

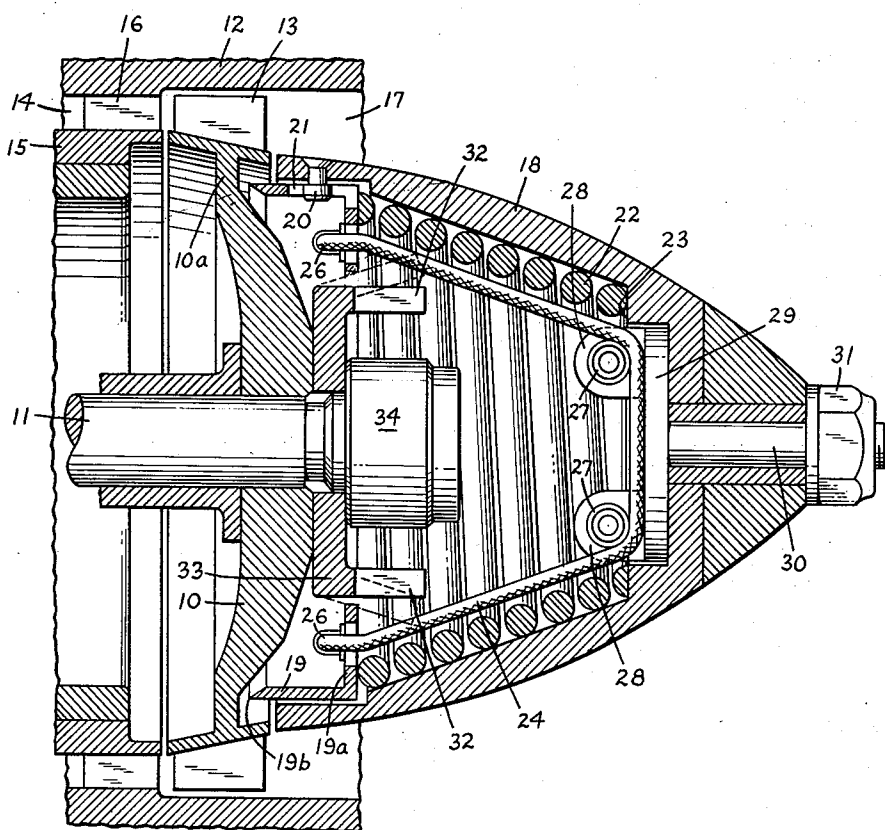
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OVERSPEED SAFETY DEVICE FOR TURBINE WHEELS

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1

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OVERSPEED SAFETY DEVICE FOR TURBINE WHEELS

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This invention relates to a safety mechanism for turbines which operates in response to an overspeed condition of the turbine rotor to exert a braking force on the turbine rotor which, if the braking force is insufficient to stop the rotor, will quickly produce a controlled failure of the turbine rotor.

It is well known that runaway turbines are highly dangerous due to the possibility of failure of the turbine rotor. Because of the extremely high rotational speeds at which such failures occur, it is not unusual for large fragments of the rotor to be projected with sufficient force to penetrate the housing within which the turbine rotor is situated. It is apparent that such failures present an extreme hazard to both personnel and equipment.

The present invention is directed to the provision of a safety mechanism which includes means for checking an overspeed condition in a runaway turbine by first exerting a braking action on the turbine rotor and then, if the braking force is ineffective to bring the rotor to a stop quickly, severing the impeller blades from the turbine rotor proper. In the safety mechanism of the present invention, a rotor engaging and cutting member is stationed adjacent one face of the turbine rotor but spaced apart therefrom so as not to interfere with the normal operation of the rotor. The cutting member is urged toward the adjacent face of the turbine rotor but movement of the cutting member into engagement with the turbine rotor is prevented by restraining means which maintains the cutting member out of contact with the turbine rotor. The present invention also includes means which is sensitive to an overspeed condition of the turbine rotor, which means is operative in response to an overspeed condition for rendering the restraining means inoperative, thereby permitting the cutting member to be moved into contact with the turbine rotor. If the turbine rotor is not quickly brought to a stop by the frictional engagement of the cutting member, it will quickly cut through the turbine rotor, causing severance of the impeller blades from the turbine rotor proper. This failure is controlled to occur at a speed of rotation which is less than the speed at which the turbine rotor proper would fail, so that damage is confined to the turbine rotor and serious damage to personnel and other equipment is prevented.

For a complete understanding of the present invention, reference may be had to the detailed description which follows, and to the accompanying drawing in which the figure is a cross-sectional view of an axial flow turbine embodying the present invention.

Referring to the drawings, a turbine rotor 10 is supported on a rotatable shaft 11 within a hollow cylindrical housing 12. The outer periphery of the rotor 10 carries a plurality of impeller blades 13, and the turbine rotor is driven by an impelling fluid which is directed against the impeller blades 13 through an annular passage 14 upstream of the impeller blades. The annular passage 14 is formed between the outer periphery of a cylindrical member 15 and the inner periphery of the turbine housing 12. Stationary vanes 16 stationed in the passage 14 direct the impelling fluid in the desired path against the impeller blades 13. Downstream of the impeller blades, the impelling fluid passes through a gradually expanding

2

annular passage 17 which is formed between the inner periphery of the housing 12 and the outer periphery of a hollow nose-like housing structure 18. The housing 18 is supported centrally within the outer housing 12 by suitable means.

The hollow housing 18 serves as a housing for an annular axially displaceable cutting member 19 which is accommodated therein adjacent one face of the turbine rotor 10. The cutting member 19 is accommodated loosely within the open end of the housing 18 to permit axial displacement of the cutting member relative to the turbine rotor. At the same time, the cutting member 19 is guided for axial displacement within the housing 18 and at the same time prevented from rotating about its axis by a pin and slot connection with the housing 18. More specifically, the inner periphery of the hollow housing 18 is provided with a plurality of radially extending pins 20 which engage axially disposed slots 21 in the annular cutting member 19. This pin and slot connection guides the cutting member 19 in its axial movement toward the turbine rotor 10 and at the same time prevents rotation of the cutting member.

The cutting member 19 is normally urged toward the turbine rotor by a compression spring 22 within the housing 18. The compression spring 22 is generally conical in shape, with one end engaging a shoulder 23 of the housing 18 and the opposite end engaging a radial flange 19a of the cutting member 19. The movement of the cutting member under the influence of the spring 22 is resisted by a restraining member 24 which holds the cutting member 19 out of engagement with the adjacent face of the turbine rotor.

The restraining member 24, in the form shown in the drawing, is a severable cord which is connected at both ends by clamps 26 to the radial flange 19a of the cutting member. The intermediate portion passes around a pair of rollers 27 at the opposite end of the housing 18. Each of the rollers 27 is supported between a pair of ears 28 which project laterally from one face of a disc 29. The disc 29 is formed with an extension rod 30 which projects laterally from the opposite face of the disc 29 and passes through the end of the housing 18. The extreme end of the rod 30 is threaded to receive a nut 31 thereon which, when tightened, anchors the disc 29 and the rollers 27 in a fixed abutment with the end of the housing 18 remote from the turbine rotor 10.

The restraining cord 24 is adapted to be severed in the event of an overspeed condition by the cutting elements or blades 32 which are formed integrally with the rotating disc 33. The disc 33 is mounted at the end of the turbine shaft 11 between the turbine rotor and a retaining collar 34, so that the disc rotates at the same speed of rotation as the turbine rotor. At normal speeds of rotation, the cutting elements 32 travel in a circular path inside of the lengths of the cord passing through the housing 18. The blades 32 are flexible or they are flexibly connected to the disc 33, so that at an overspeed condition of the turbine rotor they are deflected outwardly by centrifugal force to the positions indicated by the broken lines in the drawing. In moving outwardly, the blades 32 sever the restraining cord 24, thereby permitting the compression spring 22 to move the cutting edge 19b of the cutting member into engagement with the adjacent face of the turbine rotor. This action at first exerts a braking force on the turbine rotor and, if that is not effective to quickly stop the rotation of the turbine rotor, the action of the cutting edge separates the impeller blades from the turbine rotor proper.

The impeller blades 13 are mounted to the outer periphery of the turbine rotor by a relatively thin portion 10a near the outer periphery of the turbine rotor. This

thin portion of the web of the turbine rotor forms a weakened connection between the turbine rotor proper and the impeller blades through which the cutting edge 19b of the annular cutting member 19 acts. The cutting edge 19b is laterally offset from this annular weakened portion by only a small clearance and, therefore, when the restraining cord 24 is broken, the cutting edge 19b is moved quickly into engagement with the annular weakened portion 10a of the web. When the impeller blades are thus severed from the turbine rotor proper, the impelling fluid moving through the passage 14 is no longer effective to transmit rotation to the turbine rotor, so that the turbine rotor begins to slow down. The severance, of course, may cause the severed outer perimeter of the rotor to break into small pieces. However, the damage caused by these fragments will be considerably less than the damage produced in the event of failure of the turbine rotor proper.

The blade elements 32 of the disc 33 are designed to produce a controlled failure of the turbine rotor at a speed substantially higher than the normal speed of rotation of the turbine rotor but at a speed substantially less than the speed at which the turbine rotor proper would fail. This failure speed is also appreciably less than that which would impart sufficient energy to the impeller blade fragments to enable them to pass through the turbine housing 12.

It is understood that separation of the outer perimeter of the turbine rotor may be produced by the strain caused by the engagement of the member 19 against the face of the turbine rotor, or by a breaking, cutting, routing, gouging, sawing or shearing action, or the like.

The invention has been shown and described in a single preferred form and by way of example only, and obviously many variations and modifications may be made therein without departing from the spirit of the invention. The invention, therefore, should not be limited to any specified form or embodiment, except in so far as such limitations are set forth in the appended claims.

I claim:

1. In a turbine having a driven turbine rotor equipped with a plurality of impeller blades, an overspeed safety mechanism for severing the turbine impeller blades from a turbine rotor comprising a severing member mounted

adjacent the turbine rotor for displacement relative to the rotor to bring the severing member into engagement with the turbine rotor in the event of overspeed operation of the turbine rotor, force-exerting means acting on the severing member to urge the severing member into engagement with the turbine rotor in order to bring about severance of the impeller blades from the turbine rotor, restraining means acting on the force-exerting means to prevent the displacement of the blade severing member, and releasing means driven by the turbine rotor responsive to the overspeed condition for rendering said restraining means inoperative.

2. In a turbine, the combination of a turbine rotor, impeller blades carried at the outer periphery of said turbine rotor, said turbine rotor including a relatively thin portion connecting the turbine rotor proper and said impeller blades, an annular cutting member laterally offset from said turbine rotor, a housing surrounding said cutting member, guide means connected to said housing and permitting axial displacement of said annular cutting member without rotation, a compressed spring accommodated within said housing and acting on said cutting member to urge it into engagement with said portion connecting the turbine rotor and the impeller blades, anchoring means within said housing, an extended connection between said anchoring means and said annular cutting member, a cutting element capable of severing said extended connection, and a rotatable support for said cutting element driven by said turbine rotor, said rotatable support translating said cutting element in a circular path at normal speeds of rotation of the turbine rotor clear of the extended connection, but being deflected by centrifugal force at excessive speeds of rotation of the turbine rotor into a position for severing the extended connection, permitting the compression spring to move the cutting member against the turbine rotor to bring about severance of the impeller blades therefrom.

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