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OVER-SPEED SHUT-OFF MECHANISM FOR TURBINES AND THE LIKE

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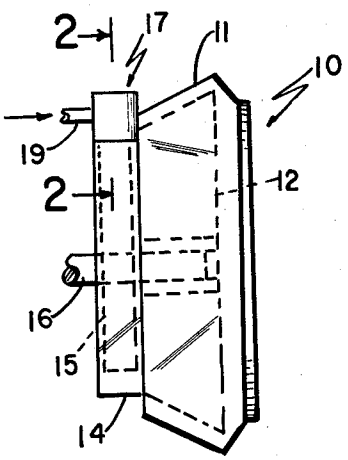


Fig. 1

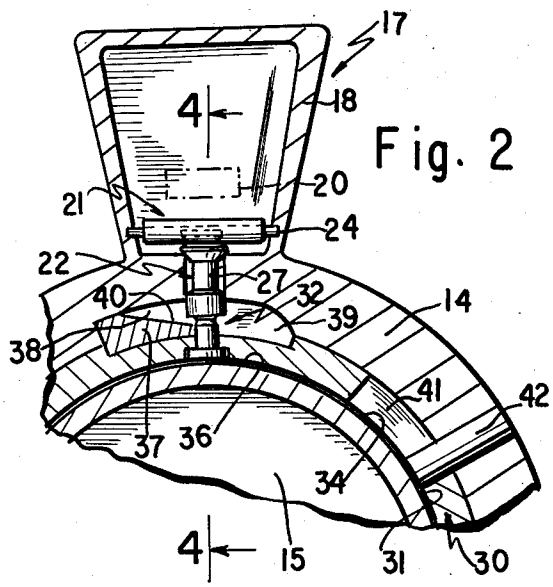


Fig. 2

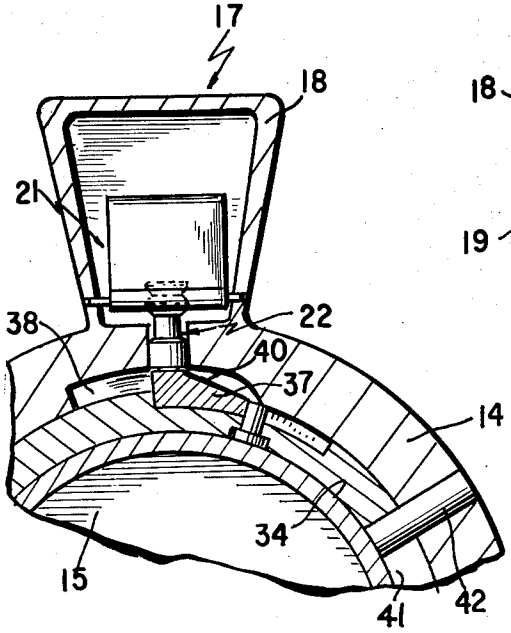


Fig. 3

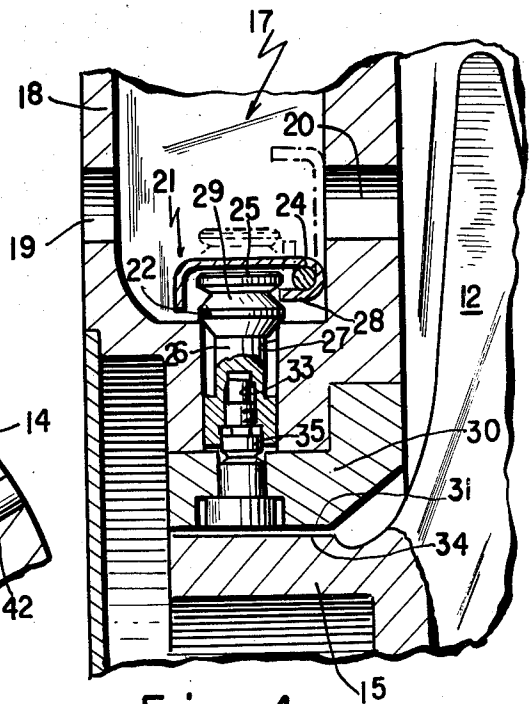


Fig. 4

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OVER-SPEED SHUT-OFF MECHANISM FOR TURBINES AND THE LIKE

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The present invention relates to turbines and, more particularly, to a mechanism for shutting-off the supply of operating fluid to the turbine and stopping the turbine in the event the turbine operates at an excessive speed which indicates that the turbine is running away.

The present invention is primarily concerned with the operation of turbines which are not manually supervised. Such turbines are utilized on missiles and non-manned space craft for supplying auxiliary power and usually are controlled by a complex electronic system which functions to start the turbine and to shut-off the turbine at a predetermined moment and when the turbine runs away. Since electronic systems are subjected to rugged environmental condition, malfunctioning of such systems in part or in their entirety is not uncommon. Thus, if the system loses control of an operating turbine, the turbine eventually will overspeed and burst to inflict damage to other systems and devices, whereby the missile or craft may be destroyed or may be put off its planned course.

Accordingly, an object of the present invention is to provide a mechanical arrangement for shutting-off runaway turbines which operates independently of electrical or electronic speed control devices.

Another object is to provide such an arrangement which first shuts off the supply of operating fluid to the turbine and then applies a braking force to stop rotation of the turbine rotor.

Another object is to provide an overspeed valve control arrangement.

A further object is to provide such an arrangement which is simple, practical and economical in construction, and is reliable in operation.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

A preferred embodiment of the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawing, forming a part of the specification, wherein:

FIG. 1 is a schematic side elevational view of a turbine equipped with mechanism in accordance with the present invention.

FIG. 2 is an enlarged fragmentary sectional view taken along the line 2—2 on FIG. 1, illustrating the elements of the mechanism in their position while the turbine is functioning normally.

FIG. 3 is a view similar to FIG. 2 illustrating the elements in their position after the turbine has attempted to run away and has been shut off.

FIG. 4 is an enlarged sectional view, taken along the line 4—4 on FIG. 2 with the shut-off valve and its operating member being shown in broken lines in their actuated position.

Referring now to FIG. 1 of the drawing in detail, there is shown a fluid pressure medium operated turbine 10 which generally comprises a casing section 11 for housing a turbine rotor 12 an annular casing section 14 at one side of the casing section 11 and concentric therewith for housing a drum 15 rotatable with the rotor 12, a turbine drive shaft 16 having the rotor secured thereon, and a valve 17 on the casing section 14 for controlling the flow of pressure medium to the turbine.

As shown in FIGS. 2, 3 and 4, the valve 17 generally comprises a housing 18 having an inlet 19 and an outlet 20 normally in fluid flow communication with the inlet and with a nozzle (not shown) in the rotor casing section for supplying the medium for driving the rotor 12, a valve member 21 for shutting off flow communication between the inlet and the outlet, and a member 22 for operating the valve member 21.

The valve member 21 preferably is a flapper pivotally mounted at 24 and positioned adjacent the valve outlet 20 to overlie the same and to be engaged by the valve operating member 22. The valve operating member has a head 25 for engaging the underside of the flapper and has a stem 26 slidably mounted in a bore 27 extending through the valve housing 18 and radially into the casing section 14. In order to retain the flapper in its normal position (FIG. 2), the flapper and its operating member are provided with coacting means for releasably locking the flapper on the valve operating member. Such means may be a tab 28 on the flapper and a recess 29 in the head 25 of the valve operating member 22 for receiving the tab 28.

The mechanism for actuating the valve operating member 21 includes a hollow drum 30 mounted for rotation in the casing section 14 and having an annular inner wall 31, an arrangement 32 for normally preventing rotation of the hollow drum, and the drum 15 mounted for rotation within the hollow drum. The drum 15 has an annular outer wall 34 in close proximity to the inner wall 31 of the drum 30 with sufficient clearance between the walls 31 and 34 for free rotary movement of the outer wall 34 with respect to the inner wall 31 under normal conditions. As shown herein, the drum may be formed integral with the rotor 12. The drum 15 is so constructed and dimensioned that when the rotor 12 and the drum 15 thereon are driven at an excessive speed the outer wall 34 is expanded due to yielding of the drum material in response to centrifugal force to cause the outer wall 35 to engage the inner wall 31 and exert a force thereon tending to rotate the drum 30 and to render the arrangement 32 ineffective. The drum 15 may be solid or hollow as shown and may be slotted at its outer wall 34 to make the peripheral portion more yieldable at a predetermined speed.

The arrangement 32 includes a hollow shear pin 35 having its inner end disposed in a radially extending bore 36 of the drum 30 in radial alignment with the bore 27 and having its outer end disposed in the bore 27 of the casing section 14 and in contact with the stem 26 of the valve operating member 21, and a cam 37 on the outer surface of the hollow drum for shearing the pin 35 upon rotation of the hollow drum 30 with the drum 15. Preferably, the outer end of the shear pin 35 is fitted into a bore 33 at the inner end of the stem 26.

The outer portion of the cam 37 is movable in an arcuate recess 38 of the casing section 14 and the inner portion of the cam 37 is mounted in an arcuate recess 39 of the drum 30 which faces the recess 38, and the bores 27

and 36 are located between the ends of the recesses 38 and 39. The trailing end of the cam 37 is engaged by the trailing end of the recess 39 to be driven by the drum 30 and the leading edge of the cam engages the shear pin 35. The outer leading surface 40 of the cam is inclined to effect radially outward movement of the valve operating member 22 when the pin is sheared, and the cam moves in a clockwise direction as viewed in FIGS. 2 and 3.

In order to limit the rotary movement of the drum 30 within the casing section 14, stop means are provided which include a circumferentially extending slot 41 in the drum 30, and one or more fixed pins 42 projecting inwardly from the casing section 14. The pin 42 normally is at the leading end of the slot 41 and is adapted to be engaged by the trailing end of the slot 41 to stop rotary movement of the drum 30. For example, the pin and the slot may be arranged to limit rotary movement of the drum 30 to about 10°.

In operation, the elements of the control mechanism are normally positioned and arranged as shown in FIG. 2 and FIG. 4 in full lines. Upon over-speeding of the turbine for example at 130% normal speed, the outer wall 34 of the drum 15 is caused to engage the inner wall 31 of the drum 30, whereby the drum 30 is rotated to cause the cam 37 to shear the pin 35 and actuate the valve member 21 to shut off the supply of pressure medium to the turbine as shown in FIG. 3 and in FIG. 4 in broken lines. Since the drum 30 is now held against further rotation by the pin 42, the inner wall 31 of the drum 30 applies a braking force on the outer wall 34 of the drum 15 to gradually stop rotation of the turbine rotor 12.

From the foregoing description, it will be seen that the present invention provides a completely mechanical arrangement for preventing the over-speeding of turbines which arrangement is simple, practical and economical in construction and reliable in operation.

As various changes may be made in the form, construction and arrangement of the parts herein, without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in any limiting sense.

I claim:

1. In a fluid pressure medium operated turbine, the combination of a casing section for housing a turbine rotor; a concentric annular casing section at one side of said rotor casing section; a valve on said annular casing section including an inlet and an outlet in fluid flow communication with said inlet and said rotor casing section, a valve member for shutting off flow communication between said inlet and said outlet, and a radially extending slidable member for operating said valve member; a hollow drum mounted for rotation in said annular casing section and having an annular inner wall; a radially extending shear pin having an outer end adjacent the inner end of said valve operating member for normally preventing rotation of said hollow drum; a turbine rotor in said rotor casing section driven by medium supplied through said valve outlet; a second drum mounted within said hollow drum and connected for rotation with said rotor and having an annular outer wall in close proximity to said inner wall with sufficient clearance therebetween for free rotary movement of said outer wall with respect to said inner wall, said second drum being so constructed and dimensioned that when said rotor is driven at an excessive speed said outer wall is expanded to cause said outer wall to engage said inner wall and exert a force thereon tending to rotate said hollow drum; and a circumferentially extending cam on the outer periphery of said hollow drum for shearing said shear pin and for effecting actuation of said valve operating member by displacement of the outer end portion of said shear pin upon rotation of said hollow drum to position said valve member to shut off the supply of medium through said valve outlet and to said rotor.

2. In a turbine according to claim 1, including stop means for limiting the extent of rotation of said hollow drum, whereby engagement between said inner and outer walls, when movement of said hollow drum is stopped, provides braking means for said rotor and said cam is positioned to maintain said valve in closed position.

3. A turbine according to claim 2, wherein said hollow drum has a circumferential slot therein and said stop means is a pin projecting inwardly from said annular casing section which is normally at the leading end of said slot and is adapted to be engaged by the trailing end of said slot to limit rotation of said hollow drum.

4. A turbine according to claim 3, wherein said pin and slot are arranged to limit rotation of said hollow drum to about 10°.

5. A turbine according to claim 1, wherein the outer wall of said hollow drum and the inner wall of said annular casing section each have a circumferentially extending recess opposite the other, said hollow drum and said annular casing section each have a radially extending bore aligned with the other and located between the ends of said recesses for respectively receiving said shear pin and said valve operating member, and the trailing end of said cam is engaged by the trailing end of said hollow drum recess and the leading end of said cam engages said shear pin.

6. In a fluid pressure medium operated turbine, the combination of a casing section for housing a turbine rotor; a concentric annular casing section at one side of said rotor casing section; a valve on said annular casing section including an inlet and an outlet in fluid flow communication with said inlet and said rotor casing section, a valve member for shutting off flow communication between said inlet and said outlet, and a member for operating said valve member; a hollow drum mounted for rotation in said annular casing section and having an annular inner wall; means for normally preventing rotation of said hollow drum; a turbine rotor in said rotor casing section driven by medium supplied through said valve outlet; a second drum mounted within said hollow drum and connected for rotation with said rotor and having an annular outer wall in close proximity to said inner wall with sufficient clearance therebetween for free rotary movement of said outer wall with respect to said inner wall, said second drum being so constructed and dimensioned that when said rotor is driven at an excessive speed said outer wall is expanded to cause said outer wall to engage said inner wall and exert a force thereon tending to rotate said hollow drum; and means on said hollow drum for rendering said rotation preventing means ineffective and for actuating said valve operating member upon rotation of said hollow drum to shut off the supply of medium to said rotor, said valve member being a pivotally mounted flapper positioned adjacent said valve outlet and to be engaged by said valve operating member, and said valve operating member being constructed and arranged to move said flapper to overlie and close said valve outlet at the upstream side thereof and to retain said flapper in such position upon operation thereof.

7. A turbine according to claim 6, wherein said valve operating member and said flapper have coacting means for releasably locking said flapper on said valve operating member before actuation of said valve operating member.

8. A control mechanism comprising an annular casing section, a valve on said casing section normally in one position, a hollow drum mounted for rotation in said annular casing section and having an annular inner wall, a radially extending shear pin having an outer end adjacent said valve for normally preventing rotation of said hollow drum with respect to said casing, a second drum mounted in said hollow drum for rotation by power driven means and having an annular outer wall in close proximity to said inner wall with sufficient clearance therebetween for free rotary movement of said outer wall with respect to said inner wall, said second drum being so constructed and dimensioned that when the same is rotated at an excessive speed said outer wall is expanded to cause said outer wall to engage said inner wall and exert

a force thereon tending to rotate said hollow drum, and a circumferentially extending cam on the outer periphery of said hollow drum for shearing said shear pin and for actuating said valve by displacement of the outer end of said shear pin upon rotation of said hollow drum to move said valve into another position.

9. Mechanism according to claim 8, including stop means for limiting the extent of rotation of said hollow drum, whereby engagement between said inner and outer

walls provides braking means for said second drum and said cam is positioned to maintain said valve in closed position.

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