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(54) Actuator for converting rotary to oscillatory motion

(57) An actuator for providing a wrist joint in a prosthetic or robotic limb including a hand member 10 angularly movable relative to a forearm portion 6 about an axis AA, comprises a rotatable shaft 34 mounted on the portion 6 and having a cam 32 obliquely skewed to the shaft axis. The cam surface 41 is engaged at diametrically opposed positions by two hemispherical cam followers 42, 44 mounted on a transverse base member 45 of the hand member 10. The axis of shaft 34, the pivot axis AA and the line joining the centres of curvature of the two cam followers 42, 44 intersect at a common point.

Fig.1.

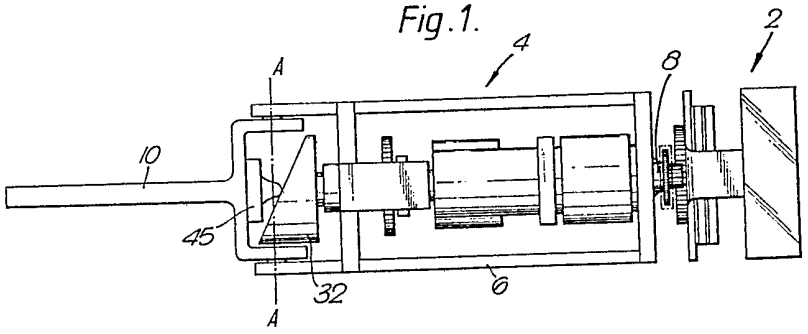
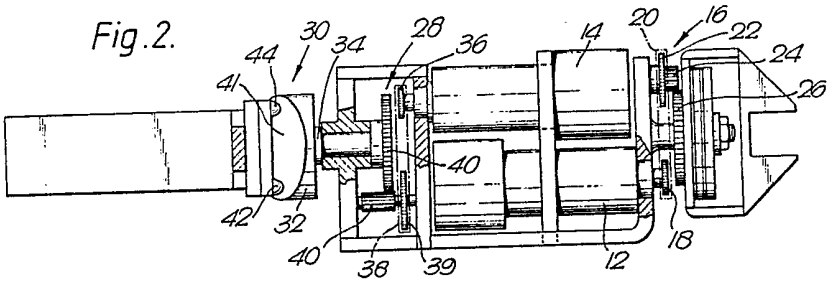


Fig.2.



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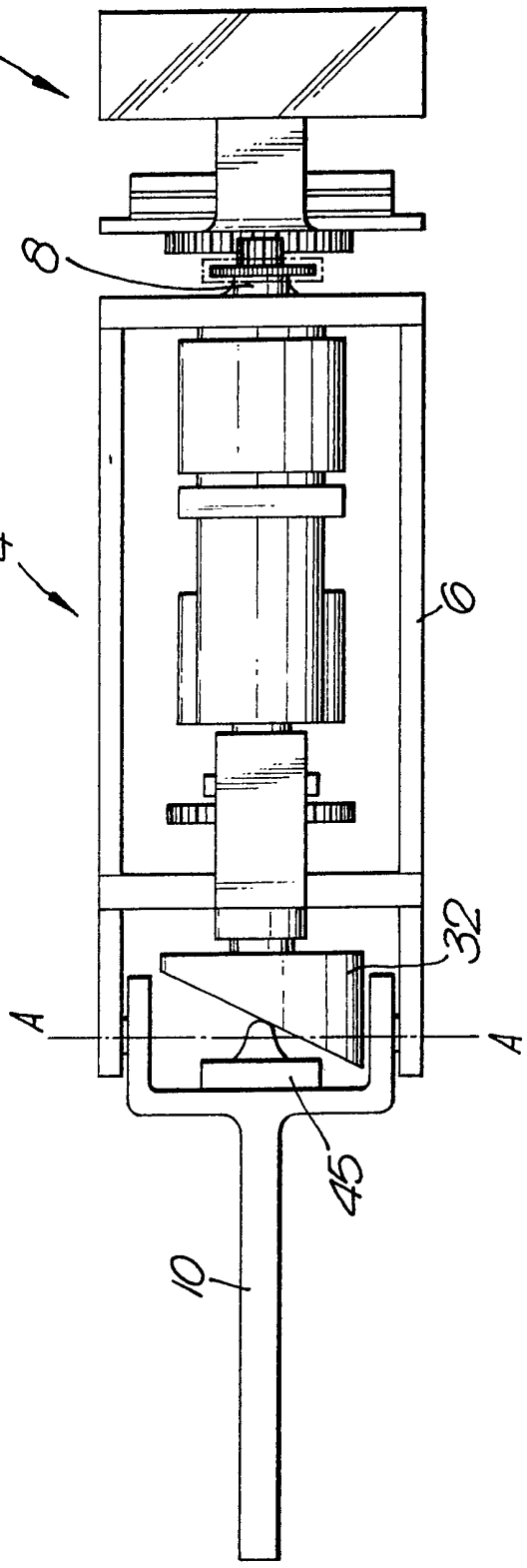


Fig. 1.

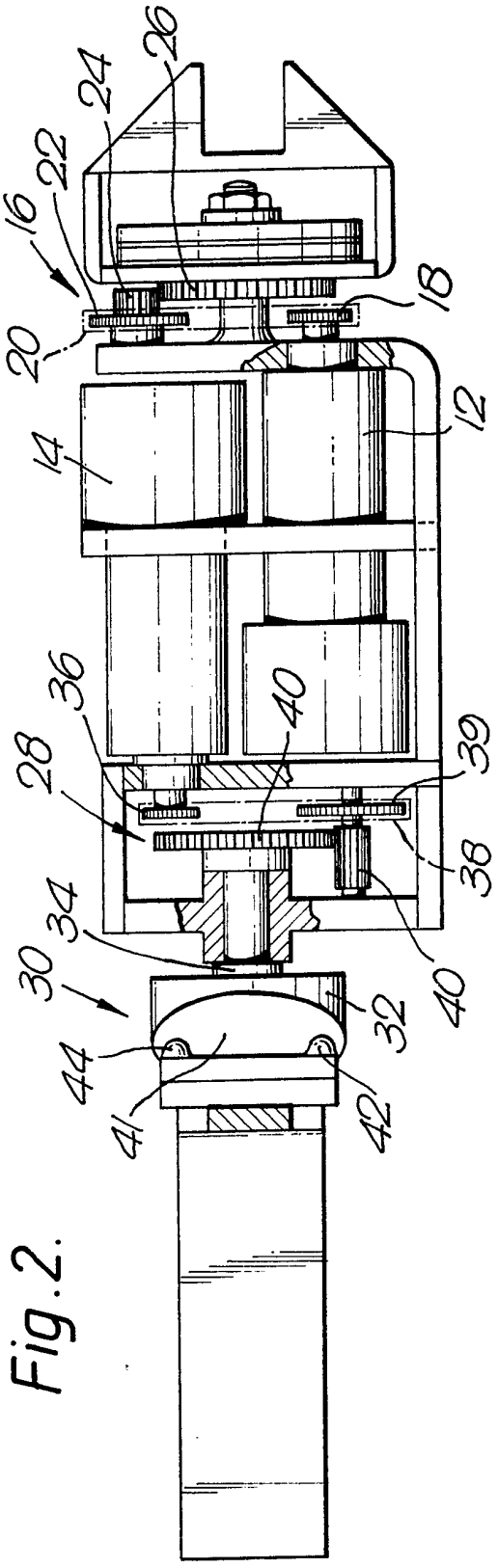
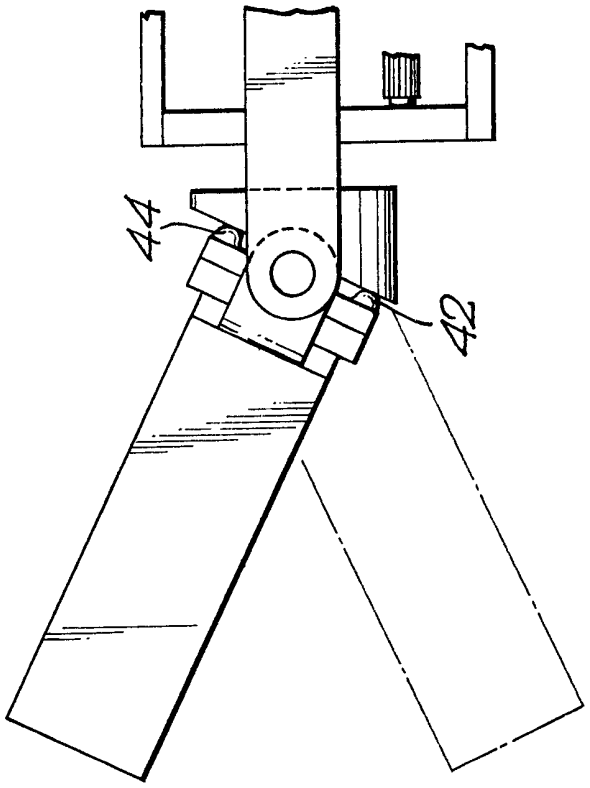


Fig. 2.

Fig. 3.



SPECIFICATION

Actuator

This invention relates to an actuator suitable for use as a joint in a prosthetic or robotic limb.

According to the invention there is provided an actuator for angularly moving an output member relative to a base member about a first axis, comprising an input member supported by the base member for angular movement about a second axis transverse to the first axis, the input member having a cam track obliquely skew to the second axis, a cam follower engaging the cam surface, the cam follower being mounted on the output member in a position spaced from the first axis, means acting on the output member for holding the cam follower in engagement with the cam track and means for turning the input member to positions corresponding to required angular positions of the output member.

In a preferred embodiment the means for holding the cam follower in engagement with the cam track comprise a second cam follower, on the opposite sides of the first axis to the first cam follower, engaging a second cam track on the input member. Preferably the first and second cam tracks together form a continuous circuit around the second axis and the cam followers are equally spaced from the first axis.

When two cam followers are used each cam follower may have a cam-track-engaging element of circular curvature and wherein the line joining the centres of the two elements, and the first and second axes all intersect at a common point. The cam track may lie in a plane oblique to the second axis and spaced from the point of intersection by a distance equal to the radius of the said elements.

The base member of the actuator may be supported by a mounting member for turning movement relative to the mounting member about an axis substantially parallel to the second axis, means being provided for turning the base member and hence the actuator to required positions about the mounting member.

The invention will now be further described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a plan view of part of a prosthetic or robotic limb incorporating the actuator;

Figure 2 is a partially cut-away side elevation of the part of the limb shown in Figure 1;

Figure 3 is a more detailed side elevation of the wrist portion of the limb.

The part of the limb illustrated in the drawings comprises an elbow portion 2 and a lower arm portion generally indicated as 4. The lower arm portion 4 comprises a base member formed by a forearm frame 6. From the upper end of the forearm frame 6 projects a shaft 8 which is journalled, by means of two ball bearings and a thrust bearing, in the elbow portion 2.

On the lower end of the forearm frame is pivotally mounted a lever or hand member 10.

Within the forearm frame 6 are mounted two bidirectional DC motors 12 and 14. The first motor 12 serves to turn the forearm frame 6 and hence the complete lower arm portion 4 with respect to the elbow portion 2 about the axis of the shaft 8. The motor 12 drives the frame through a speed reducer 16, which comprises a smaller toothed pulley 18 on the output shaft of the motor 12, a toothed belt 20, a larger pulley 22, a pinion 24 mounted on the same shaft as the pulley 22, and a spur gear wheel 26 meshed with the pinion 24 and fixed to the elbow portion 6, coaxial with the shaft 8. The shaft on which the second pulley 22 and pinion 24 are mounted is journalled via a radial ball race bearing, in the end of the forearm frame 6.

When the motor 12 is operated the pinion 24 rotates and orbits the fixed spur 26, causing the lower arm portion 4 to turn with respect to the elbow portion 2.

The second motor 14 enables the hand member 10 to be angularly displaced in the plane of Figures 2 and 3 about the pivot axis. The motor 14 acts on the member 10 through reduction gearing 28 and thence through a cam mechanism 30. The cam mechanism 30 includes a cam 32 on a shaft 34 journalled by means of two ball bearings (not shown) in the forearm frame 6. The motor 14 when operated, drives the cam from a small toothed pulley 36 on the motor shaft through a toothed belt 38 to a larger toothed pulley 39, which in turn drives a pinion 40 meshing with a spur wheel 40 mounted on the shaft 34 of the cam 32.

The cam 32 has a plane cam surface 41 inclined obliquely to the axis about which the cam member 32 may be turned. The cam surface 41 is engaged at diametrically opposed positions by two hemispherical cam followers 42, 44 mounted on a transverse base member 45 of the hand member 10. In an alternative embodiment rolling balls may be used instead of fixed cam followers. The axis of the cam shaft 34, the pivot axis AA of the hand member 10 and the line joining the centres of curvature of the two cam followers 42, 44 intersect at a common point. Thus the line joining the centres is spaced from the points of contact of the cam followers on the cam surface by a distance equal to the radius of the cam followers.

The pivot axis AA is perpendicular to the axis of the cam shaft and to the line joining the centres of the cam followers.

The cam 32 forms the input member of the wrist mechanism and the hand member 10 its output member; when the former is turned the latter is angularly displaced about its pivot axis AA. When the input member turns, for example from the central position shown in Figure 2 one of the cam followers is pushed and causes the hand member 10 to pivot about the axis AA, and the second cam follower 44 on the opposite side of the axis AA to the first cam follower 42, is maintained in engagement with the cam surface 41. When the cam member 32 is turned further in the same direction, or turned in the opposite direction, the second cam follower 44 is pushed and the hand member 10 pivots towards its central position.

The elbow portion 2 may be fixed to an upper arm

member through gearing which enables the elbow portion 2, and hence the lower arm portion 4 to be moved up and down in one plane; the upper arm member may be connected to a shoulder unit which mimics the rotation of an arm about a shoulder.

When the arm is used as a prosthetic device the user may control the various movements available by operating switches to turn the motors on and off. Computer-assisted techniques may also be used, for example, to keep the hand member 10 at the same angle in space when joints higher up the arm are moved. When the arm is used for robotic purposes its movements will be preprogrammed.

CLAIMS

1. An actuator for angularly moving an output member relative to a base member about a first axis, comprising an input member supported by the base member for angular movement about a second axis transverse to the first axis, the input member having a cam track obliquely skew to the second axis, a cam follower engaging the cam surface, the cam follower being mounted on the output member in a position spaced from the first axis, means acting on the output member for holding the cam follower in engagement with the cam track and means for turning the input member to positions corresponding to required angular positions of the output member.

2. An actuator as claimed in claim 1 wherein the means for holding the cam follower in engagement with the cam track comprise a second cam follower, on the opposite side of the first axis to the first cam follower, engaging a second cam track on the input member.

3. An actuator as claimed in claim 2 wherein the first and second cam tracks together form a continuous circuit around the second axis and the cam followers are equally spaced from the first axis.

4. An actuator as claimed in claim 2 or claim 3 wherein each cam follower includes a cam track engaging element of circular curvature and wherein the line joining the centres of curvature of the two elements, and the first and second axes, all intersect at a common point.

5. An actuator as claimed in claim 4 wherein the cam track engaging elements are rolling balls.

6. An actuator as claimed in claim 4 or claim 5 wherein the cam track lies in a plane oblique to the second axis and spaced from the point of intersection by a distance equal to the radius of the said elements.

7. An actuator as claimed in any preceding claim wherein the base member is supported by a mounting member for turning movement relative to the mounting member about an axis substantially parallel to the second axis, means being provided for turning the base member and hence the actuator to required positions about the mounting member.

8. An actuator for angularly moving an output member relative to a base member about a first axis by means including a cam and cam-follower mechanism, said cam and cam-follower mechanism being substantially as hereinbefore described with reference to the accompanying drawings.

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