S. D. MOTT.

AIRCRAFT PROPULSION.

APPLICATION FILED APR. 1, 1916.

1,361,276.

Patented Dec. 7, 1920.

2 SHEETS—SHEET 1.

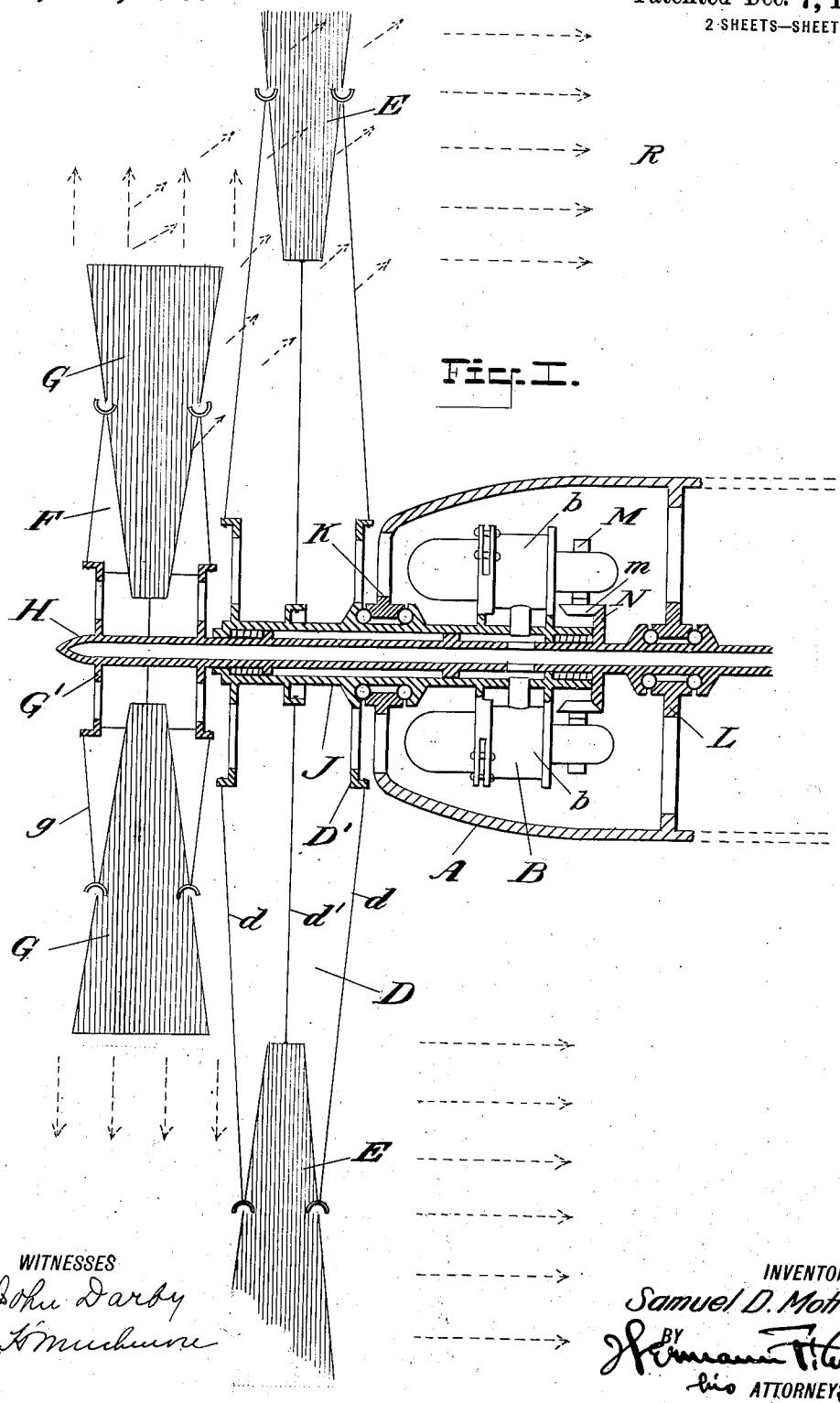


Fig. 1.

WITNESSES

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2 SHEETS—SHEET 2.

Fig. II.

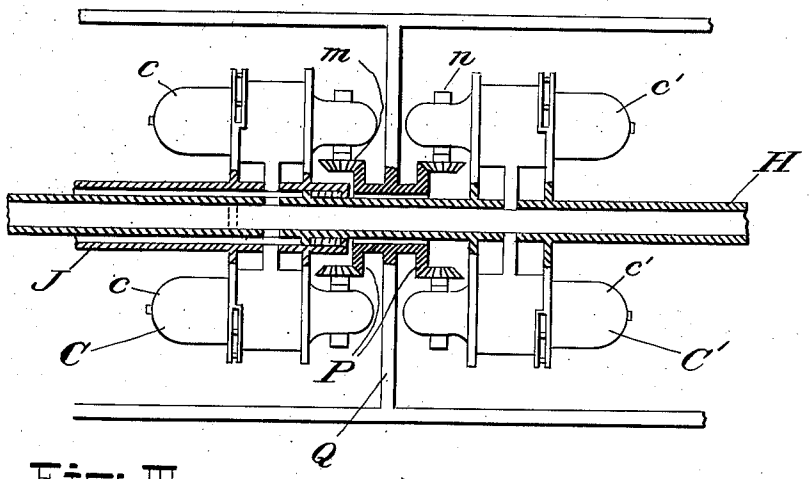
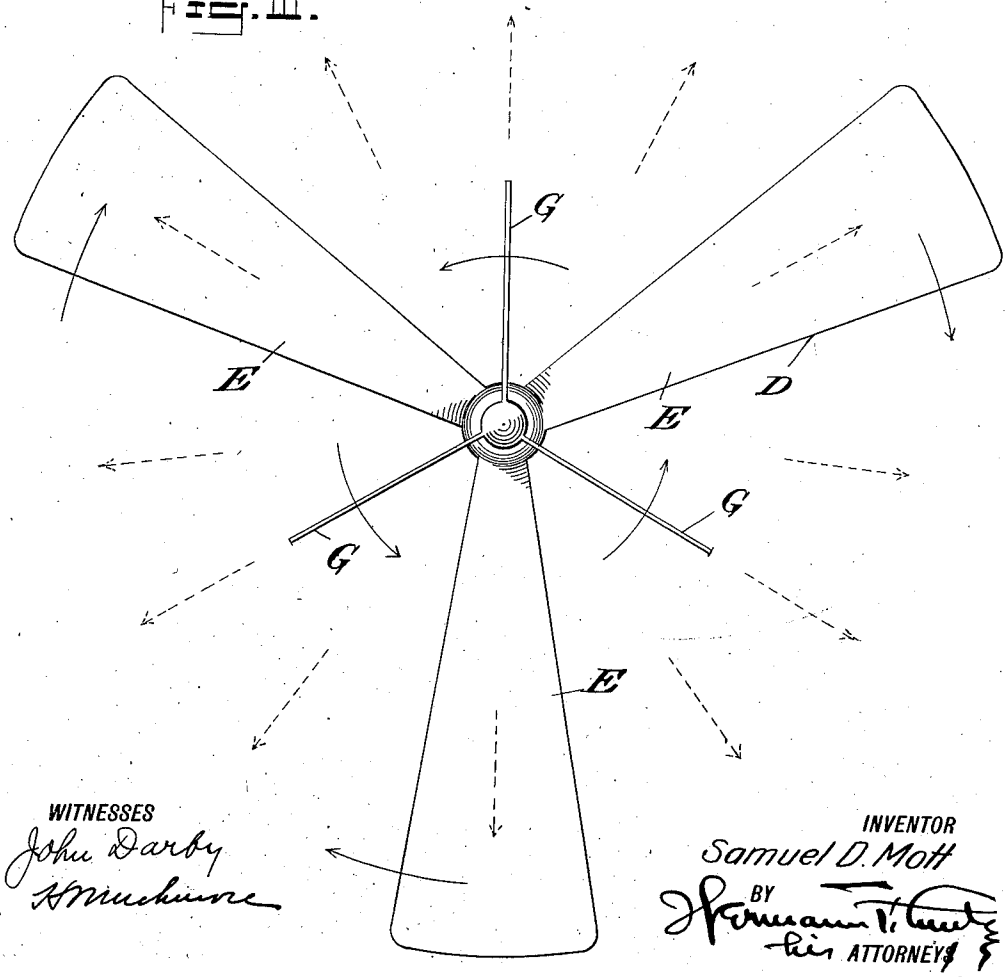


Fig. III.



WITNESSES

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UNITED STATES PATENT OFFICE.

SAMUEL D. MOTT, OF PASSAIC, NEW JERSEY, ASSIGNOR OF ONE-HALF TO ARTHUR B. SULLIVAN, OF ALLENDALE, NEW JERSEY.

AIRCRAFT PROPULSION.

1,361,276. Specification of Letters Patent. Patented Dec. 7, 1920.

Application filed April 1, 1916. Serial No. 88,192.

To all whom it may concern:

Be it known that I, SAMUEL D. MOTT, a citizen of the United States, resident of and whose post-office address is 130 Autumn street, in the city of Passaic, county of Passaic, and State of New Jersey, have invented certain new and useful Improvements in Aircraft Propulsion, of which the following is a description, reference being had to the drawings forming a part hereof.

Among the objects of my invention are the utilization of means adapted to make the power absorbed by the propeller on aircraft more effective, to reduce the air resistance of the body of the aircraft, to neutralize or compensate rotary or centrifugal effect, and for various other purposes.

When a propeller is held in place and rotated rapidly it churns the air, whereas any retardation of movement of the air will cause a tendency to displacement of the propeller resulting from increased resistance. It is expressed frequently that the propeller to get propulsion effect or reaction must act on new medium or undisturbed medium such as air. I have found by experiment that with a strong transverse wind the resistance of the propeller is greater than when the propeller is rotating in inert air, consequently assisting in the effective reaction for propulsion, which is the object of the action of the propeller in aircraft.

I therefore arrange a fan in proximity to the propeller which will project air radially from the axis of the propeller shaft, and with the movement of the aircraft, such air given a radial velocity will bank in the zone of movement of the propelling blades, thereby increasing the reactive character of the medium on which the propeller is acting. It is practically furnishing the propellers constantly more air than they would otherwise engage in the manner in which they are now usually employed.

By such arrangement, in the case of an aeroplane with the propellers in the front of the fuselage, the fan serves to radially distribute the air, thereby reducing the head resistance and skin friction in the forward part of the machine.

In brief, therefore, one of the main objects of my invention is to increase the efficiency of propellers, while also reducing resistance and counter-balancing the reaction of the motive power and also counter-balancing any tendency to gyroscopic action of the moving parts of the engine and propeller.

In the particular form herein shown and described, the accompanying drawings forming a part hereof show:

In Figure 1 the nose of an aeroplane fuselage in section, showing the relation of fan and propeller, partly broken away and largely diagrammatic.

Fig. 2 shows in part section on the axis of the drive shaft, a modified arrangement of motors.

Fig. 3 is a front elevation of fan and propeller to diagrammatically illustrate their operation.

The engines and shaft connections and structure of fans and propellers are not intended to be working drawings, but merely serve to illustrate the relative arrangement of parts, the actual construction and arrangement of which would be made for proper assembly and convenience and strength of manufacture by designers, for the particular case that may be involved for embodiment of my invention.

In the particular form herein shown and described, A is the forward end of a fuselage, B is a motor, D is a propeller, E—E are propeller blades, F is a fan with blades G and hub G′, with spokes *g*, H is a drive shaft for the fan F, J is a drive shaft for the propeller D connected by means of the hub D′ and spokes *d*, while spokes *d*′ connect with a hub flange also attached to the drive shaft J.

While concentric shafts heretofore have been shown in patents granted to me and other types of aircraft, it will be noted that the inner shaft H drives a fan not intended for propulsion, but for the purpose of directing air currents into the zone of reaction of the propeller D. The operation of these concentric shafts involves the bearing in the nose cap K of the fuselage, while a suitable bearing L elsewhere in the fuselage forms a second support, and between them the motor B is arranged, which in the case illustrated may be of a form shown in my co-pending application Serial No. 88,193 although any suitable form of motor may be used. As illustrated in the particular form shown, the motor cylinders *b*—*b* are supported rigid with relation to the shaft J, while the crank shaft M through bevel gear *m* drives

the bevel gear N attached to the shaft H. Suitable bearings are interposed for proper mechanical operation. It will thus be seen that the fan F will be driven by the operation of the motor in an opposite direction from the propeller D.

In Fig. 2 I have shown the two motors C—C′, the cylinders *c′*—*c′* being attached to the inner shaft H, while the cylinders *c* are attached to the outer concentric shaft J and the pinions *m* on the crank shafts M react on the stationary bevel gears P—P, held rigid by any suitable frame work Q, so that the operation of the motor results in a reaction turning the respective shafts to which they are attached. In this arrangement, suitable control mechanism permits the adjustment of speed of each of the engines irrespective of the other, so that the desired speed found most advantageous for the fan F will be established, and the speed desired for the propeller D will be established entirely within the control of the operator. In the case of a single engine, as shown in Fig. 1, a relation of the size of fan blades and their contour and the size and pitch and other characteristics of the propeller may be so proportioned that the relative resistance of fan and propeller will cause a balance provoking the desired absolute rotary speed of each. However, as air pockets and possible variations in internal resistance of the propelling mechanism are likely to interfere with the desired balance of operation of the two members, it is well to embody suitable brake or dampening device to relatively retard one or the other of the shafts, which may be done by any desired known means and by the use of a suitable tachometer in the view of the operator, the relative operation of the members can be noted and the control effected accordingly. It may be noted that in starting a preponderance of propeller speed may be desired, whereas under certain conditions the reverse may be true, and on this account the absolute control of both shafts may be perfected.

In Fig. 3 the blades G of the fan are indicated by arrows showing the direction of rotation, while the blades E—E—E of the propeller have arrows showing their direction of rotation. The dotted radial arrows indicate the general directions in which the fan F will project the air it encounters, and in Fig. 1 arrows similarly indicate the movement of air, while the diagonal arrows indicate the resultant drift of the air due to the radial propulsion by the fan and the forward movement of the aircraft, so that the current of air caused by the fan will pass through the zone of action of the propeller D, which in turn drives the air rearward, as indicated by the arrows R, thereby clearing the fuselage, in the case of an aeroplane structure, as indicated in the particular form illustrated. To an extent the relief of head resistance is accompanied with a tendency to partial vacuum, which further minimizes the head resistance besides reducing skin resistance.

The exact construction of fan and propeller by means of the hubs and spokes, as diagrammatically illustrated, involves the invention more particularly shown and described in other co-pending applications for Letters Patent and need not be more specifically described herein.

By observation and experiment I have ascertained that a strong wind blowing athwart the direction of movement of a flying device, supplies new air and increases the reactive effect of a propeller. Were it possible to propel air at a great velocity the resistance of the air to deflection from its course would be very materially increased, as compared with the reaction of still air, or in other words rapidly moving air would offer increasingly greater medium of reaction. The effect of radially projecting air by means of the fan in my invention, will to a greater or less degree increase the resistance of the air to offer the reaction of the propeller in like manner. So many factors enter into the question of propulsion, that the relative speeds, sizes of propellers, the nature or size of the fan, and the power involved are all relatively to be determinable for any specific case, and it will therefore be seen that various modifications may be made of the exact form herein shown and described, without departing from the spirit of my invention. The arrangement of fan to the rear instead of the front of the plane of the propeller, may be preferable in some cases. The coöperation of a fan as shown, of a maximum diameter equal to the diameter of the central free space between the propeller blades, has certain advantages, but involves a suspended propeller with a substantially free circular zone about its hub, which is possible when utilizing the propeller supporting structure shown in my co-pending application Serial No. 66,466. This permits the action of the fan in a cylindrical zone with the propeller action in an outer annular cylindrical zone, as shown in Fig. 1; whereas in Fig. 3, a modified arrangement is diagrammatically illustrated in which the fan is most naturally in front of the propeller blades. It will be noted that the practice of my invention results in giving a radial component to the movement of the air mass in which the propeller operates, and the greater the speed of the air where engaged by the propeller blades, the greater will be the reaction imparted to the blades with the resultant advantage. As

the mass of air will move in a direction influenced by the two components, namely, the relative movement of the machine and the radial movement due to the fan, means a resultant between the two directions which will give a "bank of air" at high speed in the zone of the propeller, moving in an advantageous direction for the desired purpose.

While the fan F has been shown as having direct radial blades, the desired speed of the aircraft and the predetermined rotary speed of the fan will determine the shape and contour of the fan blades, while the structural parts to transmit the desired power to the blades will be carried out in a suitable mechanical manner varying from the diagrammatic illustration herein shown. It may be desirable in some cases to warp the fan blades and to materially change their shape, with the object of throwing the desired volume of air radially in the direction most efficient under the conditions involved in any particular case. Likewise, while the propeller blades are simply indicated in a general form, the exact shape and pitch and structure will be determined by the factors involved in any particular case, using the experience and practice now familiar to one skilled in the art and the rapidly developing experience of the day.

The opposite rotation of the driving elements, as well as the fan and propeller *per se*, while serving the particular purpose above described, will neutralize any tendency to gyroscopic effect which might be involved at high speeds. Should geared down motors be used, thereby running at much greater speed, than the fan and propeller respectively, their tendency to any gyroscopic effect or reaction will be greater and the opposite rotation of the main elements proportionately of greater benefit.

The banking of air in the zone of reaction of the propeller, or as it may be, the movement of air at great velocity transverse to the reaction of the propeller will have its material effect and be the subject of much thorough investigation and determination of characteristics, so that my invention may be readily applied to any specific case of design involved.

While innumerable modifications may be made in structure, arrangement or operation, and many details may be added for control, refinement or reliability and other desired qualities of aircraft propulsion, without departing from my invention, what I claim and desire to secure by Letters Patent is:

1. In an aeroplane, the combination of a shaft projecting from the forward end of the fuselage, an air propeller carried by said shaft and having a zone of action exterior to the fuselage and a fan rotating in a plane forward of the plane of rotation of the propeller and concentrically therewith and having its maximum diameter less than the effective reactive area of the propeller blades, said fan having blade surfaces adapted to project the air core into which the fuselage is advancing radially outward into a zone in front of the forward surfaces of said propeller blades, whereby in its propulsive action the said propeller will drive the air rearward clear of the fuselage.

2. Means of propulsion for aeroplanes, comprising a motor shaft, a horizontal shaft projecting from the fuselage and substantially coinciding with the fuselage axis, a propeller rotated thereby and having its effective zone of action exterior to the path of the fuselage as the machine moves forward, and a concentric shaft having a fan rotated thereby in front of the fuselage and in a plane displaced from the plane of rotation of the propeller, said fan having air surfaces adapted to expend the motor energy primarily in projecting the air radially from the path of the fuselage and outward to the area of effective reaction of the propeller.

3. The combination with an aircraft of propulsion apparatus therefor, comprising two oppositely moving concentric shafts, a propeller on one of said shafts having blades reacting in the direction of the axis and having a zone of action such that the air driven rearwardly thereby clears the body of the machine, and fan blades on the other of said shafts rotating in a plane in advance of the plane of action of the propeller, said fan blades being adapted to project the air in the zone embracing the path of the body of the machine radially outward into an exterior zone in front of the propeller as and for the purpose described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 28 day of March, 1916.

SAMUEL D. MOTT.

Witnesses:
HERMANN F. CUNTZ.
H. MUCHMORE.