

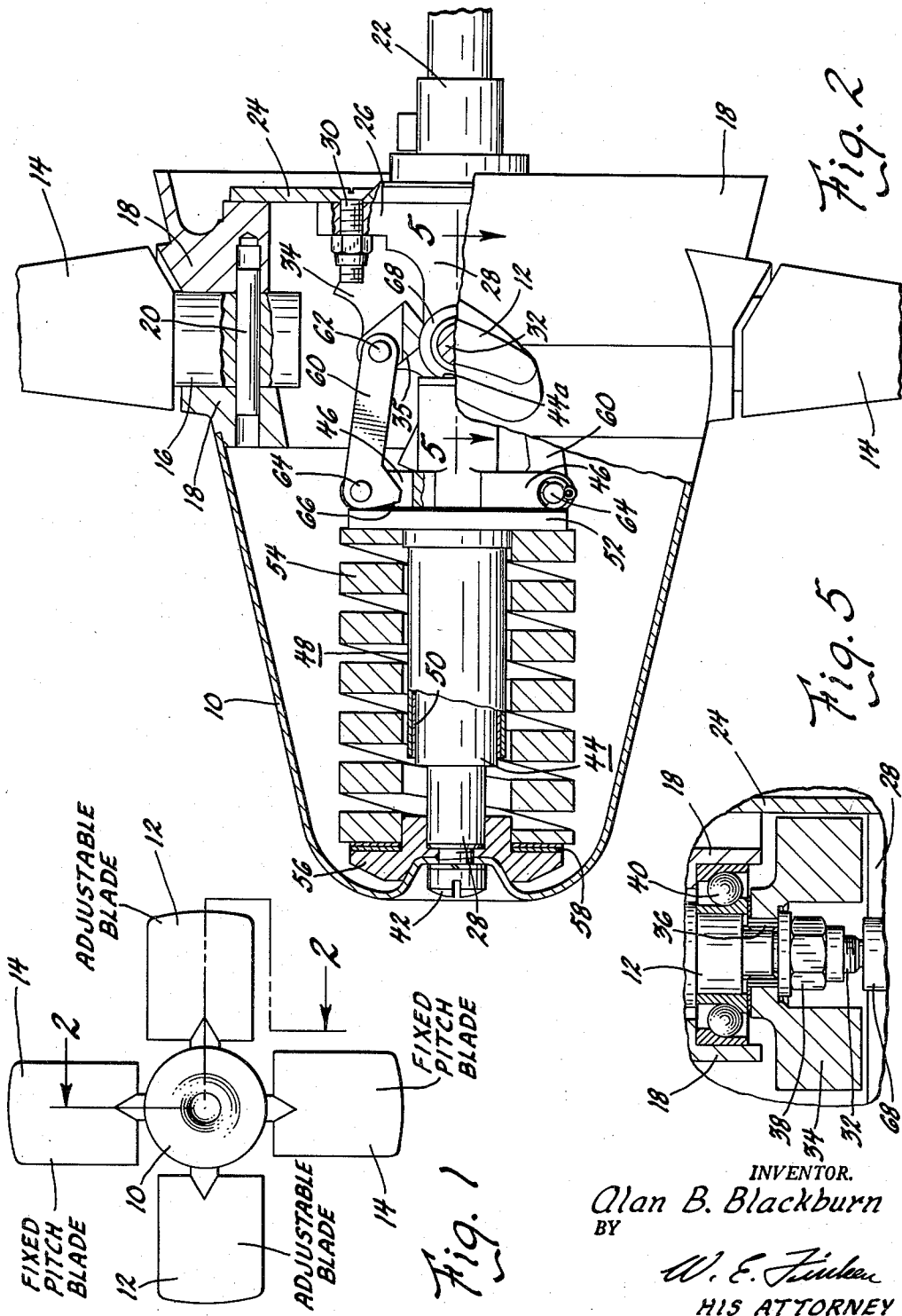
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AIR DRIVEN TURBINE

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2 Sheets-Sheet 1



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2 Sheets-Sheet 2

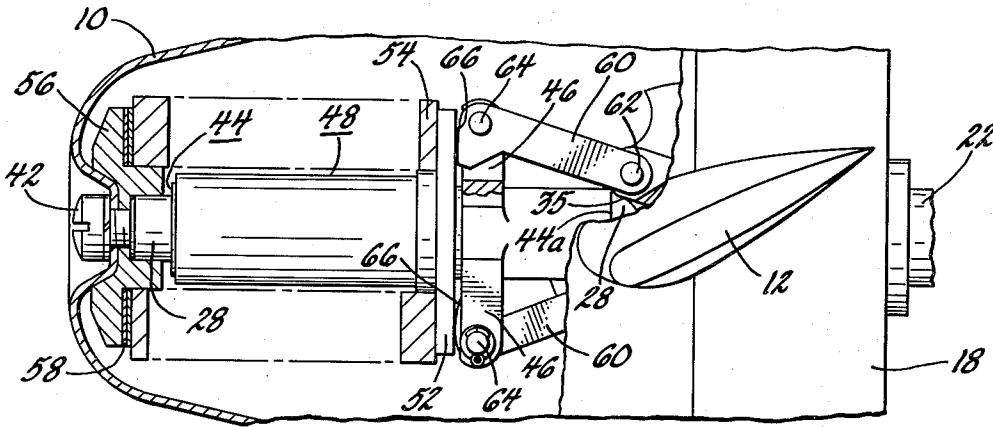


Fig. 3

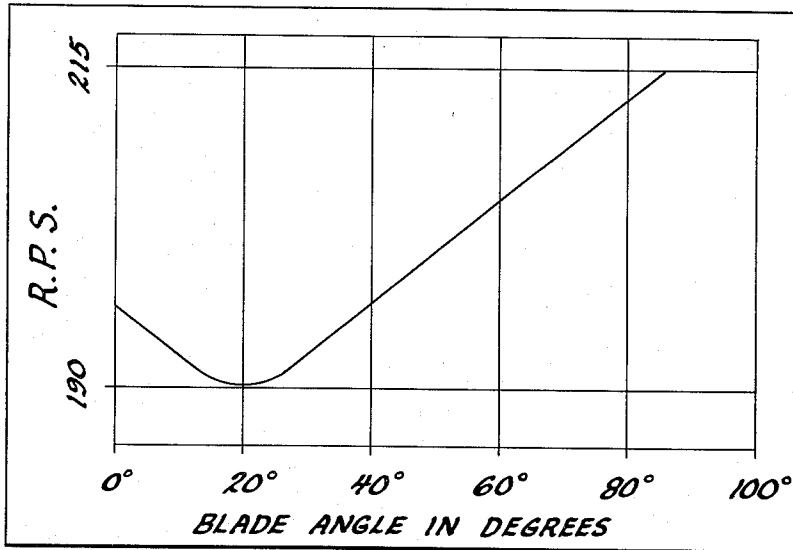


Fig. 4

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This invention pertains to air driven turbines, and particularly to variable pitch air driven turbines including governor means for maintaining turbine speed within preselected limits.

Heretofore, ram air driven turbines have been manufactured having centrifugally responsive flyweights in the form of counterweights supported for rotation about axes coincident with the longitudinal axes of the adjustable pitch turbine blades. A ram air driven turbine having governing means of this type is disclosed in Hoot et al. Patent #2,857,006, and a slightly different form of the governor is shown in Blackburn et al. Patent #2,876,847. The present invention relates to an improved spring-flyweight governor of the blade counterweight type including a modified governor linkage that permits a larger blade angle excursion while maintaining a substantial linear relationship between the blade angle and the turbine speed. Accordingly, among my objects are the provision of governor means of the spring-flyweight type for a variable pitch driven turbine including means for increasing the range of pitch positions within the governing regime; the further provision of a spring-flyweight droop governor having connecting links with cam surfaces thereon; and the still further provision of a spring-flyweight droop governor having a pair of sliders, one of which coacts with the cam surfaces on the governor connecting links to extend the governing range.

The aforementioned and other objects are accomplished in the present invention by mounting the governor spring with its axis coincident with the horizontal axis of the turbine and embodying a pair of sliders which are operable to compress the governor spring. Specifically, the ram air turbine comprises a hub suitably connected to a shaft for imparting rotation thereto. A pair of diametrically adjustable pitch blades and diametrically opposed fixed pitch blades are mounted in the hub, this arrangement being similar to that disclosed in copending application Serial No. 762,992, filed September 24, 1958, in the name of Robert L. Sayre and assigned to the assignee of this invention.

The adjustable pitch blades are bearing supported for rotation about their longitudinal axes between predetermined pitch positions. Each of the adjustable pitch blades has spline connected thereto a governor counterweight, and both governor counterweights are connected by links to a first slider. The governor spring, located coaxially of the horizontal axis of the turbine has its outer end in engagement with a fixed retainer and its inner end engaging a second slider. During movement of the blades from their minimum, or low positive pitch positions, towards the high positive pitch position, the first slider moves outwardly towards the front of the hub thereby compressing the governor spring. The links are formed with cam surfaces arranged to engage the second slider at a predetermined high pitch position so as to further compress the governor spring. This arrangement extends the range of movement of the blades while maintaining a substantially linear relationship between the angle of the blades and turbine speed thereby improving the operation and performance of the governor.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein

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a preferred embodiment of the present invention is clearly shown.

In the drawings:

FIGURE 1 is a front view, in elevation, of a ram air turbine constructed according to the present invention.

FIGURE 2 is an enlarged, fragmentary view, partly in section and partly in elevation, taken along line 2-2 of FIGURE 1.

FIGURE 3 is a view similar to FIGURE 2 with the adjustable pitch blades at a high blade angle.

FIGURE 4 is a graph showing the improved operation of the governor.

FIGURE 5 is a fragmentary view, partly in section and partly in elevation, taken along lines 5-5 of FIGURE 2.

With particular reference to the drawings, the air driven turbine includes a frusto conical spinner 10 which encloses the root portions of adjustable pitch blades 12 and fixed pitch blades 14. The fixed pitch blades 14, as seen in FIGURE 2, have root portions 16 secured to a hub 18 by means of transversely extending pins 20. In the disclosed embodiment, the fixed pitch angle of the blades 14 may be on the order of a positive 20° as measured from the plane of rotation. Thus, when the turbine is positioned in a moving air stream the fixed pitch blades 14, which are diametrically opposed, will always develop a positive windmill torque tending to rotate the hub 18 within which the blades 14 are rigidly mounted. The two-part hub 18 is clamped together by bolts, not shown, and is connected to a drive spindle 22.

The drive spindle 22 is formed with a shoulder 24, the shoulder 24 being connected with a shoulder 26 integral with a hub shaft 28 by means of a pair of nut and bolt assemblies, one of which is indicated by numeral 30. The shoulder 24 on the drive spindle, or power shaft, 22 is also connected with the two-part hub 18 by the aforementioned bolts, not shown. The hub shaft 28 has a cross bore, not shown, surrounded by a boss 68 within which the stub shaft ends of the roots 32 of the adjustable pitch blades 12 are supported by suitable bearing means, not shown. The roots 32 of the adjustable pitch blades are diametrically opposed and extend radially outward as seen in FIGURE 1. Each blade root 32 has a governor counterweight 34 drivingly connected thereto by intermeshing spline teeth indicated by numeral 36 and held in assembled relation by a nut 38. The root portions 32 of the adjustable pitch blades 12 are journaled in the two-part hub 18 by ball bearing means 40 for rotation about their longitudinal axes to different pitch positions.

The hub shaft 28 extends forwardly of the hub 18, and the spinner 10 is attached to the end thereof by means of a cap screw 42. Accordingly, the spinner shell 10 is connected to rotate with the hub 18. A slider assembly 44 is supported for reciprocable movement on the hub shaft 28 by means of a pair of spaced bushings, not shown, carried by the slider assembly 44. The slider assembly 44 is formed with a pair of radially extending arms 46, the purpose of which will be described hereinafter.

A guide assembly 48 is supported for reciprocable movement on the outer periphery of the slider assembly 46, by suitable bushings, one of which is depicted by the numeral 50. The guide assembly 48 is coaxial with the slider assembly 44, and the slider assembly 44 is coaxial with the hub shaft 28. The guide assembly 48 is formed with a flange 52 constituting a retainer for one end of a helical compression spring 54. The other end of the compression spring 54 engages a retainer 56 clamped between the spinner shell 10 and the hub shaft 28 by the screw 42. In order to adjust the preload of the governor spring 54, one or more shims 58 may be inserted between the retainer 56 and the outer end of the governor spring 54.

Each counterweight 34 is connected to one of the arms 46 of the slider assembly 44 by a connecting link 60. The

inner ends of the connecting link 60 are connected by crank pins 62 to their respective counterweights 34 and the outer ends of the connecting links 60 are connected by pins 64 to one of the arms 46 on the slider assembly 44. The outer ends of the connecting links 60 are formed with cam surfaces 66, the purpose of which will be described in particular hereinafter.

The adjustable pitch blades 12 are shown in the minimum positive pitch position in FIGURES 1 and 2. This position is determined by physical engagement of the slider assembly 44 with a boss 68 within which the inner ends of the roots of the adjustable pitch blades are journaled. The end of the slider assembly 44 is depicted by numeral 44a.

The high pitch position of the blades 12 is determined by engagement between portions 35 of the governor flyweights 34 and the hub shaft 28, as depicted in FIGURE 3. The slider assembly 44 and the links 60 constitute coordinating means for maintaining the pitch position of the adjustable pitch blades 12 at right angles.

The governor assembly disclosed is of the droop type, that is the governor mechanism will maintain the speed of turbine rotation within a predetermined range, for instance 190 r.p.s. to 215 r.p.s., with a nominal speed setting of 202 r.p.s. When the turbine is withdrawn from the air stream, the spring 54 will move the guide assembly 48 and the slider assembly 44 to the position shown in FIGURE 2 so that the adjustable blades 12 will be at the mechanical low pitch stop position.

When the turbine is positioned in a moving air stream the air impinging on the fixed pitch blades 14 and the adjustable pitch blades 12 will impart rotation to the hub 18 and the power output shaft 22. The adjustable pitch blades 12 are controlled by the spring-flyweight governor so as to maintain the speed of turbine rotation within a preselected range. As the wind velocity increases, the turbine speed will increase thereby causing the governor flyweight 34 to rotate in the counter-clockwise direction as viewed in FIGURE 2 so as to further compress the spring 34 and increase the angle of the blades 12. As the angle of the blades 12 is increased, the slider assembly 44 moves to the left as viewed in FIGURE 2, compressing the spring 54. When a predetermined high angle of the blades is obtained, the cam surfaces 66 on the connecting links 60 will engage the flange 52 on the guide assembly 48 as shown in FIGURE 3 so as to further compress the governor spring 54 and separate the flange 52 of the guide assembly from the arms 46 of the slider assembly 44. The coaction of the cams 66 with the guide assembly 46 permits a larger blade angle excursion while maintaining a substantial linear relationship between blade angle and turbine speed.

As seen in the graph of FIGURE 4, turbine speed varies substantially linearly with the angle of the adjustable pitch blades 12 between approximately a positive 20° and a positive 85°.

While the embodiment of the invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. An air driven turbine including, a hub, a blade journaled in said hub for pitch adjustment between predetermined low and high blade angles, a rotatable shaft connected with said hub so as to be driven thereby, a governor counterweight supported for rotation about the axis of said blade, means connecting said counterweight and said blade for adjusting the pitch position thereof, resilient means for opposing movement of said counterweight, and a link operatively interconnecting said counterweight and said resilient means and having cam means thereon coacting with said resilient means to increase the range of pitch adjustment of said blade within the governing regime.

2. An air driven turbine including, a hub, a blade journaled in said hub for pitch adjustment, a rotatable shaft connected with said hub so as to be driven thereby,

governor flyweight means operatively connected with said blade for adjusting the pitch position thereof, resilient means for opposing movement of said governor flyweight means, and a link operatively interconnecting said governor flyweight means and said resilient means and having cam means thereon for increasing the range of pitch adjustment of said blade within the governing regime.

3. An air driven turbine including, a hub, a blade journaled in said hub for pitch adjustment, a rotatable shaft connected with said hub so as to be driven thereby, centrifugally responsive flyweight means operatively connected with said blade for adjusting the pitch position thereof, resilient means for opposing movement of said flyweight means comprising a spring, a slider assembly operatively engaging one end of said spring and mounted for reciprocable movement for compressing said spring, a guide assembly coaxial with said slider assembly and mounted for reciprocation relative thereto, said guide assembly operatively engaging said spring for compressing the same, and a link operatively interconnecting said flyweight means and said slider assembly and having cam means thereon engageable with said guide assembly for increasing the range of pitch adjustment of said blade within the governing regime.

4. An air driven turbine including, a hub, a blade journaled in said hub for pitch adjustment, a rotatable shaft connected with said hub so as to be driven thereby, centrifugally responsive flyweight means operatively connected with said blade for adjusting the pitch position thereof, resilient means for opposing movement of said flyweight means comprising a spring mounted coaxially of said shaft, a slider assembly coaxial with said shaft and operatively engageable with one end of said spring for compressing the same, a guide assembly coaxial with said shaft and supported for reciprocable movement on said slider assembly, said guide assembly operatively engaging said spring for compressing the same, and a link operatively interconnecting said flyweight means and said slider assembly and having cam means thereon engageable with said guide assembly for increasing the range of pitch adjustment of said blade within the governing regime.

5. An air driven turbine including, a hub, a blade journaled in said hub for pitch adjustment, a rotatable shaft connected with said hub so as to be driven thereby, a governor counterweight operatively connected with said blade for imparting pitch adjusting movement thereto and supported for rotation in said hub about the axis of said blade, a governor spring coaxial with said shaft for opposing movement of said counterweight, and a link operatively interconnecting said counterweight and said spring and having cam means thereon for increasing the range of pitch adjustment of said blade within the governing regime.

6. An air driven turbine including, a hub, having a centrally disposed shaft, a blade rotatably journaled in said hub for pitch adjustment, a governor counterweight operatively connected to said blade for adjusting the pitch position thereof and supported for rotation in said hub about the axis of said blade, a governor spring supported coaxially of said hub shaft for opposing movement of said counterweight, and a link operatively interconnecting said counterweight and said spring and having cam means thereon for increasing the range of pitch adjustment of said blade within the governing regime.

7. The air driven turbine set forth in claim 6 including a slider assembly reciprocally mounted on said hub shaft and operatively engaging one end of said governor spring, a guide assembly reciprocally supported on said slider assembly and engaging one end of said governor spring, and wherein said link is pivotally connected to said slider assembly and said cam means are engageable with said guide assembly.

8. An air driven turbine including, a hub, a plurality of blades journaled in said hub for pitch adjustment

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and operable to impart rotation when positioned in an air stream, a plurality of governor counterweights equal in number to the number of said blades and supported for rotation about the axes of said blades, means interconnecting said counterweights and said blades for adjusting the pitch position thereof, a governor spring for opposing movement of said counterweights, and a pair of links operatively interconnecting said counterweights

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and said spring and having cam means thereof for increasing the range of pitch adjustment of said blades within the governing regime.

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2,857,006	Hook et al.	Oct. 21, 1958