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(54) Multi-axis hand operated controller for aircraft

(57) The present invention provides a multi-axis hand operated controller for a helicopter or other aircraft and includes a generally cylindrical hand grip (2) mounted with its major axis extending generally parallel to the pitch axis of the aircraft when in a neutral position, a forearm rest (3) associated with the hand grip and extending generally parallel to the aircraft roll axis, a first transducer (12) for generating pitch control signals when the hand grip is urged in the aircraft roll axis direction, a second transducer (7) for generating roll control signals when the hand grip is urged to rotate about an axis which is generally parallel to the aircraft roll axis, and a third transducer (10) for generating vertical control signals when the hand grip is urged to rotate about its major axis.

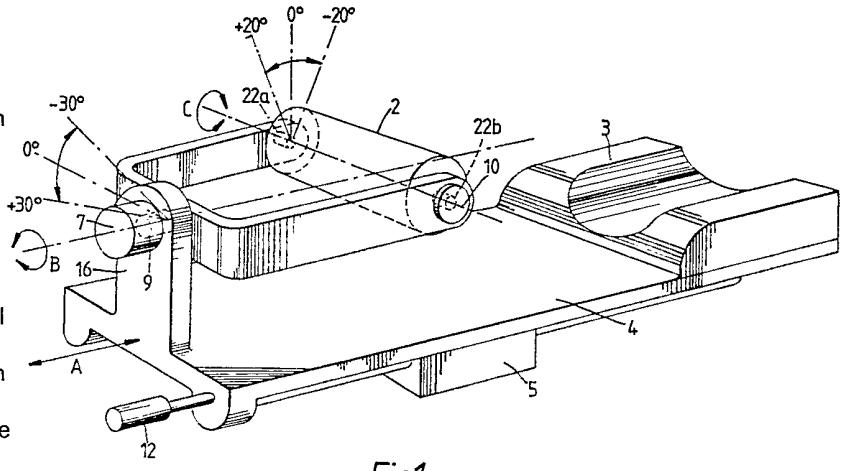

Fig.1.

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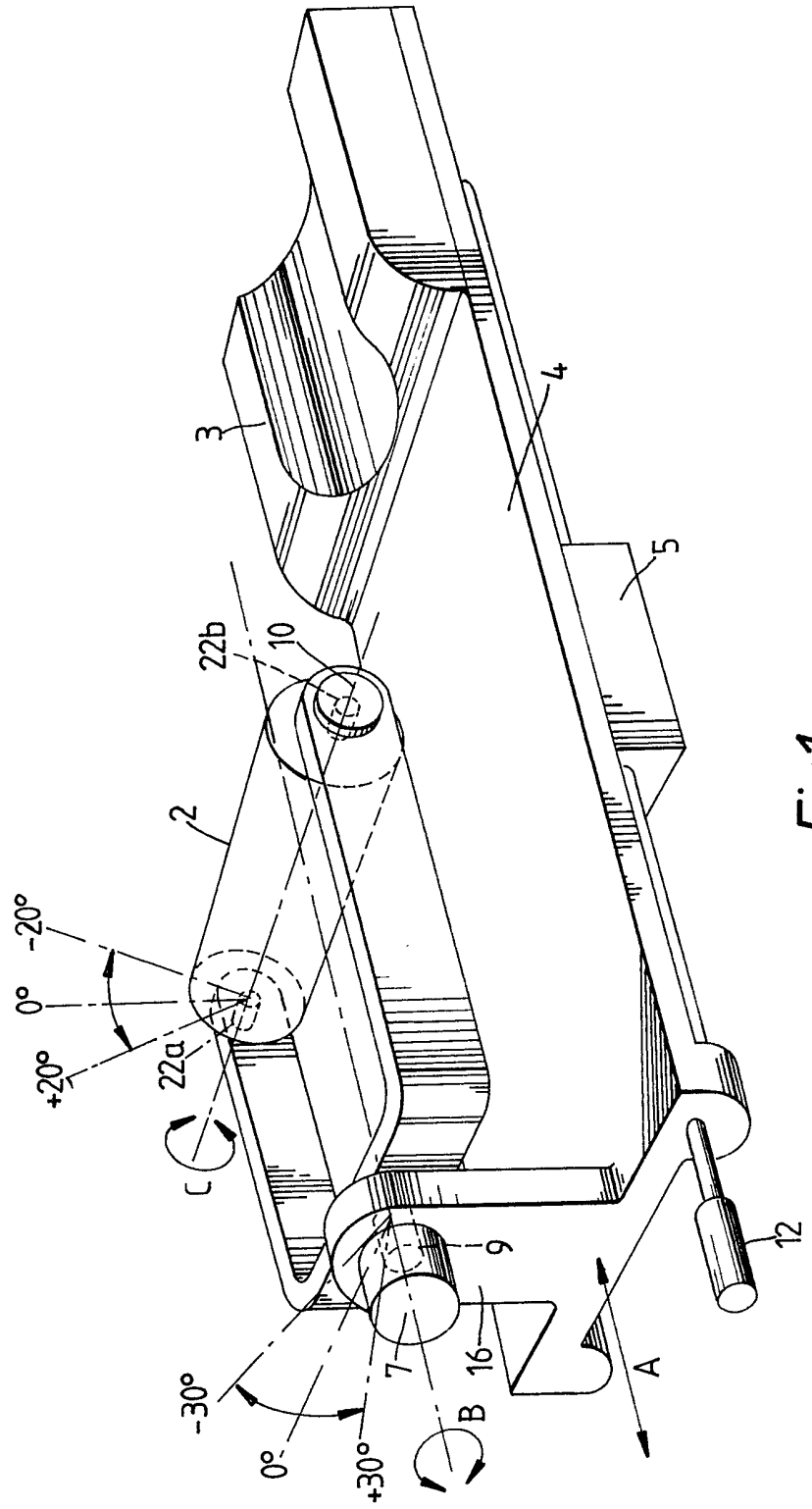

Fig.1.

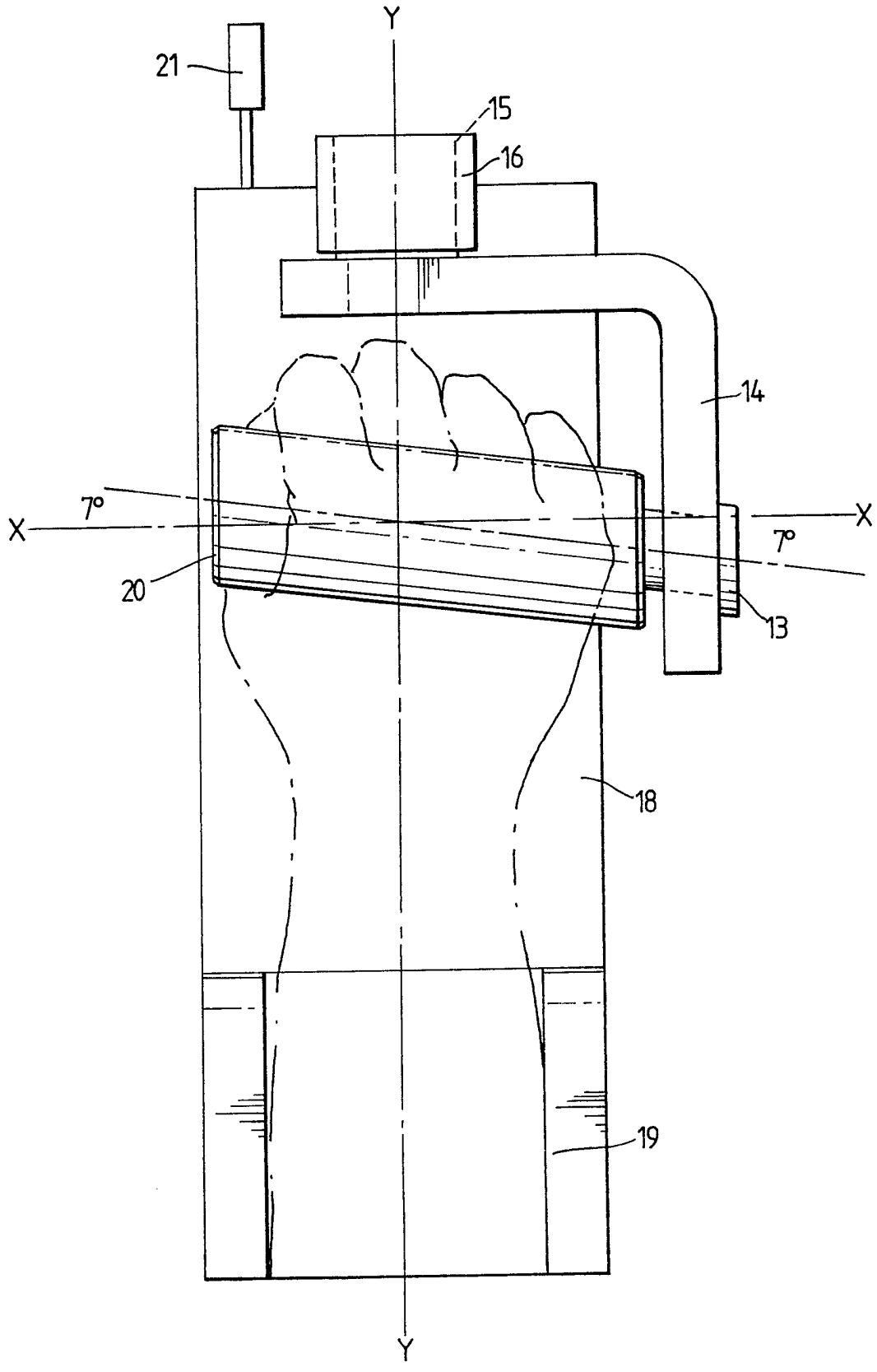

Fig.2.

SPECIFICATION

Multi-axis hand operated controller for aircraft

The present invention relates to a multi-axis hand operated controller for controlling aircraft motion.

The invention particularly relates to controllers for aircraft flight control systems in which electrical or optical signals are carried by wire or optical fibre to control surface actuators, and particularly, though not exclusively, relates to helicopter flight control.

Present fly-by-wire wing aircraft control systems employ force-feel or displacement joystick controllers which have fore-and-aft and transverse axes of motion. An advantage of a fly-by-wire system compared with a system which employs mechanical linkages between, for example, the jockstick and flight controls, is that a wider choice of location of the hand controls is possible so that control ergonomics may be improved. There are a number of disadvantages associated with joystick controllers particularly if use in helicopters is contemplated. The fore-and-aft and transverse axes are provided for pitch and roll control, and a third axis is required for vertical collective control. The latter may be achieved by employing a twist grip on the joystick handle. It has been found that such twist grips are not satisfactory because their sense of operation is not easily or naturally acquired and the wrist motion required gives rise to pilot fatigue. Vertically slideable joystick handles have been proposed for vertical collective control but is has been found that they are susceptable to helicopter vibrations and vertical forces imposed during various flight manoeuvres.

A multi-axis hand-operated controller for a helicopter is described in 'Aviation Week and Space Technology' published 2 May 1983 by McGraw-Hill, Inc, USA, on pages 74-79 under the title 'Sikorsky Pursues Sidearm Controls in Cockpit Design'. The controller, termed a sidearm controller uses four-axis control and has a cylindrical handgrip with its major axis substantially parallel to the fore-and-aft axis of the helicopter. The inputs are as follows:

1. Forward/back pressure to control pitch.
2. Right/left side pressure for roll.
3. Twist for yaw.
4. Up/down for vertical collective control.

The present invention provides a multi-axis hand operated controller which avoids coupling problems such as for example a twist couple inadvertently introduced by a fore-and-aft movement of the arm.

According to the present invention a multi-axis hand operated controller for an aircraft includes a generally cylindrical hand grip mounted with its major axis extending generally parallel to the pitch axis of the aircraft when in a neutral position, a forearm rest associated with the hand grip and extending generally parallel to the aircraft roll axis, a first transducer for generating pitch control signals when the hand grip is urged in the aircraft roll axis direction, a second transducer for generating roll control signals when the hand grip is urged to rotate about an axis which is generally parallel to the aircraft roll axis, and a third transducer for generating vertical control signals when the hand grip is urged to rotate about its major axis.

The transducers may comprise force transducers or may be displacement transducers. The control signals may be electrical or optical.

The handgrip may be mounted for true linear movement along the roll axis or for large diameter arcuate movement which approximates over a small arc to linear movement along the roll axis.

The forearm rest may be fixed relative to the aircraft or may be mounted to pivot or slide along the aircraft roll axis to facilitate movement of the hand grip without the introduction of undesired cross coupling.

Two embodiments of the invention will now be described, by way of example only, with reference to the drawings of which:

Figure 1 is a perspective view of a multi-axis hand operated controller for a helicopter;

Figure 2 is a plan view of another multi-axis hand operated controller.

The embodiments are intended for helicopters with fly-by-wire control systems (not shown).

The controller shown in Figure 1 is mounted in a helicopter (not shown) and includes a rigid body 4 which carries an arm rest 3 at the other end. A pillar 6 carries a transducer 7 which is coupled to a U-shaped member 8 by a short cylindrical shaft 9. The shaft is mounted near the top of the pillar for rotation about an axis QB' which is parallel to the roll axis of the helicopter. The transducer 7 produces an electrical output in response to rotational displacements in a clockwise or anticlockwise direction of the member 8 about the axis 'B'. The member 8 is free to rotate through an arc of 60° as shown in Figure 1.

A cylindrical hand grip 2 is rotatably mounted on stub axles 22*a*, 22*b* between arms of the U-shaped member 8 for rotation about the major axis 'C' of the hand grip, the axis 'C' being normal to the axis B. The member 8 carries a transducer 10 which is coupled to the hand grip via axle 22*b* and produces an electrical output in response to rotational displacements of the hand grip about the C axis. As indicated in Figure 1 the hand grip 2 is free to rotate through an arc of 40°.

The body 4 is slidably mounted on a grooved carriage 5 fixed to the helicopter so that the body 4 is free to move in direction 'A' parallel to the roll axis of the helicopter. A linear displacement transducer 12 fixed to the helicopter produces an electrical output in response to linear displacement of the body 4 in the direction 'A'.

In operation, when the embodiment of Figure 1 is pushed backwards or forwards in the direction 'A' so as to slide along the carriage 5, a corresponding electrical signal is produced by the transducer 12 which comprises a helicopter pitch cyclic signal. A turning motion of the pilot's wrist produces rotation of the hand grip about the 'B' axis and a corresponding electrical signal is produced by the transducer 7 which comprises a helicopter roll signal. When the pilot twists the hand grip

about the axis C a corresponding electrical signal is produced by the transducer 10 which comprises a helicopter collective control signal for ascent or descent.

Figure 2 shows a second embodiment of the invention having a body 18, a arm rest 19, a pillar 16, a hand grip 20, and transducers 13, 15 and 21, which are generally similar in design and function to body 4, arm rest 3, pillar 6, hand grip 2, and transducers 10, 7 and 12, respectively, of the embodiment of Figure 1. The embodiment of Figure 2 has however a simpler, L-shaped member 14, which has the same function as the U-shaped member 8 of Figure 1, and the hand grip 20 is mounted with its axis at 7° to the pitch axis X of the helicopter in which the controller is mounted. As shown in Figure 2 the controller is for right hand operation. The inclination of the grip axis and the position of the member 14 would be reversed (i.e. as if rotated by 180° about the Y axis shown in Figure 2,) for a controller for left hand operation. It has been found that by inclining the hand grip axis at a small angle, preferably about 7°, to the pitch axis, there is less pilot fatigue during prolonged operation of the controller and the possibility of unintentional cross-coupling between axes is minimised.

The embodiments described above has been described by way of example only, and many variations thereof within the scope of the present invention will be apparent to those skilled in the art. For example, the transducers may output light, rather than electrical signals, for a fly-by-light control system. Further, in each of the control axes there may be trimmers as is conventional in other aircraft controllers.

CLAIMS

1. A multi-axis hand operated controller for an aircraft including a generally cylindrical hand grip mounted with its major axis extending generally parallel to the pitch axis of the aircraft when in a neutral position, a forearm rest associated with the hand grip and extending generally parallel to the aircraft roll axis, a first transducer for generating pitch control signals when the hand grip is urged in the aircraft roll axis direction a second transducer for generating roll control signals when the hand grip is urged to rotate about an axis which is generally parallel to the aircraft roll axis, and a third transducer for generating vertical control signals when the hand grip is urged to rotate about its major axis.

2. A controller as claimed in claim 1 wherein the transducers comprise force transducers.

3. A controller as claimed in claim 1 wherein the transducers comprise displacement tranducers.

4. A controller as claimed in claim 2 or claim 3 wherein the transducers generate electrical control signals.

5. A controller was claimed in claim 2 or claim 3 wherein the transducers generate optical control signals.

6. A controller as claimed in claim 1 wherein the hand grip is mounted for linear movement along the aircraft roll axis.

7. A controller as claimed in any of claims 1 to 5 wherein the hand grip is mounted for large diameter arcuate movement which approximates over a small arc to linear movement along the aircraft roll axis.

8. A controller as claimed in any of the preceding claims wherein the forearm rest is fixed relative to the aircraft.

9. A controller as claimed in any of claims 1 to 7 wherein the forearm rest is mounted to slide along the aircraft roll axis to facilitate movement of the hand grip without the introduction of cross coupling.

10. A controller as claimed in claim 8 or 9 wherein the forearm rest has a groove in the upper surface thereof for receiving the forearm and wherein the groove extends parallel to the aircraft roll axis.

11. A controller substantially as claimed herein with reference to the drawings.

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