Dec. 3, 1957 D. D. NELSON 2,815,188

AUXILIARY POWER UNIT

Filed Jan. 11, 1954 3 Sheets-Sheet 1

FIG. 1.

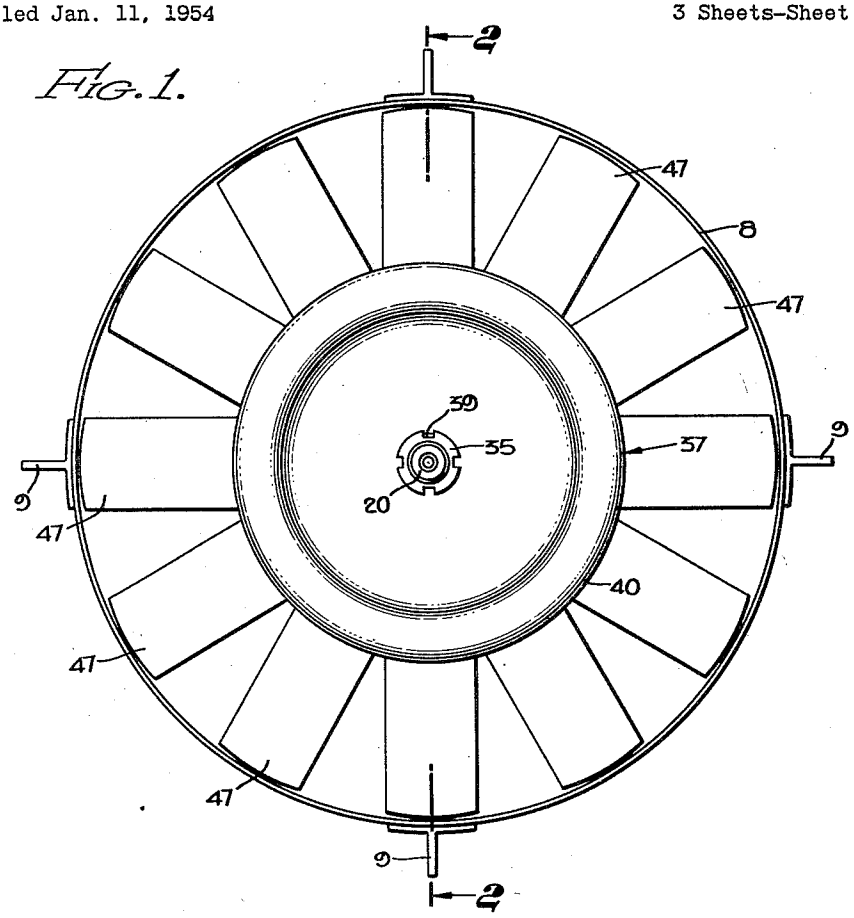
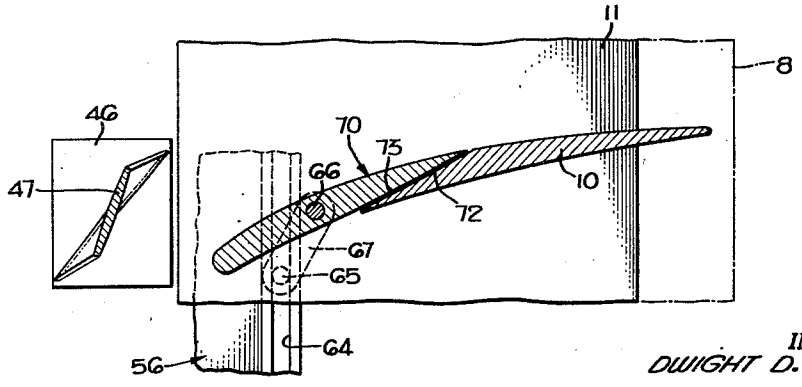


FIG. 3.



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Dec. 3, 1957 D. D. NELSON 2,815,188

AUXILIARY POWER UNIT

Filed Jan. 11, 1954 3 Sheets-Sheet 2

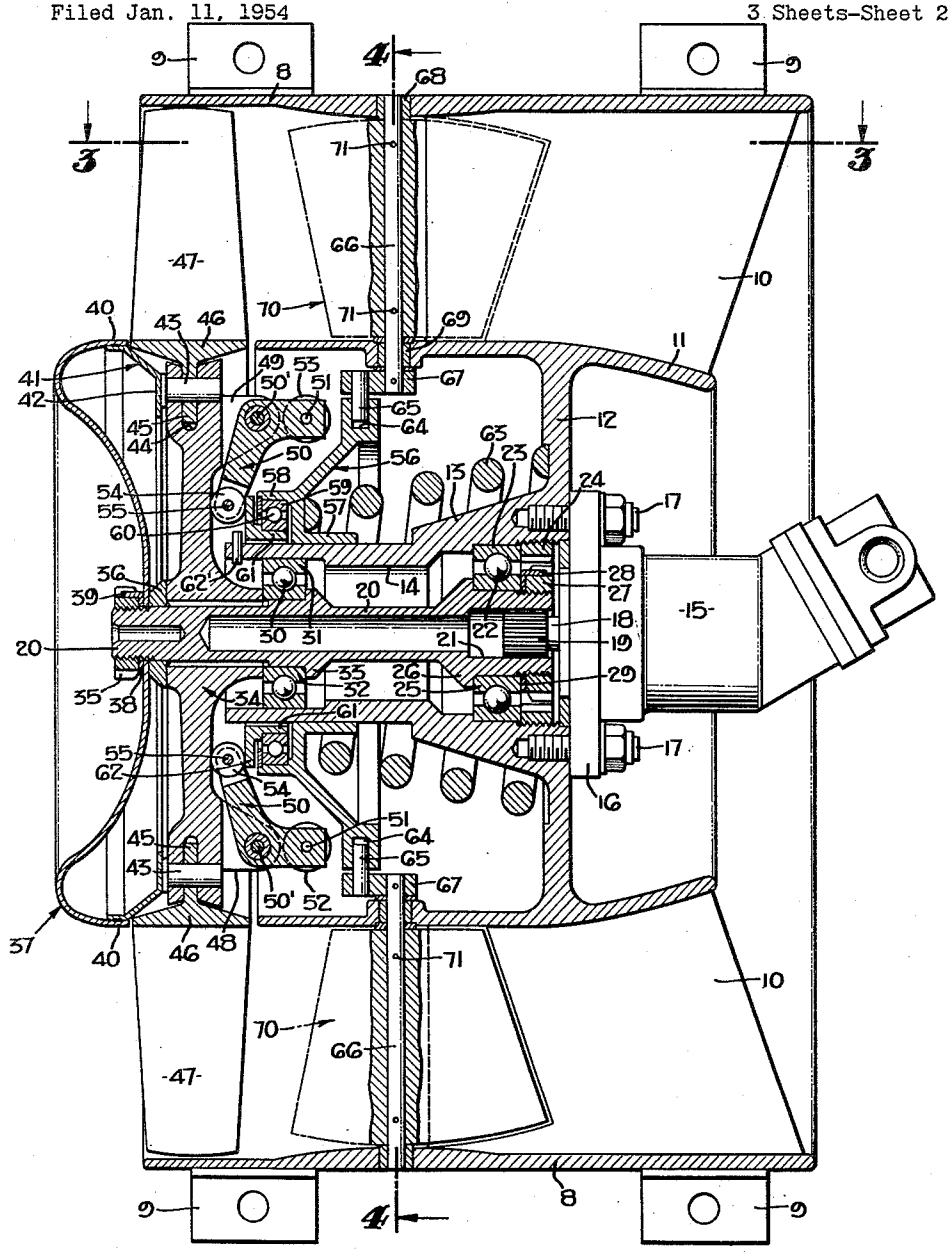


FIG. 2.

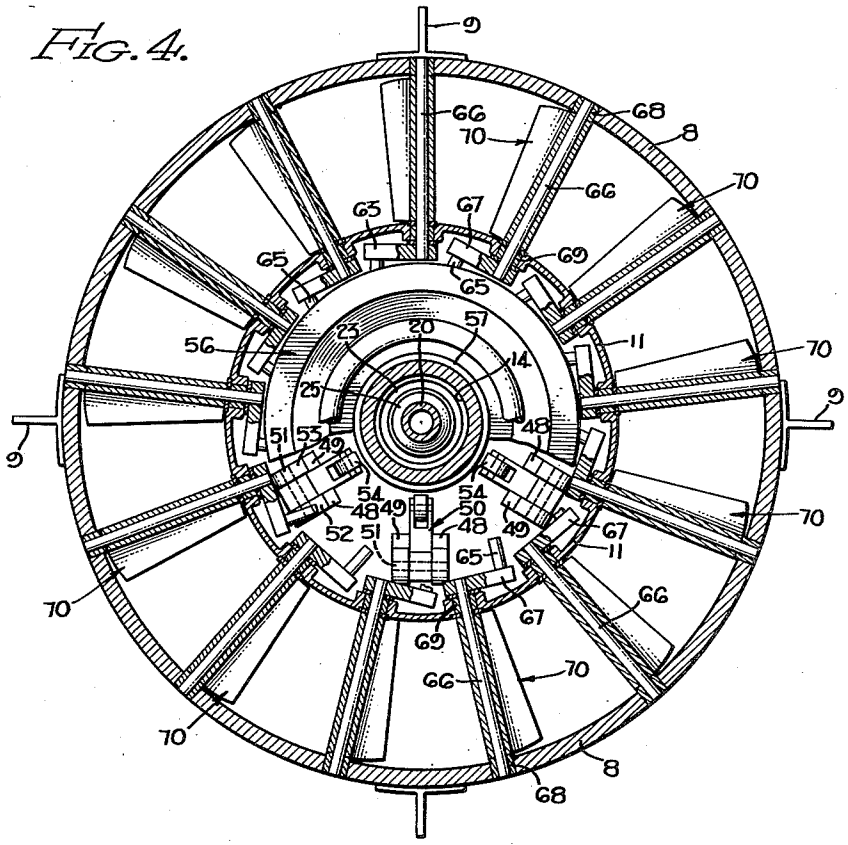
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AUXILIARY POWER UNIT

Filed Jan. 11, 1954 3 Sheets-Sheet 3

FIG. 4.



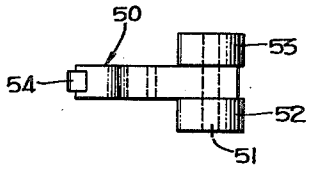


FIG. 5.

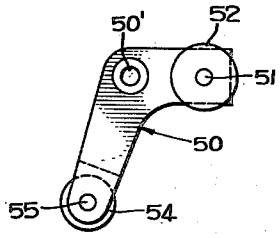


FIG. 6.

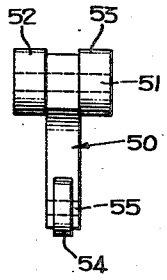


FIG. 7.

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AUXILIARY POWER UNIT

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Application January 11, 1954, Serial No. 403,365

8 Claims. (Cl. 253—59)

This invention relates to an auxiliary power unit and more particularly to an emergency power unit for an aircraft in the form of a small air turbine.

Such emergency units are normally inoperative so long as the aircraft engine is operating satisfactorily. However, upon engine failure, the unit can be placed in operation by either dropping the unit into the airstream or by opening a duct so that the airstream can enter the unit. Since the actual time of operation of such a unit is small, the unit must be of minimum weight and as inexpensive in construction as possible. During an emergency, the auxiliary turbine can be utilized to drive any type of power producing unit, such as a hydraulic pump or an electric generator, and in this connection, it is necessary that the speed of the turbine be controlled within the desired limits by a suitable governor in order to control the output of the power producing unit.

In the present invention, a single stage axial flow turbine is directly connected to the power producing unit and speed control of the unit is achieved by varying the area downstream of the turbine rotor by means of a series of vanes swiveling on radial axes. The position of the vanes is adjusted by several flyballs carried by the turbine rotor and operating against a speeder spring. Each of the movable vanes cooperate with a stationary vane section to form a single large vane section when the movable vanes are in their wide open position to permit maximum air flow through the turbine. Since the direction of airflow is changed in passing through the turbine blades, the single large vanes are positioned to act as straightening vanes to straighten out the airflow through the unit and reduce losses.

A novel connection is utilized between the flyballs and the movable vanes which consists of an axially movable collar having a circumferencial groove for receiving pins connected to the vanes. Such a construction permits the pins to move along the groove as the collar is moved by the flyballs and such movement of the pins is transmitted into rotational movement of the vanes about radial axes.

It is therefore an object of the present invention to provide an auxiliary power unit in which movable vanes are positioned within the fluid passage for a turbine to control the air flow through the turbine, and thereby control the speed of the turbine.

Another object of the invention is to provide a simple speed control device in which a member is moved linearly by flyweights and this linear movement is transmitted into rotation of movable vanes.

A further object of the invention is the provision of movable vanes positioned behind a turbine rotor for controlling the turbine speed, which vanes cooperate with stationary vane sections to straighten out the airflow behind the turbine rotor.

These and other objects of the invention not specifically set forth above will become readily apparent from the description and drawings in which:

Figure 1 is a front elevational view of the auxiliary power unit showing the blades surrounded by the cowling for the unit.

Figure 2 is a vertical sectional view along line 2—2 of Figure 1 showing the flyweights and speed control vanes.

Figure 3 is a horizontal sectional view along line 3—3 of Figure 2 showing the turbine blades, the movable speed control vanes and the stationary vane sections.

Figure 4 is a vertical sectional view along line 4—4 of Figure 2 showing the manner in which the movable vanes are positioned to control airflow through the turbine.

Figure 5 is a top plan view of one of the flyweights utilized in the present invention.

Figure 6 is a side elevational view of the flyweight shown in Figure 5.

Figure 7 is an elevational view of the flyweight shown in Figure 5.

The embodiment of the invention chosen for illustration has a circular cowling **8** which is secured to its mounting structure by means of a number of struts **9** extending radially from the cowling. A series of radial vane sections **10** are integrally formed with cowling **8** and circular housing **11** in order to centrally support the housing within the cowling. The housing **11** has a partition member **12** from which extends a projection **13** having a central opening **14**. A hydraulic pump **15** has a base **16** which is secured to member **12** by means of screws **17** and the pump shaft **18** carries a splined end portion **19** positioned within opening **14**.

A hollow shaft member **20** extends through the opening **14** and has an end opening **21** which receives splined portion **19**. The shaft member **20** is rotatably supported at one end by ball bearings **22** having an outer race **23** positioned against a shoulder of projection **13** by a nut **24** threaded into the end of opening **14**. The inner race **25** for ball bearings **22** is held against shoulder **26** of shaft member **20** by a nut **27** threaded onto the end of shaft member **20** and held in position by leg **28** of lock washer **29**. The other end of shaft member **20** is rotatably supported by ball bearings **30** having an outer race **31** positioned in opening **14** and an inner race **32** positioned between shoulder **33** of shaft member **20** and hub **34** of the turbine. The hub **34** is keyed to the shaft member **20** and is held on the shaft member by a nut **35** threaded on the end of the shaft. A spacing member **36** and a cover member **37** are positioned on shaft **20** between the hub **34** and the nut **35** and a lock washer **38** has an extension **39** for holding the nut **35** in place.

The cover member **37** is generally cup-shaped and has a circular edge **40** to which is secured a circular member **41** having a surface **42** positioned to continually press against pins **43** and retain the pins in openings in hub **34**. The hub **34** has a groove **44** around its circumference which receives lugs **45**, each of which is secured to a base **46** of one of the blades **47** of the turbine and the pins **43** pass through an opening in each lug in order to fasten the blades to the hub. The blades **47** and hub **34** form the rotor of an axial flow turbine and the shaft **20** of the turbine is connected between the hub **34** and the hydraulic pump **15** in order for the turbine rotor to drive the pump. It is understood that the hydraulic pump can be replaced by other types of power units, such as an electrical generator, and that more than one power unit can be driven by the turbine.

The mechanism for controlling the speed of the turbine and the output of pump **15** will now be described. The hub **34** mounts a number of pairs of brackets, comprised of projections **48** and **49**, positioned on opposite sides of an arm **50** which is pivotally mounted by a shaft **50'**. Each arm **50** carries a rod **51** at one end for supporting flyweights **52** and **53** on opposite sides of the arm. The other end of the arm contains a groove for receiving a

roller 54 which is pivotally supported by a shaft 55. It is therefore apparent that the arm 50 can be moved about shaft 50' in response to centrifugal force acting upon flyweights 52 and 53 during rotation of hub 34.

A conical member 56 has a circular extension 57, which slides upon the surface of projection 13, and a circular extension 58 which carries the outer race 59 for ball bearings 60. The inner race for bearings 60 is carried by one arm 61 of an angular member while the other arm 62 of the member is positioned to engage roller 54. A conical coil spring 63 surrounds projection 13 and has one end bearing against partition 12 while the other end bears against conical member 56. It is apparent that the flyweights 53 will rotate with the turbine blades 47 and will move radially outward against the force of spring 63 when the turbine rotor exceeds the desired speed. The friction between rollers 54 and arm 61 will cause the angular member, composed of arms 61 and 62, to also rotate with the turbine rotor and, at the same time, the angular member will transmit the force of the flyweights to the conical member 56. A stop 62' is provided to limit the movement of member 56 toward the hub 34.

The member 56 has a circumferential groove 64 which receives a number of pins 65 which are attached to a plurality of shafts 66 by means of arms 67. Shafts 66 are rotatably supported at opposite ends by bearings 68 and 69 in cowling 8 and housing 11, respectively, and a movable vane 70 is secured to each of the shafts by pins 71. Referring to Figure 3, each vane 70 has a surface 72 which is normally positioned against the surface 73 of section 10 when the vanes 70 are in their wide open position and thus, the vanes 70 and sections 10 form a number of larger vanes which serve to straighten out the air flow behind the turbine blade and reduce losses when vanes 70 are in the wide open position. The blades 47 are of the axial flow type as illustrated in Figure 3 and are positioned at an angle to the axis of the turbine so that the direction of air flow is changed in passing through the turbine blades. The large vanes composed of movable vanes 70 and vane sections 10 are shaped to direct the air flow behind the turbine blades back to its initial direction so that the air will tend to pass axially out of the cowling 8 with minimum losses.

When the turbine rotor overspeeds, the flyballs 53 will move outwardly under the action of centrifugal force and will move member 56 against the force of spring 63. Pins 65 will move with member 56 since they are free to slide in groove 64 and this movement of pins 65 will rotate arms 67 and vanes 70 in a direction to close down the air passage behind the turbine blades and thereby reduce the speed of the turbine by reducing the mass air flow through the turbine blades. After the turbine returns to the desired speed, the spring 63 will return the member 56 to its original position and the pins 65 will move the vanes 70 back to their original position with surfaces 72 adjacent surfaces 73. Thus, the movable vanes 70 serve the twofold purposes of regulating the quantity of air flow behind the turbine blade, and of directing this air flow.

The present embodiment of the invention utilizes twelve turbine blades 47, thirteen movable vanes 70 and six pairs of flyweights 52 but, of course, it is understood that the number of each of these elements can be varied in any desired manner. Also, it is understood that other forms of linkages can be utilized to rotate the movable vanes in response to movement of the flyweights. It is contemplated that the movable vanes can be placed ahead of the turbine rotor in order to control the airflow to the turbine, in which case the stationary vane sections behind the rotor will still serve to straighten out the airflow. Various other modifications are contemplated by those skilled in the art without departing from the spirit and scope of the invention as hereinafter defined by the appended claims.

What is claimed is:

1. A power unit comprising a turbine rotor having blades positioned within a fluid passage, stationary vane sections positioned across said passage, movable vanes pivotally supported so as to extend across said passage, said vane sections and said movable vanes being formed as sections of larger straightening vanes, and speed responsive means carried by said rotor and operatively connected with each of said movable vanes adjacent the inner end thereof for moving said movable vanes relative to said stationary vane sections to partially close said passage in response to a predetermined rotative speed for thereby controlling the speed of said turbine rotor.

2. A power unit comprising a cowling, a housing, vane sections secured to both said housing and cowling for supporting said housing within said cowling, the space between said cowling and housing forming an air passage, a turbine rotor rotatably supported by said housing and having blades located within said passage, movable vanes extending across said passage and swingably connected with said housing and said cowling downstream of said blades, and speed responsive means carried by said rotor and operatively connected with each of said movable vanes adjacent the housing end thereof for effecting movement of said vanes within said passage to control the quantity of air flow therethrough, said movable vanes cooperating with said vane sections when in wide open position to form large straightening vanes to straighten out the air flow behind said blades.

3. A power unit as defined in claim 2 having a power producing unit supported by said housing and connected to said turbine rotor.

4. A power unit as defined in claim 2 wherein said speed responsive means comprises arms pivoted upon said rotor for rotation therewith, flyweights carried by said arms, a member slidable upon a section of said housing by said arms, said member having a circumferential groove formed therein a number of pins received in said groove, and linkage means connecting each of said pins to one of said movable vanes.

5. A power unit comprising a turbine rotor having axial flow blades positioned within a fluid passage, stationary vane sections and movable vanes positioned within said passage and downstream of said blades, each of said stationary vane sections and each of said movable vanes extending across said fluid passage, and speed responsive means carried by said rotor and operatively connected with each of said movable vanes adjacent the inner end thereof for effecting movement of said movable vanes to close said passage when said rotor overspeeds, said movable vanes and vane sections forming elements of large vanes when said movable vanes are in wide open position, the contour of said large vanes being such as to counteract the change in direction of fluid flow caused by said blades and thereby straighten out the fluid flow behind the blades.

6. A power unit comprising a circular cowling, a housing, a series of radial stationary vane sections for concentrically supporting said housing within said cowling, the space between said cowling and housing forming an air passage, said housing having a partition carrying an axial extension, a turbine shaft rotatably supported within said extension, a power producing unit secured to said partition and connected to one end of said shaft, a hub secured to the other end of said shaft, a number of turbine blades carried by said hub within said passage, a series of arms pivoted to said hub, flyweights carried by said arms, a member axially slidable upon said extension and resiliently biased toward said arms, movable vane means extending across said passage downstream of said blades and means interconnected between said member and said vanes adjacent the housing ends thereof for moving said vanes in a direction to close said passage in response to axial movement of said member in one direction.

7. A power unit as defined in claim 6 wherein each of

said movable vanes is pivotally mounted on a radial shaft carried by said housing and said cowling and said member has a continuous groove, a number of pins received in said groove, and an arm connecting each of said pins to one of said radial shafts to transmit the axial movement of said member into rotational movement of said shafts.

8. A power unit comprising a circular cowling, a housing, the space between said cowling and housing forming an air passage, said housing having a partition carrying an axial extension, a turbine shaft rotatably supported within said extension, a power producing unit secured to said partition and connected to one end of said shaft, a hub secured to the other end of said shaft, a number of turbine blades carried by said hub within said passage, a series of arms pivoted to said hub, flyweights carried by said arms, a member axially slidable upon said extension and resiliently biased toward said arms, movable vane means extending across said passage downstream of said blades, and means interconnected between said member and said vanes adjacent the housing ends thereof for moving said vanes in a direction to close said passage in response to axial movement of said member in one direction.

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