The invention relates to an improved mechanism for folding rotor blades of rotary wing aircraft without injury to the control mechanism. Accordingly, an object of this invention is to provide a rotor blade mounting assembly which will permit the blade to be folded and the controls to be automatically disengaged by a simple rapid process.

Another object of this invention is to provide a hub assembly for rotary wing aircraft which automatically disengages the pitch control system when the blade is released for folding.

A further object is to provide means for folding rotor blades into a more compact space.

A further object is to provide automatic mechanism to disengage the pitch controls when the rotor blades are folded.

Another object is to provide mechanism which automatically engages the controls only when the blade is properly positioned with respect thereto.

Still another object is to provide a method of folding rotor blades which will simplify ground handling.

The foregoing, and other objects, will be obvious or pointed out in the following specification and claims.

In the drawings:

Fig. 1 is a side elevation of a helicopter with the rotor blades folded according to my invention;

Fig. 2 is a fragmentary perspective view;

Fig. 3 is a plan view showing the blade in the assembled or flight position; and

Fig. 4 is a view of Fig. 3 taken along line 4--4 with parts broken away with the blade lowered.

In my United States Patent No. 2,406,777, I have shown a method of folding the rotor blades to rest upon a jack on the tail cone of the well-known helicopter configuration of a main rotor and a torque counteracting tail rotor. The method disclosed in my patent involves two steps; releasing the rotor blade for folding and disconnecting the pitch control mechanism. When the blades are returned to the operative position the pitch control and the blade must be secured. It is the purpose of the present invention to improve upon the mechanism shown in my patent to provide a simple mounting device whereby releasing the blade for folding movement automatically disconnects the pitch control mechanism. When the blades are returned to the flight position, the pitch control mechanism is automatically engaged. This results in a material time saving which is of particular advantage aboard naval vessels where the flight deck must be cleared for further operations as rapidly as possible.

Fig. 1 shows a helicopter having a conventional configuration having a single main rotor 12 and a torque counteracting tail rotor 14. The rotor has three blades 16, 18, 20 which are shown in the position they occupy when folded according to my invention. When blade 20 overlies the tail cone the upper taper pin, to be described hereinafter, is released to allow the blade to rest on jack 22. The port and starboard blades 16, 18 are supported by slings 24 with the chord of the blade generally vertical. This provides a stabilizing support and allows the blades to lie against the tail cone, reducing the probability of damage thereto.

Referring to Figs. 2 through 4, the port blade 16 is mounted in fitting 26 which has an integral mounting cuff 28 with upper and lower sets of ears 30 parallel to the chordline of the blade. Ears 30 are adapted to mesh with ears 32 on the cuff of the sleeve 34 and have holes 36 which align with holes 38 in ears 32. Taper pins 40, 42 pass through the cooperating holes 36, 38 to hold the blade in its flight position. Pins 40, 42 are driven into a tight fit by means of a rawhide mallet and mite 44, 46 are then used to further draw up on the taper. When the upper taper pin is removed, the blade may be pivoted about the lower pin 42 which acts as a hinge, as shown in Fig. 2. Since the pins are substantially parallel to the chord of the blade, the tip of the blade may be swung down to ground level when the upper pin 40 is released. As will appear hereinafter, this feature permits of safe, easy ground handling of the blade.

Sleeve 34 is mounted on internal bearings 33, 35 which resist axial movement but permit rotation about the sleeve axis so as to change the pitch of the blade when the blade is assembled for flight. The rotational movement and position of the sleeve is controlled by the pitch control mechanism through push pull rod 59 which is actuated by the usual rotating and stationary star assembly, not shown, and is connected, by means of pin 52, to the bifurcated end of the collar arm 54. Collar arm 54 is integral with collar 56 which is mounted on bearing ring nut 37 in a conventional manner. On the upper portion of collar 56 is lug 58 which has tapered hole 60 passing therethrough. A spring loaded device 60 is mounted within aligned holes in ears 62, 64 on top of sleeve 34 and connects collar ear 62 to sleeve 34 to transmit pitch control movements to the blade.
When the upper taper pin 40 is removed and the blade is pivoted about the lower pin 42, spring 70 will move the device 66 out of engagement with the collar 58 to permit free rotation of the sleeve 34 with respect to collar 58 without "loading" the pitch mechanism.

The spring loaded device 66 comprises the central tube 74 which has a latch pin 80 slidably mounted in the left-hand end thereof (Fig. 4) and restrained from movement completely out of the housing by means of an internal shoulder 150 on tube 74 and cooperating shoulder 78 on pin 88. A latch pin 80 has a cylindrical end fixed in the right-hand end of tube 74 by a pin 81 and projects beyond tube 74 and is slidable received in the hole in ear 64. The free end of pin 80 is suitably tapered to facilitate entry thereof into the like tapered hole 60 in lug 58. Inside the tube and between the facing ends of latch pins 68 and 80 is a preloaded safety spring 82, the purpose of which will be more fully described hereinafter. Compression spring 70, outside tube 74, is positioned against a plane 72 which seats against an external annular shoulder 83 on tube 74.

As shown in Fig. 3, when the rotor is assembled the middle ear 30 on cuff 28 bears against the end of latch pin 68 and displaces it to the right. This force acting through spring 82 moves pin 80 and tube 74 to the right against the bias of spring 70 which constantly urges the device 66 into the position shown in Fig. 4. The safety spring 82 drives the latch pin 80 into operative engagement with the holes 60 in ear 58 on collar 56. As shown in Fig. 3 and 4, when the upper taper pin 40 is removed and the blade is pivoted about the lower hinge pin 42, the disengaging spring 70 moves the latch pin 80 out of engagement with the collar arm ear 58. The blade and the sleeve are now freely rotatable about the sleeve axis and, therefore, the blade may be folded back against the tail cone of the helicopter without damaging the pitch mechanism.

When the blade is returned to the flight position, the middle ear 30 moves the latch pin 68 inwardly against the force of spring 70. Should the holes 60 in the ears 64 and 58 be misaligned, the safety spring 82 will compress when latch pin 80 is unable to move into the hole in the ear 58, preventing damage to the mechanism. The taper pin 40 may be driven through the holes 38, 39 in the ears 38, 32 and the blade may then be rocked about its pitch changing axis until the holes in ears 64, 58 become aligned, at which time the spring 82 drives latch pin 80 into engagement with collar arm ear 58. As an alternative to rocking the blade about its axis, the pitch control stick may be "worked" until the collar arm becomes aligned with the sleeve and latch pin 80 is driven into engagement with tapered hole 60.

All the blades are mounted in the same manner but it will be obvious that the blade on the starboard side must be rotated in the opposite direction with respect to the direction of blade rotation of the starboard blade.

This construction permits simple, rapid, and safe ground handling of the blades during the folding process. When the taper pin 40 is removed the blade is free to pivot about hinge pin 42, allowing the blade tip to drop to a crewman within the ground. This "walks" the blade back adjacent the tail cone and places it in sling 24. This movement causes the sleeve 34 to rotate on bearings 33, 35 and will also cause further movement of the blade about hinge pin 42. Since the pitch mechanism is disengaged there is no danger of damage to the controls. Since the blade may be moved freely about the hinge pin 42 and up to the pitch changing axis the crewman can conveniently handle the blade safely, even in winds of high velocity. When the blade has been placed in the slings it is more secure and less vulnerable. It will be apparent that this device provides a convenient and simple blade folding process which precludes damage to the control system and minimizes the danger of damage to the blades.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit as defined by the following claims.

1. In a helicopter having a sustaining rotor and a body including a tail, a blade mounted on said rotor, blade support means cooperating with said tail, and means for folding blade blade to lie adjacent said tail and blade support means with its chord generally vertical including a hinge in the blade root portion having an axis generally parallel with the chord of the blade.

2. In a helicopter having a sustaining rotor and a body including a tail, in combination, three blades mounted on said rotor, pitch control means for said blades, means for folding said blades including a hinge in the blade root portion of each blade having an axis generally parallel with the chord of the blade, means for automatically releasing said pitch control means upon operation of said folding means, means controlling said blade to lie adjacent said tail and one of said blades to support said one blade over said tail cone, and means cooperating with said tail for supporting the others of said blades adjacent said tail with the chords of said blades generally vertical.

3. In a helicopter, a rotor hub, a variable pitch blade mounted on said hub, blade folding means including a hinge in the root portion of said blade, whereby a combined pivotal movement of said blade about said hinge and about the pitch varying axis of the blade enables the blade to be folded and unfolded, means for locking said hinge with said blade in flight position, manually operable means for varying the pitch of said blade including a member movable with said blade during pitch variation through a limited movement which is less than that required about said pitch varying axis in said blade folding movement, means operatively connecting said member and blade in the flight position of the latter, and mechanism operative in response to pivotal movement of said
blade for operating said connecting means to disconnect said member and blade during the latter part of the flight movement.

5. In a helicopter, a rotor hub, a variable pitch blade mounted on said hub, blade folding means including a hinge in the root portion of said blade, whereby a combined pivotal movement of said blade about said hinge and about the pitch varying axis of the blade enables the blade to be folded and unfolded, means for locking said hinge with said blade in unfolded position, manually operable means for varying the pitch of said blade including a member movable with said blade during pitch variation through a limited movement which is less than the movement required about said pitch varying axis in said blade folding movement, means operatively connecting said member and blade in the unfolded position of the latter, and mechanism operated by said blade during unfolding movement thereof for operating said connecting means to connect said member and blade.

6. In a helicopter, a rotor hub, a blade mounted on said hub for pitch changing movement about the longitudinal axis of said blade, means for moving said blade between flight position and a folded position including a hinge in the root portion of said blade having an axis transverse to said pitch changing axis, whereby pivotal movements of said blade about its pitch changing axis and about said hinge axis enable said blade to be moved between said positions, means for locking said hinge with said blade in flight position, manually operable means for changing the pitch of said blade including a member movable with said blade during pitch change through a limited range which is less than the movement required about said pitch changing axis in moving said blade between said flight and folded positions, means operatively connecting said member and blade in the flight position of the latter, and mechanism operatively responsive to folding and unfolding movements of said blade for disconnecting and connecting said member and blade.

7. In a helicopter, a rotor hub, a blade mounted on said hub for pitch changing movement about the longitudinal axis of said blade, means for moving said blade between flight position and a folded position including a hinge in the root portion of said blade having an axis transverse to said pitch changing axis, whereby pivotal movements of said blade about its pitch varying axis and about said hinge axis enable said blade to be moved between said positions, means for locking said hinge with said blade in flight position, manually operable means for changing the pitch of said blade including a member movable with said blade during pitch change through a limited range which is less than the movement required about said pitch changing axis in moving said blade between said flight and folded positions, means operatively connecting said member and blade in the flight position of the latter, and mechanism operated by said blade as the latter moves about said hinge axis during folding and unfolding movements for disconnecting and connecting said member and blade.

8. In a helicopter, a rotor hub, a blade mounted on said hub for pitch changing movement about the longitudinal axis of said blade, means for moving said blade between a flight position and a folded position including a hinge in the root portion of said blade having an axis transverse to said pitch changing axis, whereby pivotal movements of said blade about its pitch changing axis and about said hinge axis enables said blade to be moved between the aforesaid positions, means for locking said hinge with said blade in a folded position, manually operable pitch changing mechanism including a member movable with said blade during pitch change through a limited range which is less than the movement required about said pitch changing axis in moving said blade between said folded and said blade's position, means operatively connecting said member and blade in the flight position of the latter comprising a latch element constantly biased to release said member, said latch element having a portion projecting into the path of said blade in the latter is swung about said hinge axis into flight position for moving said latch element against its bias into position to connect said member and blade.

9. In a helicopter, a rotor hub, a stub shaft mounted on said hub, a blade having a root sleeve journaled on said shaft for pitch changing movement about the longitudinal axis of the blade, means for moving said blade between a flight position and a folded position including a hinge between said root sleeve and said blade having an axis transverse to said pitch changing axis, whereby pivotal movements of said blade and pivotal movements of said blade about said hinge axis enable said blade to be moved between the aforesaid positions, means for locking said hinge with said blade in flight position, manually operable pitch changing mechanism including a member journaled on said stub shaft adjacent said sleeve and movable with said sleeve during pitch change through a limited range which is less than the movement required about said pitch changing axis in moving said blade between said flight and folded positions, aligned apertures in said sleeve and member, a plunger mounted in said sleeve apertures in position to project into the aperture in said member, and means constantly biasing said plunger out of the aperture in said member, said plunger having a portion projecting into the path of said blade as the latter is swung about said hinge axis into flight position, whereby said member and said sleeve are operatively connected in the flight position of said blade.

10. In a helicopter, a rotor hub, a stub shaft mounted on said hub, a blade having a root sleeve journaled on said shaft for pitch changing movement of said blade about the longitudinal axis thereof, means for moving said blade between a flight position and a folded position including a hinge between said root sleeve and said blade having an axis transverse to said pitch changing axis, whereby pivotal movements of said blade and pivotal movements of said blade about said hinge axis enable said blade to be moved between the aforesaid positions, means for locking said hinge with said blade in flight position, manually operable pitch changing mechanism including a member journaled on said stub shaft adjacent said sleeve and movable with said sleeve during pitch change through a limited range which is less than the movement required about said pitch changing axis in moving said blade between said flight and folded positions, a plunger mounted on said sleeve in position to project into the aperture in said member and operatively connect said member and sleeve, means constantly biasing said plunger out of the aperture in said member, said plunger having a portion projecting into the path of said blade as the latter is swung about said hinge axis.
into flight position, whereby said member and sleeve are operatively connected in the flight position of said blade, said plunger including a tubular member having latch pins projecting from the inboard and outboard ends thereof, one of said pins being fixed to said tubular member and the other telescoping therewith, cooperating abutment means on said telescoping pin and tubular member for limiting the telescoping movement therebetween, and a compression spring biasing said telescoping pin in a direction to engage said abutments and project the outboard pin into the path of movement of said blade as the latter is moved about said hinge axis into flight position.

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