

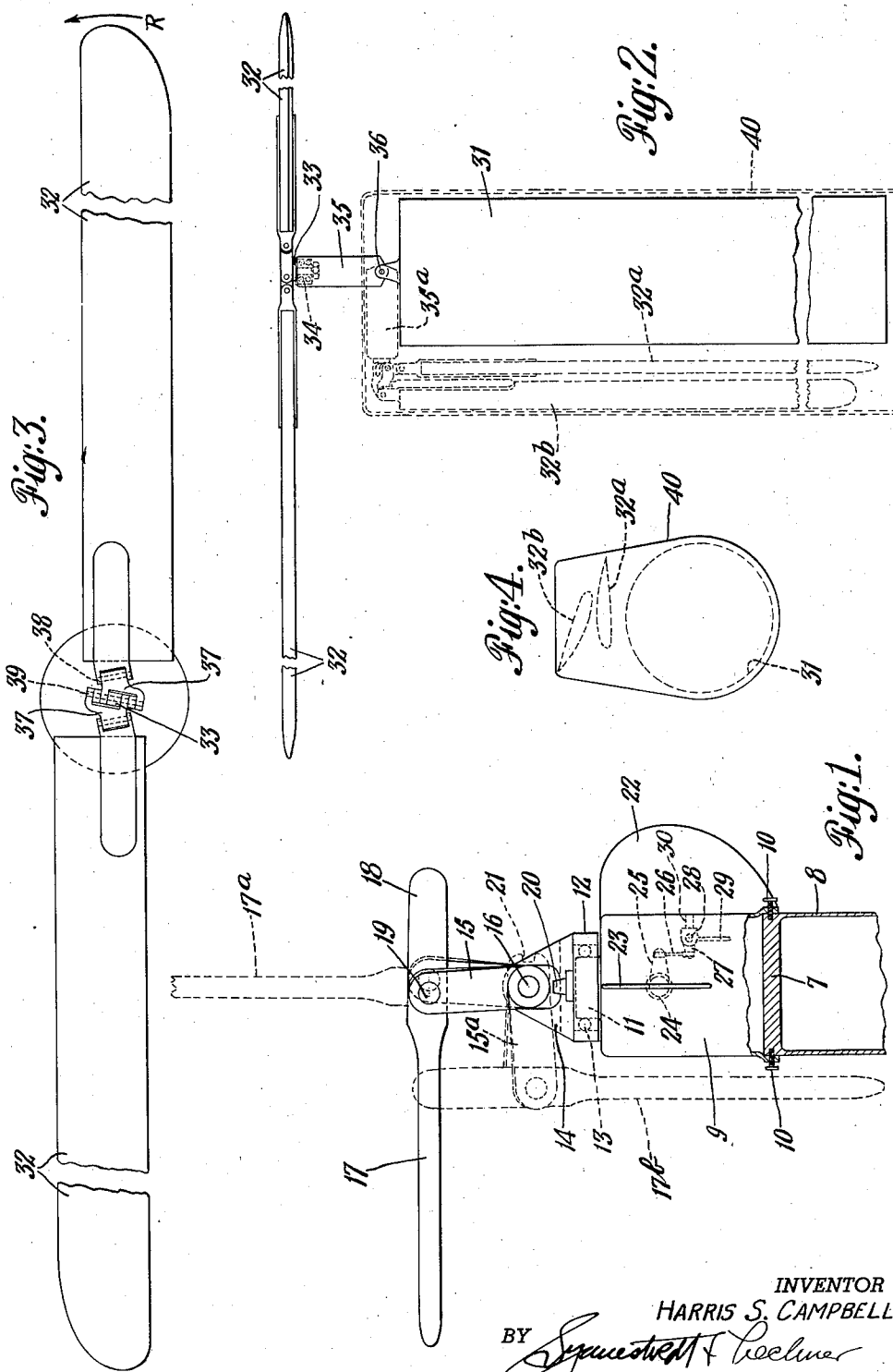
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ROTOR EQUIPPED AERIAL DEVICE

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ROTOR EQUIPPED AERIAL DEVICE

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This invention relates to an aerial device and especially to a device adapted to be dropped from an aircraft, the device incorporating a rotor providing for retarded descent thereof. Certain features of the invention, moreover, are particularly adapted to a device of this general type further equipped with controllable means for regulating the path of descent.

The arrangement of the invention is adaptable to aerial devices of various types, including man-carrying devices, in which event the control mechanism may be manually operable, and also to cargo or other load-carrying devices, such as explosive bombs, in which event the control mechanism is adapted to be actuated by automatic remotely controlled means, such as radio control apparatus.

One of the objects of the invention is the provision of a rotor mount adapted to attach the rotor to the bomb or other body, the rotor mount being pivotally connected with the body and providing for movement of the rotor as a whole between its operating position and a position closely paralleling a side wall of the body, whereby to facilitate compact stowage of the device.

A further object of the invention is the provision of a novel arrangement of rotor blade pivots incorporating blade pivot axes obliquely inclined with reference to the longitudinal blade axis in a manner providing for decrease of blade pitch as the blades swing upwardly, to thereby facilitate initial rotation of the rotor upon release of the device from an aircraft, the pivot mechanism at the same time further providing for folding of the rotor blades, preferably a pair of such blades, into positions adjacent to each other in which the longitudinal axes of the blades substantially parallel each other. This feature also contributes to compactness for stowage purposes.

Still another object of the invention is the provision of a unitary rotor and rotor mount provided with attachment means adapted to connect the device with a bomb or other body.

In the preferred embodiment the rotor mounting unit also incorporates stabilizing and control mechanism for steering the device or influencing the path of descent thereof, all of these elements being arranged as parts of a unified structure adapted for ready attachment to the bomb or other body to be dropped. In this way the bombs and rotor units may be separately made and separately handled and shipped and, if desired, not assembled until just prior to use thereof.

Although provision may be made for driving the rotor, in the forms illustrated herein and described herebelow, it is contemplated that the

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rotor blades are preferably so mounted as to provide for aerodynamic or autorotational actuation thereof under the influence of the air flow on the blades during descent of the device.

How the foregoing objects and advantages are obtained together with others which will occur to those skilled in the art will be clear from the following description referring to the accompanying drawing in which—

Figure 1 is a side elevational view of a unitary rotor and rotor mounting device adapted to be attached to a body to be dropped, such as a bomb, the upper end of the bomb shell being shown in vertical section;

Figure 2 is a side elevational view of a modified arrangement incorporating certain features of the rotor mount;

Figure 3 is a top plan view of the device shown in Figure 2; and

Figure 4 is an end view of a casing adapted to be employed in association with the device of Figures 2 and 3.

In considering Figure 1, it may first be mentioned that the unitary rotor and rotor mounting device shown therein may be employed in association with bodies of various types, sizes and shapes. It is assumed that in Figure 1 the device is associated with a bomb, for instance, carrying an explosive charge. An end wall of the bomb shell appears at 7, the upper end of the side wall being shown at 8. The rotor and rotor mounting device comprises a mounting member 9 of cylindrical shape, the lower edge of which is adapted to fit the upper end of the bomb and to be secured thereto in any suitable manner, for instance, by means of attachment screws 10. A non-rotative hub mounting spindle 11 projects upwardly from the cylindrical member 9. A rotative part 12 is mounted on the spindle 11 by means of a bearing 13. Member 12 carries an upstanding apertured ear 14 to which a yoke 15 is pivotally connected by means of pivot pin 16. A rotor blade 17 having a counterweight 18 is, in turn, pivotally attached to the yoke 15 by means of a pivot 19, the axis of which pivot is obliquely inclined to the major axis of the blade in a direction such that, when viewed in plan, the pivot axis forms an acute angle with the blade axis at the leading side of the blade axis and at the outboard side of the pivot axis. This obliquity causes the pitch angle of the blade to decrease as the blade swings upwardly.

The yoke is of such size as to permit the counterweight 18 to swing therethrough, thereby enabling the blade 17 to assume the position indi-

cated in dotted lines at 17a. This is of importance in the launching or release of the device, the action being as follows.

When the device is released the air flow over the blade during the initial portion of the descent causes the blade to swing upwardly to a negative pitch position, thereby facilitating initiation of rotation. As rotational speed increases the action of centrifugal force on the weight and on the blade causes the weight to swing out of the yoke toward one side, thus bringing the blade to a position in which appreciable "lift" is derived therefrom, and thereby retarding the descent of the device. Provision may be made for retarded descent of such devices at different rates, by employing different rotor characteristics, such as blade pitch, blade length, etc.

With respect to the blade pitch angle to be employed, it may be said that appreciable variation is permissible. An appropriate autorotative setting found suitable for the purpose is about 4 or 5 degrees above the no-lift setting calculated with reference to a plane perpendicular to the axis of rotation when the blade is perpendicular to the rotational axis.

For purposes of compact stowage of the device the rotor mounting yoke 15 is pivotally movable about the axis of pivot 16 to the position indicated at 15a, in which the blade itself may be brought to the position 17b in which the blade lies along a side of the bomb. A spring pressed latch member 20 is arranged to cooperate with a notch 21 formed in a lower part of the yoke 15, the yoke being so shaped that when the air flow causes the blade to swing upwardly upon launching, the latch 20 will be depressed and then snap into the notch 21 and thereafter retain the yoke and rotor in proper position for descent.

As hereinabove mentioned, provision is also desirably made for control of the path of descent of the device. A fixed stabilizing fin 22 is arranged at one side of the cylindrical member 9, and this fin, especially where the device is released from an airplane moving at high speed, contributes "weathercock" stability, thereby serving to prevent rotation of the device as a whole about a vertical axis.

The controllable mechanism includes a pair of similarly arranged pivotally mounted fins 23, one positioned at each side of the device in a plane generally perpendicular to the plane of the fixed fin 22. Fins 23 are adjustable on individual mounting pivots 24 by means of an arm 25 arranged inside the cylindrical member 19 which arm is coupled by a link 26 with one arm 27 of a bell crank mounted on a pivot 28, the other arm 29 of the bell crank serving as a controlling lever. The bell crank 27—29 is also movable on another pivot 30, and the two pivots 28 and 30 permit universal movement of the control lever 29 and thereby provide for differential as well as similar adjustment of the fins 23 in the manner more fully disclosed in copending application of Harold F. Pitcairn, Serial No. 534,245, filed concurrently herewith. The foregoing mechanism provides for control of the path of descent of the device.

In the event of employment of the invention in a relatively large man-carrying device, the occupant may manually actuate the control system above described, and in the event of a device of the type adapted to carry cargo or explosive only, the lever 29 may be coupled with any suitable remotely controlled apparatus such as the known type remote radio control apparatus, which apparatus is also advantageously housed

within the cylindrical member 9 and thus also constitutes a portion of the rotor mounting unit.

Turning now to the arrangement of Figures 2, 3 and 4, here the rotor device is shown as associated with an aerial flare, indicated at 31. The rotor here shown incorporates a pair of blades 32—32 which are connected by means of pivots described below to a rotative hub member 33 which is journaled by a bearing 34 at the upper end of a link 35 pivotally connected with the flare body 31 as at 36.

As best seen in Figure 3, each blade is connected with a mounting link 37 by means of a pivot 38, the two mounting links 37 in turn being pivotally attached to the hub 33 by a pivot 39. As seen in Figure 3 the axis of pivot 39 is obliquely inclined in a sense forming an acute angle with the longitudinal axis of each blade at the leading side of the blade axis and at the outboard side of the pivot axis. The effect of this is to cause the blade pitch angle to decrease when the blades swing upwardly, and this is of importance at the time of launching the device, since the blades at that time would be caused to flap upwardly thereby reducing their pitch angle, in which reduced pitch position the air flow may readily initiate rotation of the rotor. Here again the blades are desirably mounted to provide for aerodynamic or autorotative actuation thereof, and as the rotor R. P. M. picks up, the blades will move to an approximately horizontal position, thereby providing substantial lift and thus appreciably retarding the descent of the device.

The outboard blade pivot 38, for each blade, as will be seen from Figure 3, is inclined in a sense opposite to the inclination of pivot 39, the inclination preferably being substantially equal and opposite, when measured with relation to the blade axis. These pivots 38 thus provide for upward folding of the two blades into substantial parallelism and also for folding to positions shown in Figure 2. In Figure 2 the mounting link 35 for the rotor is also shown in position 35a in dotted lines in which the rotor hub is brought to one side of the body portion 31. With the mounting link in this position, one of the blades may take the position indicated at 32a, the other blade being folded both on pivot 39 as well as on its pivot 38 to the position indicated at 32b. The equal and opposite obliquity of pivots 38 and 39 provides for folding to the positions just described while retaining the longitudinal axes of the blades in substantial parallelism. This is further illustrated in Figure 4.

Figure 2 also includes a dotted showing of a casing 40 for the entire unit when the blades are in folded position, the end outline of this casing appearing in full lines in Figure 4. From Figures 2 and 4 it will readily be seen that the entire unit is quite compact when the rotor is folded, thereby facilitating stowage.

When launching or releasing the device of Figures 2 to 4, all that is required is to permit the entire unit to slip out of the casing 40, whereupon the action of the air on the blades will cause the rotor to assume its proper position, the initial portion of the descent serving to first initiate the rotation of the rotor after which the device will descend slowly to the earth.

The arrangement of Figures 2 to 4 is also useful for the purpose of dropping either an occupant or cargo of types for which a very low rate of descent is desirable. When the arrangement of Figures 2 to 4 is employed as an aerial flare, the

flare may be ignited either by a fuse or by a timing device during descent.

According to the foregoing, a unified structure is provided incorporating one or more of a number of elements including the rotor itself, rotor bearings, rotor folding means, stabilizing fin, and controllable mechanism such as movable fins. Even equipment for remote radio control of the device may be incorporated in the unit, and this unified structure is arranged for convenient attachment to a bomb or other body.

I claim:

1. An aerial device comprising an elongated body portion, a bladed sustaining rotor disposed at the upper end thereof and providing for retarded descent of the device, and mounting means for the rotor adjustably connected to said body portion so that the adjustment of said mounting means provides for movement of the rotor as a whole between its operating position and a folded position closely paralleling a side wall of the body portion, whereby to facilitate compact stowage of the device.

2. An aerial device comprising an elongated body portion, a bladed sustaining rotor providing for retarded descent of the device, mounting means for the rotor adapted to position the rotor at an end of the body portion when the rotor is in operation, the mounting means being adjustable to provide for alternative positioning of the rotor blade means as a whole in a position closely paralleling one side wall of the body portion, whereby to facilitate compact stowage of the device, and a casing for enclosing said device, the casing having an enlargement at one side thereof adapted to accommodate the rotor when in its position adjacent said side wall of the body portion.

3. An aerial device comprising a body portion, a multi-bladed sustaining rotor providing for retarded descent of the device, mounting means for the rotor including a journal providing for rotation thereof, and blade mounting pivot mechanism for the rotor blades including for each blade, a pivot axis making an acute angle with the longitudinal blade axis at the leading side of the blade axis and at the outboard side of the pivot axis, and the pivot mechanism further including, for each blade, another pivot axis oppositely inclined to said first pivot axis, said two pivot axes providing for folding of the rotor blades into adjacent positions in which the longitudinal axes of the blades substantially parallel each other.

4. A construction in accordance with claim 3 in which the rotor mounting means is pivotally secured to the body to provide for adjustment between its operating position and a position adapted to bring the rotor blades, when folded, into close parallelism with a side wall of the body portion, whereby to facilitate compact stowage of the device.

5. An aerial bomb comprising, in combination

with an elongated bomb shell, a bladed sustaining rotor providing for retarded descent of the bomb, the sustaining rotor incorporating a single counterweighted blade and a mounting yoke therefor to which the blade and counterweight are pivoted on an axis providing freedom for the counterweight to swing through the yoke, and means for connecting said yoke to the bomb with freedom for swinging movement of said yoke toward a side of the bomb, to provide for positioning of the rotor blade in parallelism with a side wall of the bomb, whereby to facilitate compact stowage of the device.

6. An aerial device comprising an elongated body portion, a bladed sustaining rotor connected to the upper end thereof and providing for retarded descent of the device, mounting means for the rotor providing for movement of the rotor as a whole between its operating position and a folded position closely paralleling a side wall of the body portion, whereby to facilitate compact stowage of the device, and a latch device automatically operated upon movement of the rotor from its folded position to its operating position to retain the rotor in the latter position.

7. A sustaining rotor unit adapted for attachment to the upper end of an elongated body to provide for retarded descent thereof in an upright position, comprising a bladed sustaining rotor, and mounting means adapted to adjustably connect the rotor to a body in a manner to provide for movement of the rotor as a whole between its operating position and a folded position closely paralleling a side wall of the body.

8. A sustaining rotor unit adapted for attachment to the upper end of an elongated body to provide for retarded descent thereof in an upright position, comprising a bladed sustaining rotor, a fin for controlling descent of the body, and mounting means adapted to adjustably connect the rotor to a body in a manner to provide for movement of the rotor as a whole between its operating position and a folded position closely paralleling a side wall of the body.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,192,492	Bennett	Mar. 5, 1940
1,537,713	Sperry	May 12, 1925
2,329,414	Nelson	Sept. 14, 1943
1,792,937	Sperry	Feb. 17, 1931
2,348,249	Ferro	May 9, 1944
2,384,640	Robins	Sept. 11, 1945

FOREIGN PATENTS

Number	Country	Date
660,793	Germany	June 2, 1938