343-064

CROSS REFERENCE SEARCH ROOM

Nov. 11, 1969 V. J. ADAMS, JR 3,478,353

ROTOR BLADE ANTENNA INSPECTION DEVICE

Filed March 15, 1967

FIG_1

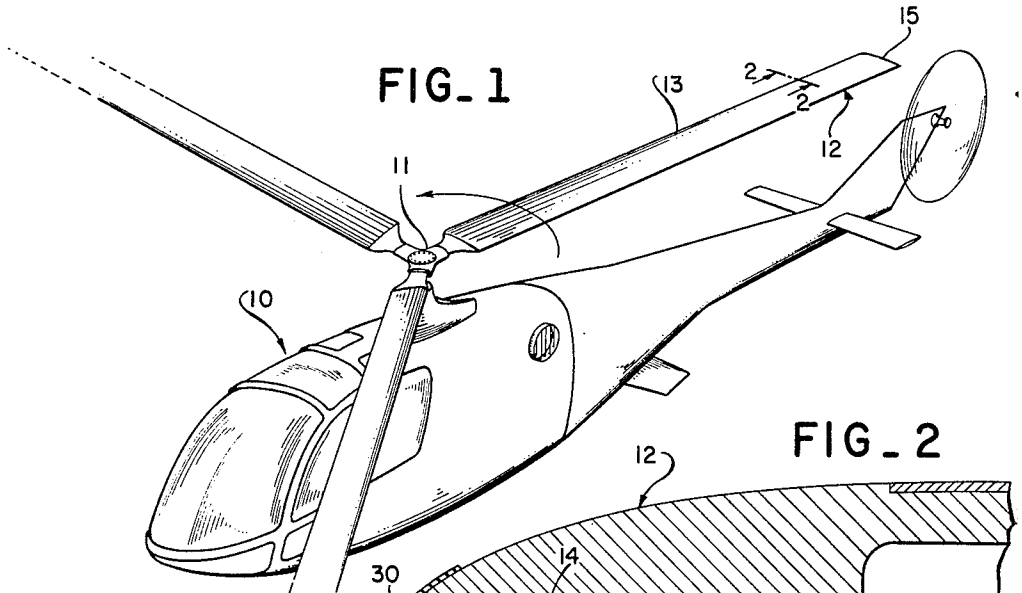
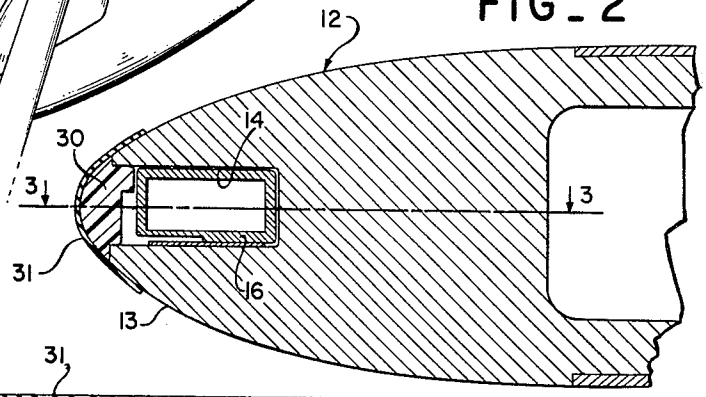



FIG_2



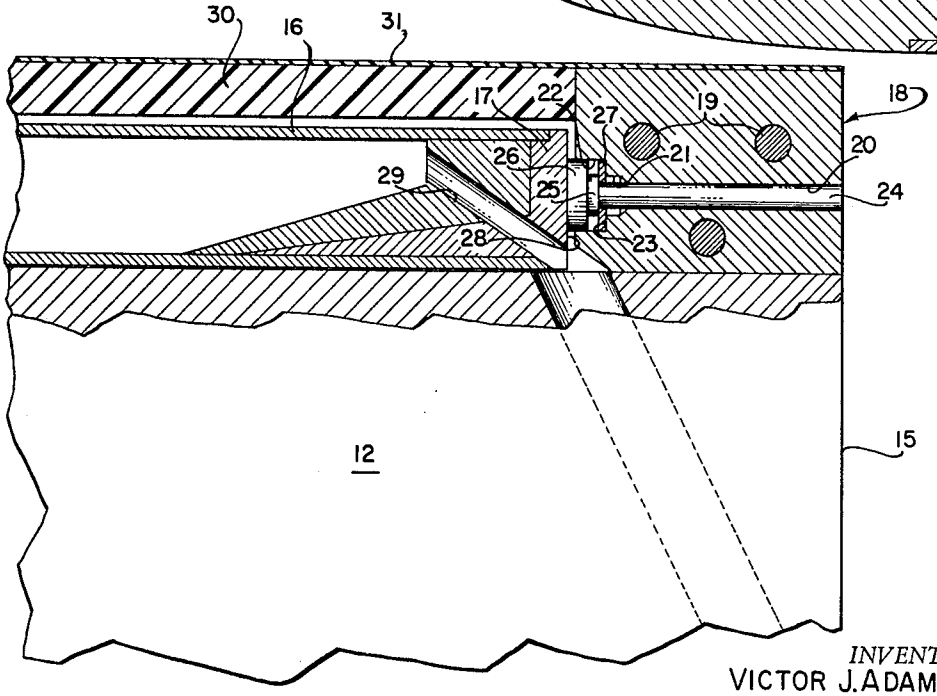




FIG_3

INVENTOR.
VICTOR J. ADAMS, JR.

BY George C. Sullivan

Agent

United States Patent Office

3,478,353

Patented Nov. 11, 1969



3,478,353

# ROTOR BLADE ANTENNA INSPECTION DEVICE

Victor J. Adams, Jr., Parsippany, N.J., assignor to Lockheed Aircraft Corporation, Burbank, Calif.

Filed Mar. 15, 1967, Ser. No. 623,311

Int. Cl. H01q 1/28

U.S. Cl. 343—708 6 Claims

## ABSTRACT OF THE DISCLOSURE

A rotor blade construction having a waveguide antenna mounted therein adjacent an end plug spaced from the antenna wherein the end plug carries a pin held by a shear disk so as to engage the antenna and detect movement thereof relative to the end plug.

This invention relates generally to inspection devices for detecting structural failures in rotating members and more particularly to an inspection device for antennas or the like mounted in helicopter rotor blades.

As described in co-pending application Ser. No. 528,425, now Patent No. 3,389,393, entitled "Low Profile Broad Band Microwave Antenna System" filed Feb. 18, 1966 in the name of David W. Young, Jr. and assigned to the same assignee, waveguide antennas may be advantageously placed in helicopter rotor blades for radiant energy transmission or reception. Such construction of rotor blades generally involves forming a groove in either or both the leading and trailing edges thereof and suitably securing a length of slotted waveguide therein such as by adhesive bonding. A fairing or cover of a material such as vinyl or synthetic rubber, or both, is then placed over the antenna and secured to the rotor blade to obtain the desired smooth aerodynamic shape.

The centrifugal force and elongation of the rotor blade as well as the vibration level in such an environment places heavy stress on the waveguide as well as the bond between the waveguide and rotor blade structure. Regular inspection of these parts is therefore essential.

An object of this invention is to provide a rotor blade construction which includes a shear disk and pin assembly responsive to centrifugal force for indicating bond failure between the blade structure and other structure such as waveguide antenna.

Another object of this invention is to provide a fail-safe mechanical inspection device for helicopter rotor blades and the like which will permit sensory inspections to be made quickly and reliably.

Still another object of this invention is to provide a mechanical inspection device for rotor blade antennas which will retain the antenna after bond failure and permit safe completion of the flight.

Further and other objects will become apparent from a reading of the following detail description wherein like numerals refer to like parts.

In the drawing:

FIGURE 1 is a generalized perspective view of a helicopter and rotor blade incorporating the teachings of the invention;

FIGURE 2 is a sectional view taken on line 2—2 of FIGURE 1; and

FIGURE 3 is a fragmentary sectional view taken on line 3—3 of FIGURE 2.

Referring to FIGURE 1, there is shown a helicopter 10 having a rotor 11 carrying a plurality of blades 12. One or more of the blades has a spanwise slot 14 of generally rectangular cross sectional shape formed therein as at the leading edge 13 thereof, as best shown in FIGURE 2. Slot 14 extends from the tip 15 inboard toward



hub 11 a distance sufficient to receive a desired length of waveguide antenna 16. The detail construction features of the waveguide are described in the above-mentioned co-pending application. It should be sufficient here to identify the antenna merely as being one of the slotted-leaky waveguide type. Antenna 16 is preferably surface bonded throughout its length to the blade structure in which slot 14 is formed so as to avoid the concentrated loads of bolts or rivets. The strength of the thin walled waveguide antenna is critical to the design and surface bonding distributes the loads over a larger area and thus helps to keep the stresses in the antenna within safe limits.

As shown in FIGURE 3, the outer end of antenna 16 is closed except for a small moisture drain hole 29 by a cap 17 specially shaped within the waveguide to provide an efficient electrical termination. Since the electrical properties of the antenna per se form no direct part of this invention, further discussion of this detail shall be avoided.

Spaced a small distance outboard from antenna cap 17 is an end plug 18 removably secured in slot 14 such as by rivets 19, as best shown in FIGURE 3. A bore 20 generally axially aligned parallel with the longitudinal axis of the waveguide antenna and blade 12 is formed through end plug 18. The inner end of bore 20 adjacent waveguide antenna 16 is counter-bored to provide dual diameter wells 21 and 22 forming an annular seat 23 therebetween. A pin 24 having dual heads 25 and 26 at the inner end thereof is slidably received in bore 20. The diameter of heads 25 and 26 is such as to be slidably received in wells 21 and 22, respectively, on axial movement of pin 24 in the outboard direction, which is to the right as viewed in FIGURE 3.

Head 26 of pin 24 is normally held against the end 17 of waveguide antenna 16 by a shear washer 27 slidably received on pin 24 and resting against seat 23. Shear washer 27, being located in well 22 between head 25 and well 21, must be sheared off before pin 24 can move outboard. The normal loads on the shear washer, due mainly to the centrifugal forces produced by the weight of pin 24, are by design of the shear washer made to be withstood without failure of the washer. However, the additional load caused by a structural failure of the antenna, allowing the latter to press hard against head 26 of pin 24, is made sufficient at normal rotor speeds to shear the shear washer. The gap 28 between antenna 16 and end plug 18 should be at least nearly equal to the thickness of shear washer 27 and the thickness of head 25 should be at least equal to the thickness of the shear washer. Then, with sufficient well depth as shown, pin 24 is caused to move outboard to indicate antenna failure.

By selecting the pin length so as to be flush with tip 15 of blade 12 and with the outboard surface of end plug 18 when retracted, it will project slightly beyond the tip if washer 27 is sheared off to provide a sensory indication of antenna failure. The centrifugal force of the rotating blade provides the necessary energy for positive actuation of the pin and the result is a very reliable pre-flight inspection device.

The efficient aerodynamic shape of the rotor blade is preferably achieved, as best shown in FIGURES 2 and 3, by use of an elongated radome 30 shaped to seat in slot 14 and provide a small cavity optimizing the antenna beam pattern. Substantially the entire leading edge 13 of the blade, including radome 30, is covered by an abrasion resistant boot 31 made of a tough, durable material such as synthetic rubber.

With antenna 16 buried inside the rotor blade, visual inspection of the antenna itself is not possible. Yet the structural condition of the antenna must be determined regularly because it not only affects the structural integ-

rity of the entire blade, but also the boresight accuracy of the radar guidance system in the aircraft.

Should the antenna structurally fail during flight, centrifugal force will cause the antenna to press hard against head **26**, shearing washer **27** and moving pin **24** outboard within the limits of gap **28**. The end of the pin thus projects beyond the tip of the blade to indicate that a failure has occurred while end plug **18** retains the antenna within the blade at least until the flight can be completed.

Only one embodiment of the invention has been shown and described for purposes of illustration rather than limitation. The device might, for example, be readily modified for remote reading or used on any type of rotating member other than a helicopter rotor. In this connection, it is to be understood that certain alterations, modifications and substitutions may be made to the disclosure without departing from the teachings of the invention as defined by the spirit and scope of the appended claims.

I claim:

**1.** In a rotor blade having a longitudinal enclosed slot formed therein, an elongate member carried in said slot, fastening means securing said member in said slot, an end plug secured in said slot and spaced from said member to form a gap therebetween whereby said member is movable by centrifugal force to close said gap on failure of said fastening means, and indicator means responsive to movement of said member closing said gap for detecting failure of said fastening means.

**2.** A device as defined in claim **1** wherein said indicator means includes a pin engaging said member for movement therewith to provide a sensory indication of said failure of said fastening means.

**3.** In a device as defined in claim **2** including structural supporting means holding said pin in a retracted position



in engagement with said member, said supporting means having the strength to withstand only forces less than the normal centrifugal force exerted by said member on failure of said fastening means.

**4.** In a device as defined in claim **2** including bore formed in said end plug and generally axially aligned with said member, said bore being counterbored to form a recessed shear seat, said pin having head means adapted to mate with said counter bore, and washer means interposed between said seat and head means for holding said pin retracted and in engagement with said member, said washer having the strength to withstand only forces less than the normal centrifugal force exerted by said member on failure of the fastening means.

**5.** A device as defined in claim **2** wherein said elongate member is a thin-walled waveguide antenna surface bonded to the wall forming said slot.

**6.** A device as defined in claim **5** wherein said waveguide antenna is recessed within the slot, and said slot is covered by a radome defining in part the external shape of said rotor blade.


**References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,666,572 | 1/1954 | Pickels | 75—548 |
| 3,389,393 | 6/1968 | Young | 343—708 |
| 3,390,393 | 6/1968 | Upton | 343—708 |



HERMAN KARL SAALBACH, Primary Examiner

F. P. BUTLER, Assistant Examiner

U.S. Cl. X.R.

116—114; 170—160.22; 244—17.11; 343—872, 762