said rotor for supporting the rotor blades, said portion being provided with slots which divide such portion into a plurality of sections and permit expansion of such sections, means for directing combustion gases against the blades of said rotor, and nozzles arranged to direct a cooling medium upon such slotted blade-supporting portion.

6. In an explosion turbine, the combination of a rotor, a blade-supporting portion at the circumference of said rotor and provided with slots which divide such portion into a plurality of sections and permit expansion of such sections, means for directing combustion gases against the blades of said rotor, said rotor having radial bores opening at the bottom of such slots, said wheel having also an axial bore communicating with such radial bores, and means for conducting a cooling medium to said axial bore.

HANS HOLZWARTH.