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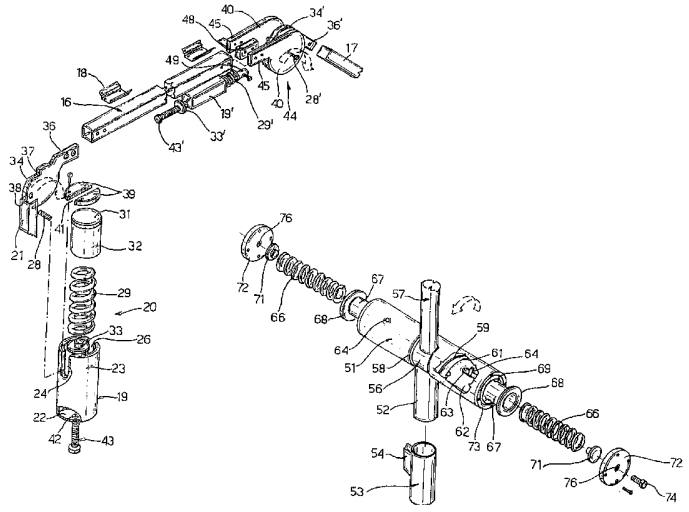
**(54) Title:** DEVICE FOR BALANCING AN ARM PIVOTING ABOUT AN AXIS OF ROTATION, FOR EXAMPLE, AN ARM SUPPORTING A WORK STATION ALL-PURPOSE FUME OR GAS EXHAUST CONDUIT



**(57) Abstract:** The torque, due to the weight of the arm, (16, 17), is balanced according to the angular position of the arm by a contrast spring (29) acting perpendicular to the axis of rotation of the arm (16, 17). The spring (29) is controlled by a cam (34, 34') integral with the arm (16, 17), is housed in a container (32) closed by a wall (31) acted on by the profile of the cam (34, 34'), and rests on a guide disk (33) hose position relative to the container (32) is adjusted by means of an adjusting screw (43) to calibrate the precompression of the spring (29) according to the minimum torque due to the weight of the arm (16, 17). In another embodiment, at least one contrast spring (66) acts parallel to the axis of rotation of the arm (16, 17), and is controlled by a cam edge (59) of a cylinder (56) for axially moving a corresponding sleeve (62) housing the spring (66).

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# DEVICE FOR BALANCING AN ARM PIVOTING ABOUT AN AXIS OF ROTATION, FOR EXAMPLE, AN ARM SUPPORTING A WORK STATION ALL-PURPOSE FUME OR GAS EXHAUST CONDUIT

## TECHNICAL FIELD

The present invention relates to a device for balancing an arm pivoting about an axis of rotation, for example, an arm supporting a work station all-purpose fume or gas exhaust conduit.

## BACKGROUND ART

In an arm pivoting about an axis of rotation, the torque, with respect to the axis of rotation, due to the weight of the arm and any fixture supported by it, often varies alongside the angular position of the arm about the axis. The arm can be used for various types of equipment, particularly those involving moving the fixture by manually rotating the arm.

To reduce the effort required of the user, the torque due to the weight of the arm is normally balanced by elastic means, such as a contrast spring; and, to compensate the variation in torque produced by a variation in the angular position of the arm, means have

been proposed for automatically controlling the action of the spring according to the angular position of the arm.

In an all-purpose fume exhaust conduit, an arm balancing device has been proposed in which the action of the spring is regulated by means fitted to an articulated parallelogram, the pivot of which is eccentric with respect to the axis of rotation of the arm. Though satisfactory in terms of performance, the above balancing device is relatively complex and expensive to produce, on account of the large number of moving parts, and the rods of the parallelogram having to be formed to house the spring inside a substantially closed channel.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a highly reliable, low-cost device for balancing an arm pivoting about an axis of rotation, and designed to eliminate the aforementioned drawbacks of known balancing devices.

According to the present invention, there is provided a device for balancing an arm pivoting about an axis of rotation, and so located as to vary the torque, due to the weight of said arm and with respect to said axis of rotation, according to the angular position of said arm; said torque being balanced by the contrasting action of elastic means; and control means being provided to control said contrasting action according to said angular position; characterized in that said control means comprise at least one cam member associated with

said arm and which acts on said elastic means to control said contrasting action.

BRIEF DESCRIPTION OF THE DRAWINGS

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

Figure 1 shows a view in perspective of a work station all-purpose fume or gas exhaust conduit featuring two pivoting arms fitted with respective balancing devices in accordance with a first embodiment of the invention;

Figure 2 shows a larger-scale, partial exploded view in perspective of the two arms and respective balancing devices in Figure 1;

Figure 3 shows a side view of a detail in Figure 2;

Figure 4 shows a view in perspective of the Figure 1 conduit featuring arms fitted with balancing devices in accordance with a further embodiment of the invention;

Figure 5 shows a larger-scale, exploded view in perspective of one of the Figure 4 balancing devices;

Figure 6 shows a detail of the Figure 5 device;

Figure 7 shows an exploded view in perspective of another of the Figure 4 balancing devices;

Figure 8 shows a detail of the Figure 7 device;

Figure 9 shows an exploded view in perspective of a variation of Figure 5 balancing device;

Figure 10 shows a detail of the Figure 9 device.

BEST MODE FOR CARRYING OUT THE INVENTION

Number 5 in Figure 1 indicates as a whole an all-purpose fume or gas exhaust conduit, e.g. for a work station in a factory or workshop. Conduit 5 preferably has a circular cross section, is fitted at one end with an exhaust hood 6 moved manually over to the fume source, and is defined by two straight portions 7 and 8 connected to each other by a flexible articulated connecting portion 9. Portions 7 and 8 are also connected by another two articulated connected portions 11 and 12 to a rigid portion 13 of conduit 5 and to hood 6 respectively.

Rigid portion 13 rotates inside a sleeve having a flange 10 connecting the sleeve to a fixed support 14 possibly housing an aspirator not shown. More specifically, conduit 5 is defined by a single flexible, e.g. undulated, pipe, the two portions 7 and 8 of which are fixed to two corresponding rigid arms 16 and 17, each defined by a hollow metal section with a rectangular cross section. Straight portions 7 and 8 may be connected, for example, by clamps 15 to corresponding tabs 18 fixed to arms 16 and 17.

Arm 16 is connected to rigid portion 13 by a balancing device indicated as a whole by 20 and for balancing the torque due to the weight of arm 16 together with the weight of conduit 5 as a whole. For which purpose, an appendix 21 of a sleeve 19 is fixed to rigid portion 13, so that sleeve 19 is parallel to rigid portion 13. Sleeve 19 (Figure 2) comprises a flat bottom

wall 22; and a lateral wall 23 having two diametrically opposite axial slots 24 and 26. Appendix 21 is welded at slot 24, outwards of wall 23, and has a C-shaped cross section; and the two wings of appendix 21 are fitted with a pivot 28 defining the axis of rotation of arm 16.

Sleeve 19 is fitted with elastic means for contrasting the torque, with respect to the axis of pivot 28, due to the weight of arm 16 together with the weight of conduit 5 as a whole. The elastic means may be defined by any type of contrast spring, e.g. a compression spring defined by a bar of elastomeric material such as polyurethane, or an air or gas, e.g. nitrogen, spring, which may be in the form of a pneumatic cylinder with a piston for compressing the air or gas inside.

In the embodiment shown in Figures 1 to 3, the contrast spring is defined by a helical compression spring 29 resting at one end on a guide disk 33, and at the other end on a wall 31 closing a container 32 housing spring 29 and itself housed inside sleeve 19.

Arm 16 is connected rigidly to a cam member for controlling the contrasting action of spring 29 according to the angular position of arm 16 about pivot 28. More specifically, the cam member is defined by a cam 34 defined by a profiled disk pivoting eccentrically on pivot 28, and is housed inside the two slots 24 and 26 in sleeve 19. Cam 34 has an appendix 36 fixed rigidly to one end of arm 16, and a shoulder 37 which cooperates with an edge 38 of appendix 21 to define a stop for the travel,

anticlockwise in Figure 2, of cam 34.

The outer profile of cam 34 acts on the convex surface of wall 31 of container 32 to compress spring 29 according to the angular position of cam 34, and therefore of arm 16, with respect to pivot 28. Slot 26 in sleeve 19 allows appendix 36 to rotate to the extent that arm 16 is positioned substantially horizontally. Two substantially semicircular members 39 are fixed, e.g. by screws, to the free edge of sleeve 19 to define a passage 41 for cam 34, and so lock container 32 inside sleeve 19.

Spring 29 is adjusted, i.e. calibrated, to vary the precompression force of the spring by means of an adjusting member. For which purpose, flat wall 22 of sleeve 19 has a threaded hole 42 engaged by an adjusting screw 43 which acts on guide disk 33 of spring 29. The precompression of spring 29 is obviously adjusted before inserting cylinder 32 inside sleeve 19, and is preferably adjusted to balance, at rest, the minimum torque due to the weight of arm 16 and of conduit 5 as a whole.

Arm 17 is connected to arm 16 by a balancing device 44 for balancing the torque due to the weight of arm 17, together with the weight of portion 8 (Figure 1) of all-purpose conduit 5 and of hood 6. Balancing device 44 is identical to balancing device 20, so the relative component parts are indicated in the drawings using the same reference numbers with superscripts, and are described here only briefly. In balancing device 44, sleeve 19' is fixed directly to the end of arm 16, and

cam 34' has an appendix 36' fixed in known manner to the end of arm 17.

Pivot 28' of cam 34' is carried by two circular plates 40, each having a substantially tangential appendix 45; plates 40 are held apart by a spacer block 48 located between appendixes 45 to permit rotation of cam 34'; and appendixes 45 and block 48 are inserted inside and fixed by screws to the end of arm 16, so that pivot 28' of arm 17 is carried by the end of arm 16.

Compression spring 29' is located between disk 33' and a cylindrical block 49 (Figure 3) held resting on the profile of cam 34'; the other end of arm 17 (Figure 1) is connected to hood 6 by a universal joint 46; and hood 6 is fitted with a grip 47 by which it is moved manually with respect to support 14.

Each of the two balancing devices 20 and 44 in the Figure 1-3 embodiment operates as follows.

Assuming springs 29, 29' of the two balancing devices 20, 44 are calibrated to balance the respective minimum torques of arms 16 and 17, displacement of hood 6 by means of grip 47 both in height and along support 14 varies the angular position of arm 16 and/or arm 17, together with that of relative cams 34, 34', on relative pivots 28, 28', so that cam 34 acts on flat wall 31 of relative container 32 to vary the compression of relative spring 29 according to the angular position of arm 16 with respect to sleeve 19.

Cam 34' in turn acts on block 49 to vary the

compression of relative spring 29' according to the angular position of arm 17 with respect to arm 16. In the Figure 1-3 embodiment, the action of elastic means 29, 29' is therefore directed radially with respect to the axis of rotation of relative arm 16, 17.

In the Figure 4 embodiment, the action of the elastic means of balancing devices 20 and 44 is substantially parallel to the axis of rotation of relative arm 16, 17. More specifically, balancing device 20 of arm 16 comprises an outer sleeve 51 (Figure 5) having a radial pin 52, which is fixed removably in known manner inside a vertical sleeve 53 having an appendix 54 by which it is fixed to rigid portion 13 (Figure 4) of conduit 5.

A cylinder 56 is inserted inside sleeve 51, and has another radial pin 57 which is fixed removably in any known manner to one end of arm 16. Pin 57 is located at a circumferential slot 58 in sleeve 51, so that cylinder 56 rotates inside, but is axially fixed with respect to, sleeve 51. The axis of sleeve 51 therefore represents the axis of rotation of arm 16, and sleeve 51 acts as a pivot about which arm 16 rotates.

Cylinder 56 has two symmetrical helical cam edges 59 (see also Figure 6), each of which cooperates with a complementary edge 61 of a corresponding sleeve 62 having the same diameter as cylinder 56. Each sleeve 62 has an axial slot 63 engaged by a radial pin 64 fixed in known manner to sleeve 51 and directed inwards, so that each

sleeve 62 slides axially, but is angularly fixed, with respect to sleeve 51.

Sleeves 62 house respective contrast springs acting axially in opposite directions. More specifically, in the Figure 5 and 6 embodiment, each contrast spring is defined by a helical compression spring 66 housed in a corresponding cylindrical container 67 in turn housed inside corresponding sleeve 62. Each container 67 has a flange 68, which rests on a second edge 69 of, and perpendicular to the axis of, corresponding sleeve 62.

Container 67 also has an end wall (not shown), on which one end of spring 66 acts to keep the end wall resting against an end wall of sleeve 62. The other end of spring 66 rests on a guide disk 71, which, together with container 67 and spring 66, is locked inside corresponding sleeve 62 by a cover 72 fixed by screws to an edge 73 of sleeve 51, so that springs 66 are coaxial with sleeve 51.

The member for adjusting or calibrating each spring 66 is defined by a corresponding adjusting screw 74, which engages a threaded hole 76 in cover 72, and acts on disk 71 to adjust the distance between disk 71 and the end wall of container 67, and so adjust the precompression force of spring 66 in the same way as described relative to adjusting screw 43 (Figure 2).

Balancing device 44 between arms 16 and 17 is similar to device 20 in Figure 5, so the relative component parts are indicated using the same reference

numbers with superscripts, and are described here only briefly. Sleeve 51' (Figure 7) has a radial pin 52' fixed to the end of arm 16, and cylinder 56' has a radial pin 57' fixed to the end of arm 17. In view of the smaller torque to be balanced with respect to device 20, cylinder 56' may advantageously have one cam edge 59' (see also Figure 8) which cooperates with one sliding sleeve 62'. Provision may therefore be made for one spring 66' housed inside sliding sleeve 62' in the same way as springs 66 in Figure 5.

Each of balancing devices 20 and 44 in the Figure 5-8 embodiment operates as follows.

Assuming springs 66, 66' of the two balancing devices 20, 44 are calibrated to balance the respective minimum torques of arms 16 and 17, springs 66 and 66' normally keep respective flanges 68, 68' of containers 67, 67' resting on edges 69, 69' of respective sleeves 62, 62', and manual displacement of hood 6 both in height and along support 14 varies the angular position of arm 16 and/or arm 17, together with that of relative cylinders 56, 56'.

Cam edges 59 of cylinder 56 of device 20 move the two sleeves 62 axially, and with them containers 67, to vary the compression of relative springs 66 according to the angular position of arm 16 with respect to sleeve 51; and cam edge 59' of cylinder 56' of device 44 in turn axially moves sleeve 62', and with it container 67', to vary the compression of relative spring 66' according to

the angular position of arm 17 with respect to arm 16.

In a variation of the balancing device, e.g. the one in Figures 5 and 6, the two springs 66 are located axially outside the two sleeves 62 (Figure 9), in which is inserted a fixed inner sleeve 77. Each end of sleeve 77 is closed by a wall 78 having a threaded hole 79; and each sleeve 62 has a radial pin 82, which engages a corresponding axial slot 81 in inner sleeve 77, so that each sleeve 62 slides axially with respect to, but do not rotate on, inner sleeve 77.

Inner sleeve 77 is fitted with radial pin 52 for connection to vertical sleeve 53 (see also Figure 4), which engages a radial slot 83 in a cylinder 84, in which sleeve 77 is also inserted. Cylinder 84 therefore rotates with respect to, but does not slide axially on, sleeve 77, has two cam edges 59 cooperating with two complementary edges 61 of the two sleeves 62, and has an appendix 57 by which it is fixed to the end of arm 16, so that arm 16 rotates about the axis of inner sleeve 77.

Each spring 66 is located between two guide disks 87 and 88, each having a central hole. Disk 87 is located outwards, and disk 88 has a flange 89 normally held resting on perpendicular edge 69 of sleeve 62. A long adjusting screw 86 extends through the holes in both disks 87, 88, and engages threaded hole 79 in sleeve 77, so that the precompression of spring 66 is adjusted by adjusting the distance, at rest, between disks 87 and 88.

Operation of the Figure 9 and 10 balancing device is

identical to that of device 20 in Figures 5 and 6, and is therefore not described here. Device 44 with a single spring 66' (Figures 7 and 8) may also be designed with spring 66' outside sliding sleeve 62', and with the fixed sleeve inside. Like the device in Figures 9 and 10, the cylinder with the cam edge is also located on the outside of the inner sleeve to move sliding sleeve 62' axially.

The advantages, as compared with known devices, of the balancing device according to the invention will be clear from the foregoing description. In particular, the device is extremely compact; springs 29, 29' and 66, 66' are adjusted by cam members 34, 34' and 59, 59', so that the mechanism is cheap and easy to produce; and the precompression of springs 29, 29' and 66, 66' is adjusted easily by means of a straightforward adjusting screw.

Clearly, changes may be made to balancing devices 20, 44 as described herein without, however, departing from the scope of the accompanying Claims. For example, the profile of cams 34, 34' may comprise a lift to achieve optimum balance of the torque of arms 16, 17 in each position; and the cam member may be carried by container 32, as opposed to being fixed to arm 16, and be carried by block 49, as opposed to being fixed to arm 17.

Moreover, the helical compression spring 29, 29' may be replaced with an extension spring, which may even be located outside sleeve 19, 19'. In which case, the profile of cam 34, 34' may comprise a groove engaged by a transmission cable connected to one end of the extension

spring. Each cam edge 59, 59' may cooperate with a cam-follower member to permit a non-linear edge 59, 59' for optimum balancing of the torque of arms 16, 17 in each position. And arms 16 and 17 may even be balanced by any combination of the balancing devices described above, with a spring acting perpendicular to the axis of rotation of arm 16, 17, as in Figures 1 to 3, and with a single spring 66' or pair of springs 66 acting parallel to the axis of rotation.

The straight portions 7 and 8 of conduit 5 may be defined by rigid, smooth pipes; flange 10 of the member supporting rigid portion 13 of conduit 5 may be wall- or ceiling-mounted, as opposed to being fixed to a bottom support 14, which is normally mounted on a trolley; and the balancing device may be applied to any arm supporting fixtures to be moved by hand or motor.

# CLAIMS

1) A device for balancing an arm (16, 17) pivoting about an axis of rotation, and so located as to vary the torque, due to the weight of said arm (16, 17) and with respect to said axis of rotation, according to the angular position of said arm (16, 17); said torque being balanced by the contrasting action of elastic means (29; 66, 66'); and control means (34, 34'; 59, 59') being provided to control said contrasting action according to said angular position; characterized in that said control means comprise at least one cam member (34, 34'; 59, 59') associated with said arm (16, 17) and which acts on said elastic means (29; 66, 66') to control said contrasting action.

2) A device as claimed in Claim 1, characterized in that said elastic means (29; 66, 66') are calibrated to balance said arm (16, 17) in the minimum-torque angular position.

3) A device as claimed in Claim 1 or 2, characterized in that said elastic means (29; 66, 66') comprise at least one bar of elastomeric material.

4) A device as claimed in Claim 1 or 2, characterized in that said elastic means (29; 66, 66') comprise at least one air or gas spring.

5) A device as claimed in Claim 1 or 2, characterized in that said elastic means comprise at least one helical spring (29; 66, 66').

6) A device as claimed in one of the foregoing Claims, characterized in that said elastic means (29; 66, 66') are housed in a cylindrical container (32; 67, 67') sliding inside a sleeve (19; 62, 62') supporting said axis of rotation; said cam member (34, 34'; 59, 59') being integral with said arm (16, 17).

7) A device as claimed in any one of the foregoing Claims, characterized in that the action of said elastic means (29) is substantially perpendicular to said axis of rotation; said cam member being a cam (34, 34') in the form of a disk rotating about said axis of rotation.

8) A device as claimed in Claims 5 and 7, characterized in that said helical spring is an extension spring; said cam (34, 34') cooperating with a transmission cable connected to one end of said extension spring.

9) A device as claimed in Claims 5 and 7, characterized in that said helical spring is a compression spring (29; 66, 66') having another end cooperating with a guide disk (33; 71, 71'; 87); said compression spring (29; 66, 66') being calibrated by an adjustable member (43; 74; 74'; 86) acting on said guide disk (33; 71, 71'; 87).

10) A device as claimed in Claims 6 and 9, characterized in that said compression spring (29) has one end resting against a closing wall (31) of said container (32); said closing wall (31) cooperating with said cam (34, 34').

11) A device as claimed in one of Claims 1 to 6, characterized in that the action of said elastic means (66, 66') is substantially parallel to said axis of rotation; said cam member being defined by a cam edge (59, 59') of a cylinder (56, 56') integral with said arm (16, 17).

12) A device as claimed in Claim 11, characterized in that said cam edge (59, 59') is helical, and acts on an axially sliding sleeve (62, 62') having an edge (61, 61') complementary to said cam edge (59, 59'); said elastic means being defined by a compression spring (66, 66') housed in said sliding sleeve (62, 62').

13) A device as claimed in Claim 12, characterized in that said cylinder (56, 56') rotates with respect to a supporting sleeve (51, 51') fixed and external with respect to said sliding sleeve (62, 62'); said sliding sleeve (62, 62') having an axial slot (63, 63') cooperating with a radial pin (64, 64') carried by said supporting sleeve (51, 51'); and said cylinder (56, 56') being connected to said arm (16, 17) by a member (52) extending through a circular slot (58) in said supporting sleeve (51, 51').

14) A device as claimed in Claim 12, characterized in that said cylinder (84) rotates with respect to a fixed supporting sleeve (77) internal with respect to said sliding sleeve (62); said fixed supporting sleeve (77) having at least one axial slot (81) cooperating with a radial pin (82) carried by said sliding sleeve (62);

said cylinder (84) being connected to said arm (16, 17) by a member (57); and said fixed supporting sleeve (77) having a member (52) extending through a circumferential slot (83) in said cylinder (84).

15) A device as claimed in Claim 14, characterized in that said compression spring (66, 66') is outside said sliding sleeve (62); one end of said compression spring (66, 66') engaging a guide disk (88) cooperating with said sliding sleeve (62); the other end of said compression spring (66, 66') engaging another guide disk (87); and said adjusting member (86) cooperating with an end wall (78) of said fixed supporting sleeve (77) to adjust the distance between said guide disks (87, 88).

16) A device as claimed in one of Claims 11 to 15, characterized in that said cylinder (56, 84) has two specular cam edges (59); two helical compression springs (66) being carried by two sliding sleeves (62) and acting in opposite directions.

17) A device as claimed in one of the foregoing Claims, characterized in that said arm (16, 17) supports a portion (7, 8) of a work station all-purpose fume or gas exhaust conduit (5).

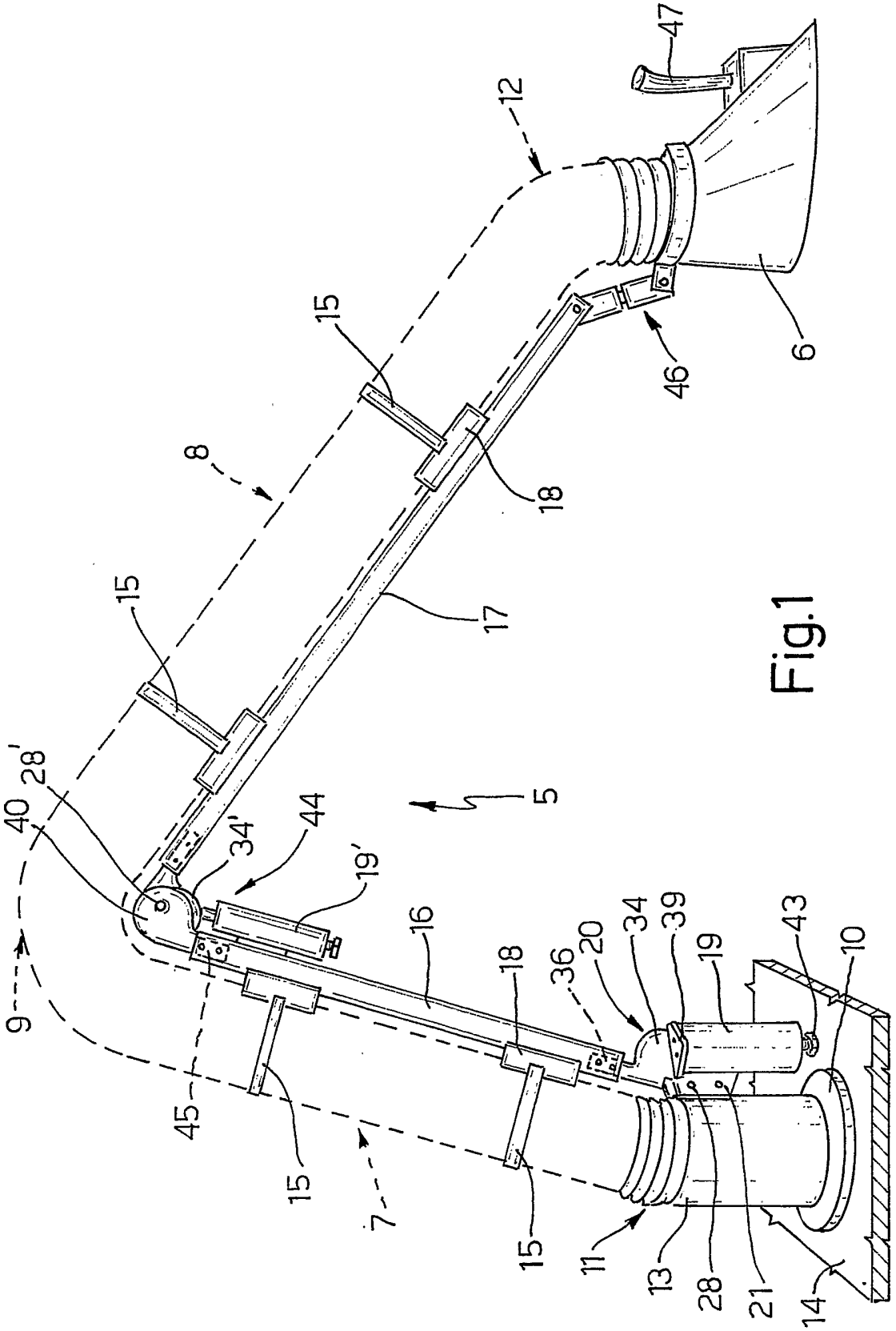
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Fig.1

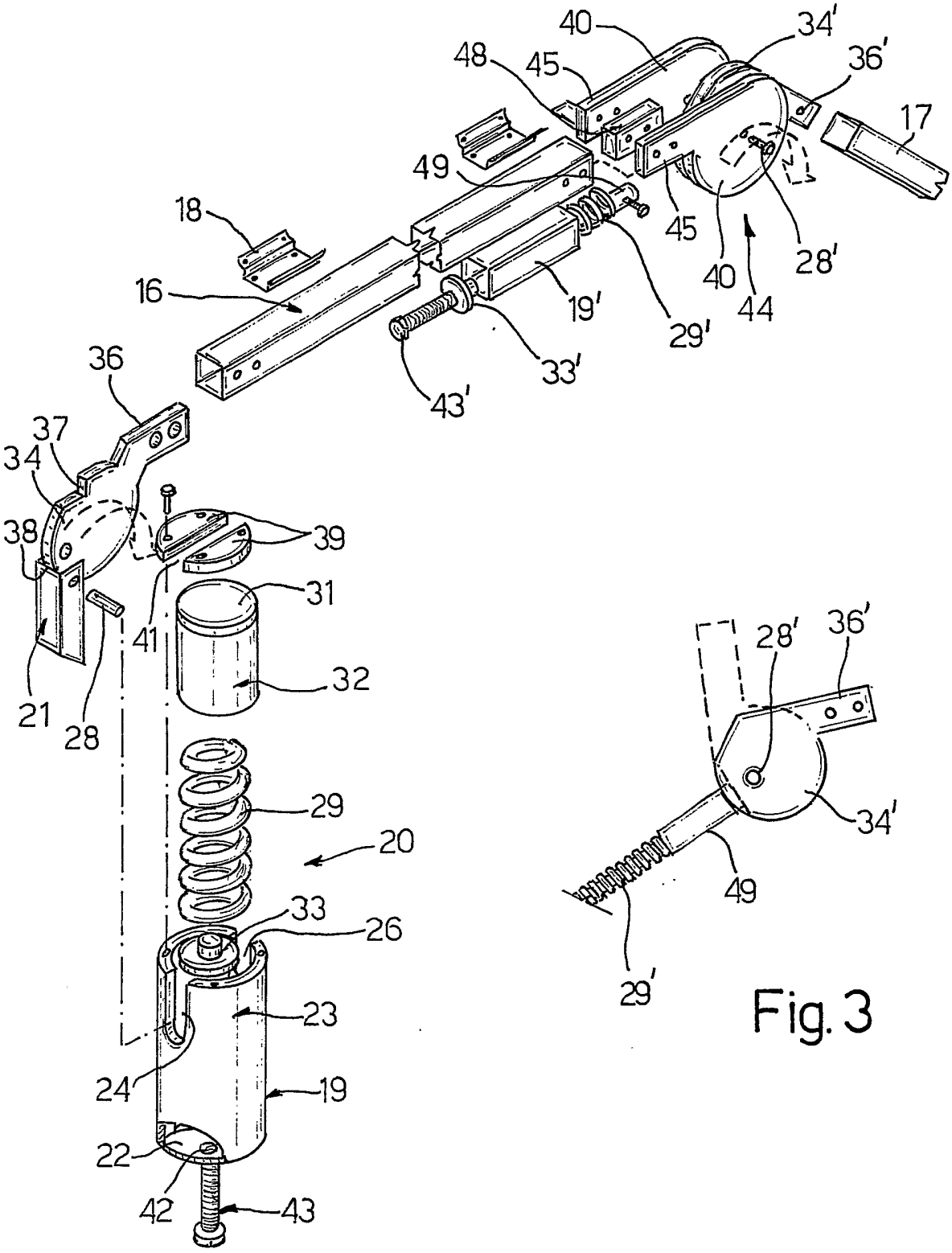
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Fig.2


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Fig. 3

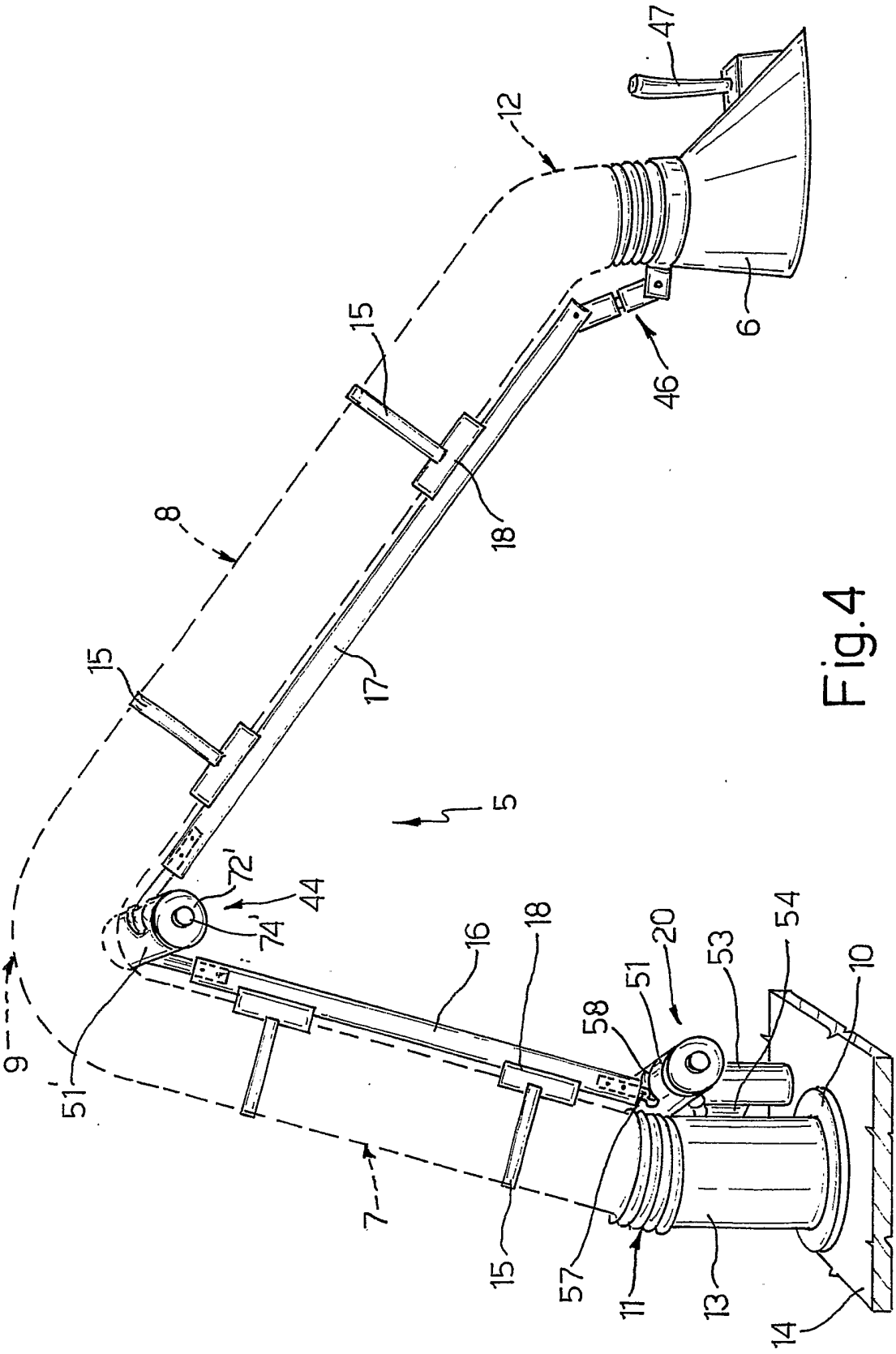
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Fig.4

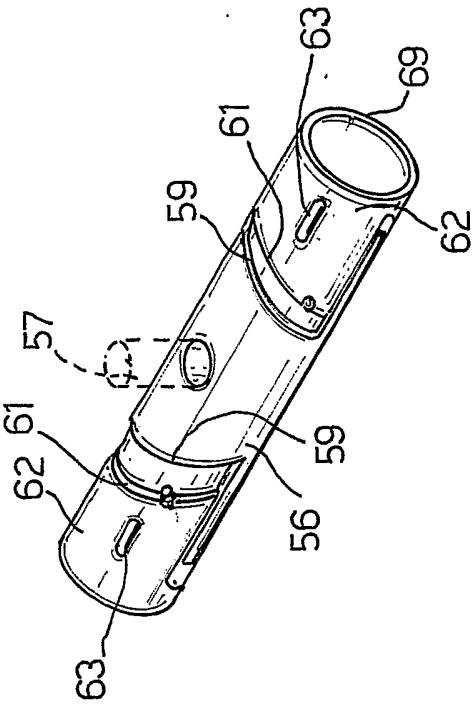
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Fig.6


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Fig.5

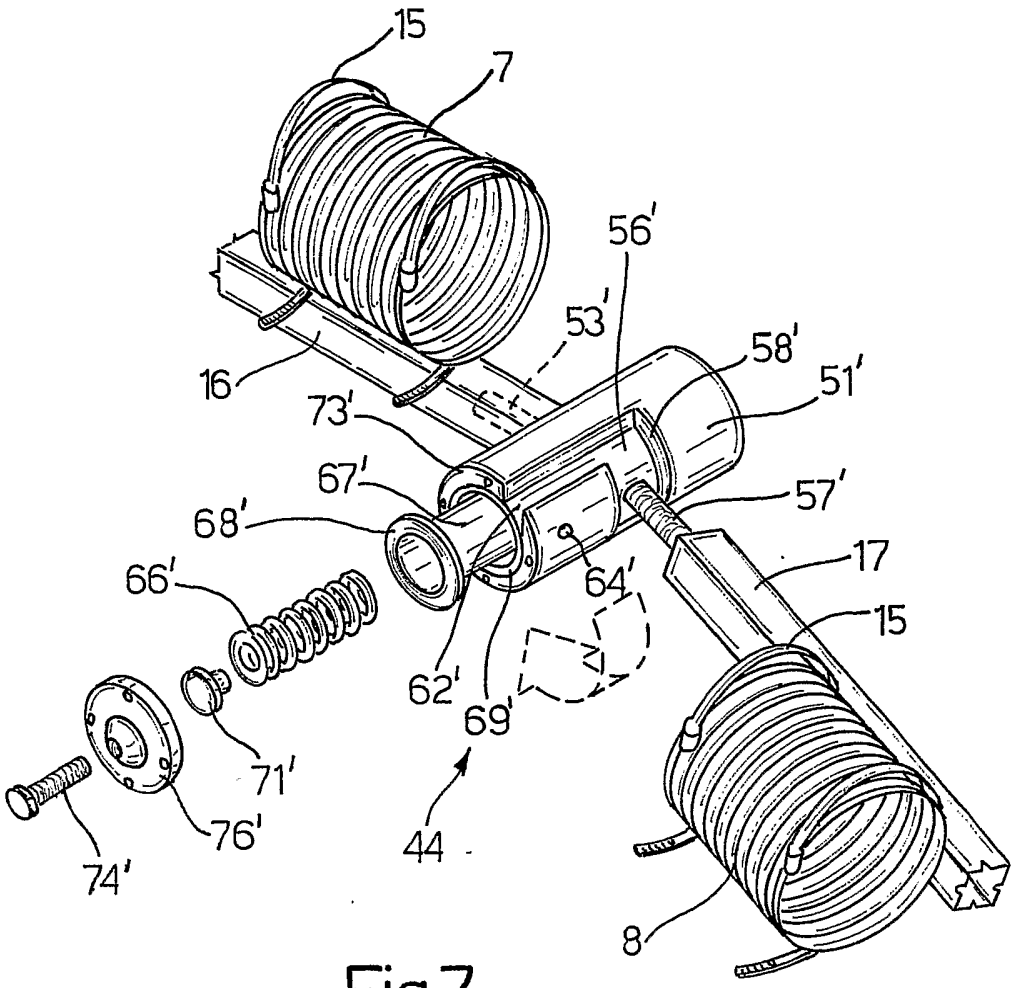
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Fig.7

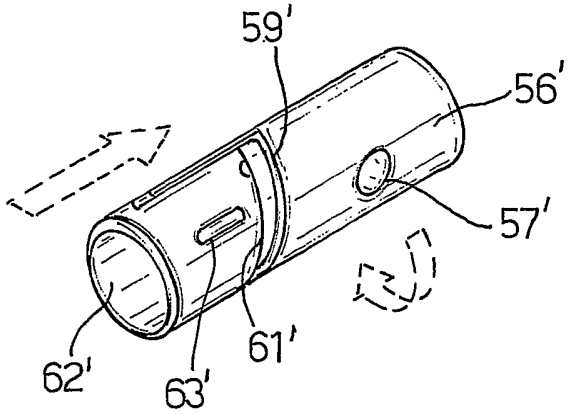
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Fig.8

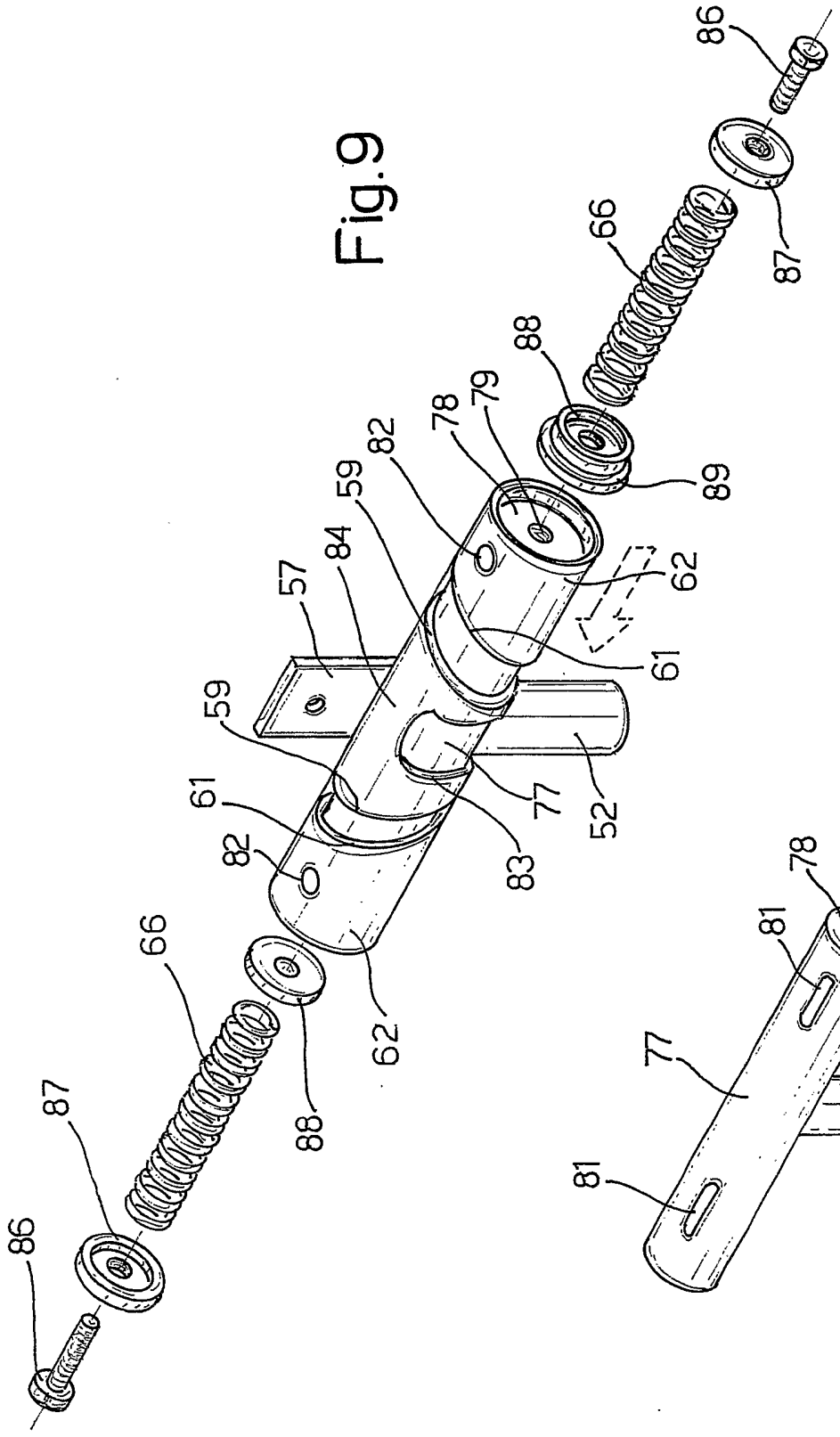
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Fig.9


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Fig.10

# INTERNATIONAL SEARCH REPORT

Internat Application No
PCT/IT 03/00318

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F16M11/04 B08B15/00 F16F15/28

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F16M B08B F16F E05F E05D B23K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data, PAJ, EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 4 768 762 A (LUND KURT O)<br>6 September 1988 (1988-09-06)<br>the whole document | 1,2,5,7,<br>8 |
| X<br><br>A | FR 974 634 A (MALOJA AG)<br>23 February 1951 (1951-02-23)<br>the whole document | 1,2,5,7,<br>9<br>6,10 |
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 9 October 2003 | 16/10/2003 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL – 2280 HV Rijswijk<br>Tel. (+31–70) 340–2040, Tx. 31 651 epo nl,<br>Fax: (+31–70) 340–3016 | Baron, C |

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