

Sept. 8, 1953

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2,651,376

EXPLOSION-CYCLE JET PROPELLER FOR AIRCRAFT PROPULSION

Filed Oct. 31, 1949

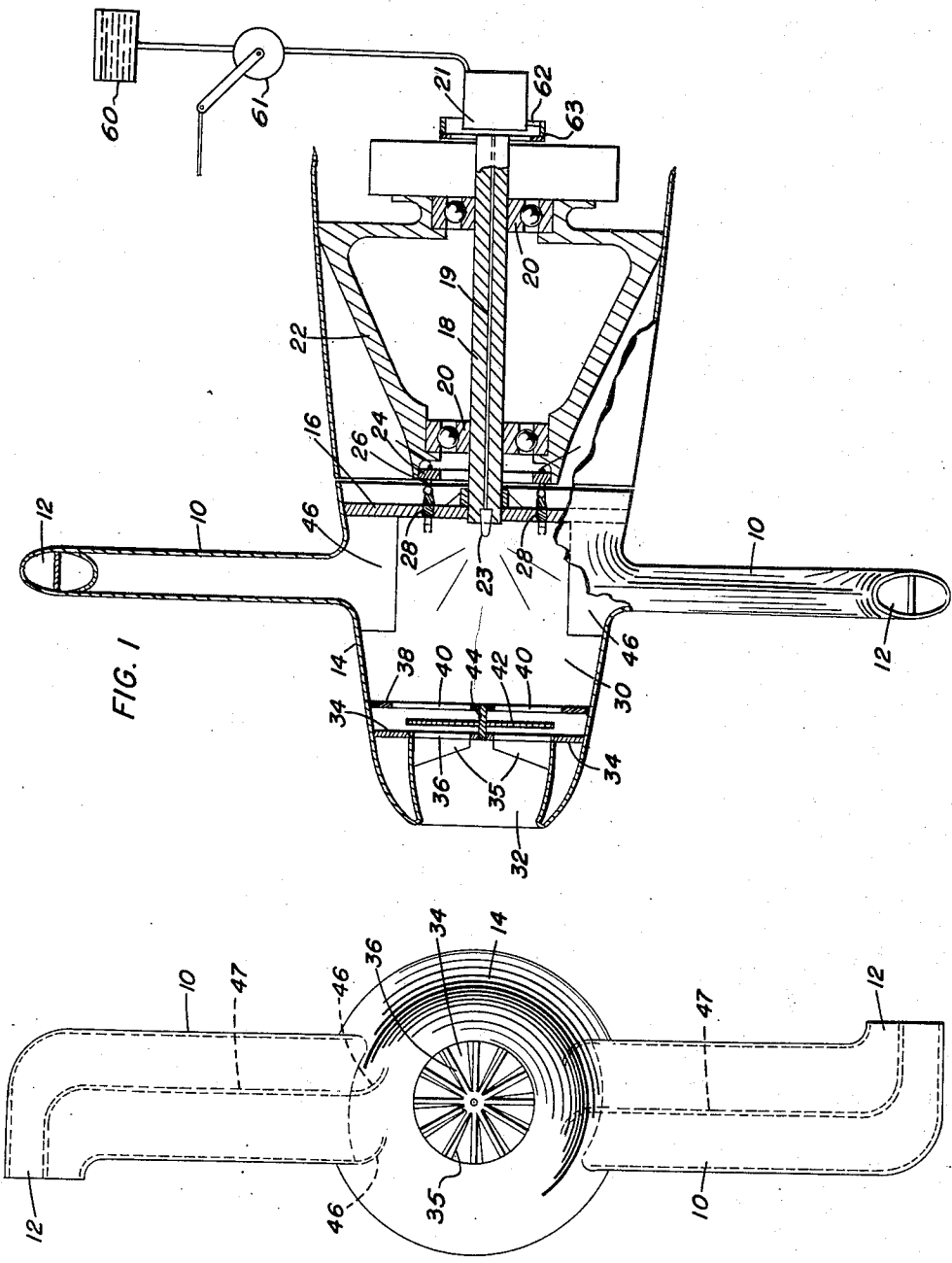


FIG. 2

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2,651,376

EXPLOSION-CYCLE JET PROPELLER FOR
AIRCRAFT PROPULSION

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Application October 31, 1949, Serial No. 124,693

5 Claims. (Cl. 170-135.4)

(Granted under Title 35, U. S. Code (1952),
sec. 266)

1 This invention relates to jet operated propellers and in particular to an efficient explosion-cycle jet propeller engine for the propulsion of aircraft.

The general object of the invention is to provide such a jet driven propeller.

It is also an object of the invention to provide an explosion-cycle jet propeller engine in which the combustion chamber is located within the hub of the propeller.

It is a further object of the invention to provide an explosion-cycle jet propeller engine which, by reason of the location of the combustion chamber within the hub of the propeller, operates under higher explosion pressures and with increased efficiency resulting therefrom.

It is an additional object of the invention to provide an explosion-cycle jet propeller which is of relatively low cost in manufacture whereby the primary application may be to light, privately owned aircraft.

Other objectives will be apparent from the following description and drawings herewith submitted, which are merely illustrative of a preferred embodiment of the invention and are not otherwise limitative thereto.

Prior art jet driven propellers are of two general types, viz, the steady flow type and the explosion-cycle jet type in which the propeller is actuated by jets located in the tips of the propeller blades. Considering the explosion-cycle type (that which concerns this invention), the prior art generally consists of locating the combustion chamber in the propeller blades and employs some valve mechanism near the root of the propeller blade to prevent the explosion from blowing back into the propeller hub and out through the ram intake. In general, the jet nozzles of this type are open to the atmosphere. When the charge is exploded in the propeller blades the gases rush out through the nozzles which are located at the tips of the blades in such a way that the jet reaction turns the propeller which propels the plane.

One disadvantage of this old type of explosion-cycle jet propeller results from the fact that large quantities of air must be handled in order to provide sufficient jet reaction to do useful work. The large quantities of air require large jet nozzle areas; in fact, require such large jet nozzle areas in relation to the combustion chamber volume in the propeller blades that the explosion-cycle peak pressures are low (the gases escape through the nozzles before the pressure can be built up) and therefore the cycle efficiency is low.

The applicant overcomes this disadvantage by

2 constructing and arranging his explosion-cycle jet propeller engine as shown in the accompanying drawing wherein:

Fig. 1 is a partial longitudinal sectional, elevational view through the propeller showing the structural bearing support; and

Fig. 2 is a front elevation thereof.

As shown in Fig. 1 the propeller may comprise two or more tubular blades 10 at the tips of which are provided jet nozzles 12. These blades are integral with streamlined hub 14, which is provided at its rear with an end plate 16. Shaft 18 is firmly attached to plate 16 at the center thereof and is rotatably mounted in bearings 20 which are in turn supported by bearing block 22. At its front end bearing block 22 supports ignition ring 24 which by brush contact 26 supplies high tension electrical current continuously to spark plugs 28 which extend through end plate 16 into combustion chamber 30. Rotary shaft 18 is drilled longitudinally and axially as at 19 to provide a passage for fuel from pump 21. This pump is connected to a fuel reservoir 60 through manual valve 61, as shown. The front end of passage 19 terminates in a nozzle 23 which extends into combustion chamber 30 and injects metered fuel from the pump into said combustion chamber. The frequency of fuel injection from the pump to the combustion chamber 30 is controlled by any conventional means such, for example, as the cam actuated injection pump shown in the patent to William M. Quick, No. 2,446,785, dated 10 August 1948. The forward end of hub 14 is provided with an air inlet 32 the rear of which is covered by valve seat plate 34. Plate 34 may be slotted as at 36 or it may be perforated by a plurality of holes for the transmission of air therethrough. Inducer vanes 35 may be attached to valve seat plate 34, extending therefrom into inlet 32, to impart a rotation to the incoming air at the entrance. A second valve seat plate 38 is provided in hub 14. Valve seat plate 38 is provided with a plurality of radial ports 40 extending therethrough, said ports having the form, for example, of slots 36 in plate 34, but of sufficient area to pass readily the air flow inwardly or outwardly of the combustion chamber, the ports extending beyond the edges of the valve disc for inlet use. Seat plate 38 is spaced from plate 34 to provide room for the operation of floating disc valve 42. This valve is slidably mounted on pin 44, which is supported centrally in valve seat plates 34 and 38. The functional operation of disc valve 42 will be described hereinafter.

The tubular propeller blades 10 are provided

with scoops 46 and partition plates 47 which assist in gathering and guiding the combusted gases out through jet nozzles 12. Partition plates 47 also strengthen propeller blades 10 enabling them to hold their shapes.

In the operation of the jet engine of this invention air enters combustion chamber 30 in the propeller hub through inlet port 32 and around floating disc valve 42. This air is mixed with fuel injected through nozzle 23. The mixture is exploded at relatively high pressure due to the fact that floating disc valve 42 operates as a check valve in moving to a seat on valve seat plate 34. The exploded mixture expands through the propeller blades and out through jet nozzles 12 which are located at the tips of the propeller blades in such a way that the jet reaction imparts rapid rotation to the propeller which in turn propels the plane. After the explosion and blowdown the combustion chamber is purged by the inertia of the gas column flowing through the blades during blowdown, by the centrifugal pumping action of the rotating blades, and by the ram air at the engine intake. When the combustion chamber pressure becomes low enough disc valve 42 moves off of its seat on valve seat plate 34 thereby admitting air through the slotted (or perforated) valve seat plate 34 and through ports 40 of plate 38 in the areas thereof beyond the periphery of the valve disc, when moved against plate 38. When the explosion occurs, the disc valve closes preventing blowback of the charge through the intake and thereby increasing the explosion pressure and forcing the gases out through the blade jets. In both the open and closed positions the floating disc valve rests on slotted or perforated seats which support the said disc valve. This disc valve is sufficiently light to respond quickly to the pressure differentials so that the charging time does not occupy too large a percentage of the total cycle time.

During the flow of the air into the combustion chamber or thereafter, the fuel is injected through a suitable nozzle 23 and ignited by a continuous spark as previously indicated. The cyclic frequency of the engine is controlled by the frequency of fuel injection and may be increased up to the maximum value possible with sufficient time for charging, combustion and blowdown. The power output of the engine is controlled by the frequency of fuel injection and the quantity of fuel injected during the cycle.

The combustion chamber in the propeller hub is made sufficiently large relative to the jet nozzle area to enable high explosion pressures to be developed therein. The combustion chamber must be sufficiently large so that the gases escaping through the nozzles during combustion do not greatly reduce the peak pressures resulting from combustion.

After combustion the gases flow through the tubular or hollow propeller blades and out and through the jet nozzles. The nozzle area is selected to provide the required jet power and may be any size up to and including the cross-sectional area of the propeller blade. While propeller blades are twisted in actual practice to conform to aerodynamic requirements, in the drawings the blades are shown straight for ease of illustration.

The advantages of a jet propeller engine constructed in accordance with this invention are:

1. Improved efficiency because of the higher

explosion pressures made possible by combustion in the propeller hub.

2. A simplified method of controlling engine frequency, i. e. controlled fuel injection frequency.

3. A simplified method of controlling engine power, i. e. controlled fuel injection frequency and fuel quantity per cycle.

While the applicant has disclosed herein a specific form of a jet propeller engine, he does not desire to be strictly limited thereto as one skilled in the art could vary the structure shown without departing from the spirit or scope of the invention as defined. For instance the check valve in the inlet could be varied structurally and the rotation of the propeller hub could be used to enable the air to flow more easily into the combustion chamber than out. Such variations are included in the scope of the invention to the extent as defined by the herewith appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

1. In combination with supporting aircraft structure, a jet driven propeller provided with hollow blades, a hub for said propeller connected to the blades thereof, a shaft, provided with an axially extending conduit, centrally connected to one end of said hub and mounted for rotation with respect to the supporting aircraft structure, a combustion chamber positioned within said hub, said combustion chamber being in communication with the interior of the blades of said propeller, an air inlet port in the other end of said hub in communication with said combustion chamber for introducing combustion air into said chamber, check valve means positioned between said inlet port and said combustion chamber effective on gas explosion for preventing backflow of gases from said chamber into said air inlet port at the instant of gas explosion, fuel jet nozzle means mounted on the end of said shaft within said combustion chamber and in communication with said conduit therein, a reservoir mounted on said aircraft structure, pump means mounted on the other end of said shaft for supplying fuel from said reservoir to said conduit and said fuel jet nozzle at a predetermined frequency and quantity to form an explosive mixture with the inlet air in said combustion chamber, means extending into said combustion chamber for igniting said explosive mixture as it is formed and jet nozzle means positioned at the tips of said propeller blades, in communication with the interior of said blades, for imparting rotation to said propeller blades by the jet reaction of the combustion gases passing therethrough from said combustion chamber.

2. In combination with supporting aircraft structure, a jet driven propeller provided with hollow blades, a hub for said propeller connected to the blades thereof, a shaft, provided with an axially extending conduit, centrally connected to one end of said hub and mounted for rotation with respect to the supporting aircraft structure, a combustion chamber positioned within said hub, said combustion chamber being in communication with the interior of the blades of said propeller, an air inlet port in the other end of said hub in communication with said combustion chamber for the introduction of combustion air

thereinto, two spaced inner and outer perforated valve seats positioned between said inlet port and combustion chamber, a disc check valve slidably mounted between said valve seats on a pin supported by said valve seats centrally thereof, said disc check valve having a diameter sufficient to cover the apertures of the outer valve seat but insufficient to cover the inner valve seat apertures permitting the flow of inlet air therearound into said combustion chamber but on gas explosion preventing backflow of gases from said chamber into said air inlet port, a fuel nozzle mounted on the end of said shaft within said combustion chamber and in communication with said conduit therein, a reservoir mounted on said aircraft structure, pump means mounted on the other end of said shaft for supplying fuel from said reservoir to said conduit and said fuel nozzle at a predetermined frequency and quantity to form an explosive mixture with the inlet air in said combustion chamber, a plurality of electrical spark plugs the spark gaps of which extend into said combustion chamber, an electrical energy distributing ring having a continuous brush contact with the spark circuit of said spark plugs whereby said spark gaps constantly discharge to ignite said explosive mixture as it is formed in said combustion chamber, and jet nozzles positioned at the tips of said propeller blades in communication with the interior of said blades for imparting rotation to said propeller blades by the jet reaction of the combustion gases passing therethrough from said combustion chamber.

3. In the apparatus as defined in claim 2, a plurality of spaced vanes attached to the first of said perforate valve seats and extending into said inlet port to impart a rotation to the incoming air.

4. In combination with supporting aircraft structure, a jet driven propeller provided with hollow blades, a hub for said propeller connected to the blades thereof, a shaft provided with an axially extending conduit connected to one end of said hub and mounted for rotation with respect to the supporting aircraft structure, a combustion chamber within said hub and in communication with the interior spaces of said blades, an air inlet port in the other end of said hub in communication with said combustion chamber for introducing combustion air into said chamber, a check valve positioned between said

inlet port and combustion chamber effective on gas explosion for preventing backflow of gases from said chamber into said air inlet port, fuel jet nozzle means mounted in said combustion chamber wall in communication with said shaft conduit, means connected to said conduit for supplying fuel to said fuel nozzle through said conduit from a source of fuel supply to form an explosive mixture with chamber air, means extending into said combustion chamber for igniting said combustion mixture, and jet nozzles positioned at the tips of said propeller blades in communication with the blade interior spaces for imparting rotation to said blades.

5. In combination with supporting aircraft structure, a jet driven propeller provided with hollow blades, a hub for said propeller connected to the blades thereof, a shaft connected to one side of said hub and mounted for rotation with respect to the supporting aircraft structure, a combustion chamber within said hub and in communication with the interior spaces of said blades, a fuel inlet within said chamber, means including a pump and connecting conduit for supplying fuel intermittently to said inlet and chamber, an air inlet port in the other end of said hub in communication with said chamber, a check valve positioned between said port and chamber for preventing backflow of gases from said chamber into said port while permitting inflow of air from the port to the chamber, and means including a continuous electric arcing device positioned in said chamber for igniting an explosive mixture of said fuel and air, said check valve being actuated to close said inlet port only by the explosive expansion of said ignited gases.

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