

Jan. 1, 1957

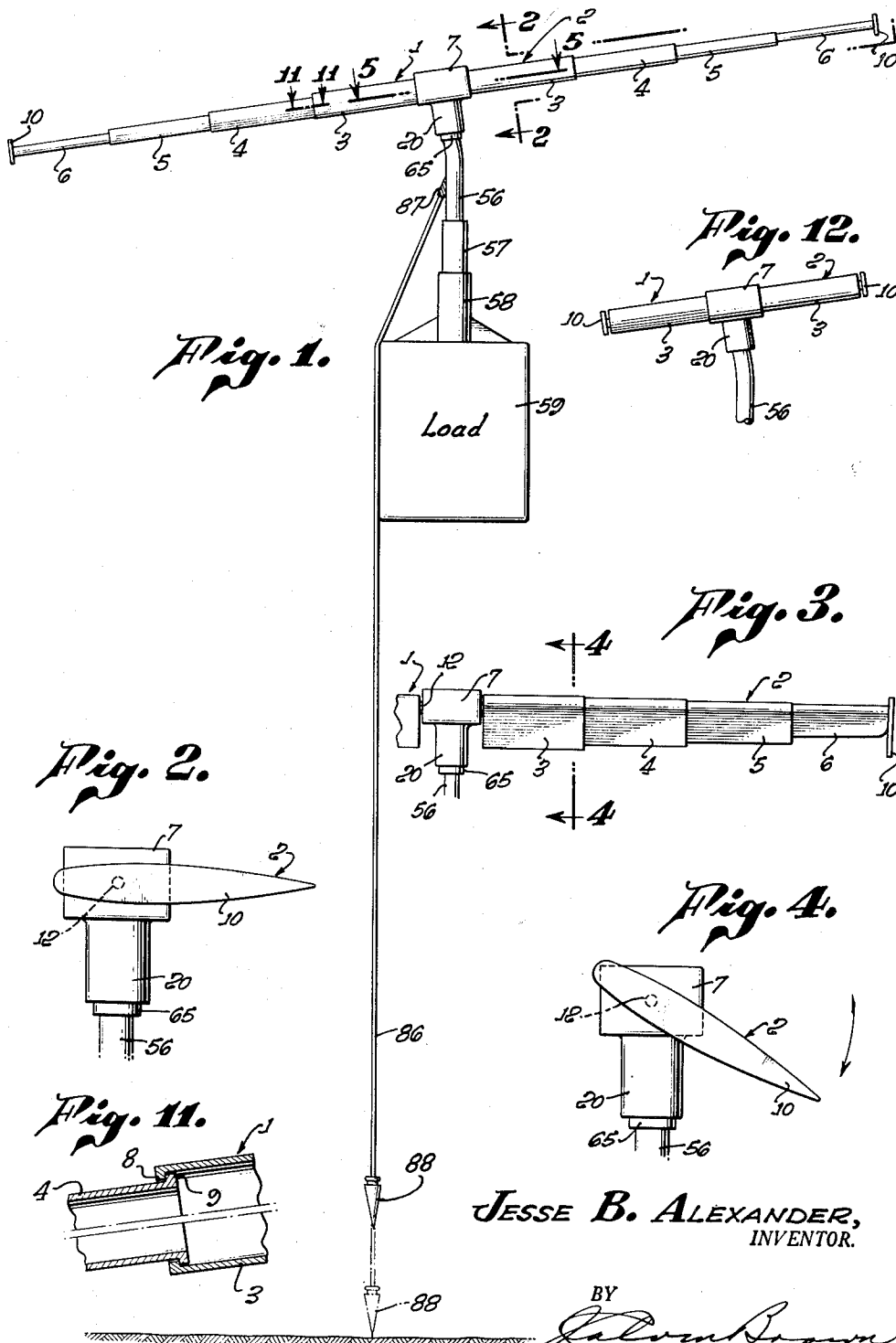
J. B. ALEXANDER

2,776,017

TELESCOPING ROTOR

Filed April 20, 1953

3 Sheets-Sheet 1



JESSE B. ALEXANDER,  
INVENTOR.

BY

*Robert Brown*  
ATTORNEY.

Jan. 1, 1957

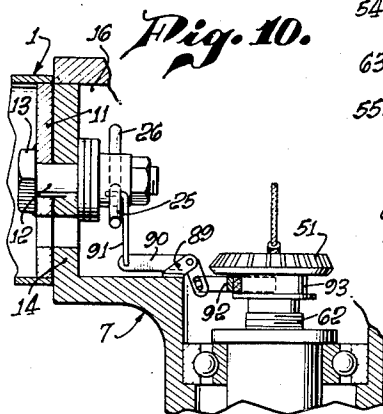
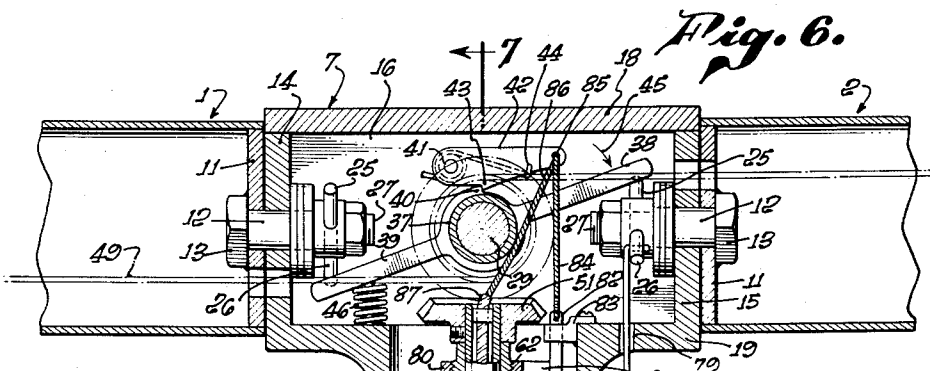
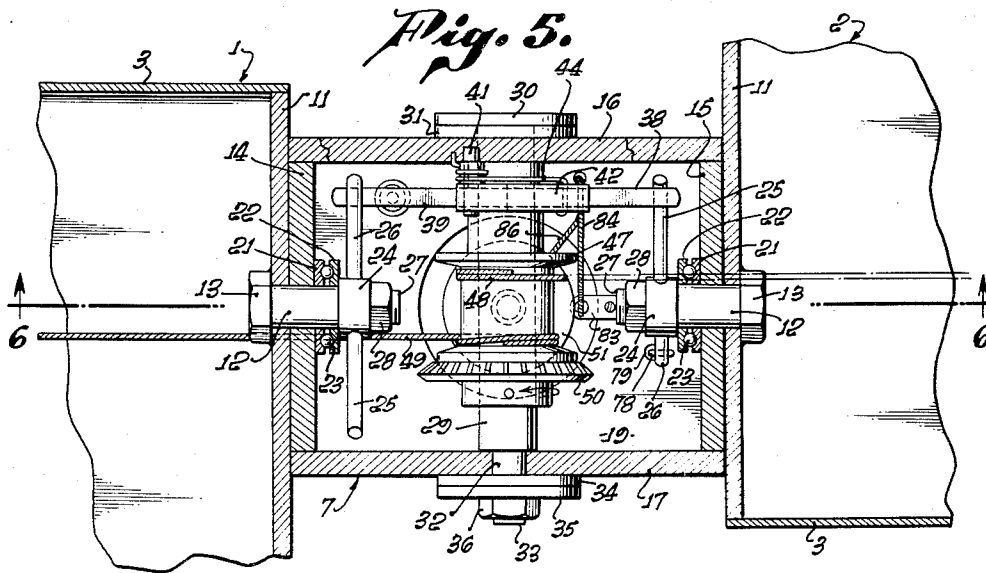
J. B. ALEXANDER

2,776,017

TELESCOPING ROTOR

Filed April 20, 1953

3 Sheets-Sheet 2



INVENTOR.  
**JESSE B. ALEXANDER,**  
BY  
*Calvin Brown,*  
ATTORNEY.

Jan. 1, 1957

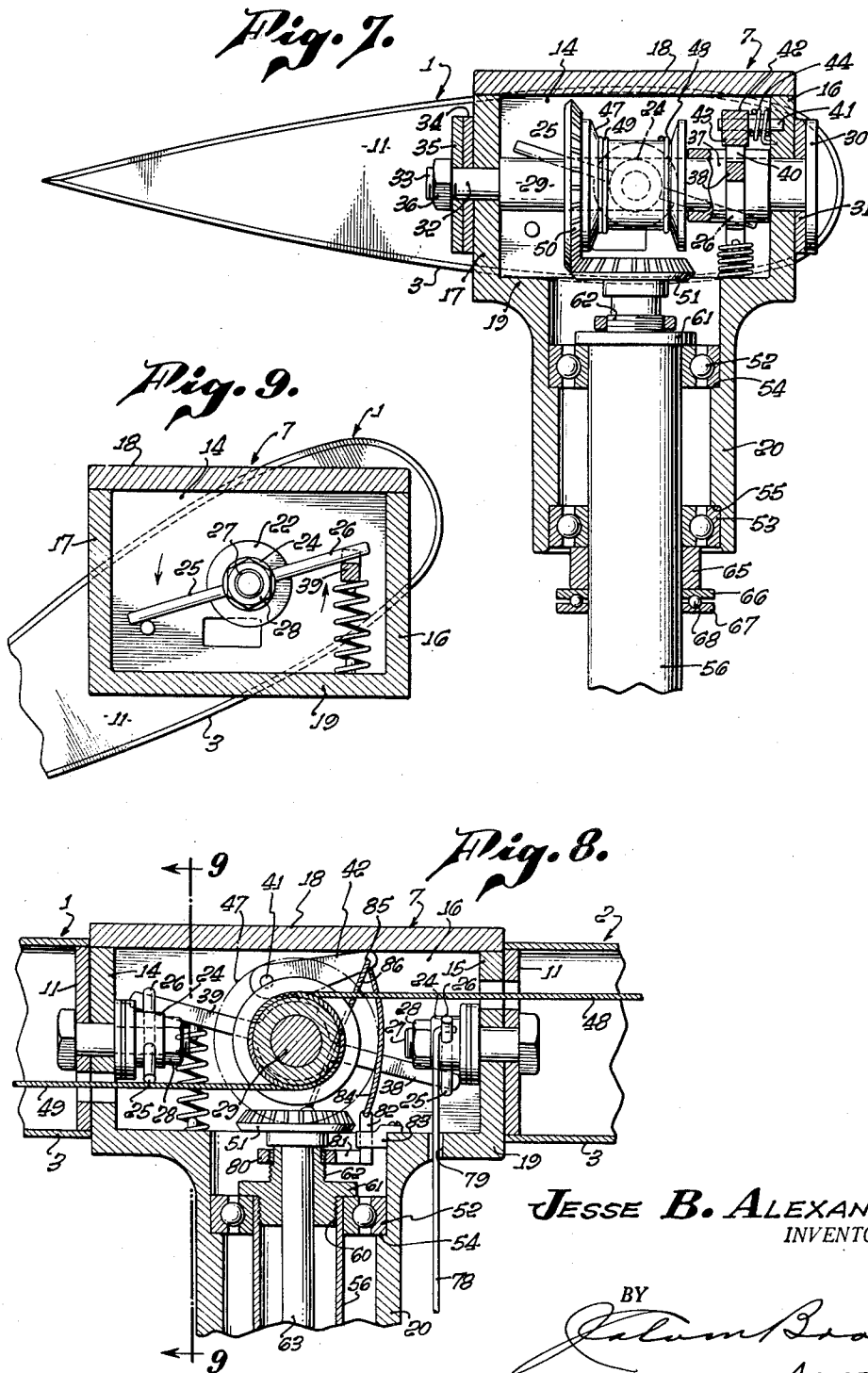
J. B. ALEXANDER

2,776,017

TELESCOPING ROTOR

Filed April 20, 1953

3 Sheets-Sheet 3



JESSE B. ALEXANDER,  
INVENTOR.

BY  
*Calvin Brown*  
ATTORNEY.

1

2,776,017

## TELESCOPING ROTOR

Jesse B. Alexander, Anaheim, Calif., assignor to Gifford H. Teeple, Los Angeles, Calif., as trustee

Application April 20, 1953, Serial No. 349,651

3 Claims. (Cl. 170—160.11)

The present invention relates to a telescoping rotor of a type which is useful as an aerial delivery device, in that it is capable of carrying heavy loads at a high rate of descent, and which high rate of descent may be abruptly checked to the end that cargo to be delivered may be landed at a reduced rate, so that the rotating blades will not dig into the ground, with resulting hazard in the event that the rotor tends to cart-wheel.

The present invention is superior to the well known parachute, in that it has smaller cubic displacement when airborne, more durable, lighter, and of lower unit cost and requires no repacking.

The present invention may be installed on jet aircraft and used as a braking medium therefor. Its effectiveness as a retractable braking surface for jet aircraft may be utilized both in the air and on the ground. By extending the rotor in the same manner as airplane landing gears are extended, and while the rotor is retracted to its smallest diameter, the rotor will serve as sufficient drag to increase the angle of approach before landing. After landing, the rotor may be allowed to extend to its maximum diameter to brake the airplane on the landing roll. While not shown here, the application of power to the blade tips of the rotor provides a means of increasing the effective drag of the rotor several times that of autorotation, all of which is within the scope of the invention.

A further object of the invention is the provision in a rotor having telescoping blades of a construction wherein the blade sections progressively and equally move outwardly as the rotor spins.

A further object of the invention is to provide positive means for retracting the sections of a telescoping blade rotor at a given speed and simultaneous to landing the said rotor.

A further object is the provision of a rotor which may be directionally controlled during descent thereof.

A further object is the provision of a rotor which may be launched from aircraft moving at high velocities.

A further object is the provision of a rotor which may be controlled as to its rate of descent.

In the drawings:

Figure 1 is an elevation of the rotor shown carrying a load,

Figure 2 is a fragmentary view looking in the direction of the arrows 2—2 of Figure 1,

Figure 3 is a fragmentary elevation of one of the blades shown extended and at a changed angle of incidence from that of Figures 1 and 2,

Figure 4 is a view looking in the direction of the arrow 4—4 of Figure 3,

Figure 5 is a fragmentary sectional view on the line 5—5 of Figure 1, and on an enlarged scale,

Figure 6 is a fragmentary sectional view on the line 6—6 of Figure 5,

Figure 7 is a fragmentary sectional view on the line 7—7 of Figure 6,

Figure 8 is a view similar to Figure 6, certain parts being in moved relationship,

2

Figure 9 is a fragmentary sectional view on the line 9—9 of Figure 8,

Figure 10 is a fragmentary sectional view of a modification of certain elements of the invention,

Figure 11 is a fragmentary sectional view on the line 11—11 of Figure 1, and,

Figure 12 is a fragmentary side elevation of the rotor, the sections of the blades being telescoped.

Referring now to the drawings, the rotor is shown as an entirety in Figure 1, and wherein I have provided a pair of diametric telescoping blades 1 and 2, each made up of sections 3, 4, 5 and 6. The sections 3 are fixed to a hub 7 while sections 4, 5 and 6 are telescopically related. The sections 3 are provided with inwardly directed flanges at the ends thereof, as shown in Figure 11, at 8, while the section 4 has an external end flange 9. When the sections have been extended from their nested or telescoped relationship, the flanges 8 and 9 are in contact to limit further outward movement of the section 4. This flange construction is continued for the remaining sections, which is to say that the opposite end of section 4 is provided with an inwardly directed flange, while the section 5 has an external flange for cooperation with the inwardly directed flange of section 4, the opposite end of section 5 having an inwardly directed flange end section 6 having an external flange for cooperation therewith. The outermost end of section 6 is provided with a plate or flange 10 having the same profile as the outermost end of section 3. Thus, when the sections 4, 5 and 6 are nested within the section 3, the plate 10 closes the end of section 3.

The innermost end of each section 3 is provided with an attaching angle plate 11. Secured to the plate 11 is an outwardly extending stud 12. In Figure 5, this stud is shown as headed, at 13, and secured to said plate 11 by brazing, welding, or other means, so that the stud rotates when the angle of incidence of the blade is changed. The studs for each of the blades is passed through the end walls 14 and 15 of the hub casing or housing, and said hub housing has two substantially parallel side walls at 16 and 17, enclosing the end walls, and a top wall or cover 18 which overlies the side and end walls. No particular means is shown for securing the walls in working relationship. The end walls 14 and 15 are integral with a bottom wall 19, which bottom wall has a depending annular wall 20.

Adjacent each end wall 14 and 15 and surrounding the studs 12 are a pair of discs 21 and 22, formed with annular bearing races, between which races are balls 23. The said studs each carry a boss 24 provided with diametrically extending arms 25 and 26. Each stud 12 is screw-threaded at 27 to receive a nut 28 for securing a boss 24 in position of service, and in such manner that any change in the angle of incidence of the blades 1 or 2 will produce rotation of the stud and of the arms 25 and 26.

Substantially intermediately positioned between the walls 14 and 15 and extending between the sides 16 and 17 is a shaft 29. This shaft is provided with a disc type head 30, which head overlies a washer 31 which abuts the external surface of the side 16. The opposite end of the shaft is reduced in diameter, at 32, and passed through an opening in the side 17, the reduced diameter portion being externally screw-threaded at 33. Carried on the reduced diameter portion 32 are a pair of washers 34 and 35, the assembly being secured by a nut 36 received on the screw-threads 33. The construction just described, to wit, the head 30, washer 31, and the two washers 34 and 35, function as brakes to regulate rotation of the shaft 29, the degree of braking depending upon the tension imposed by the nut 36 on the shaft to bring the members 30 and 31, 34 and 35 into compressive engagement.

3

Carried on the shaft 29 is a boss 37 provided with a pair of diametric arms 38 and 39, the arms being of a length sufficient to cross the arms 25 and 26. The said boss is provided with a catch 40. Mounted on the side wall 16 by means of a pin 41 is a lever 42 provided with a detent 43 adapted to cooperate with the catch 40. In the construction shown, I have provided a spring 44 having a portion coiled about the pin 41 and secured to the wall 16 at one end thereof, while the opposite end portion of the spring underlies the lever 42 to normally swing the lever in a counter-clockwise direction, viewing Figure 6. The lever 39 is normally urged to rotate in a clockwise direction, as indicated by the arrow 45, by a coil spring 46 interposed between the base 19 and said lever. Thus, in the construction shown, if the detent 43 is lifted from the catch 40, the arms 38 and 39 will rotate in the direction of the arrow 45, and in so doing, arm 26 will be moved upwardly, thus turning the blade 1, while the arm 25 for blade 2 will be depressed, each blade, therefore, being given the same turning angle of incidence. However, movement of the arm 42 is under control, and said arm is not allowed to release the detent from the catch until the rotor has reached a selected elevation above a landing surface.

Mounted upon the shaft 29 is a spool or pulley 47. Secured to said pulley are tapes or cables 48 and 49. Each tape is fastened to a blade tip, that is, the outermost end of each tape is fastened to the section 6 adjacent the plate 10. Assuming the blades in the extended position shown in Figure 1, upon revolving the pulley, the respective tapes will wind upon the pulley and progressively retract the sections within the fixed sections 3.

Fixedly secured to the shaft 29, and adjacent one end of the pulley is a bevel gear 50. Bevel gear 50 is in mesh with the teeth of a further bevel gear 51 which directly controls the rotation of the pulley 47, under certain conditions of operation of the rotor. The annular depending portion 20 of the hub housing confines upper and lower bearing members 52 and 53 comprising pairs of races, with interposed balls therebetween. Specifically, the annular housing portion 20 is internally shouldered at 54 and 55 so as to accommodate the upper and lower outermost races. The innermost races surround a tube 56, this tube being of extended length and made up of sections as shown in Figure 1, at 57 and 58, the sections being held together in the same manner as the blade sections, which is to say, flanged internally and externally so that said sections are held in telescopic working relationship. The tube 56, together with its sections 57 and 58, carry the load shown at 59. Tube 56 is internally threaded at 60 for connection with a fitting 61, which fitting is flanged so as to overlie one of the uppermost races. Fitting 61 is externally screw-threaded at 62, and passed through said fitting is a tubular shaft 63, the bevel gear 51 being locked to the upper end of said tubular shaft. The lowermost end of said tubular shaft carries an annular disk 64 positioned within the tube 56.

A collar 65 is carried upon the tubular member 56, and supports the inner race of bearing member 53. Immediately below said collar 65 is an annular disc type race member 66 and a second annular disc type race member 67, between which race members are balls 68. The tubular member 56 is slotted at 69 to permit passage of an arm 70 therethrough, one end of said arm being pinned to a lug 71 carried by an annular disc 72 which surrounds the tubular shaft 63. The disc 72 is adapted to bear against a disc 74 which surrounds the tubular shaft 63 and is positioned between the discs 72 and 64. The disc 74 is formed of fibrous material, such as used for brakes. A bracket 75 depends from an annular portion 20 and a lever 76 is pinned thereto. One end of said lever is pinned to a lug 77 carried by the race member 66. The outermost end of said lever 76 has secured thereto a link 78, which link is passed through an opening 79 in the base 19, and then is secured to the arm 26.

4

What is termed a "safety" catch includes a nut 80 adapted to be screw-threaded to the threads 62 of the fitting 61, there being an arm 81 extending radially from said nut, and a pin 82, secured to one end of said arm 81, is passed through a guide bracket 83, the bracket being secured to the base 19. A cable 84 is secured between pin 82 and the arm 42, at 85. Thus, in the position of the parts, as viewed in Figure 6, the cable 84 is taut and the arm 42 is so held that the detent portion 43 cannot escape from the catch 40. Also secured to the arm 42 is one end of a cable 86. Cable 86 is housed in a sheathing 87, the said sheathing being centered within the tubular shaft 63 at spaced points. The centering of the sheathing may be accomplished by providing one or more roller type bearings housed in suitable race members, as shown. The cable and a part of its sheathing extends through a slot in the tubular member 56, the said cable 86 being of extended length, as shown in Figure 1, with the lowermost end thereof carrying a weight, such as a plumb bob 88.

In Figure 10, I have shown a modification of the means for braking rotation of gear 51, and wherein a bracket 89 carries a lever 90, the outermost end of the lever being linked, by means 91, to one of the arms 25 or 26, in this instance, the arm 25, while the opposite end of said lever is secured to a brake means 92, in part surrounding the hub of gear 51.

The operation, uses and advantages of the invention just described, are as follows:

Assuming that the rotor is to be used for delivering a load 59, the rotor is carried in the fuselage of the aeroplane, with the sections of the blades 1 and 2 telescoped, that is, nested together in the interest of saving space. Also, the sections 57 and 58, and a portion of the tube 56, are nested. If, at a predetermined height, the rotor with its load is released from the aeroplane, the load carrying tubes 56, 57 and 58, will move to the extended position shown in Figure 1, and the rotor will commence rotation, the blade sections being nested, as shown in Fig. 12, and at a zero angle of incidence (see Figure 2). At zero angle of incidence, the parts within the hub are in the positions shown in Figures 5, 6 and 7. The nut 80 of the "safety" catch is fully screwed upon the threads 62 so that the lever 42 has its detent engaging the catch 40 and the arms 38 and 39 are in a canted position, as shown in Figure 6, with the spring 46 compressed. Furthermore, the tapes or cables 48 and 49 are wound upon the pulley. The rotor will auto-rotate and the load will fall very rapidly. Previous determination has indicated the speed of rotation of the blades required to move the sections (under centrifugal force) outwardly from their nested telescoped position, and this is regulated by adjusting the nut 36, which effects frictional engagement between the parts 30, 31, and 34 and 35.

Assuming that auto-rotation has increased to 175 revolutions per minute, the sections 4 commence moving from the fixed sections 3, followed by movement of sections 5 outwardly from sections 4, and then the outermost sections 6 move from sections 5. All of the sections move at a definite rate, progressively, and at equal distances for each blade, this being controlled in that the outermost sections 6 are provided with plates 10, and sections 6 cannot move except as the pulley 47 rotates and allows the tapes or cables 48 and 49 to move. The end plates 10 prevent other sections from moving unevenly, the control being entirely through the sections 6 and the end plates 10, it being remembered that the end plates 10 have the same profile as the ends of the fixed sections 3. When the blades are extended with the plumb bob 88 hanging downwardly, the blades and the hub 7 are rotating, and there is no relative rotation between the gears 50 and 51. The gear 51 is mounted upon the tubular shaft 63, which is free to rotate within the tube 56; the bearings at 52 and 53, however, allow the hub housing to rotate without communicating such

5

rotation to the tube 56. In other words, the load, 59, the tube 56 and its sections 57 and 58, are non-rotating. As the hub rotates through the air, the "safety" catch will unscrew from the threads 62 and move to the position shown in Figure 8, which releases the cord or cable 84. The cord or cable 86, however, remains substantially taut, as it depends below the load 59 a certain distance and is held by the plumb bob 88, as in Figure 1. The "safety" catch assures that until the rotor is in the air and actually rotating, the detent 43 will not escape from the catch 40 to release the arm 42. As the rotor descends, a point above the ground will be reached at which the plumb bob 88 will contact the earth, as shown in Figure 1, which will immediately release tension in the cable 86 and permit the arm 42 to move from the position of Figure 6 under action of the spring 44 to the position shown in Figure 8. When this occurs, the spring 46 immediately expands to rotate the arms 38 and 39, and such rotation produces movement of the arms 25 and 26 to change the angle of incidence of the blades 1 and 2, and move the said blades from a zero angle of incidence to the angle of maximum lift, shown in Figures 3 and 4. This immediately slows the descent of both the rotor and its load. At the same time that the angle of incidence of the blades is changed, braking action occurs through the medium of the link 78 to move the plate 72 and braking disc 74 into engagement with the disc 64 carried on the end of the tubular shaft 63. This braking tends to stop rotation of the tubular shaft 63, and hence stops rotation of the gear 51. If rotation of the gear 51 is stopped, then gear 50 starts rotation by traveling around the teeth of the stationary gear 51, and in so doing, the pulley 47 is rotated, and the tapes or cables are rove thereabout to retract the sections 4, 5 and 6 of the blades within the fixed sections 3. The load is then landed and the danger of any cart-wheeling of the blades along the ground is effectively overcome.

I have thus provided a rotor which is useful for many purposes, and which assures a rapid descent for a given fall of the rotor and its load, followed by a sudden checking of the descent and a nesting of the telescoping blade sections.

It is evident from the foregoing statement that a certain sequence in operation of the rotor occurs, to wit: the rotor falls with its load at a given rate of speed, the blades being at zero angle of incidence; secondly, that when the plumb bob strikes a surface, tension on the cord 86 is released to permit mechanism within the hub to change the angle of incidence of the blades from zero to maximum lift. This change in angle of incidence increases the lift, and slows rotation of the rotor; and thirdly, the brake comes into operation and progressively functions through the bevel gears to retract the movable sections of each blade. However, this retraction is slow as the braking action has a certain amount of slippage and the blades are under load. The length of the cable or cord 86 may be determined either by calculation or by experiment and so that the free falling of the rotor may be at 100 feet per second and gradually reduced upon the plumb bob striking the earth to a fall of 25 feet per second, as a landing speed.

After the load is landed, the rotor may be made ready for re-use by maintaining a tension upon the cord or cable 86 and revolving the blades to zero angle of incidence, which will cause the detent 40 to engage the

6

catch 43. The operator turns the tube 56, which will cause the nut 80 to re-engage the threads 62, whereupon cord 86 may be released and the rotor is again ready for use.

I claim:

1. In rotor construction, a hub, blades extending from said hub, each blade including a fixed section and movable sections for telescopic reception within the fixed sections, means rockably mounting the fixed sections of each blade to the hub, a shaft within the hub, diametric arms rockably mounted on said shaft, means extending from each fixed section of the blades for engagement with said arms to be moved by said arms to vary the angle of incidence of said blades; releasable means for said arms for holding the arms in a defined position which, when released, permits the said arms to rock and engage the second named means, and means for moving said arms when said releasable means is released.

2. In rotor construction, a hub, blades extending from said hub, each blade having movable sections in telescopic engagement, a stud shaft fixed to each blade for mounting each blade to the hub, a shaft within the hub, arms carried on said second named shaft, means fixedly secured to said blades adapted to be engaged by said arms to turn the stud shafts to vary the angle of incidence of said blades from an initial zero lift position to maximum lift position, a spool carried on said second named shaft, cables on said spool and connected to the outermost sections of each blade, a bevel gear on said second named shaft, a second bevel gear rotatively mounted in the hub and in mesh with the first bevel gear, releasable means for holding the arms in one position, a brake operable to prevent rotation of the second bevel gear, means moving said arms when released by said releasable means to cause said arms to engage the first means to change the angle of incidence of the blades from zero lift to maximum lift, and a link between the brake and one of said arms to actuate said brake when the arms are moved to retard rotation of the second bevel gear, the first bevel gear having planetary motion therearound to rotate the spool and cause the cables to retract the movable sections of each blade.

3. In rotor construction, a hub, blades extending from said hub, stud shafts fixedly mounted to said blades and rotatably mounted to the hub, each stud shaft provided with a pin, a shaft within said hub, a pair of arms rockably mounted on said second named shaft, the said arms adapted to engage the said pins on the stud shafts, means for urging said arms to move against said pins and vary the angle of incidence of said blades from zero lift to maximum lift, releasable means normally preventing movement of said arms to engage the said pins, said releasable means when actuated releasing the arms for movement by said first named means to cause the said arms to engage the said pins to vary the angle of incidence of said blades.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

1,919,089	Breguet et al. ....	July 18, 1933
1,922,866	Rosenberg et al. ....	Aug. 15, 1933
2,108,245	Ash .....	Feb. 15, 1938
2,509,481	Crise .....	May 30, 1950
2,637,406	Isacco .....	May 5, 1953