March 21, 1961 D. U. HUNTER 2,976,013

TURBINE CONSTRUCTION

Filed Aug. 17, 1955

FIG. 1.

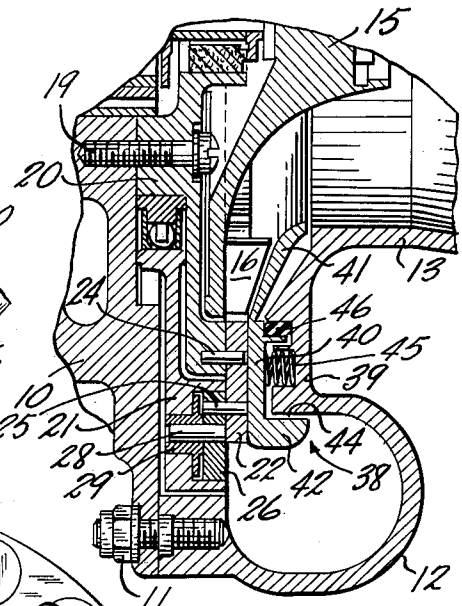
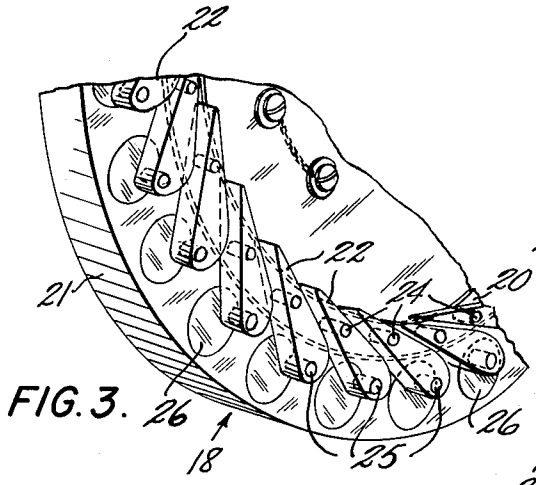


FIG. 3.



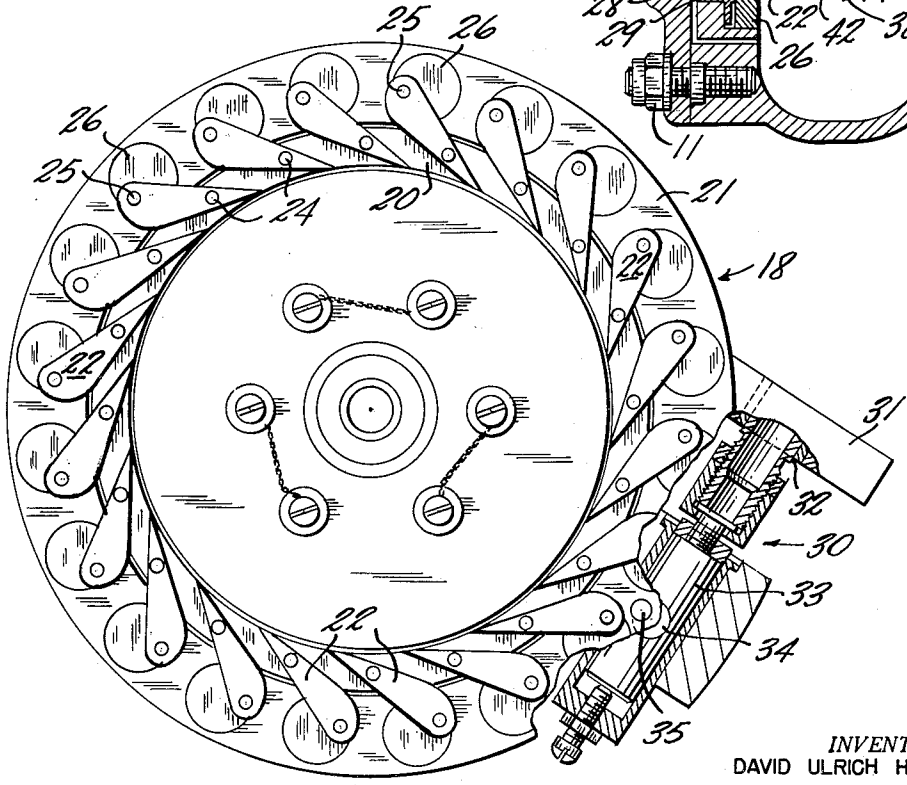


FIG. 2.

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TURBINE CONSTRUCTION

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The present invention relates to seals for gas turbines and the like fluid flow machines, and, more particularly, to novel and improved means for sealing that portion of a turbine adjacent the nozzle blades and turbine wheel blades.

In accordance with the invention, a novel differential pressure responsive floating back plate is provided adjacent the nozzle blades to form a sealing engagement therewith. Unitary with the floating back plate, there is provided a shroud adapted to lie closely adjacent the blades of the turbine wheel. The floating back plate is forced against the nozzle blades by differential pressure.

For an understanding of the invention, reference may be had to the following detailed description taken in conjunction with the accompanying figures of the drawing, in which:

Figure 1 is a partial axial section of a turbine wheel, nozzle assembly, and associated intermediate housing disclosing an exemplary embodiment of a floating back plate, in accordance with the invention;

Fig. 2 is a view in side elevation of the nozzle and control rod assembly for the turbine, shown in part in Fig. 1, and partially broken away to show the manner in which the movable outer nozzle disc is controlled; and

Fig. 3 is a partial perspective view of the face of the nozzle assembly.

Referring now to Fig. 1, the intermediate housing **10** of a gas turbine has bolted to it by means of bolts **11** a volute **12** forming a passageway for feeding fluid to the turbine and an exhaust tube **13**. Axially mounted in a conventional manner within the exhaust tube **13** is an impeller or turbine wheel **15** having a plurality of turbine blades **16** of conventional form. A nozzle plate **18**, shown in detail in Figs. 2 and 3, is interposed between the intermediate housing **10** and the turbine wheel **15** and is bolted to the intermediate housing **10** by means of bolts **19**.

In the disclosed embodiment, the nozzle plate includes a fixed inner nozzle ring **20** and a movable outer nozzle ring **21**. A plurality of movable nozzle blades **22** are mounted on the inner and outer nozzle rings **20** and **21**. The nozzle blades **22** are shaped as shown in Figs. 2 and 3 in the drawing, so that the area of the nozzle orifices therebetween may be varied by relative reorientation of the respective nozzle blades **22** and so that the angle of impingement of the fluid flow from the volute **12** upon the turbine blades **16** may be varied.

Each of the nozzle blades **22** are rotatably pinned at one end to the fixed inner nozzle ring **20** by a pin **24**. The opposite ends of the respective nozzle blades **22** are rotatably pinned by pins **25** to a freely rotatable nozzle disc **26** at a point displaced from the center thereof. The nozzle disc **26** is fixedly mounted on a shaft **28** which rotates freely within a nozzle disc bearing **29** disposed in the movable outer nozzle ring **21**, as shown in Fig. 1.

The relative reorientation of the nozzle blades **22** is controlled by a nozzle actuator **30** mounted on an actuator mount **31** and having an actuator piston rod **32**, a nozzle control rod **33**, a control rod bushing **34**, and an outer

nozzle ring pin **35** engaging the outer nozzle ring **21** in such a manner as to translate longitudinal movement of the nozzle control rod **33** into a rotational movement of the outer nozzle ring **21**. The rotational movement of the outer nozzle ring **21** relative to the fixed inner nozzle ring **20** causes an angular displacement of the nozzle blades **22** about their respective pins **24**, thereby varying the effective nozzle area between the nozzle blades **22**.

An annular member **38** forming a floating back plate is positioned intermediate the nozzle blades **22** and a portion **39** of the casing forming the volute **12** and the exhaust tube **13**. The annular member **38** has a flat central portion **40**, an inner portion **41** forming a shroud for the turbine blades **16**, and an outer portion **42** forming a passageway **44** with the inner wall of the volute **12**. The face of the central portion **40** adjacent the nozzle blades **22** is adapted to lie contiguous therewith so as to form a seal therebetween. The central portion **40** of the floating back plate **38** may be, as shown in Fig. 1, forced against the nozzle blades **22** by a suitable biasing means **45**, such as a compression spring.

While the annular floating back plate member **38** is independent of the casing forming the volute **12** and the exhaust tube **13** and is adapted for relative movement therebetween, it is necessary to seal the space between the floating back plate member **38** and the casing to prevent the flow of gases from the volute through the space to the exhaust tube **13**. This may be done by suitable sealing means, such as the O-ring seal **46**.

It is well known that due to the high operating temperatures and pressures of the gases flowing from the volute through the nozzles to the turbine wheel blades, a substantial expansion and deflection of the volute casing away from the adjacent surfaces of the nozzle blades occurs. This deflection provides a space for the flow of gases other than through the nozzles. This flow causes a reduction in the efficiency of operation of the turbine. Further, it is equally obvious that in order to have efficient operation of the turbine wheel, substantially all of the gases must impinge upon the turbine wheel blades. Therefore, the inner portion **41** of the annular floating back plate member **38** must be designed to have as close as possible a clearance with the rotating turbine blades **16**. For example, it has been found that with a minimum clearance of .0005 in. between the volute casing and the turbine blades, the efficiency of the turbine wheel is 85%. If there is a change in clearance between the back plate and the turbine wheel blades of .002 in., the efficiency of the turbine wheel will drop to 84%. If the change in clearance is .010 in., the efficiency drops to 80%. Accordingly, it is evident that the amount of clearance that can be maintained between the nozzle blades and the volute casing is a factor of substantial importance in the overall operation of the turbine.

The annular floating back plate member **38** provides the necessary sealing action, in the following manner. The passage of the gases from the volute through the relatively restricted nozzle areas toward the turbine wheel blades causes a substantial pressure differential between the gases in the volute and the gases passing through the nozzle areas. The passageway **44** permits the passage of gases flowing through the volute **12** into the space between the annular floating back plate member **38** and the volute casing. Since the pressure of the gases in the space behind the floating back plate member is the same as the pressure of the gases in the volute **12**, a large differential force is exerted on the floating back plate member **38** forcing it against the adjacent surfaces of the nozzle blades **22**. When fixed area nozzles are used in the turbine, the floating back plate member **38** lies directly on the adjacent surfaces of the nozzle blades. However, when variable area nozzles are used, as in the instant embodiment,

it may be desirable to have the pins 24 and 25 of each of the nozzle blades 22 protrude very slightly beyond the surface of the nozzle blades 22 so as to support the floating back plate on the nozzle pins rather than on the movable nozzle blades. If such a technique is used, it will be obvious that the amount of protrusion of the pins 24 and 25 of the nozzle blades 22 should be very small.

Thus there has been provided novel and improved means for preventing leakage between the nozzle blades and the volute casing.

It will be obvious to those skilled in the art that the above disclosed embodiment is meant to be merely exemplary and that it is susceptible of substantial modification and variation without departing from the spirit and scope of the invention. For example, while the specific embodiment of the invention disclosed utilizes variable area nozzles, it is evident that the invention is equally apposite to use with fixed nozzles. Further, while the casing forming the volute 12 and the exhaust tube 13 have been shown as being unitary, it will be evident that these portions of the casing may be made separate in any suitable conventional manner. Accordingly, it is deemed that the invention is not to be limited except as defined by the appended claims.

I claim:

1. In a turbine or like fluid flow machine having nozzle blades for controlling the flow of fluid under pressure from a passageway to the blades of an impeller, wherein the casing for said passageway overlies said nozzle blades and said impeller blades, the improvement comprising the combination therewith of differential pressure responsive sealing means interposed in sealing relation between said nozzle blades and said overlying casing and including means whereby said sealing means is responsive to the difference in pressure between the fluid flowing in said passageway and the fluid flowing between said nozzle blades, including a portion thereof movable against said nozzle blades by said difference in pressure and another portion thereof in overlying relation to said impeller blades and movable toward the said impeller blades to maintain a minimum clearance therebetween.

2. In a turbine or like fluid flow machine having nozzle blades for controlling the flow of fluid under pressure from a passageway to the blades of an impeller, wherein the casing for said passageway overlies said nozzle blades and said impeller blades, the improvement comprising the combination therewith of differential pressure responsive sealing means interposed in sealing relation between said nozzle blades and said overlying casing, including a portion thereof spaced from said overlying casing and movable against said nozzle blades, means in communication with said passageway and said space for introducing fluid from said passageway to the space between said portion and said overlying casing, the difference in pressure between said fluid introduced into said space and the fluid flowing between said nozzle blades causing said portion of said sealing means to be urged against said nozzle blades, and another portion of said sealing means extending in overlying relation to said impeller blades intermediate said impeller blades and said casing and movable theretoward intermediate said impeller blades and said casing.

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