(12) UK Patent Application (19) GB (11) 2 119 894 A

(21) Application No **8311171**
(22) Date of filing **25 Apr 1983**
(30) Priority data
(31) **8212786**
(32) **4 May 1982**
(33) **United Kingdom (GB)**
(43) Application published **23 Nov 1983**
(51) INT CL[3] **F16H 13/06**
(52) Domestic classification **F2Q** 7A2C 7A2E 7A2X **U1S** 1866 F2Q
(56) Documents cited **GB A 2038992**
(58) Field of search **F2Q**
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(54) A rotary drive

(57) A rotary drive for a manipulator or teleoperator comprises a ring member 36 freely rotatable about an eccentric boss 34 extending from an input driver shaft 30. The ring member 36 has a tapered rim portion 40 wedged between two resiliently biassed friction rings 41, 42, of larger diameter than the ring member 36 and coaxial with the driver shaft 30, and the ring member 36 is rotatably connected to an output driven shaft 26. The rotary drive provides a considerable velocity ratio, and also provides a safety feature in that friction between the rim portion 40 and the friction rings 41, 42 only causes rotation of the driven shaft 26 if the load on the driven shaft 26 is less than a certain limiting value. This limiting value may be varied by adjusting the resilient bias on the friction rings 41, 42.

Fig. 1.

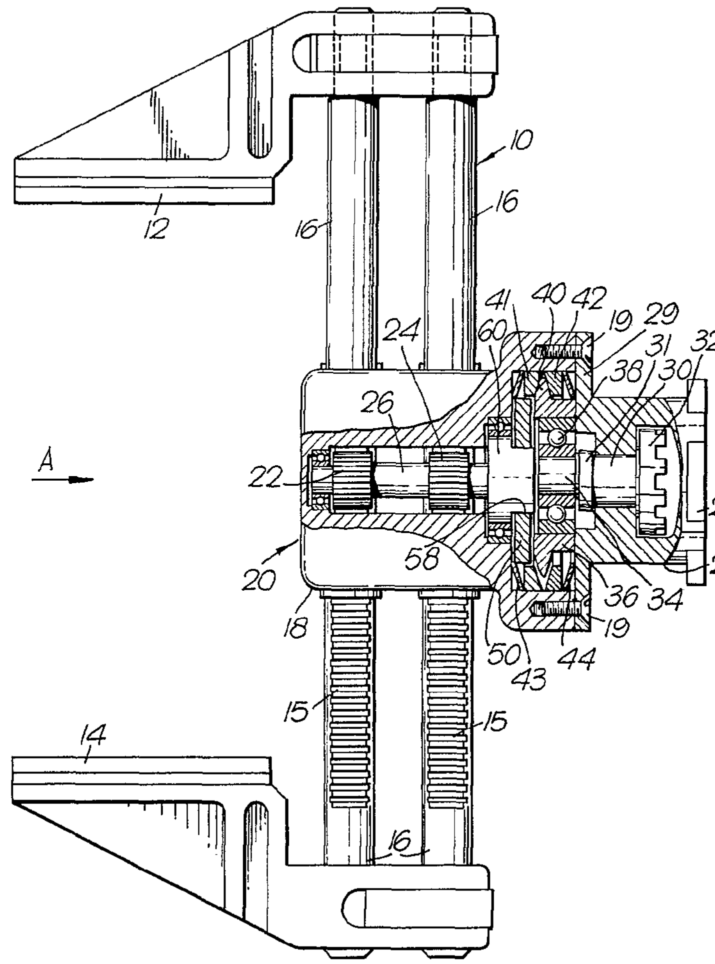

Fig.1.

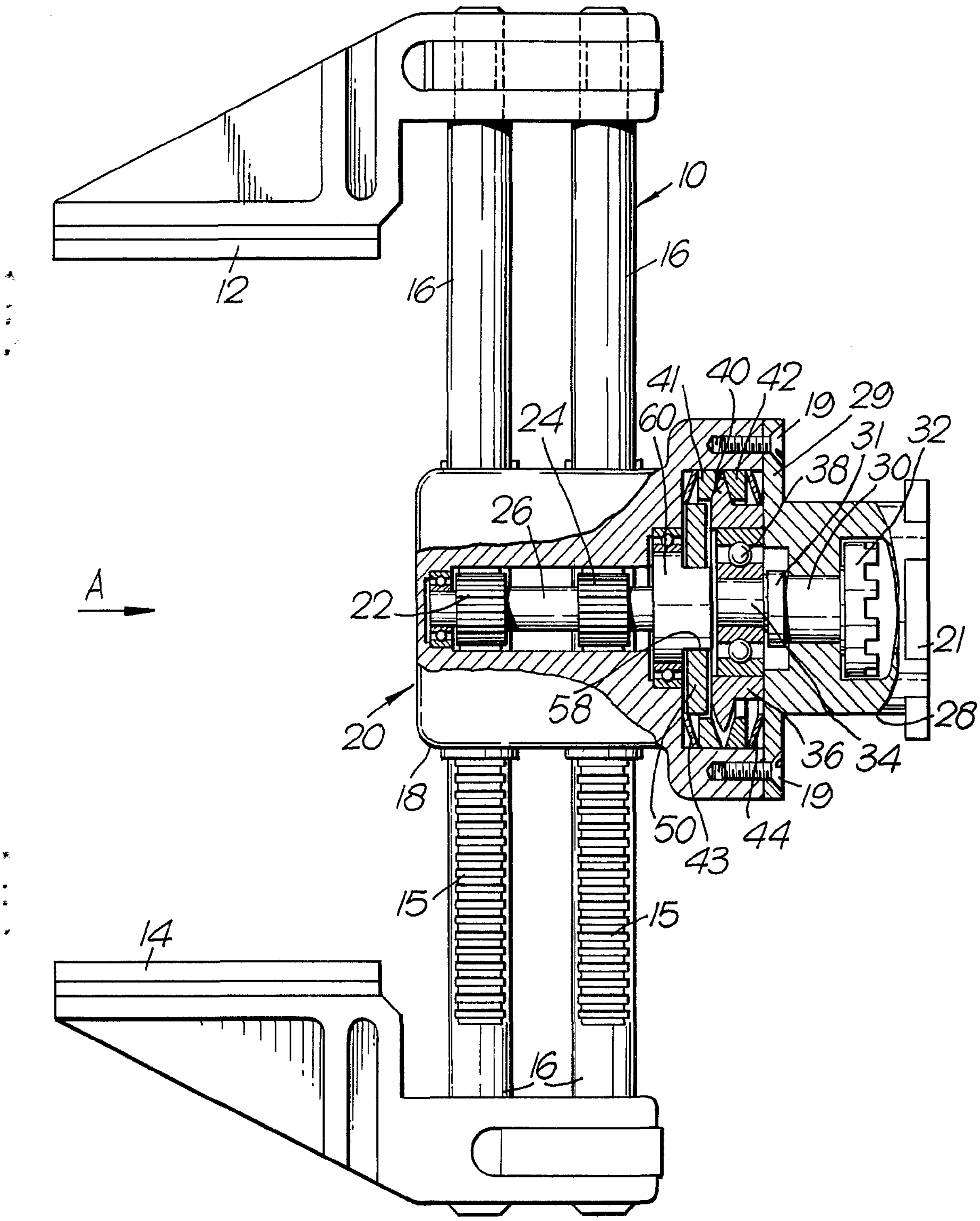
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Fig. 1a.

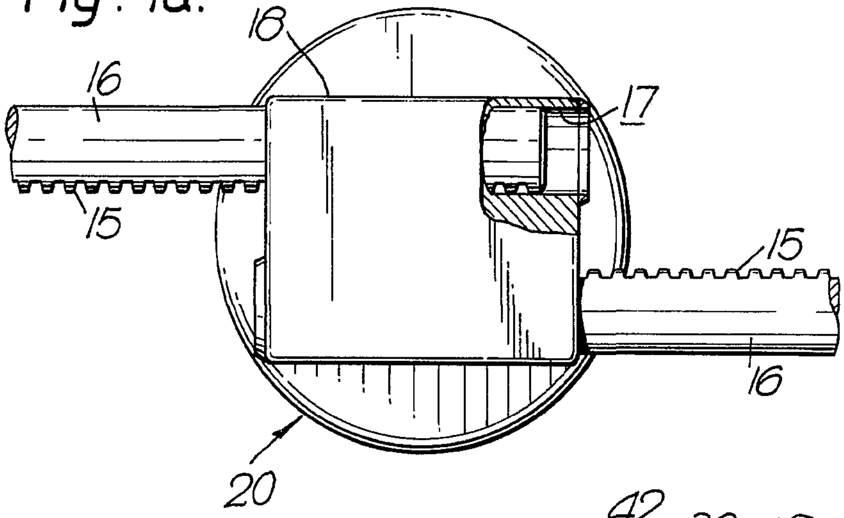


Fig. 2.

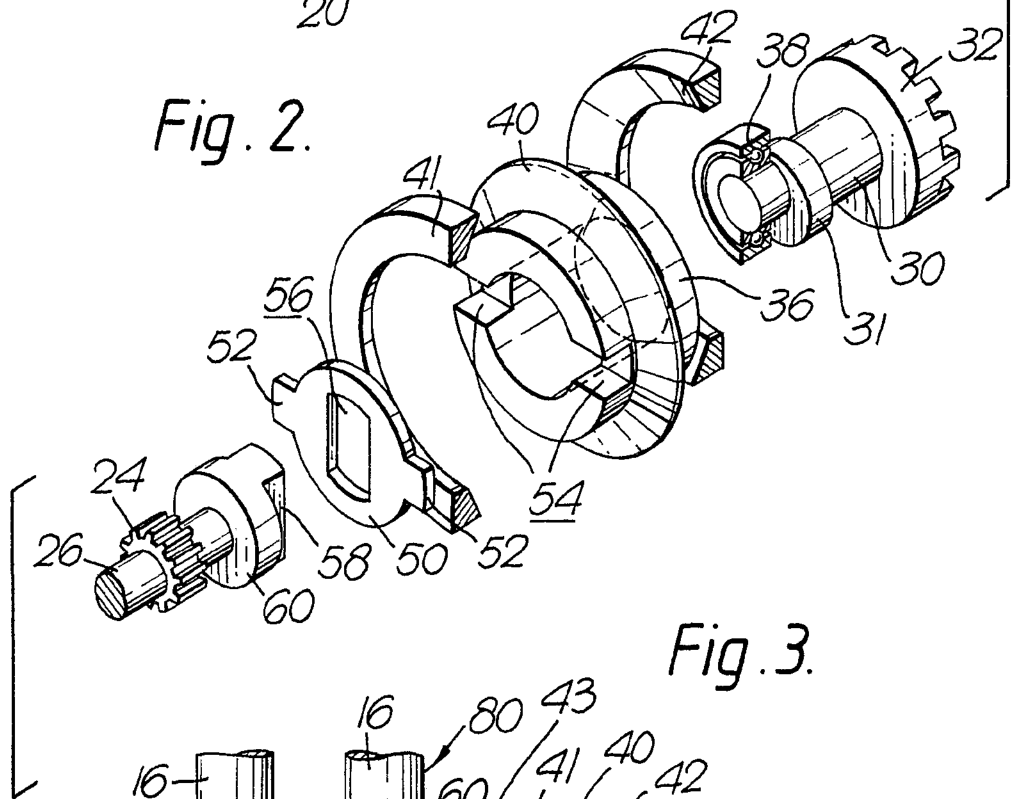
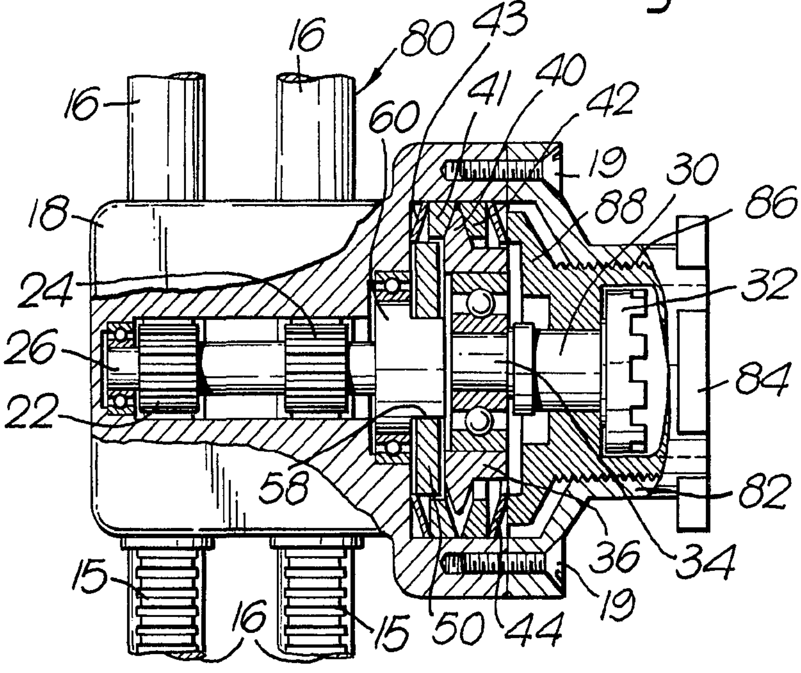


Fig. 3.



SPECIFICATION

A rotary drive

This invention relates to rotary drives for devices such as teleoperators and manipulators, and more particularly but not exclusively to the grip mechanism of such devices. These devices are widely used for example on the atomic energy industry, a manipulator usually referring to a device in which a master arm under the control of an operator is mechanically linked to a slave arm, while a teleoperator usually refers to a slave arm whose motions are remotely controlled electrically.

One of the problems associated with teleoperators or manipulators is that of handling fragile objects without crushing, and this problem becomes acute where there is no transfer of feel from a grip mechanism handling the object to the operator.

According to the present invention there is provided a rotary drive for a manipulator or teleoperator, the rotary drive comprising, a rotatable driver member, a ring member eccentrically mounted on one end of the driver member and freely rotatable thereon, at least one annular member coaxial with the driver member and frictionally engaging the ring member, a rotatable driven member, and means rotatably connecting the ring member to the driven member, whereby rotation of the rotatable driver member causes rotation of the ring member and thereby of the driven member unless the load on the driven member exceeds a predetermined value.

Preferably, the or each annular member is of tapered form and engages with a correspondingly tapered face of the ring member. Biassing means preferably resiliently bias the or each annular member into frictional engagement with the ring member, and the biassing means may incorporate means for adjusting the resilient bias.

The rotatable driver member may include a clutch portion, and the rotary drive may be demountably engageable with the teleoperator or manipulator.

The driven member may drive at least one pinion engaging with a respective rack to cause linear motion of the rack. Alternatively, the driven member may be threaded and carry a nut, to cause linear motion of the nut.

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

Figure 1 shows a partly broken away view of a teleoperator or manipulator grip;

Figure 1a shows a partly broken away view in the direction of arrow A of Figure 1;

Figure 2 shows an exploded, part sectional, perspective view of part of the grip of Figure 1; and

Figure 3 shows a partly broken away view of an alternative teleoperator or manipulator grip.

Referring to Figures 1 and 1*a*, a teleoperator or manipulator grip 10 comprises two parallel jaws 12 and 14 each mounted on a respective pair of parallel rods 16. All four rods 16 pass through respective holes 17 (only one hole 17 being shown in Figure 1*a*) through a drive unit 20, one side of each rod 16 defining a rack 15 which engages with a respective pinion 22 or 24 on an output shaft 26 in the drive unit 20. The pair of rods 16 attached to one jaw 12 lie in a plane on one side of the output shaft 26, while the pair of rods 16 attached to the other jaw 14 lie in a parallel plane on the opposite side of the output shaft 26. Hence rotation of the output shaft 26 and thereby of the pinions 22 and 24 causes both the jaws 12 and 14 to move towards or away from each other, depending on the direction of rotation of the output shaft 26.

The drive unit 20 comprises a friction drive mechanism within a housing having a first portion 18 enclosing the output shaft 26. A second housing portion 28, having at one end a flange 29, is attached to the first housing portion 18 by screws 19, and has at the other end a bayonet flange 21 which forms one half of a coupling by means of which the teleoperator grip 10 may be mounted onto a teleoperator or manipulator arm (not shown).

As shown in Figure 2, the friction drive mechanism includes an input shaft 30 coaxial with the output shaft 26, which may be drivably connected to a rotary drive (not shown) in the teleoperator or manipulator arm through a dog clutch 32 (only one side of which is shown), and at the end of the input shaft 30 remote from the dog clutch 32 is an eccentrically mounted cylindrical boss 34 extending from an enlarged portion 31 of the input shaft 30.

A cylindrical ring 36 is rotatably mounted on the boss 34 by a ball bearing 38, and has a rim portion 40 symmetrically tapered on each side and wedged between the sides of two correspondingly tapered friction rings 41 and 42 of greater diameter than the rim portion 40 and coaxial with the input shaft 30, the friction rings 41 and 42 being resiliently biassed onto the rim portion 40 by two conical springs 43 and 44 (see Figure 1). The ring 36 is drivably connected to the output shaft 26 by an Oldham-type coupling consisting of a circular floating disk 50 with two diametrically arranged tabs 52 engaging in diametrically situated slots 54 in one face of the ring 36, and with a central rectangular slot 56 extending perpendicular to the tabs 52, in which a tongue 58 on a boss 60 on one end of the output shaft 26 engages, the slot 56 being longer than the tongue 58.

In operation the grip 10, rotation of the dog clutch 32 and thus of the input shaft 30 by the rotary drive in the teleoperator or manipulator arm causes rotary displacement of the eccentric boss 34 and thereby of the axis of the ring 36. The rim portion 40, owing to its eccentric mounting, engages the friction rings 41 and 42 more firmly at one sector of its circumference than at the remainder of its circumference, and so is caused to turn at a much reduced angular velocity than the input shaft 30 and in the opposite direction. This causes rotation of the output shaft 26, and hence of the pinions 22 and 24 in mesh with the racks 15, so causing the rods 16 to move and both jaws 12 and 14 to move towards or away from each other, depending on the direction of rotation of the output shaft 26. The friction drive mechanism thus provides a considerable velocity ratio, and a correspondingly large mechanical advantage.

If the gripping force exerted by the jaws 12 and 14 reaches a certain limiting value, then the frictional forces between the rim portion 40 and the friction rings 41 and 42 will be sufficient to turn the ring 36 and hence the floating disk 50 and the output shaft 26. The input shaft 30 will continue to rotate, but the jaws 12 and 14 will not move; the floating disk 50 will oscillate to and fro along the tongue 58 of the boss 60, and in the slots 54, while the output shaft 26 remains stationary. This property of the grip 10 is an advantageous safety feature, as it lessens the chance of crushing fragile objects between the jaws 12 and 14.

The limiting value of gripping force is determined by the frictional force between the rim portion 40 of the ring 36 and the friction rings 41 and 42, and this may be adjusted by changing the biassing force of the conical springs 43 and 44. One means by which this may be accomplished is shown in Figure 3, to which reference is now made.

In Figure 3, a teleoperator or manipulator grip 80 is shown similar in most respects to that of Figure 1, but differing in that the second housing portion 28 of Figure 1 is replaced by a housing portion 82, partly of truncated conical form, attached at one end to the first housing portion 18 by screws 19, and with a bayonet flange 84 at the other end. The housing portion 82 is internally threaded and engages with a correspondingly threaded portion 86 of an adjusting member 88, one end of which abuts the conical spring 44. Rotation of the adjusting member 88 relative to the housing portion 82 changes the degree of compression of the conical springs 43 and 44, so changing the frictional force exerted on the rim portion 40 by the friction rings 41 and 42.

Although the invention has been described in relation to the operation of a rack and pinion for operating parallel motion jaws, if desired the rotation of the output shaft 26 might be used to drive some other mechanism. For example the output shaft 26 might have a threaded end portion on which a nut locates to convert rotation of the output shaft 26 into linear motion of the nut. Alternatively, the rotary drive might be connectable to an apparatus, or might be incorporated in a rotary drive system within a teleoperator or manipulator to provide a torque-limiting safety feature.

It will be understood that the velocity ratio, and hence the mechanical advantage, provided by the friction drive mechanism is determined by the mean diameters of the rim portion 40 and of the friction rings 41 and 42, the velocity ratio being equal to the ratio of the mean diameter of the rim portion 40 to the difference between the mean diameters of rim portion 40 and of the friction rings 41 and 42. It will also be appreciated that the degree of eccentricity of the boss 34 is half the difference between the aforementioned mean diameters.

CLAIMS

1. A rotary drive for a manipulator or a teleoperator, the rotary drive comprising, a rotatable driver member, a ring member eccentrically mounted on one end of the driver member and freely rotatable thereon, at least one annular member coaxial with the driver member and frictionally engaging the ring member, a rotatable driven member, and means rotatably connecting the ring member to the driven member, whereby rotation of the rotatable driver member causes rotation of the ring member and thereby of the driven member unless the load on the driven member exceeds a predetermined value.

2. A rotary drive as claimed in Claim 1, wherein the or each annular member is of tapered form and engages with a correspondingly tapered face of the ring member.

3. A rotary drive as claimed in Claim 1 or Claim 2, further comprising means resiliently biassing the or each annular member into frictional engagement with the ring member.

4. A rotary drive as claimed in Claim 3 wherein the biassing means incorporates means for adjusting the resilient bias.

5. A rotary drive as claimed in any one of the preceding Claims, further comprising a clutch portion at the other end of the driver member adapted to cooperate with a corresponding clutch portion in a teleoperator or a manipulator to which the rotary drive is demountably engageable.

6. A rotary drive as claimed in any one of the preceding Claims further comprising at least one pinion drivably connected to the driven member and engaging with a respective rack, whereby operation of the rotary drive cause linear motion of the or each rack.

7. A rotary drive as claimed in any one of the preceding Claims wherein the driven member has a threaded portion engaging a nut and means are provided to prevent rotation of the nut, whereby operation of the rotary drive causes linear motion of the nut.

8. A rotary drive as claimed in any one of the preceding Claims wherein the driven member is coaxial with the driver member.

9. A rotary drive as claimed in any one of the preceding Claims wherein the diameters of the ring member and of the or each annular member are such as to provide a desired mechanical advantage.

10. A rotary drive for a manipulator or a teleoperator substantially as hereinbefore described and with reference to Figures 1, 1*a*, and 2 of the accompanying drawings.

11. A rotary drive as claimed in Claim 10 modified substantially as hereinbefore described and with reference to Figure 3 of the accompanying drawings.

12. A manipulator or a teleoperator incorporating a rotary drive as claimed in any one of the preceding Claims.

Printed for Her Majesty's Stationery Office, by Croydon Printing Company Limited, Croydon, Surrey, 1983.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.