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Demonstration of Collective and Cyclic Pitch Control of Helicopter Swash Plate

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***Abstract**: As in case of Aircrafts the control surfaces helps the aircrafts in maneuvering. Where as in Helicopters swash plates does the work of control surfaces. Helicopters are the one of the most complex machines present in the world. With advancement in technology it becomes a need to reduce complexity and weight of this machine. The purpose of the swash plate is to convert stationary control inputs from the pilot into rotating inputs which can be connected to the rotor blades or control surfaces. The conventional Swash plates are bulky and becomes a major problem for aerodynamics of helicopters. In this paper a design of swash plate is discussed. In major it consists of two main parts: stationary plate and a rotating plate.The whole assembly is placed inside the main rotor mast (which is hollow from inside) and connected to the cyclic and collective controls by a series of push rods. The whole assembly is not connected to the rotor mast at any point and can tilt in all directions and move vertically. The rotating swash plate is mounted to the stationary swash plate by means of a thrust bearing. It is connected to the rotor blades by drive links and must rotate in constant relationship with the rotor blades. Both swash plates tilt and slide up and down as one unit. A tap is introduced to keep both the plates and bearing intact.*

Keywords: Rotor Mast, Push Rods, Thrust Bearing

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1. Introduction

Blade feathering, or pitch change, could be achieved in various ways. The use of aerodynamic servo tabs, auxiliary rotors, fluidically controlled jet flaps, or pitch links from a control gyro as possible methods. The widely adopted method, however, is through a swash plate system.

The stationary swash plate is mounted inside the main rotor mast and connected to the cyclic and collective controls by a series of pushrods. It is restrained from rotating by an ant drive link but can tilt in all directions and move vertically. The rotating swashplate is mounted to the stationary swashplate by means of a uniball sleeve. It is connected to the mast by drive links and must rotate in constant relationship with the main rotor mast. Both swashplates tilt and slide up and down as one unit. The rotating swashplate is connected to the pitch horns by the pitch links.

2. Literature Review

A Swash plate assembly according to the present invention includes a rotationally stationary Swash plate and rotational swashplate which rotates relative to the rotationally station ary Swashplate through a bearing system. The bearing system includes a duplex bearing which need not increase to accommodate bolt or expandable pin removal as typical of conventional systems. Such a bearing system provides for an uncomplicated and lightweight arrangement. Each servo control rod is attached to the Swashplate assembly to communicate control inputs thereto through a respective servo lug. Each servo lug defines a servo pivot point off an in-line plane inboard of the bearing system. As the servo lugs extend below the rotationally stationary Swashplate, a relatively uncomplicated attachment arrangement is facilitated as compared to a more conventional trunnion attachment. Attachment is provided by a servo lug fastener Such as bolted connection. Such attachment facilitates for redundant locking features at a highly inspectable location which simplifies maintenance and increases safety.

Each pitch control rod is attached to the rotational swashplate assembly to communicate pitch commands to a respective rotor blade assembly through a respective pitch lug which defines a rotor pitch control point. The rotor pitch control point as defined by the rotational Swashplate is located on the in-line plane which passes through the central pivot point.

By locating the servo pivot point just inboard of the bearing system, an exceeding compact load path is defined thereby. The load path is defined from the servo control rod, to the servo lug, through the rotationally stationary Swash plate, bearing system, the rotational Swash plate, the rotor pitch control point and into the pitch control rod. The present invention therefore provides an uncomplicated, short load path Swash plate assembly which provides the desired compactness.[1]

Accordingly, it is an object of this invention to provide a swash plate control system that provides a better control over rotor blade positioning under different operating conditions than obtainable with prior art swash plate control systems. It is another object of the invention to provide such a swashplate control system that decouples lateral and longitudinal cyclic inputs to the swashplate without requiring the use of a mixer box. It is a further object of the invention to provide such a swashplate control system which provides direct, linear read-out of lateral cyclic, longitudinal cyclic and collective swashplate positions. It is still another object of the invention to provide such a swashplate control system that returns the swashplate to a zero collective position rapidly when desired. The attainment of these and related objects may be achieved through use of the novel swashplate control system herein disclosed.

A swashplate control system in accordance with this invention has a first gimbal ring pivotally mounted along a longitudinal axis. A second gimbal ring is pivotally attached to the first gimbal ring along a lateral axis. A first linear actuator is connected to pivot the first gimbal ring along the longitudinal axis. A second linear actuator is connected to pivot the second gimbal ring along the lateral axis. One of the first and second linear actuators is mounted on one of the first and second gimbal rings. A swashplate is rotatably mounted on one of the first and second gimbal rings. A swashplate control system constructed in accordance with this invention makes the longitudinal and lateral cyclic inputs to the swashplate truly independent of one another, so that these inputs are decoupled from each other without use of a mixer box [2].

3. Parts and Working

Major parts of a Swashplate

- Rotating plate
- Stationary Plate
- Tap
- Lugs
- Bearing

COLLECTIVE PITCH

This input (θ_o) increases the main rotor blade pitch angles by the same amount, and, therefore this changes the magnitude of rotor thrust. The collective is changed by a lever that is held in the pilot’s left hand, with an upward pulling motion required for a increase in thrust. Increasing collective pitch also requires an increase in power. On some helicopters this requires pilot to open a throttle (increasing fuel flow to the engine), which is operated by a twist grip at the end of the collective lever. However, on most helicopters the fuel-flow is controlled by an engine governor, which automatically maintains rotor rpm at the regulated value as rotor torque required increases or decreases [3].

CYCLIC PITCH

These inputs impart a once-per-revolution cyclic pitch change to the blades. Lateral cyclic (θ_{1c}) is applied such that the rotor disk can be tilted left and right. This changes the orientation of the rotor-thrust vector producing both a side force and a rolling moment about the center of gravity of the helicopter. Longitudinal cyclic (θ_{1s}) imparts a once-per-revolution cyclic pitch change to the blades such that the rotor disk can be tilted fore and aft. Like the lateral cyclic, this changes the orientation of the rotor thrust vector, in this case producing both a longitudinal force and pitching moment. Both lateral and longitudinal cyclic are controlled by the pilot using a cyclic stick which is held in the pilot’s right hand [3].

A helicopter's main rotor is the most important part of the vehicle. It provides the lift that allows the helicopter to fly, as well as the control that allows the helicopter to move laterally, make turns and change altitude. To handle all of these tasks, the rotor must first be incredibly strong. It must also be able to adjust the angle of the rotor blades with each revolution they make. The pilot communicates these adjustments through a device known as the swashplate assembly.

The swashplate assembly consists of two parts -- the upper and lower swashplates. The upper swashplate connects to the mast, or rotor shaft, through special linkages. As the engine turns the rotor shaft, it also turns the upper swashplate and the rotor blade system. This system includes blade grips, which connect the blades to a hub. Control rods from the upper swashplate have a connection point on the blades, making it possible to transfer movements of the upper swashplate to the blades [4].

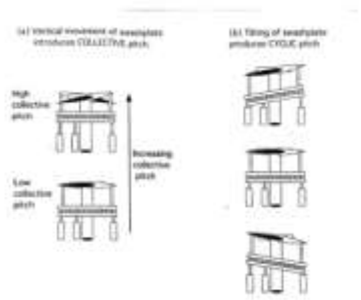
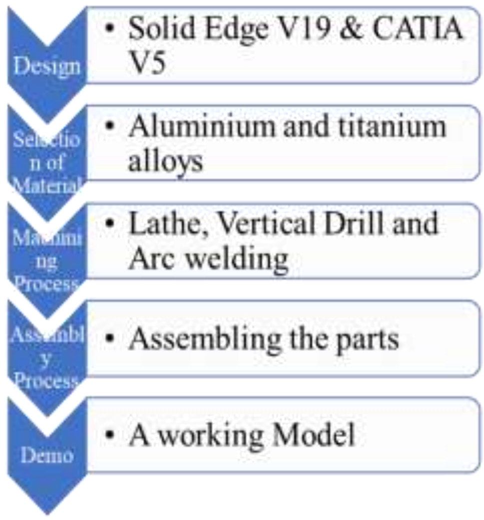


Figure 1: Collective and cyclic pitch representation [3]

4. Methodology



The above methodology was followed for the fabrication of swashplate. The design was prepared in Solid edge V19 and CATIA V5. Generally the aluminium and titanium alloys are used for the fabrication because of there high strength to weight ratio. The machines used for machining operations are lathe machines, Vertical drill machine and arc welding. Individual parts were fabricated seperately. After fabrication of parts, those were assembled to get a swashplate assembly. A working model was prepared and a animation of moving parts in CATIA V5.

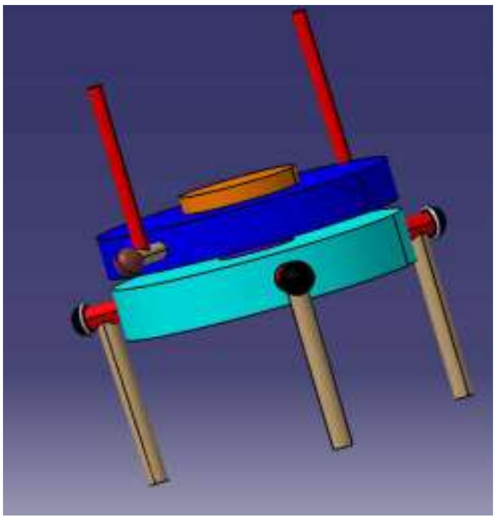


Figure 2: View of an Assembled Swashplate

5. RESULTS AND DISCUSSION

The pitch control mechanism plays an important role for the maneuvering of helicopter. In conventional swashplates there are large aerodynamic losses, since the swashplates are placed over the rotor mast. The inner swashplate mechanism fabricated above solves the problem of aerodynamic obstruction faced in conventional swashplates as it is placed inside the rotor mast. The conventional swashplates are heavy and bulky, whereas the inner swashplate are compact and light-weight. But as of now the inner swashplates can not be used for bigger size helicopters. There is lot of vibration on the swash plate and load bearing capacity is low since it is not mounted on a solid still structure.

6. CONCLUSION

By the process of machining the swashplate model was fabricated using the design. The swashplate is compact, rigid and light weight. It completes the function of a swashplate and gives more aerodynamic characteristics to helicopter compared to conventional type. It is the mechanism to control the pitch of main rotor blades used in the Ultra-light helicopters.

7. REFERENCES

1 David N. Schmaling, Southbury. Statestal. (US); Michael R. Robbins, Guilford, Frank P. D'Anna, Seymou “Compact load path swashplate assembly” Patent No.: US 8,142,158 B2 Date of Patent: Mar. 27, 2012

2 Richard J. Peyran, Palo Alto; GeorgeneH. Laub; H. Andrew Morse “Swashplate control system” Patent No.: 4,669,958 45 Date of Patent: Jun. 2, 1987

3 J. Gordon Leishman, Principles of Helicopter Aerodynamics, Cambridge University Press, 2002.

4 Assembly and operating manual by Mosquito helicopter Rev. 4, Dec 2012