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RADIAL WHEEL CONSTRUCTION

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Fig. 1.

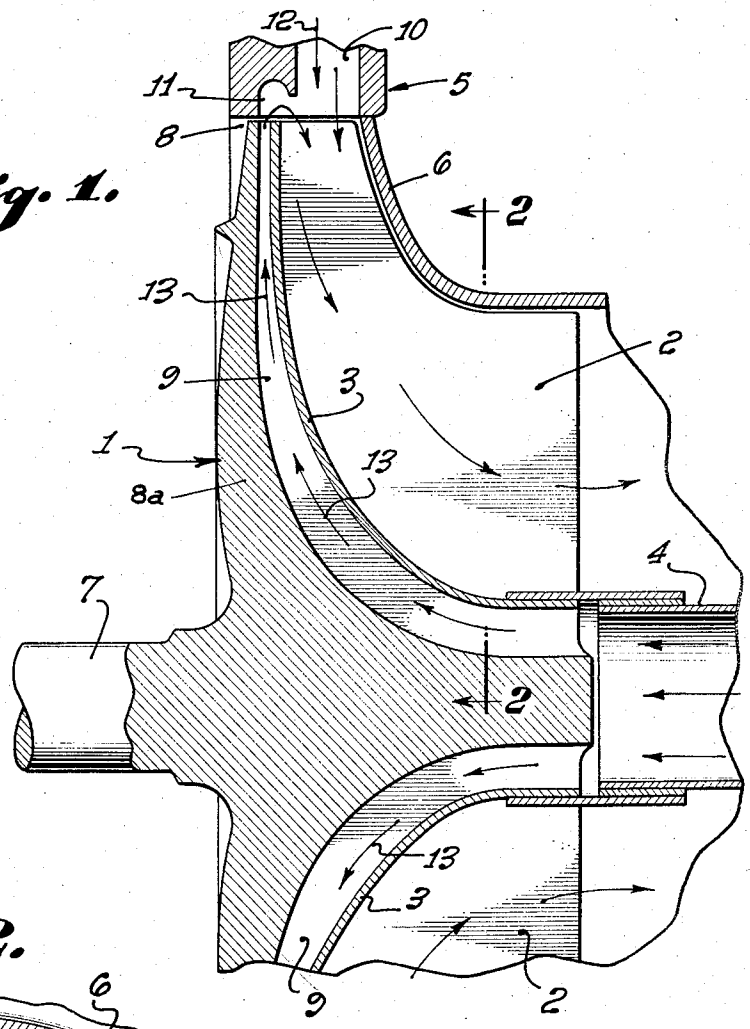
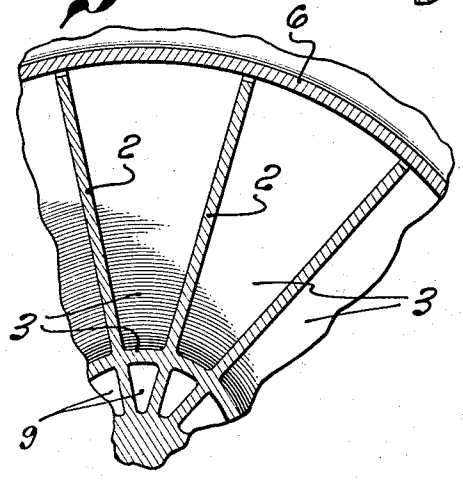


Fig. 2.



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RADIAL WHEEL CONSTRUCTION

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5 Claims. (Cl. 253—39.15)

This invention relates to a centripetal turbine wheel construction and more particularly to a fluid cooled structure for hot turbine wheels.

In the operation of hot turbine wheels, high temperature gases cause overheating of the thin peripheral rim of the turbine wheel, and when such hot gases are shut off the peripheral rim of the wheel contracts radically due to more rapid cooling thereof than the cooling of the body portion of the wheel. Such subjection of the rim of the wheel to high temperature operation which causes extreme compression and subsequent rapid cooling contraction at the rim of the wheel creates structural cracks leading to eventual destruction of the entire turbine wheel.

It is an object of the present invention to provide cooling passages in a centripetal turbine wheel intermediate the body and the working surfaces of the blades thereof whereby the body and the rim of the wheel are shielded from the high temperature gases flowing intermediate the blades of the wheel.

Another object of the invention is to provide a centripetal turbine wheel having cooling passages therein disposed laterally of the flow path of the hot gases, whereby the rim of the wheel body is shielded from direct impingement of the hot gases flowing onto the blades of the wheel.

Another object of the invention is to provide a centripetal turbine wheel construction having fluid cooling passages therein communicating with an axial fluid inflow conductor whereby rotation of the wheel centrifugally forces cooling fluid through the passages in the wheel intermediate the hub body portion thereof and the blade region onto which hot gases flow.

Another object of the invention is to provide a centripetal turbine wheel construction having cooling fluid passages communicating with an axial inlet said wheel having a hot gas outlet concentric to said inlet for the purpose of promoting regenerative heat exchange from the exhaust of the hot gases to the incoming cooling fluid, thereby contributing to the thermal efficiency.

A further object of this invention is to provide a centripetal turbine wheel construction having cooling passages therein between the hub body and the working blades thereof co-operating with nozzle box structure at the periphery of the wheel said wheel having hot gas passages laterally of the cooling air passages therein, permitting the peripheral rim of the wheel and the cooling passages to operate without interference with the flow of hot gases onto the working surfaces of the wheel.

A still further object of this invention is to provide centrifugal cooling passages in a hot turbine wheel which communicate with the hot gas flow between blades of the wheel, whereby compressed cooling air is subsequently expanded and a substantial amount of the work expended compressing the same is recovered.

Further objects and advantages will be apparent from the following specification and appended claims.

Reference is directed to the accompanying drawing in which

Figure 1 of the drawing is an axial fragmentary sectional view of a radial flow turbine wheel construction according to the present invention wherein arrows indicate the direction of flow of cooling air and hot gases relative to the wheel; and

Figure 2 is a fragmentary sectional view taken from the line 2—2 of Figure 1.

The turbine wheel 1 is a disc-shaped wheel having a central shaft 7 and a body 8*a* of modified disk-like form, the body having a peripheral rim 8. This peripheral rim is relatively thin compared with the body of the wheel as shown in Figure 1 of the drawings. The side surface of body 8*a* remote from the shaft 7 curves forwardly adjacent the center of the wheel and is provided with blades 2 which have radially and forwardly extending portions, the blades being spaced from one another to form channel-like passages for working fluid employed to effect the operation of the turbine. Partitions 3 are disposed between the blades 2 and are spaced from the front surface of the body 8*a* to provide cooling fluid passages 9 which extend from the forward portion of the wheel adjacent the center thereof to the periphery of the wheel. The partitions 3 intermediate the blades separate the cooling fluid passages 9 from the working surfaces of the blades which are subjected to the flow of hot gases from the nozzles 10 of the nozzle box 5. It will be noted that while the nozzles are substantially co-extensive with the peripheral extremities of the blades 2 at the portions thereof extending beyond the partitions 3, they terminate a short distance to one side of such partitions thus the partitions 3, passages 9, and peripheral rim 8 of the wheel 1 are all disposed in laterally offset relation to the nozzles and the flow path of gases passing therefrom. The axially disposed air inlet conductor 4 is concentric with the exhaust passage of the turbine and communicates with the passages 9 which extend to the periphery of the wheel 1. The nozzle box 5 adjacent the peripheral rim of the wheel is provided with a communicating passage 11 adapted to reverse the direction of the cooling fluid after issuance from the passages 9 to cause it to flow substantially parallel to the flow path of hot gases directed from the nozzles 10 to the blades 2 of the turbine wheel. Surrounding the working portions of the blades 2 is a substantially conventional casing 6 forming an outlet and expansion chamber for the hot gases issuing from the nozzle box 5.

During rotative operation of the wheel, hot gas flows through the nozzles 10 in the direction as indicated by the arrows 12 and passes over the working surfaces of the blades 2 outwardly of the partitions 3. The cooling fluid as indicated by arrows 13 is centrifugally forced toward the rim 8 of the wheel 1 to the passage 11 wherein its direction is reversed into the flow path and in the direction of hot gases issuing from the nozzles 10 onto the blades 2. Air compressed by centrifugal force in the passages 9 is conducted into the hot gas flow path and is then expanded. The compressed air thus returns a considerable amount of the work expended in compressing it. The disposition of the rim 8 outside the flow path of hot gases shields it from impingement by the hot gases. The flow of cooling fluid in the passages 9 reduces conduction of heat from the blades 2 to the rim 8, and thus prevents undue heating of the turbine wheel 1 at this point. The continuous flow of cooling fluid in the passages 9 carries away sufficient heat to permit the normal useful operation of the turbine wheel 1 by gases of a higher temperature than heretofore considered optimum. The continuous flow of cooling fluid in the passages 9 maintains the peripheral rim 8 of the

wheel at a lower temperature and effectively reduces the thermal gradients which have heretofore cracked the wheel rim due to severe differential contraction occasioned by the rapid cooling down after the hot gases are shut off. The extent of the temperature fluctuation in the wheel rim 8 is considerably reduced due to its relatively lower operating temperature, and thus the expansion and contraction stresses do not approach the ultimate strength of the material of the wheel 1, thus minimizing the cracking tendency hertofore encountered.

Although my invention has been disclosed as related more particularly to a certain radial flow turbine wheel construction, variations may be effected in the structure and use thereof without departing from the spirit of the claims.

I claim:

1. In a gas turbine: a wheel structure comprising a shaft; a substantially disk-shaped body means on said shaft; a plurality of blades projecting from one side of said body means, said blades being spaced from one another and cooperating with said body means to provide working fluid channels having inlet and exhaust ends; means forming cooling fluid passages in said body means separated from said working fluid channels by a relatively thin partition portion of said body means, said cooling fluid passages being coextensive with said working fluid channels and having inlet and exhaust ends, the inlet ends of said cooling fluid passages being disposed adjacent the exhaust ends of said working fluid channels, the exhaust ends of said cooling fluid passages being disposed adjacent the inlet ends of said working fluid channels; means forming nozzles in registration with the inlet ends of said working fluid channels; cooling fluid conducting means communicating with the inlet ends of said cooling fluid passages; and means disposed exteriorly of said body means to form a reversing passage establishing communication between the exhaust ends of said cooling fluid passages and the inlet ends of said working fluid channels.

2. In a gas turbine: a wheel structure comprising a shaft; a substantially disk-shaped body means provided on said shaft, said body means having one side extending axially adjacent the center and radially near the periphery; a plurality of blade elements projecting from said side of said body means, said blade elements being spaced and cooperating with said body means to provide working fluid channels extending radially inwardly from the periphery of said wheel and axially adjacent the center thereof, said body means being formed adjacent the side provided with said blade elements with cooling fluid passages separated from said working fluid channels by relatively thin partition portions of said body means, said cooling fluid passages having open ends facing the same directions as the ends of said working fluid channels; nozzle means registering with said working fluid channels at one end; means forming an exhaust passage in registration with said working fluid channels at the opposite end; a cooling fluid conducting means communicating with said cooling fluid passages at the ends thereof adjacent said exhaust passage; and means exteriorly of the periphery of said wheel forming a reversing passage establishing communication between the other ends of said cooling fluid passages and said working fluid channels adjacent said nozzle means.

3. In a gas turbine: a turbine wheel structure comprising a shaft; a disk body provided on said shaft, said body having one side extending axially adjacent the center and radially near the periphery; a plurality of radially and axially extending blades projecting from said side of said body, said blades being angularly spaced about the axis of said shaft; partition means between adjacent blades and spaced from said body, said partition means cooperating with the body and adjacent portions of said blades to provide cooling fluid passages extending axially at the center of the wheel and radially at the periphery thereof, said partition and said blades cooperating to form working fluid channels spaced throughout their length from said disk body by said cooling fluid passages; means forming a conductor communicating with said cooling fluid passages at the center of the wheel; means outside of the periphery of the wheel forming inlet nozzles in registration with the outer ends of the radially extending portions of said working fluid channels; and means adjacent the periphery of said wheel forming a fluid reversing passage registering in part with the outer ends of the radially extending portions of said cooling fluid passages and said working fluid channels, said last-named means being shaped to cause cooling fluid flowing from said cooling fluid passages to flow in the opposite direction into the working fluid channels.

4. In a gas turbine: a turbine wheel structure comprising a shaft; a body of substantially disk shape provided on said shaft; a plurality of radially and axially extending blades projecting from one side of said body, said blades being spaced angularly about the shaft axis and cooperating with said body to provide working fluid channels extending radially inwardly from the periphery of said wheel and axially adjacent the center thereof; means on said wheel forming cooling fluid passages coextensive with said working fluid channels and separated therefrom by a relatively thin partition portion of said disk-shaped body; means forming a cooling fluid conductor communicating with said cooling fluid passages at the center of said wheel; and means exteriorly of the periphery of said wheel forming inlet nozzles in registration with the outer ends of the radially extending portions of said working fluid channels, said means also forming a flow reversing passage projecting across the outer ends of said cooling fluid passages and part of the outer ends of said working fluid channels.

5. In a gas turbine: a turbine wheel structure comprising a shaft; a disk-shaped body provided on said shaft; a plurality of radially and axially extending blades projecting from one side of said body, said blades being angularly spaced and cooperating with said body to provide working fluid channels extending radially inwardly from the periphery of said wheel and axially adjacent the center thereof; means on said wheel forming cooling fluid passages coextensive with said working fluid channels and separated therefrom by a relatively thin partition portion of said disk-shaped body; means forming a cooling fluid conductor communicating with said cooling fluid passages at the center of said wheel; means at the periphery of said wheel forming inlet nozzles in registration with the outer ends of the radially extending portions of said working fluid passages; and flow directing means at the periphery of said wheel partially registering with the outer ends of the radially extending portions of said cooling fluid passages, said flow directing means receiving cooling fluid from said cooling fluid passages and discharging the same in the opposite direction in a stream along the side of said body from which said blades project.

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