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OVERSPEED SAFETY DEVICE FOR TURBINE WHEELS

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FIG.1.

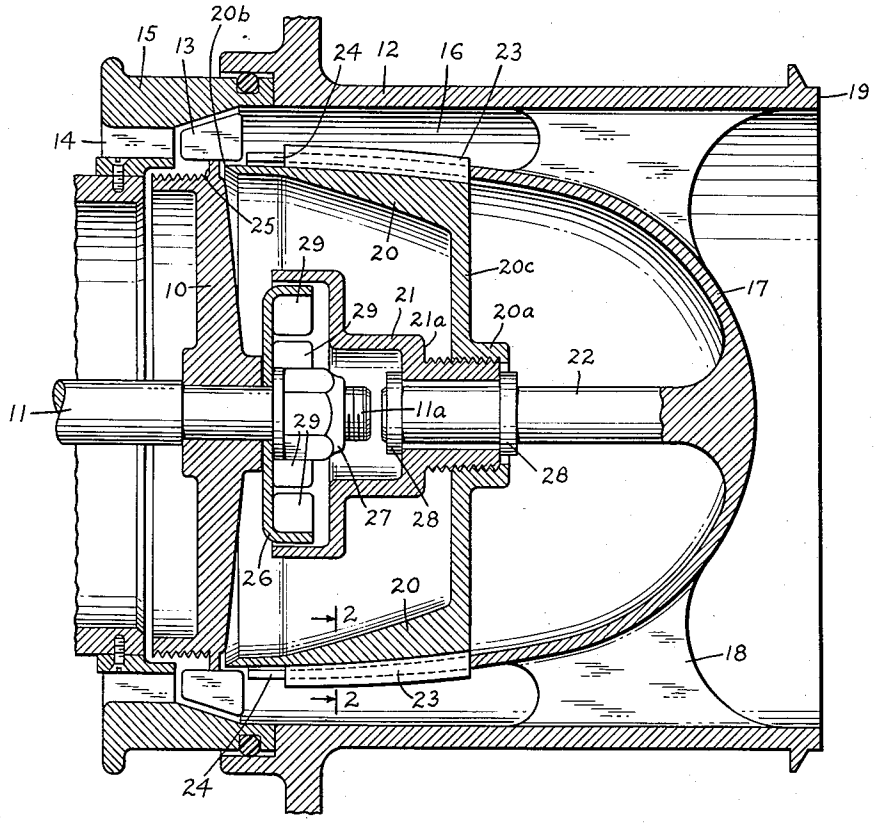
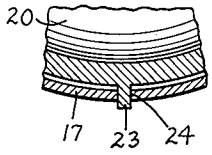


FIG.2.



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OVERSPEED SAFETY DEVICE FOR TURBINE WHEELS

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8 Claims. (Cl. 253—59)

This invention relates to safety mechanism for turbines which operates in response to an overspeed condition of the turbine rotor to exert a braking action on the turbine rotor which either brings the rotor to a complete stop or quickly produces 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 whch failures of turbine rotors 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 a safety mechanism 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 turbine rotor to a stop quickly, severing the impeller blades from the turbine rotor. The safety mechanism embodies a rotor engaging member which is stationed adjacent the turbine rotor but out of contact therewith. In the event of an overspeed condition of the turbine rotor, the member is moved into cutting and braking engagement with the outer perimeter of the turbine rotor, eventually bringing about a severance of the impeller blades from the turbine rotor proper. This severance, of course, damages the turbine rotor and may even cause the severed outer perimeter of the rotor to break into small pieces. The failure, however, is controlled to occur at a speed of rotation which is less than a speed at which the turbine rotor proper would fail so that the damage is confined to the turbine rotor blades, and more 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:

Figure 1 is a cross-sectional view of an axial flow turbine embodying the present invention; and

Figure 2 is a fragmentary cross-sectional view taken on the line 2—2 of Figure 1 looking in the direction of the arrows.

Referring to the drawing, a turbine rotor **10** is supported on a rotatable shaft **11** within the 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** of the rotor. The impelling fluid is directed toward the impelling blades **13** through an annular passage **14** formed in an annular member **15** which forms one end of the housing **12**. Downstream of the impeller blades **13** the impelling fluid passes through a gradually expanding annular passage **16** which is formed between the inner periphery of the housing **12** and the outer periphery of a hollow nose-like housing structure **17**. The nose-like housing is supported centrally within the outer housing **12** by webs **18** which may also serve as

vanes for controlling the direction of flow of the impelling fluid before it leaves the discharge end **19** of the housing **12**.

The hollow nose-shaped structure **17** serves as a housing for an annular axially displaceable member **20** which is accommodated therein adjacent one face of the turbine rotor **10**. One end of the member **20** is formed with a central hub **20***a* which surrounds and is threadably coupled with one end of a stepped sleeve **21**. The other end of the member **20** is formed with an annular cutting edge **20***b* which normally is laterally offset from one face of the turbine rotor. The threaded sleeve **21** is rotatably supported on a shaft **22** which is formed integrally with the end of nose-like structure **17**. The shaft **22** is disposed coaxially in tandem in the rotor shaft **11**. With this arrangement, when the sleeve **21** is rotated in the same direction as the turbine rotor, the member **20** is displaced axially, moving the annular cutting edge **20***b* toward and into engagement with the adjacent face of the turbine rotor. However, axial displacement of the sleeve **21** on the shaft **22** is prevented by a pair of thrust bearings **28** mounted on the shaft **22**.

The axially displaceable cutting member **20** is prevented from rotating with the sleeve **21** by a tongue and slot connection with the housing **17**. More specifically, the outer periphery of the member **20** is formed with a plurality of radial tongues or fins **23** which engage axial guide slots **24** (see Figure 2) formed in the housing structure **17**. This tongue and slot connection, although preventing rotation of the cutting member **20**, nevertheless permits axial displacement of the cutting member toward the adjacent face of the turbine rotor.

The impeller blades **13** are mounted to the outer periphery of the turbine rotor by a weakened connection **25**. As shown, the weakened connection **25** is an annular thin web which forms an annular groove between the outer periphery of the turbine rotor and the impeller blades. The cutting edge **20***b* of the member **20** is laterally offset from this annular weakened portion by only a small clearance. Therefore, when the sleeve **21** is driven by the turbine rotor, the edge **20***b* is moved into engagement with this weakened connection or groove.

The extreme end of the turbine shaft **11** carries an annular disc **26** which is accommodated within one end of the hollow sleeve **21**. The annular disc is mounted adjacent the turbine rotor **10** on the shaft **11** by a large nut **27** which is received on the threaded end **11***a* of the shaft **11**. The outer periphery of the disc **26** is formed with an axially extending rim which is split by axial slits to form a plurality of clutch elements **29**. Normally there is clearance between the outer surface of the elements **29** and the inner periphery of the sleeve **21**, so that the disc **26** is free to rotate with the shaft **11** without transmitting rotation to the sleeve **21**. However, in the event of an overspeed condition, the elemens **29** are urged radially outwardly by centrifugal force, thereby frictionally engaging the inner periphery of the sleeve **21**. This frictional engagement forms a drive transmitting clutch between the turbine rotor and the sleeve **21** for moving the cutting member **20** axially into engagement with the annular weakened groove **25** of the turbine rotor **10**. Due to the high speed of rotation of the turbine rotor, the impeller blades **13** are quickly severed from the turbine rotor proper, permitting the rotor to slow down before it attains a speed at which the turbine rotor proper will fail.

The elements **29** are approximately of equal size, and the material of which the disc **26** is formed is relatively flexible, so that at excessively high speeds, representing an overspeed or runaway condition of the turbin rotor **10**, the elements **29** fan out, frictionally engaging with the inner periphery of the sleeve, thus establish-

ing the driving connection between the turbine rotor and the sleeve. Because of the threaded coupling between the sleeve and the member **20**, the member is displaced axially along the outer periphery of the sleeve until the annular edge engages the weakened connection, exerting a braking action on the rotor. If this braking action is not effective to stop the rotor, it will quickly sever the impeller blades from the rotor. The limit of the axial displacement on the sleeve **21** is determined by the engagement of the radial portion **20***c* with the shoulder **21***a* of the sleeve, which shoulder functions as a stop.

Preferably the disc **26** is designed to produce a controlled failure of the turbine rotor at a speed substantially higher than the normal speed of rotation, 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 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 **20** 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 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. An overspeed safety mechanism comprising a rotor, a rotor engaging member spaced apart from the rotor but translatable into frictional engagement with the rotor, means for guiding the rotor engaging member for movement toward said rotor without rotation, drive means operatively connected to the rotor engaging member for converting rotational motion into the translational motion necessary to bring the rotor engaging member into frictional engagement with the rotor, and means driven by the rotor and responsive to an overspeed rotation thereof for establishing a drive connection between the rotor and said drive means, thereby moving the rotor engaging member into engagement with the rotor.

2. An overspeed safety mechanism as set forth in claim 1 in which the rotor includes an annular thin web connecting the outer periphery of the rotor to the central portion thereof.

3. An overspeed safety mechanism as set forth in claim 1 in which the means driven by the rotor and responsive to an overspeed condition thereof comprises a rotatable member which expands radially due to the effect of centrifugal force in the event of an overspeed condition of the rotor.

4. An overspeed safety mechanism as set forth in claim 1 in which said drive means operatively connected to the rotor engaging means includes a rotatable member and a threaded coupling between the rotatable member and the rotor engaging member.

5. An overspeed mechanism comprising a turbine rotor, a rotor engaging member spaced apart from one face of the turbine rotor but translatable into frictional engagement therewith, guide means for supporting the rotor engaging member for translation without rotation toward and into contact with said face of the turbine rotor, a drive means operatively coupled to the rotor engaging member to convert rotary motion into the translational motion necessary to bring the rotor engaging member into frictional engagement with the turbine rotor, and a coupling between the turbine rotor and the drive means which is disengaged at normal speeds of rotation of the turbine rotor, said coupling including rotary means driven by the turbine rotor and responsive to an overspeed condition thereof to complete the coupling to move the rotor engaging member into frictional engagement with the said face of the turbine rotor.

6. An overspeed safety mechanism comprising a rotor, a rotor engaging member disposed adjacent one face of the rotor, means for guiding the rotor engaging member into frictional engagement with the rotor, a clutch including a drive element and a driven element, a threaded connection between the driven element and the rotor engaging member to convert the rotary motion of the rotor into translational motion which is imparted to the rotor engaging member, the drive element of the clutch being operatively connected to and driven by the rotor, and means carried by the drive element of the clutch and responsive to centrifugal force when the rotor attains a high speed of rotation for coupling the drive and driven elements of the clutch.

7. In a turbine, the combination of a turbine rotor, impeller blades carried at the outer periphery of said turbine rotor, an annular axially displaceable member having a cutting edge at one end which is laterally offset from said turbine rotor, a housing surrounding said annular member, a tongue and slot connection between said annular member and said housing for permitting axial displacement of said blade severing member without rotation, a rotatable sleeve disposed centrally within said annular member and housing, a support shaft for said rotatable sleeve, a threaded coupling between said sleeve and said annular member, whereby rotation of the sleeve acts to displace the member axially, and a disengaged drive transmission between the rotor and the sleeve including means connected to said turbine rotor and responsive to an overspeed condition thereof for completing said drive transmission between the rotor and the sleeve, whereby the cutting edge of the annular member is moved into engagement with the turbine rotor to sever the blades therefrom.

8. The combination set forth in claim 7 wherein the said means connected to the rotor and responsive to an overspeed condition thereof comprises a disc driven by the turbine rotor and disposed within the sleeve, the enlargement of said disc due to centrifugal force in the event of an overspeed condition of the turbine rotor causing frictional engagement between the disc and the sleeve by means of which the sleeve is driven to displace the annular member with respect thereto.

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