July 2, 1935. J. M. GWINN, JR 2,006,805

VANE FOR RECOVERY OF ENERGY IN PROPELLER SLIPSTREAM

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Fig. 1.

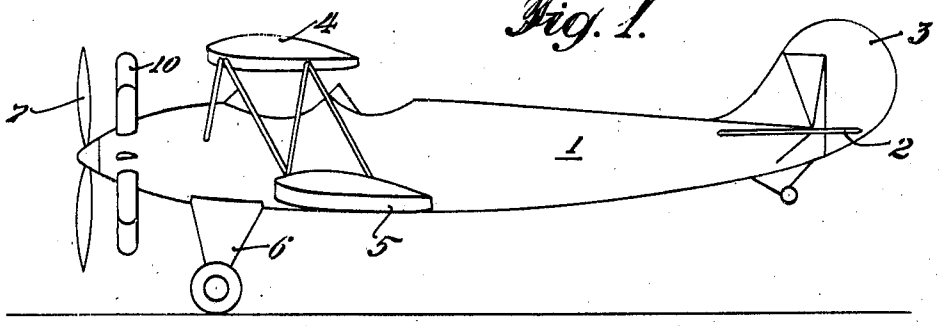


Fig. 3.

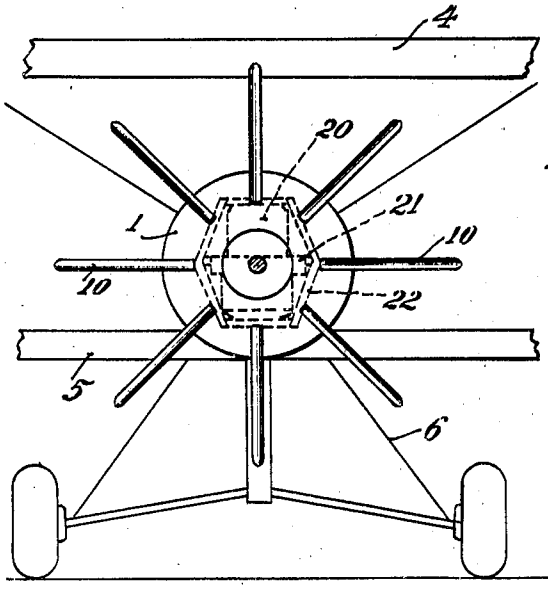
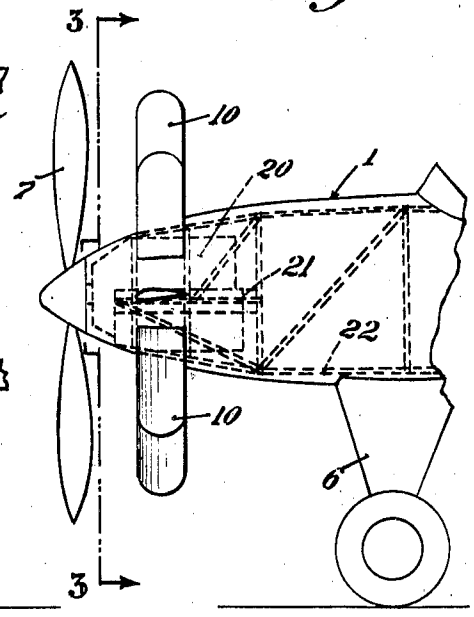


Fig. 2.



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Fig. 4.

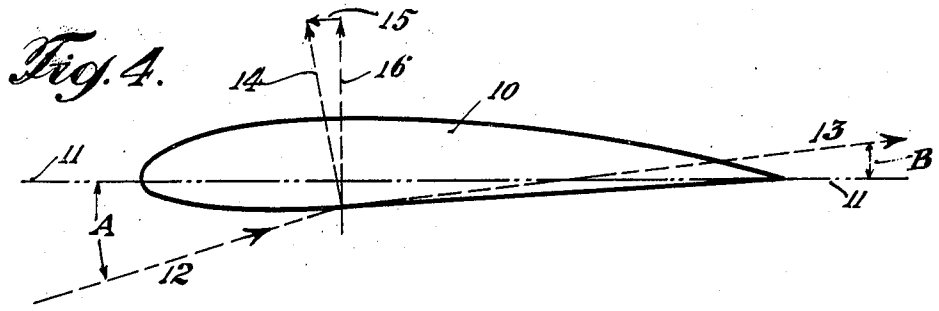


Fig. 6.

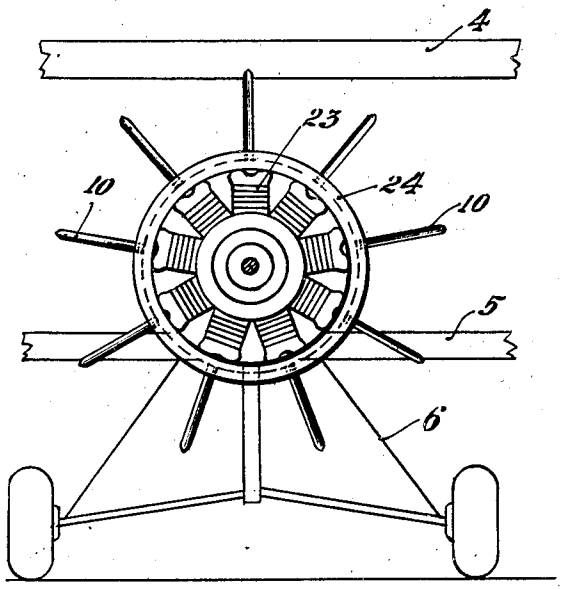


Fig. 5.

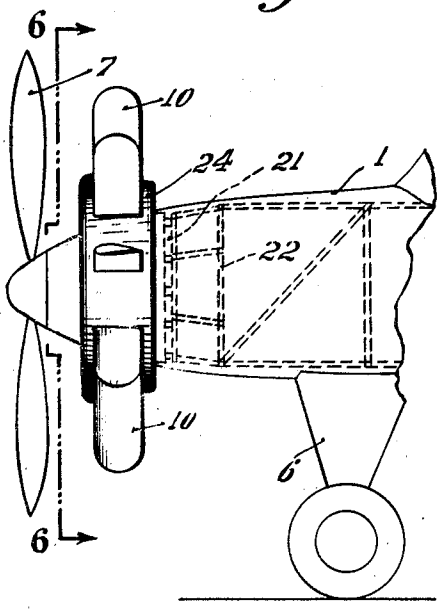
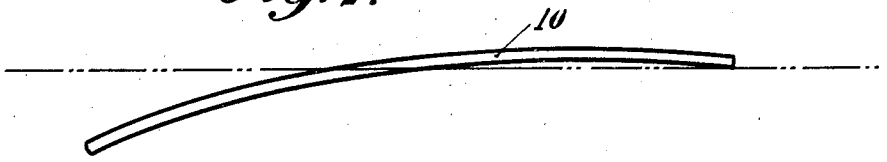


Fig. 7.



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UNITED STATES PATENT OFFICE

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VANE FOR RECOVERY OF ENERGY IN PROPELLER SLIPSTREAM

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Application August 2, 1933, Serial No. 683,256

2 Claims. (Cl. 244—25)

The present invention relates to the propulsion of aircraft generally, and more specifically to a means for eliminating as much as possible the rotation of the slipstream of the propeller and converting the energy thus regained into useful forces to assist in stabilizing and propelling an airplane.

In order to obtain thrust from a propeller working in a fluid medium, it is necessary to displace a volume of the medium aft or in other words, in a direction opposite to that in which the useful thrust is obtained. This involves an energy loss due to the aft motion of the fluid which is not recoverable. In addition, there are other energy losses due to the rotation of the slipstream and to turbulence, which constitute a large part of the total loss so that recovery of one of them will result in an appreciable improvement in efficiency.

It is known in the art of ship propulsion that a counter-propeller so-called may be used for this purpose and suggestions have been made by prior inventors that the principle of such devices be applied to aircraft in general, and in at least one instance to the propulsion of airplanes. Not only have prior unsuccessful attempts been made to obtain the result which I have attained by the use of stationary vanes mounted in the propeller slipstream, but in the instance above referred to, such devices have been combined with other structural parts of the airplane, notably the elevational and directional control surfaces thereof, in an endeavor to arrive at a practical adaptation of the principle. It is significant to note that none of these prior attempts have been successful in accomplishing the present result, nor have any of them prior to my invention been adopted commercially, notwithstanding the recognized desirability of turning this energy to a useful purpose.

It is, consequently, an object of the present invention to provide a practical adaptation of the above principle to an airplane by suitably locating a plurality of vanes in the propeller slipstream for the purpose of recovering rotational energy therefrom and by so doing to eliminate the rotation of the slipstream, and convert the energy thus regained into useful forces which assist in stabilizing and propelling the airplane.

More specifically, it is intended by the present invention to so shape and locate such vanes as to effectively resolve the forces regained into two components of force, both of which are useful, one in a forward direction with respect to the flight path which supplements the forward thrust on the airplane thereby considerably increasing the propulsive efficiency, and the other in a direction about the thrust line opposite to that of the torque produced by the rotation of the propeller, which is in effect a counter-torque cancelling to a great extent the engine torque, and greatly reducing the resultant change in lateral balance of the airplane with different engine speeds.

In small high powered airplanes, the latter feature is of considerable importance for the wing span available to oppose the large engine torque is so small that it is often extremely difficult to hold the airplane level laterally during take-off. This has been especially noticed in racing seaplanes where the engine torque has been, in some cases, sufficient to bury one float of a twin float system. The objection is present, however, in all types of aircraft, but this example is cited merely as an illustration of the advantages to be gained by the use of my invention.

A further object of the invention resides in the location of such vanes at the forward end of the fuselage at approximately the position of the center of mass of the engine whereby the counter-torque is applied practically to the engine or engine mounting itself, so that the fuselage framework is not required to be of such construction as would be necessary if the stresses imposed by the recovered energy were transmitted throughout any part of its length.

Another object of my invention resides in the location of such vanes on a tractor type of airplane in such a manner as to eliminate the rotation and turbulence of the slipstream and give a smooth flow of air around the sides of the fuselage and over the other surfaces of the airplane thereby reducing the head resistance and improving the efficiency and effectiveness of the flight controls.

It is still another object of my invention to obtain all of the above results by the use of such vanes in connection with a radial type air cooled engine having a low drag cowling, and by such use to increase the effectiveness of such cowling both as to the cooling effect produced on the engine and as to the effect of the cowling on the drag of the engine and fuselage of the airplane as well as on the propulsive efficiency.

Other not less important objects of my invention such as the use of a plurality of such vanes so spaced that the effect produced is evenly distributed, and the shape of the vanes to give the best results, will appear to a person skilled in the art from reading the following description.

The invention consists of the novel features

of construction and arrangement of parts, hereinafter fully described, claimed and illustrated in the accompanying drawings forming parts of this specification. It being understood that the specific adaptations of my invention herein shown are by way of example only, and although considered to represent acceptable embodiments thereof, may be modified in accordance with suggestions herein contained within the scope of the claims appended hereto.

Fig. 1 is a view in elevation of a light airplane equipped with vanes in accordance with my invention, representing a typical embodiment thereof;

Fig. 2 is an enlarged view of the embodiment shown in Fig. 1 showing the position of the vanes in relation to the fully enclosed in line engine of the liquid cooled or other conventional type;

Fig. 3 is a sectional front view of the embodiment shown in Fig. 1 taken on line 3—3 of Fig. 2, while

Fig. 4 shows an acceptable shape which the vanes for carrying out my invention may assume, including a diagrammatic analysis of the forces which would act on each of the same during flight at any given engine speed.

Fig. 5 is an enlarged view in elevation similar to Fig. 2 of a modification of my invention used in connection with a radial type air cooled engine embodying a low drag cowling of conventional type;

Fig. 6 is a sectional front view of the modification shown in Fig. 5 taken on line 6—6 thereof, and

Fig. 7 shows an alternative form of vane which may also be used to carry out my invention, and is intended to be covered by the appended claims.

Referring more particularly to the drawings, in which like characters of reference denote corresponding parts in all the views, Figs. 1 to 3 inclusive show a tractor type of light airplane having a fuselage 1, an empennage comprising control surfaces 2 and 3, upper and lower main supporting planes 4 and 5, a landing gear 6, a propeller 7, which may be of any conventional type rotated by power supplied from an engine 20 shown in dotted lines mounted on a supporting structure 21 carried by the framework 22 of the fuselage, also shown in dotted lines, and vanes 10 located aft of the propeller for recovery of the rotational energy in the propeller slipstream in accordance with my invention. If desired, the propeller may be of the variable pitch type and the engine may be partially or totally enclosed within the fuselage, or as hereinafter pointed out may be exposed to the airstream so as to be cooled by the action thereof as when a low drag cowling is used.

As above stated, in order to obtain thrust from a propeller working in a fluid medium, it is necessary to drive a volume of the fluid aft, or in other words, to displace the fluid in a direction opposite to that in which the useful thrust is obtained. This involves an energy loss due to the aft motion of the fluid, known as the propeller slipstream, and to the rotation thereof as well as to the turbulence set up in the fluid as it is displaced rearwardly. The energy losses due to the rotation of the slipstream and to turbulence constitute a large part of the total loss, so that the recovery of one of these losses in the manner proposed will result in an appreciable increase in the propulsive efficiency together with other advantages to be hereinafter described in detail.

The vanes 10 for carrying out my invention preferably are cambered sections either of airfoil shape having appreciable thickness as shown in Fig. 4 or of thin sheet metal, for which see the modification shown in Fig. 7. The vanes may also be of symmetrical section of any suitable material, or of flat metal. It being understood, that inasmuch as the manner of fabrication of the vanes is not considered to form a part of this invention, no attempt is made herein to claim or describe any particular material or manner of construction of the vanes except to point out that metal would be considered to be a suitable material for such purpose. The vanes obviously may be of such structural design as is considered to be best adapted to withstand the stresses imposed upon them. The practice in constructing airplane propeller blades would be considered to be a precedent therefor.

Referring particularly to Fig. 4 of the drawings, the numeral 11 indicates a line parallel to the axis of rotation of the propeller. The vane 10, shown as having an airfoil section which is deemed to be preferable, although other sections as pointed out above may be used successfully, is located aft of the propeller as shown in Fig. 1 at such an angle that the slipstream 12 from the propeller approaching at an angle A to the thrust line will leave the vane 10 in a direction 13 at an angle B from the thrust line. It is to be noted that the angle of the vane 10 may be varied throughout the range of efficient operation thereof depending upon the aerodynamic characteristics of the section chosen, the object being to make the angle B at which the slipstream leaves the vane as small as practicable for the reason that, as hereinafter explained, within certain limits the smaller the angle B, the greater the amount of energy recovered, and the straighter will be the airflow about the fuselage and over the control surfaces.

The force on the vane due to the slipstream is in the direction of the vector 14 which would have components 15 in a forward direction and 16 in the same direction as the original rotation of the slipstream. It will, therefore, be seen that the forward component 15 provides additional thrust which serves directly to increase the propulsive efficiency, while the component 16 being in the same direction as that of the rotation of the propeller 7 of the airplane, provides a torque around the propeller axis which opposes the torque of the engine. This torque, being the sum of the couples formed by the resultant of the forces 16 acting on each of the vanes is sufficient to counterbalance the engine torque to a great extent with the result that the change in lateral balance of the airplane with different engine speeds is greatly reduced. The advantages gained by this action and the manner of utilization of these forces in connection with different types of engine installations will now be described more in detail.

Returning to a description of the embodiment of my invention shown in Fig. 1, an enlarged view of the forward portion thereof is shown in Fig. 2, showing more in detail the position of the vanes 10 with relation to the engine 20 which is shown fully enclosed as in the case of an in line type cooled by the circulation of water or other fluid, it being understood that the cylinders or other parts of the engine may be partially or wholly exposed so as to be cooled by the airstream if desired, the invention being applicable to such installations in all of its details. The case of an air cooled radial engine either with or without a low drag cowling will be hereinafter referred to.

Whether the engine 20 be directly connected to

the propeller 7, or reduction gears be used to transmit the power to the propeller, a torque is produced in a direction opposite to that of the rotation of the propeller 7, which tends to rotate the entire engine and its mountings. This is the engine torque above referred to. Since the engine is mounted on supports which are carried by the fuselage structure, this engine torque is transmitted to the airplane as a whole and unless other means are provided, must be counterbalanced by the action of the wings or the control surfaces. In present practice, the wings are "washed out" on one side and the vertical stabilizer at the rear of the airplane is set at a small angle to the line of flight so as to counteract the tendencies of the entire airplane to rotate. The engine torque is applied to the airplane directly by the engine 20 through the connection of the engine supports 21 to the fuselage framework 22, shown in dotted lines in Figs. 2 and 5 of the drawings, or other parts of the airplane to which such supports are secured, it being understood that the invention is adaptable for use in connection with any installation of the tractor type, whether the engines be inboard or outboard, in the nose of the fuselage as shown in the drawings, above the wing in accordance with more recent practice, or in advance of the leading edge of the wing, as is becoming conventional. It will thus be seen that even in conventional types of airplanes the draft system including the fuselage framework must be designed to assume the loads imposed by the corrective forces which in the case of the wings would be throughout a portion of the fuselage, and in the case of the vertical stabilizer, would be throughout the entire length of the fuselage.

Likewise, in previous attempts which have been made to utilize the principle of the present invention in which it was proposed that the counter-propeller blades be combined with the elevational and directional control surfaces of the airplane, it would be necessary for the corrective loads, if any, to be transmitted from the engine mounting to the extreme rear of the fuselage, which would involve structural as well as other disadvantages. It is, therefore, proposed according to the present invention to locate the blades 10 approximately at the center of mass of the engine 20 so that the sum of the couples formed by the resultant of the forces 16 acting on each of the vanes will be applied practically to the engine itself relieving the fuselage structure of the necessity for carrying any of these loads throughout any portion of its length.

It will be seen from Fig. 3 of the drawings that in the present embodiment of the invention the vanes 10 are spaced at frequent intervals about the fuselage, or in other words about the axis of rotation of the propeller 7. This is not only for the purpose of distributing the effect produced as evenly as possible so that the corrective torque is applied at a greater number of points, but also to recover the energy from the entire slipstream with the result that all of the displaced fluid is acted upon in the same manner and a greater amount of energy is converted into useful forces. Another major advantage to be gained from the use of a large number of vanes is that by reducing the rotation and turbulence of the entire slipstream, a more uniform airflow is produced around the sides of the fuselage, and at the same time increased stability and control results from the straight line flow of air over the tail surfaces. The fact that both the vertical and horizontal stabilizing surfaces as well as the movable control surfaces were compelled to operate in the highly turbulent and rotative slipstream immediately behind the pusher propeller installation probably contributed as much to the failure of previous attempts to utilize the principle as the added weight of the structural parts required to transmit the loads imposed due to the location of the blades, whether the control surfaces themselves constituted such blades or the stabilizing surfaces were also given a corrective camber.

Figs. 5 and 6 show views similar to those of Figs. 2 and 3 of an application of my invention to an airplane equipped with a radial type air cooled engine embodying a low drag cowling. In this case the engine 23 having radial cylinders extending beyond the sides of the fuselage 1 is either partially or totally enclosed by the cowling 24 carrying the vanes 10 which perform in substantially the same manner as in the embodiment above described to produce a similar result, the only difference being that the airflow over the engine cylinders is confined and accelerated by the action of the cowling 24 which in addition directs the airflow rearwardly and inwardly about the sides of the fuselage to reduce the drag thereof. It will be seen that the vanes 10 in this case produce the same corrective effect on the airstream which in turn produces the same desirable results supplementing the action of the cowling to reduce the drag and improve the airflow over the control surfaces. Also, since the cowling encompasses the cylinders of the engine 23, the corrective torque sufficient to counterbalance the engine torque is likewise applied directly to the engine in approximately the plane of the center of mass thereof. As pointed out above, the vanes may also be used with equally as good results in connection with an engine of the radial type without a cowling, in which case, if desirable, the vanes may be placed in such a position with respect to the engine cylinders as to enhance the cooling thereof by controlling the airflow about the exposed portions of the engine.

As in the case of the embodiment shown in Figs. 1 to 3 inclusive, no description has been given of the manner of attachment of the vanes 10 to the cowling 24 or of the stressing of the cowling to carry the loads which will be imposed upon it, because it is desired that the invention be considered in its broadest aspect, instead of relating to specific features of construction, other than the relative location of the essential elements with respect to each other and to the other parts of the airplane as a whole. For the same reason no showing has been made of different types of fuselage construction, or of particular engine mountings, it being understood that the invention is adaptable for use with any installation of the tractor type as hereinbefore pointed out.

It is thought that the full nature and manner of operation of my invention will be apparent from the description which has been given. However, I wish it to be understood that I do not desire to be limited to the exact details shown and described, for the reason that modifications coming within the scope of the appended claims will occur to persons skilled in the art to which the same appertains.

I claim as my invention:

1. In an aircraft, the combination with a tractor propeller, a radial type engine for driving said

propeller, and a low drag cowling mounted on the exposed cylinders of said engine, of a counter-propeller mounted on said cowling.

2. In an aircraft, the combination with a tractor propeller, a radial type engine for driving said propeller, and a low drag cowling mounted on the exposed cylinders of said engine, of a counter-propeller mounted on said cowling, the counter-torque of which acts in the plane of the center of mass of said engine.

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