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I-10121 Torino (IT)(54) **Linear actuator.**

(57) A linear actuator (1) for actuating the feed device (204) of a parabolic antenna in relation to the reflector (202), to permit reception from variously located satellites. The actuator (1) comprises a cylindrical casing (3) housing an electric motor (5) for powering a screw (9) housed in a tubular body (7) extending axially from one end of the casing (3). The screw (9)

is fitted with a slide (98) housed in the tubular body (7) and presenting a recirculating-ball nut screw (114) connected to the screw (9); and the slide (98) is also connected to a support (120) projecting from the tubular body (7) and supporting the feed device (204).

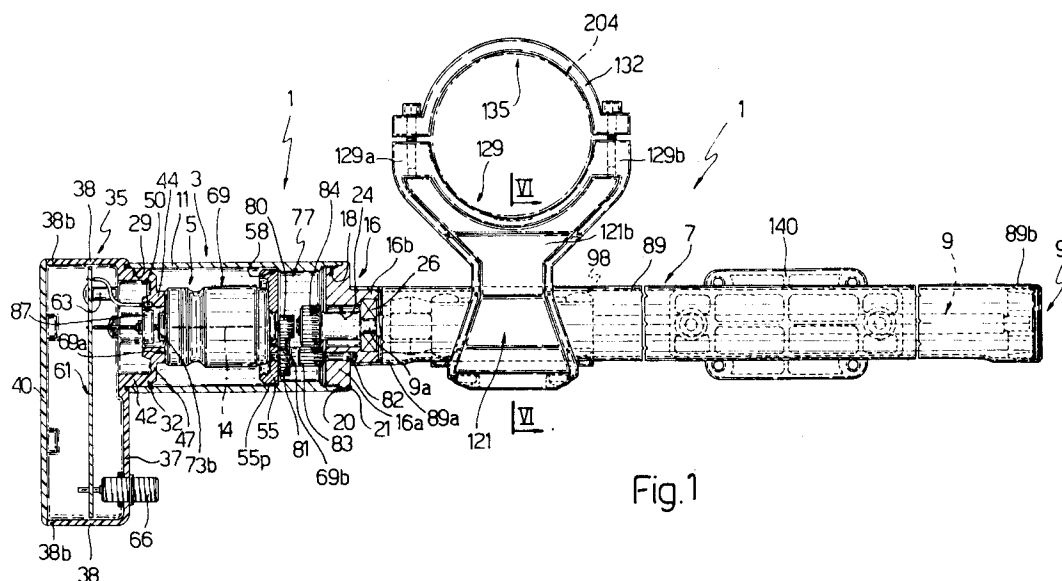
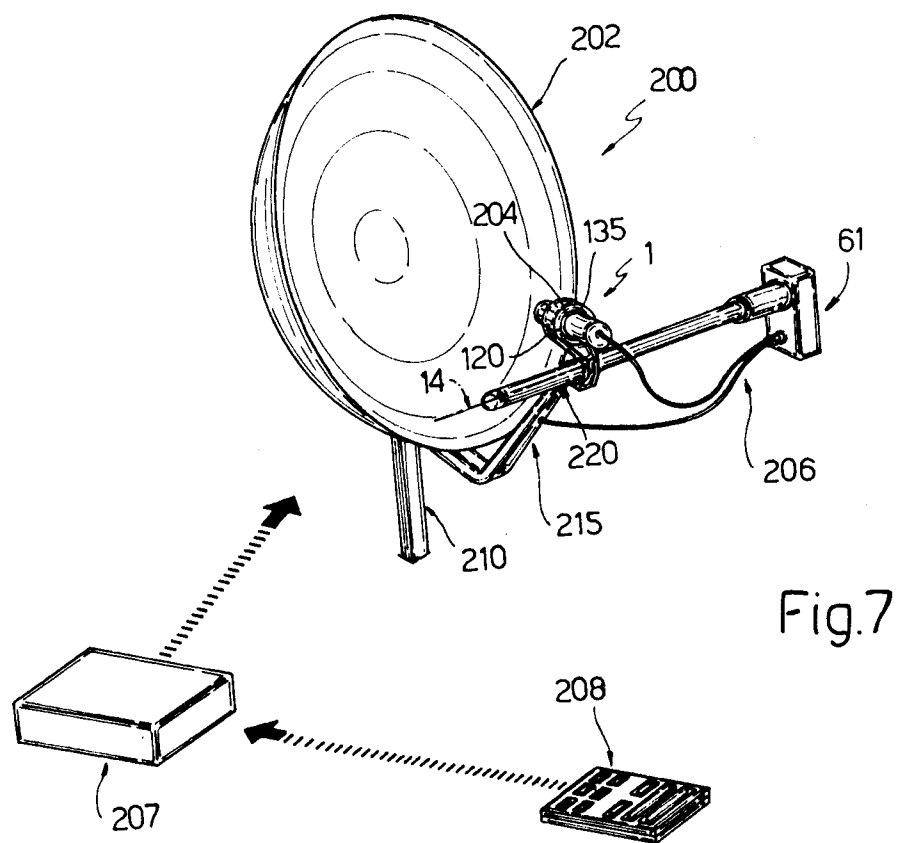


Fig.1

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The present invention relates to a linear actuator, particularly for actuating the feed device of a parabolic antenna.

Parabolic antennas are known comprising a parabolic reflector, and a feed device located at the focus of the reflector and which receives electromagnetic radiation reflected by it.

Parabolic antennas of this type are conveniently used for receiving electromagnetic signals transmitted by satellite, particularly television satellites.

Some parabolic antennas also feature an actuating device for moving the parabolic reflector by varying the tilt of the reflector axis in relation to the horizontal, for receiving signals from variously located satellites.

Known actuating devices however are extremely complex (and expensive) and require at least two distinct connecting cables: one for carrying the signal received by the feed device; and the other for carrying the actuating device supply and control signals.

Other parabolic antennas for receiving signals from different satellites feature a horizontally-fixed reflector; the feed device is movable by a linear actuator in relation to the reflector; and one cable is provided for carrying both the signal received by the feed device and the actuator supply and control signals.

It is an object of the present invention to provide a highly efficient, highly reliable linear actuator for actuating the feed device of a parabolic antenna.

According to the present invention, there is provided a linear actuator as described in Claim 1.

A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a partially sectioned side view of an actuator in accordance with the teachings of the present invention;

Figure 2 shows a partially sectioned bottom plan view of the Figure 1 actuator;

Figures 3 and 4 show larger-scale views of a detail of the Figure 1 actuator;

Figure 5 shows a section along line V-V in Figure 4;

Figure 6 shows a section along line VI-VI in Figure 1;

Figure 7 shows an example application of the actuator according to the present invention.

Number 1 in Figures 1 and 2 indicates a linear actuator, in particular for actuating the feed device of a parabolic antenna.

Actuator 1 comprises a tubular casing 3 housing a d.c. electric motor 5; and an elongated tubular body 7 extending axially from one end of tubular casing 3 and housing a screw 9 movable angularly by motor 5.

More specifically, tubular casing 3 comprises a cylindrical tubular wall 11 coaxial with an axis 14; and a front cap 16 closing a first end opening 18 of casing 3.

Front cap 16 comprises a first cylindrical portion 16a fitted inside tubular casing 3 and presenting an annular shoulder 20 contacting the peripheral end edge 21 of opening 18.

Front cap 16 also comprises a second cylindrical portion 16b integral with and smaller in diameter than first portion 16a, and extending axially from first portion 16a and outwards of casing 3. Front cap 16 presents a cylindrical through hole 24 coaxial with axis 14 and housing a ball bearing 26 supporting a first end portion 9a of screw 9.

Tubular casing 3 also presents a second end opening 29 closed by a rear cap 32 extending integrally towards casing 3 from a parallelepiped box 35 perpendicular to axis 14.

More specifically, box 35 is made of plastic material, and comprises a rectangular wall 37 perpendicular to axis 14 and integral with cap 32; four rectangular lateral walls 38 integral with wall 37; and a rectangular cover 40 opposite wall 37 and which snaps on to the end edges 38b of lateral walls 38.

Rear cap 32 comprises a first cylindrical tubular wall 42 extending integrally from wall 37 and fitted inside casing 3; and a second cylindrical tubular wall 44 extending coaxially with axis 14 from the free end of tubular wall 42 towards front cap 16. Second tubular wall 44 is smaller in diameter than first wall 42, is connected to first wall 42 by radial spokes 47 extending between facing portions of walls 42 and 44, and houses a Hall effect sensor 50 the function of which is described later on.

Box 35 is fixed to tubular casing 3 by means of screws 52 extending parallel to axis 14 from rear cap 32 to front cap 16, and which present threaded end portions 52f screwed inside holes formed in front cap 16.

Electric motor 5 is housed inside casing 3 between rear cap 32 and a circular flange 55 which is perpendicular to axis 14 and presents peripheral edges 55p contacting an annular shoulder 58 of tubular wall 11.

Electric motor 5 is controlled by an electronic circuit 61 formed on a rectangular printed circuit board housed inside box 35 and fixed to wall 37 by cylindrical spacer elements 63. Electronic circuit 61 is connected to Hall effect sensor 50, and presents an input/output terminal conveniently formed by a connector 66 fitted to wall 37 of box 35.

Motor 5 comprises a cylindrical housing 69 coaxial with axis 14 and presenting a first end wall 69a contacting peripheral end edges of tubular wall 44, and a second end wall 69b contacting and

fitted to flange 55 by means of screws 71.

Motor 5 presents an output shaft 73 presenting a first end 73a extending perpendicularly from wall 69b and engaging a through hole 75 formed in flange 55 and coaxial with axis 14. Output shaft 73 is connected to screw 9 by a reduction gear transmission 77 comprising a first gear 80 fitted to end 73a of shaft 73 and meshing with a second gear 81 larger in diameter than first gear 80 and supported on a shaft 82 extending parallel to axis 14 between flange 55 and front cap 16.

Transmission 77 also comprises a third gear 83 integral with and smaller in diameter than second gear 81, and which is supported on shaft 82 and meshes with a fourth gear 84 fitted to first end 9a of screw 9.

Output shaft 73 of electric motor 5 presents a second end 73b extending perpendicularly from wall 69a and supporting a cylindrical permanent magnet 87 housed inside second tubular wall 44 and cooperating with Hall effect sensor 50.

Elongated tubular body 7 comprises a cylindrical tubular wall 89 coaxial with axis 14 and presenting a first end portion 89a screwed on to portion 16b of cap 16, and a second end portion 89b with an opening 90 closed by a plug 91.

More specifically, plug 91 is made of plastic material, and comprises a circular wall 92 perpendicular to axis 14; and a cylindrical tubular wall 93 integral with wall 92 and which snaps inside tubular body 7. Circular wall 92 is integral with a tubular body 94 coaxial with axis 14, extending inside tubular body 7 towards cap 16, and defining a bush for supporting a second end portion 9b of screw 9 which extends coaxially with axis 14 along the full length of tubular body 7.

Tubular body 7 also presents an elongated rectangular opening 96 with rounded shorter edges, and which extends parallel to axis 14 along substantially the full length of tubular body 7.

Tubular body 7 houses a slide 98 movable along screw 9 between a first limit position adjacent to front cap 16, and a second limit position adjacent to plug 91.

Slide 98 (Figures 3, 4, 5) comprises a first elongated parallelepiped body 99 in turn presenting lateral end portions 102 contacting and sliding with very little friction along the cylindrical inner surface of tubular body 7, and a longitudinal through opening 105 engaged by screw 9. Slide 98 also comprises a tubular body 108 extending axially from one end of parallelepiped body 99 and which presents a central hole 111 coaxial with axis 14 and communicating with longitudinal opening 105 in parallelepiped body 99. Internally, tubular body 108 defines a recirculating-ball nut screw 114 connected to screw 9 and which provides for low-friction displacement of body 108 and of slide 98

integral with body 108.

With reference to Figure 6, slide 98 is fitted with a support 120 which comprises a substantially C-shaped portion 121 externally surrounding tubular body 7; and a connecting appendix 123 extending between a first end 121a of C-shaped portion 121 and slide 98 and through opening 96.

Support 120 is fitted to slide 98 by means of two screws 125 fitted through appendix 123 and presenting end portions screwed inside threaded holes formed in parallelepiped body 99.

With reference to Figure 1, support 120 also comprises a curved C-shaped end portion 129 comprising two diverging arms 129a, 129b extending from a second end 121b of C-shaped portion 121. The ends of arms 129a, 129b are fitted, e.g. screwed, to the end portions of a C-shaped half ring 132 opposite end portion 129 and defining, with end portion 129, a circular opening 135 for housing a feed device, in particular a cylindrical tubular feed device 204 (Figure 7).

Tubular body 7 also presents an assembly plate 140 (Figure 6) secured to body 7 by screws 143 extending through body 7 and presenting end portions screwed inside threaded holes formed in a mating body 146 housed in body 7.

Figure 7 shows a preferred application of actuator 1 wherein a parabolic antenna 200 comprises a parabolic reflector 202, and a feed device 204 facing the opening of reflector 202 and fitted to support 120 of actuator 1. Feed device 204 presents an output (not shown) connected by a coaxial cable 206 to circuit 61 which sends the signal received by feed device 204 to an electronic control unit 207 for decoding the signal received by antenna 200 and for controlling actuator 1.

Electronic circuit 61 is also supplied by control unit 207 with signals for controlling electric motor 5 and generated by a remote control 208 cooperating with control unit 207.

Parabolic reflector 202 is supported on a vertical rod 210 extending between a base (not shown) secured to a fixed structure such as a roof, and a rear portion (not shown) of reflector 202. Parabolic antenna 200 also comprises a rod 215 sloping in relation to rod 210 and extending upwards from a bottom peripheral portion of reflector 202 to an end portion 220 facing the opening of reflector 202.

End portion 220 is also secured, e.g. by means of bolts (not shown), to assembly plate 140 of actuator 1 (Figure 6).

In the above position, axis 14 of actuator 1 is parallel to the plane (not shown) through the end edges of reflector 202, and feed device 204 is located close to the focus of reflector 202.

In actual use, power is transmitted by transmission 77 from motor 5 to screw 9 which is thus rotated to move nut screw 114 and slide 98 along

tubular body 7.

The position of slide 98 along tubular body 7 is detected by a position sensor (ENCODER) formed by Hall effect sensor 50 and magnet 87. More specifically, for each turn of magnet 87, sensor 50 supplies a voltage pulse, which pulses are detected and counted by circuit 61 for determining the number of turns of the shaft of motor 5 (and hence the position of slide 98) in relation to a reference.

The position of feed device 204 in relation to reflector 202 may thus be regulated according to the command imparted by remote control 208. More specifically, feed device 204 may be positioned at or moved away on either side of the focus of reflector 202.

Moving feed device 204 in relation to reflector 202 makes it possible to receive signals from different television satellites. More specifically, positioning feed device 204 at the focus of reflector 202 provides for receiving a first satellite whose signal is propagated in a direction parallel to the axis of reflector 202; and moving feed device 204 in relation to the focus provides for receiving signals propagated in a direction at an angle to the axis of reflector 202. The intensity of these signals is less than that of the signal from the satellite oriented optically with the reflector, but is nevertheless sufficient for ensuring good reception.

The advantages of the present invention are as follows.

Slide 98 travels along the guide by means of a screw connected to a recirculating-ball nut screw, thus providing for low-friction, low-power displacement of the feed device and hence high efficiency of the actuator as a whole.

By virtue of presenting an extremely straightforward structure and small number of component parts, actuator 1 provides for fast, low-cost manufacture and a high degree of reliability. Tests have shown the actuator to be capable of operating satisfactorily within an extremely wide temperature range (-30°C $+40^{\circ}\text{C}$) with no noticeable variation in the current absorbed by motor 5 and hence with substantially constant energy absorption.

Claims

1. An actuator for actuating the feed device (204) of a parabolic antenna (200); characterized in that it comprises:
 - a screw (9) movable angularly by drive means (5);
 - a slide (98) traveling axially along said screw (9);
 - recirculating-ball screw-nut screw connecting means (114) interposed between said slide (98) and said screw (9); and

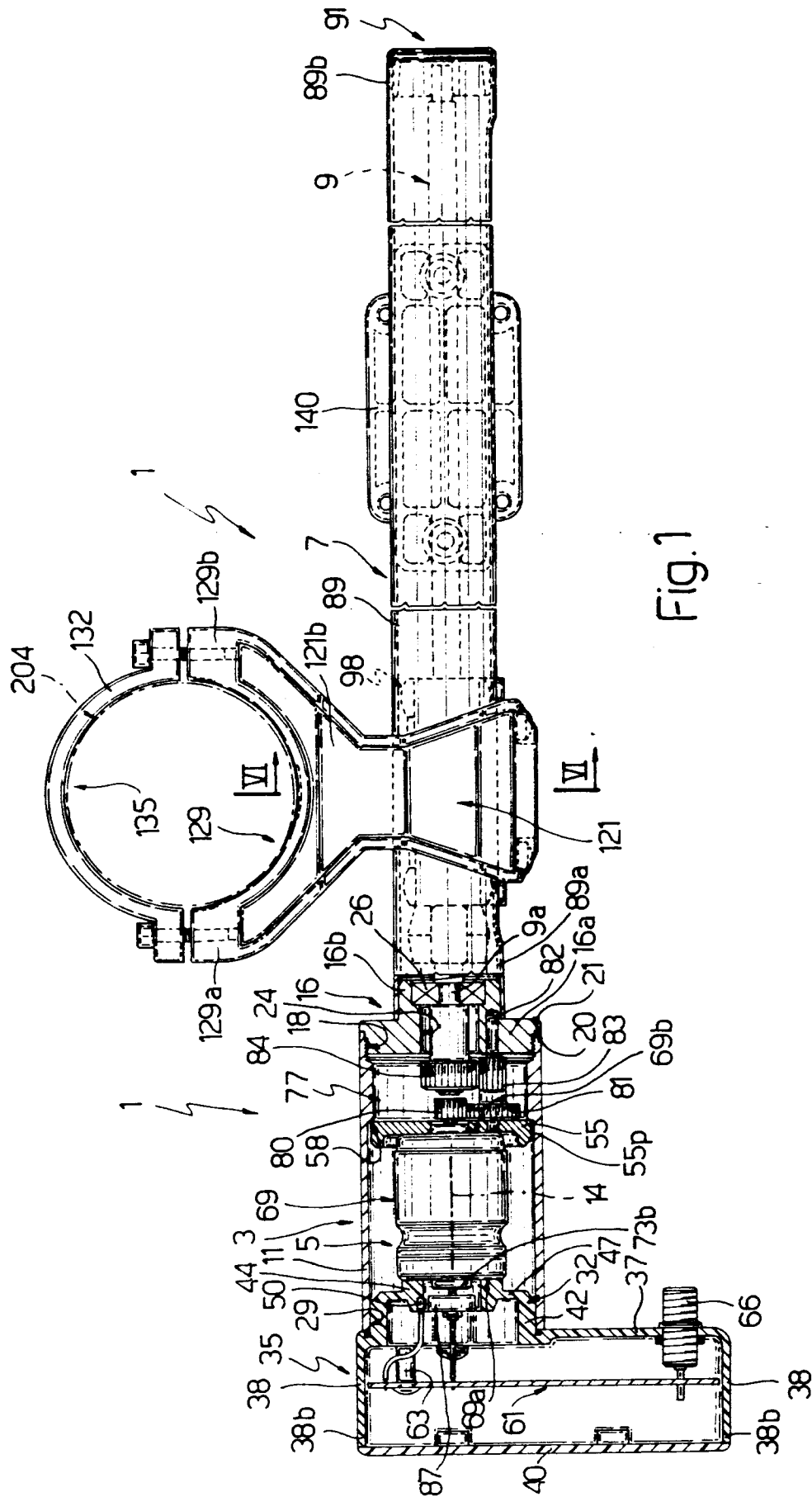
- a support (120) for said feed device (204); said support (120) being fitted to said slide (98).

2. An actuator as claimed in Claim 1, characterized in that it comprises a casing (3) housing said drive means (5); and an elongated tubular body (7) extending from said casing (3);
 - said tubular body (7) axially housing said screw (9), and said slide (98) traveling axially inside said tubular body (7);
 - said tubular body (7) also presenting an elongated opening (96) extending axially; and
 - said support (120) presenting a portion (123) engaging in sliding manner said opening (96) and secured to said slide (98).
3. An actuator as claimed in Claim 2, characterized in that said support (120) comprises a central, substantially C-shaped portion (121) externally surrounding said tubular body (7); and a connecting appendix (123) extending from a first end (121a) of the central portion (121) to said slide (98) and through said opening (96).
4. An actuator as claimed in Claim 2 or 3, characterized in that said support (120) also comprises a curved C-shaped peripheral portion (129) comprising two diverging arms (129a, 129b) extending from one end (121b) of said support (120);
 - the ends of said arms (129a, 129b) being connected to end portions of a C-shaped half ring (132) fitted opposite said C-shaped peripheral portion (129) and defining, together with said C-shaped peripheral portion (129), a circular opening (135) for housing said feed device (204).
5. An actuator as claimed in one of the foregoing Claims from 2 to 4, characterized in that said casing (3) is a substantially cylindrical tubular casing, and houses said drive means (5) interposed between a rear body (32) closing a rear opening of said tubular casing (3), and a flange (55) perpendicular to said casing (3).
6. An actuator as claimed in Claim 5, characterized in that said rear body (32) comprises a substantially cylindrical cap extending integrally from a flat wall of a box (35) fitted to said tubular casing;
 - said actuator (1) comprising electronic means (61) for controlling said drive means (5); said electronic means (61) being housed in said box (35).

7. An actuator as claimed in Claim 6, characterized in that said cap (32) comprises an inner tubular body (44) housing a cylindrical magnet (87) rotated by said drive means (5) and cooperating with a Hall effect sensor (50) fitted to said cap (32). 5
8. An actuator as claimed in one of the foregoing Claims from 2 to 7, characterized in that said casing (3) is a substantially cylindrical tubular casing, and presents a front opening (18) closed by a front body (16); 10
 said front body (16) being fitted to a first end portion (89a) of said elongated tubular body (7) extending axially from the front body (16) itself; and 15
 said front body (16) presenting a central through hole (24) engaged by a first end portion of said screw (9). 20
9. An actuator as claimed in Claim 8, characterized in that it comprises a reduction gear transmission (77) housed in said casing (3) and interposed between the output shaft (73) of said drive means (5) and said first end portion (9a) of said screw (9). 25
10. An actuator as claimed in Claim 8 or 9, characterized in that said tubular body (7) presents a second end portion (89b) closed by a plug (91) defining a bush (94) for supporting a second end of said screw (9). 30
11. An actuator as claimed in any one of the foregoing Claims, characterized in that said slide (98) comprises an elongated body (99) presenting lateral end portions (102) contacting and sliding with very little friction along the cylindrical inner surface of said tubular body (7); 35
 said elongated body (99) presenting a longitudinal through opening (105) engaged by said screw (9); and 40
 said recirculating-ball nut screw (114) being formed on a body (108) connected to said elongated body (99). 45

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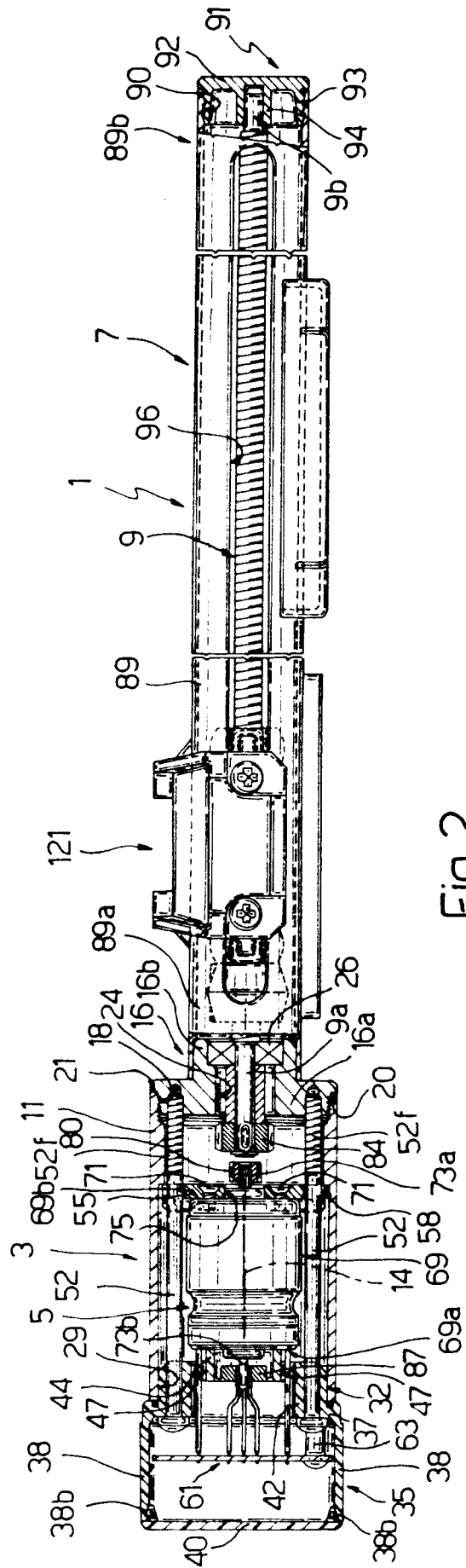
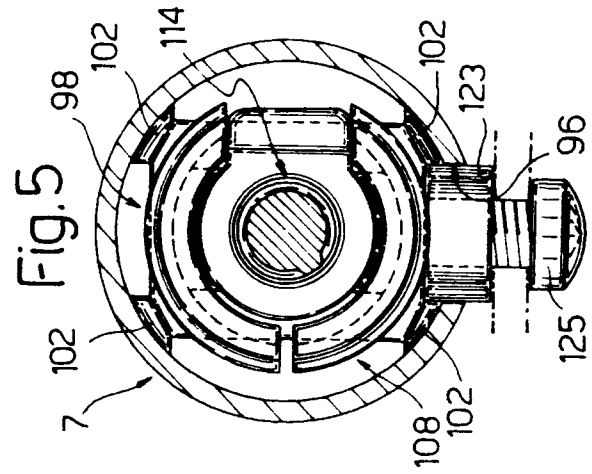
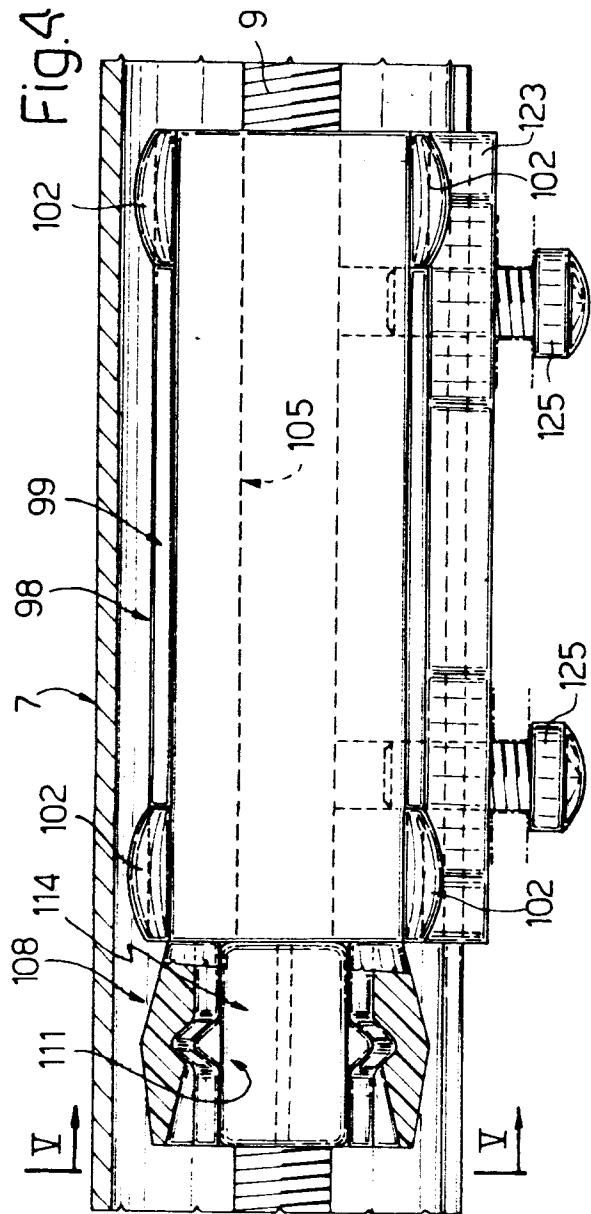
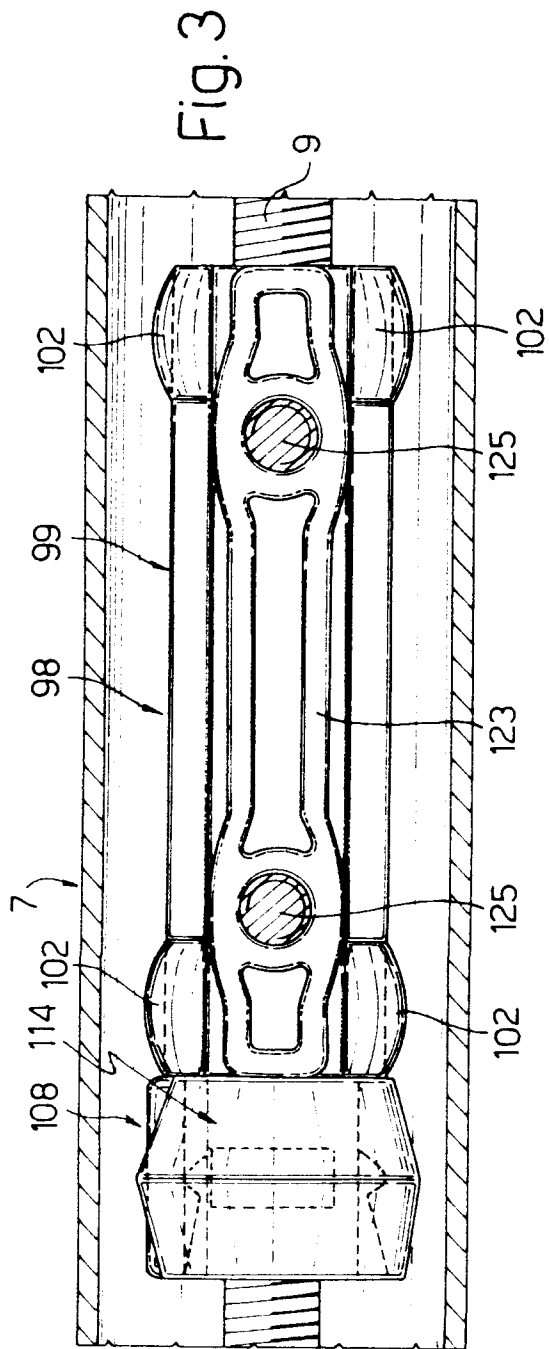
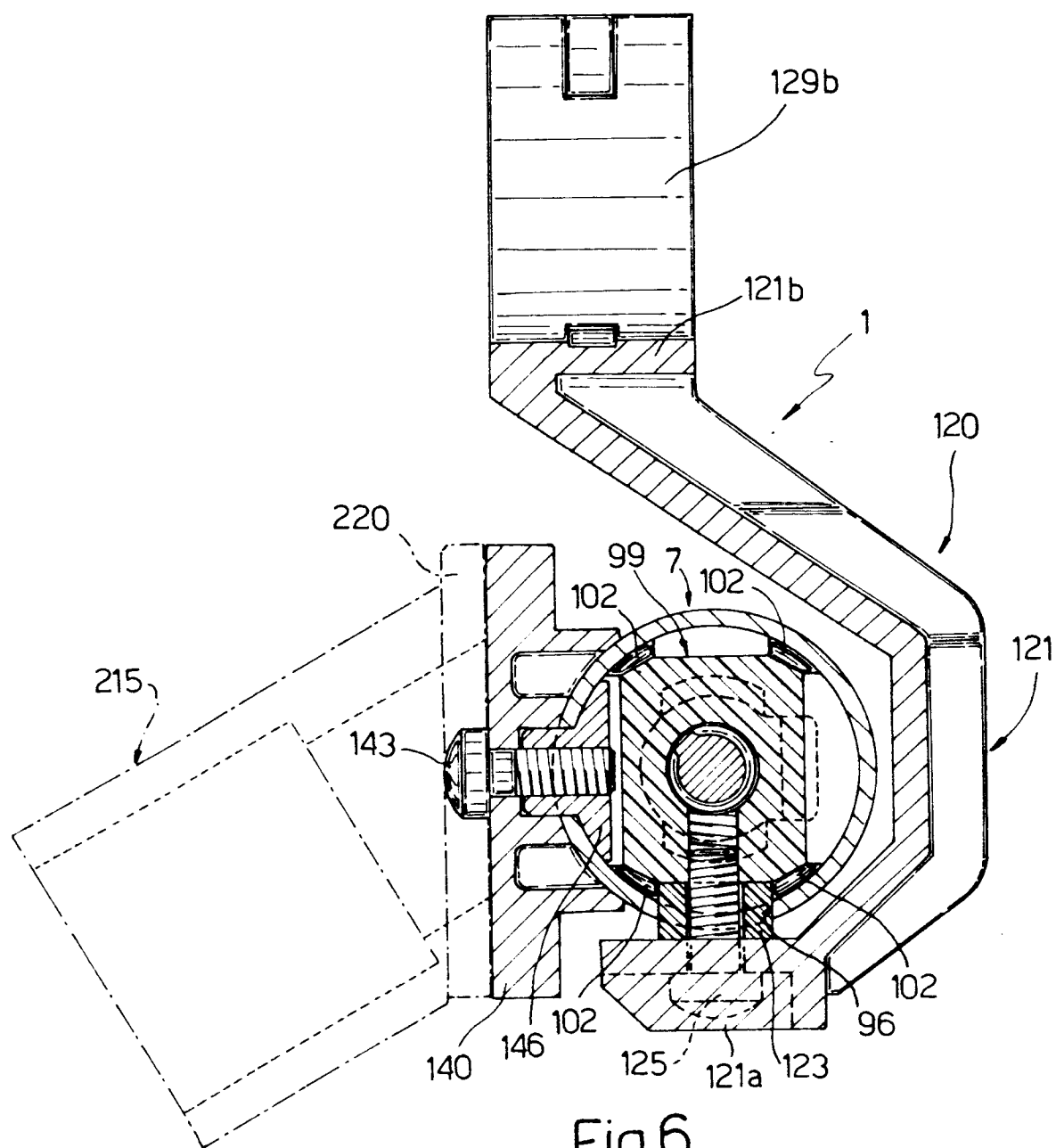
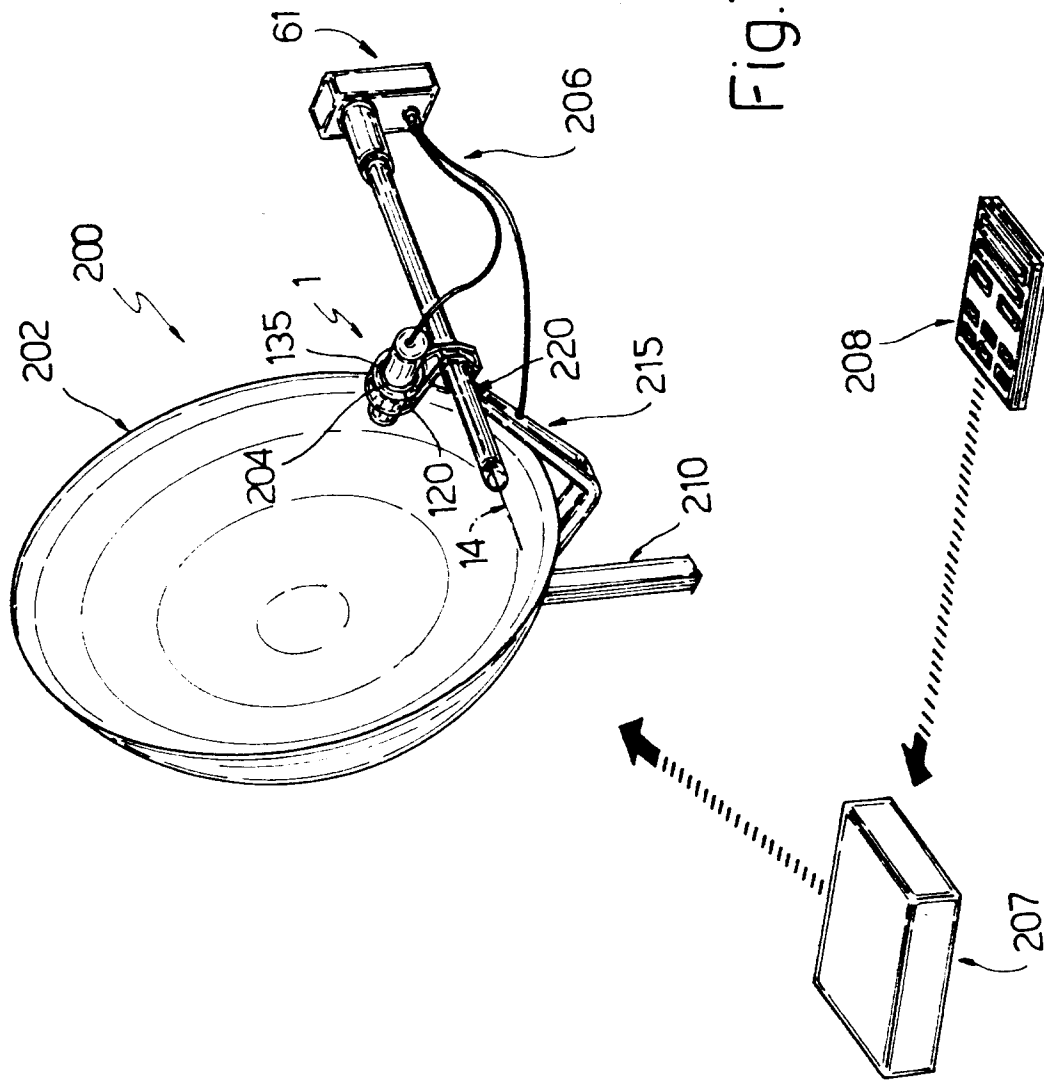


Fig. 2









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EUROPEAN SEARCH REPORT

Application Number
EP 94 11 8142

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	PATENT ABSTRACTS OF JAPAN vol. 17 no. 476 (E-1424) ,30 August 1993 & JP-A-05 114815 (YAGI ANTENNA) 7 May 1993, * abstract * ---	1	H01Q1/12 H01Q3/18
Y	EP-A-0 371 213 (SELENIA SPAZIO) * abstract; figure 3 * ---	1	
A	DE-U-93 06 769 (HÜGELMANN ET AL) * claims 1,3,5-10; figures 1-4 * ---	2-11	
A	DE-U-93 06 769 (HÜGELMANN ET AL) * claims 1,3,5-10; figures 1-4 * ---	1-11	
A	FR-A-1 126 441 (COMPAGNIE FRANCAISE THOMSON-HOUSTON) * the whole document * ---	1-11	
A	DE-A-43 07 675 (MAKSAN) * claims 1-11; figures 7-11 * ---	1	
A	US-A-4 918 363 (HOLLIS ETV AL.) * claims 1-10; figures 1-11 * ---	1	
P,X	DE-U-93 06 071 (SUPER SAT ELECTRONIC) * figures 1,2,A-C * -----	1	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 14 March 1995	Examiner Angrabeit, F
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			