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(54) Title: AUTOMATIC RETURN HINGE WITH FORCE INVERTER FOR FIRE DOORS

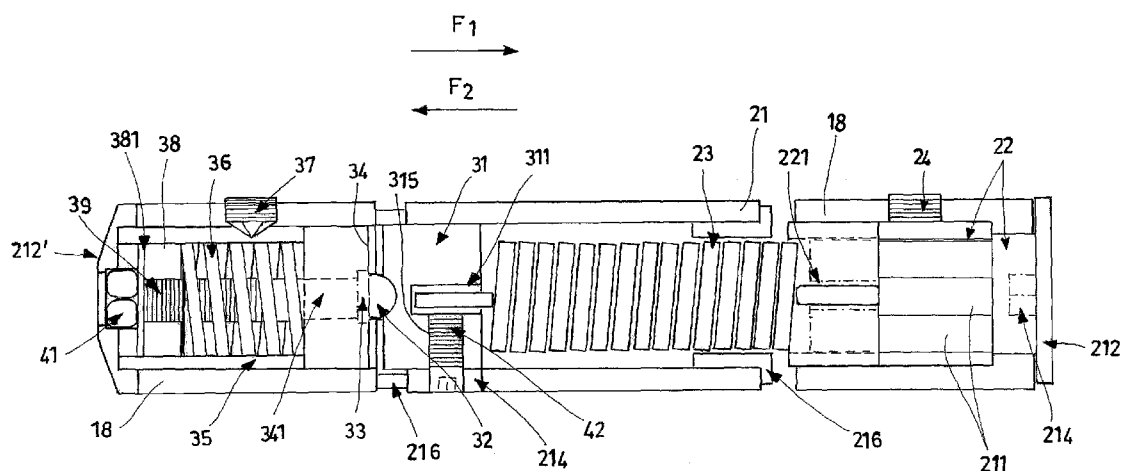


Fig.2

(57) Abstract: An automatic return hinge for fire doors adapted to be mounted on a wall (12) within a jamb frame (12') on which a leaf (14) of such door is provided. Such hinge comprises a frame-side portion (15) and a door-side portion (16), the frame-side portion is (U)-shaped and comprises a first fixing plate 17, which is fixed to the door case that extends in a pair of side tubular elements (18). The door-side portion comprises a second fixing plate (20), which is fixed to the door itself and rotates therewith, that extends in a central tubular element (21). The side tubular elements (18) and the central one (21) are aligned with each other to form altogether an overall tubular element inside which both an automatic door re-closing device and a device for inverting the force of the door re-closing movement are positioned, which cooperate with each other to generate a controlled movement of automatic re-closing, thus controlling the rotation movement of the central tubular element and accordingly of the second door fixing plate.



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AUTOMATIC RETURN HINGE WITH FORCE INVERTER FOR FIRE DOORS

The present invention relates to an automatic return hinge with force inverter for fire doors.

- 5 Currently, fire doors are self-closing doors that close by means of a torsion spring arranged in at least one hinge of the door that causes the loading of the return torsion spring when the door goes from closed to open at the maximum opening (180° or 90°). In releasing step, the energy of the spring is returned by the hinge, thus allowing
10 the automatic re-closing of the door.

Clearly, such return force is to be conveniently adjusted.

An example of such door is described in Patent Application EP2691589 to the same Applicant, in which there is described a device for adjusting the return force generated by such return spring.

- 15 Such device is usually inserted only in one of the two hinges that constrain the door upon opening.

- Once the door is released, it closes and the force of the spring is unloaded. In this return movement at the beginning step, from the moment the spring is loaded at the maximum possible caused by
20 opening, the door takes on a high speed, while accelerating, and may slam with extreme violence despite the adjustment device imposing the most adequate force. If the door is particularly heavy, as in the case of fire doors, the quick return may cause dangerous conditions, especially if there are children, youth or elderly people present who
25 could suffer the impact of such a door in a negative manner more than

other people. Moreover, the excessive closing speed may induce undesired vibrations on the door frame.

For this purpose, devices for inverting the force of the door contrasting the action of the return spring, have been proposed. Such
5 devices are positioned in the other hinge of the door, that is the one that does not have the return spring. They provide the presence of a further spring that contrasts the return spring of the other hinge only in the end portion of the closing stroke of the door, thus slowing down the speed in such section.

10 An example of such braking device is described in Patent Application EP2691588 to the same Applicant.

The Applicant has perceived that the closing movement of the door is improved by integrating the adjustment device with the spring and the force inversion or braking device in the same hinge.

15 One aspect of the present invention relates to an automatic return hinge with force inverter for fire doors having the features of appended claim 1.

The features and advantages of the present invention will be more apparent from the following description of an embodiment of the
20 invention, which is to be understood as exemplifying and not limiting, with reference to the schematic attached drawings, wherein:

- figure 1 shows a diagrammatic and summary view of a fire door provided with at least one hinge according to the present invention;

- figure 2 shows a partially cross-sectioned plan view of the hinge according to the invention, in open position with spring loaded;
- figure 3 is an overhead view of the hinge as shown in figure 2;
- figure 4a shows a perspective view of a cam body according to
5 the invention;
- figure 4b shows the cam body of figure 4a in a top view.

With reference to the mentioned drawings, the present invention applies to a fire door mounted on a wall 12 within a jamb frame 12' on which a leaf 14 is provided. A hinge, for example the upper one, is
10 made according to the present invention and is indicated as a whole with 11. The hinge 11 comprises a frame-side portion 15 and a door-side portion 16, both made from thick sheet metal, for example galvanized steel or other suitable metal material. The frame-side portion 15, which is U-shaped in elevated view, comprises a first fixing
15 plate 17, which is fixed to the frame of the door case that integrally extends in a pair of side tubular elements 18, that are folded at the ends of the fixing plate 17.

A square-folded connection area 19 is provided between the first fixing plate 17 and the tubular elements 18. The door-side portion 16 -
20 is also shaped as shown in side elevation view - comprises a second fixing plate 20, which is fixed to the door itself and rotates therewith, that extends in a central tubular element 21. A square-folded connection area is provided between the second fixing plate 20 and the central tubular element 21.

The side tubular elements 18 and the central one 21 are hinge-assembled substantially aligned with each other to form altogether an overall tubular element inside which both an automatic door re-closing device possibly provided with adjustment means of the re-closing force, and a device for inverting the force of the door re-closing movement, are positioned, which cooperate with each other to generate a controlled movement of automatic re-closing, thus controlling the rotation movement of the central tubular element 21 and accordingly of the second door fixing plate, thus avoiding the door to gain speed during closing.

Such re-closing controlled movement for a first corner portion is obtained due to the contribution of a torsion spring of the automatic re-closing device contrasted by the contribution of the force inverter device, while for a second corner portion until the closing of the door, it is obtained due to the sum of the contribution of such torsion spring of the re-closing device and the contribution of a further spring of the force inverter device, thus accelerating the automatic closing movement of the door in the last section thereof.

Such automatic re-closing device comprises, inside a side tubular element 18, a fixing body 22 provided with a boring 221 in which a first termination of a re-closing spring 23 (for example, a torsion spring) is inserted. Such fixing body is made integral with the tubular element 18 by means of a dowel 24 threaded in a cross hole obtained on such tubular element.

Such automatic re-closing device is provided with means for adjusting the torsion of such spring 23. Indeed, such fixing body is provided with a plurality of planar facets 211 so as to have a polygonal cross section. The dowel 24 presses on the facets when screwed in the tubular
5 element 18, thus blocking the possible rotation movement of the fixing body. Thereby, when the hinge is assembled and constrained to the door, by unscrewing the dowel, it is possible to act on the head of such fixing body provided with cap 212 and a suitable slotted screw or Allen screw 214, rotate the body by loading or unloading the torsion
10 of the spring 23. Once the adequate force for re-closing the door is selected, the dowel is re-screwed, causing it to abut with one of the faces or planar facets of the fixing body. The number of facets (i.e. twelve) determines just as many spring force adjustment positions.

The device for inverting the force is at the second end of the re-closing
15 spring, which device comprises a substantially cylindrical cam body 31 provided with a boring 311 in which such second termination of the spring 23 is inserted.

The surface of the cam body opposite to the one that has the boring has a wavy profile and comprises preferably four concave portions
20 312, preferably of equal sizes and degree of concavity, that join to one another in raised corners having a substantially triangular flat portion 314. The concave portions have rises 312' and depressions 312''.

Two balls 32 (or four) are housed in two opposite such concave portions, such balls being inserted in seats 33 obtained on the surface
25 of a closed base 34 of an internally hollow cylindrical body 35, having a

through hole 341 on such base and inside which a compression spring 36 is inserted.

Such cylindrical body is inserted and made integral with the tubular element 18 opposite to the one that comprises the fixing body 21 by
5 means of a pointed dowel 37, threaded in a cross hole obtained on such tubular element and that is inserted in a notch or hole or an equivalent housing obtained on the back of such cylindrical body 35.

At its end opposite to the one provided with the closed base 34, the cylindrical body 35 comprises a thrust bearing 38 with washer 381 for
10 lubrication that presses on the termination of the compression spring. The whole device for inverting the force is kept assembled by a through shaft 39 threaded at the termination thereof, that screws in a longitudinal central hole 341 of the cam body, that has a self-locking nut 41 at its tail. Such self-locking nut adjusts the degree of
15 compression of the spring and a crimping of the shaft is provided thereon so as to allow the adjustment of the compression by acting on the nut, however preventing it from being completely unscrewed.

In an alternative embodiment, the through shaft 39 is made in a single body with the cam 31 and has the end portion thereof threaded for its
20 coupling with the above self-locking nut.

The cam body is arranged in the overall tubular element so as to be covered by the central tubular element 21, that covers also the re-closing spring 23 and has a preferably internally threaded side hole 315 on its side surface. A slot 214 obtained on the central tubular
25 element allows the connection, for example by means of a screw 42

which is inserted in such slot 214 and which is screwed in the side hole 315, between such body and the central tubular element 21. Thereby, when the central tubular element 21 rotates due to the effect of the opening or closing movement of the door, the cam also integrally
5 rotates with it, ascending and descending according to the design of the cam. Sealing and self-lubricating bushings 216 are provided at the opposite ends of the central tubular element during the rotation movement of the tubular element so as to minimize the friction.

Closing caps 212, 212' are at the opposite ends of the hinge.

10 The hinge works in the following manner.

During the opening of the door, the rotation of the tubular element 21 plus the rotation of the cam 31 load the torsion spring 23 until the door is completely open (about 180° or 90° of rotation).

When the door is released, the force of the torsion spring is returned
15 to the cam, which transfers it in turn to the central tubular element 21, thus putting it into rotation to close the door. The "wavy" upper surface of the cam body has the balls that abut against these waves which in addition to the rotation in the cam body, also cause an axial movement (transmitted also to the shaft 39) contrasted by the force
20 of the compression spring when the balls are in the ascending portion of such concave portion, or favoured when the balls are in the descending portion of such concave portion.

When the balls 32 tend to ascend along the wavy profile of the cam body (moving the cam body in the direction of the arrow F1 in figure
25 3), the compression also increases of the torsion spring, which

advantageously has open coils; the compression spring contrasts the force released to the door by the torsion spring 23. When the balls 32 tend to descend along the wavy profile of the cam body (moving the cam body in the direction of the arrow F2 in figure 3), the compression
5 spring contributes to increasing the force released to the door by the torsion spring 23. Thereby, by conveniently positioning the cam body, firstly a deceleration effect is obtained (for example, from 90° to 45° of opening) and then a successive re-acceleration is obtained (from 45° to 0°) during the step of re-closing the door, thus ensuring the
10 complete and secure closing of the door. Clearly, the slowing down and re-acceleration effect in the end part of the closing movement depends on the waves of the cam and on the load given to the compression spring 36 by means of the self-locking nut 41. Indeed, if the concave portions are very deep, the axial movement of the cam
15 will be more pronounced, while if they are not very deep, there is less of an effect, the compression of the spring being equal. In the disclosed embodiment of the present invention, since there are four concave portions joined to one another, the cam has rises and depressions every 45° of movement. Other equivalent shapes of the
20 cam are possible.

The axial bearing on the end of the compression spring before the washer allows the spring to remain stopped during the rotation of the cam body.

The balls 32 are housed in a hole having size smaller than the diameter of the ball, so as to allow the balls themselves to be able to rotate and not cause friction.

In a further embodiment, three further balls (placed at 120° from one
5 another) that are smaller than the balls 32 are interposed between the hole for housing the balls 32 and the balls themselves, the further balls allowing an improved rotation of the balls 32 with respect to the housing. Moreover, a sealing ring nut is positioned on the balls 32, thus preventing them from coming out of the housings. Finally, a
10 guide bushing that abuts with the thrust bearing 38 is advantageously inserted in the compression spring 36.

Grouping two systems (automatic re-closing and force inverter) into a single hinge decreases the friction in the movement of the door with respect to inserting the re-closing device in one hinge and the device
15 for inverting the force in another one.

CLAIMS

1. Automatic return hinge for fire doors adapted to be mounted on a wall (12) within a jamb frame (12') on which a leaf (14) of such door is provided
- 5 such hinge comprises a frame-side portion (15) and a door-side portion (16),
the frame-side portion being (U)-shaped comprises a first fixing plate 17, which is fixed to the door case that extends in a pair of side tubular elements (18),
- 10 the door-side portion comprises a second fixing plate (20), which is fixed to the door itself and rotates therewith, that extends in a central tubular element (21),
the side tubular elements (18) and the central one (21) being, once the hinge is assembled, aligned with each other to form altogether an
- 15 overall tubular element inside which both an automatic door re-closing device, and a device for inverting the force of the door re-closing movement are positioned, which cooperate with each other to generate a controlled movement of automatic re-closing, controlling the rotation movement of the central tubular element and of the
- 20 second door fixing plate accordingly.
2. Hinge according to claim 1, wherein the re-closing controlled movement for a first corner portion is obtained due to the contribution of the torsion spring of the automatic re-closing device contrasted by the contribution of the force inverter device, while for a
- 25 second corner portion until the closing of the door, due to the sum of

the contribution of such torsion spring of the re-closing device and the contribution of a further spring of the force inverter device, accelerating the automatic closing movement of the door in the last section thereof.

5 3. Hinge according to claim 1, wherein such automatic re-closing device comprises, inside one of the two side tubular elements (18), a fixing body (22) provided with a boring (221) in which a first termination of a re-closing spring (23) is inserted, at the second end of such re-closing spring the force inverter device is present, which
10 device comprises a substantially cylindrical cam body (31) provided with a boring (311) in which such second termination of the spring (23) is inserted, the cam body is arranged in the overall tubular element so as to be covered by the central tubular element (21), which also covers the re-closing spring (23) such cam body being
15 integral with said central tubular element (21) which rotates due to the opening or closing movement of the door.

4. Hinge according to claim 3, wherein the cam body has a side hole (315) on its side surface, a slot (214) obtained on the central tubular element (21) allows the connection, for example by means of
20 a screw (42) which is inserted in such slot (214) and which is screwed in the side hole (315), between such body and the central tubular element (21).

5. Hinge according to claim 2, wherein such fixing body (22) is made integral with the tubular element (18) by means of a dowel (24)
25 threaded in a cross hole obtained on such tubular element.

6. Hinge according to claim 5, wherein such automatic re-closing device is provided with means for adjusting the torsion of such spring (23).
7. Hinge according to claim 6, wherein such means comprise a plurality of planar facets (211) obtained on such fixing body (22) so has to have a polygonal cross section, the dowel (24) presses on the facets when screwed in the tubular element (18), blocking the possible rotation movement of the fixing body, the number of facets determines a corresponding number of spring force adjustment positions.
8. Hinge according to claim 2, wherein the surface of the cam body opposite the one provided with the boring has a wavy profile and preferably comprises four concave portions (312) that are connected to each other, two balls (32) are housed in two opposite such concave portions, such balls being inserted in seats (33) obtained on the surface of a closed base (34) of a cylindrical body (35) integral with the internally hollow tubular element (18) having a through hole (341) on such base and inside which a compression spring (36) is inserted.
9. Hinge according to claim 8, wherein the cylindrical body, at its end opposite the one provided with the closed base, comprises a thrust bearing (38) with washer (381) for lubrication that presses on the termination of the compression spring, the whole force inverter device being kept assembled by a through threaded shaft (39) whose tip is screwed in the longitudinal central hole (341) of the cam body

which has, at its tail, a self-locking nut (41) that adjusts the degree of compression of the spring.

10. Hinge according to claim 9, wherein the balls (32) are housed in a hole having size smaller than the diameter of the ball, so as to allow
5 the balls themselves to be able to rotate and not cause friction.

11. Hinge according to claim 9, wherein the through shaft (39) is made in a single body with the cam (31) and has the end portion thereof threaded for its coupling with the above self-locking nut.

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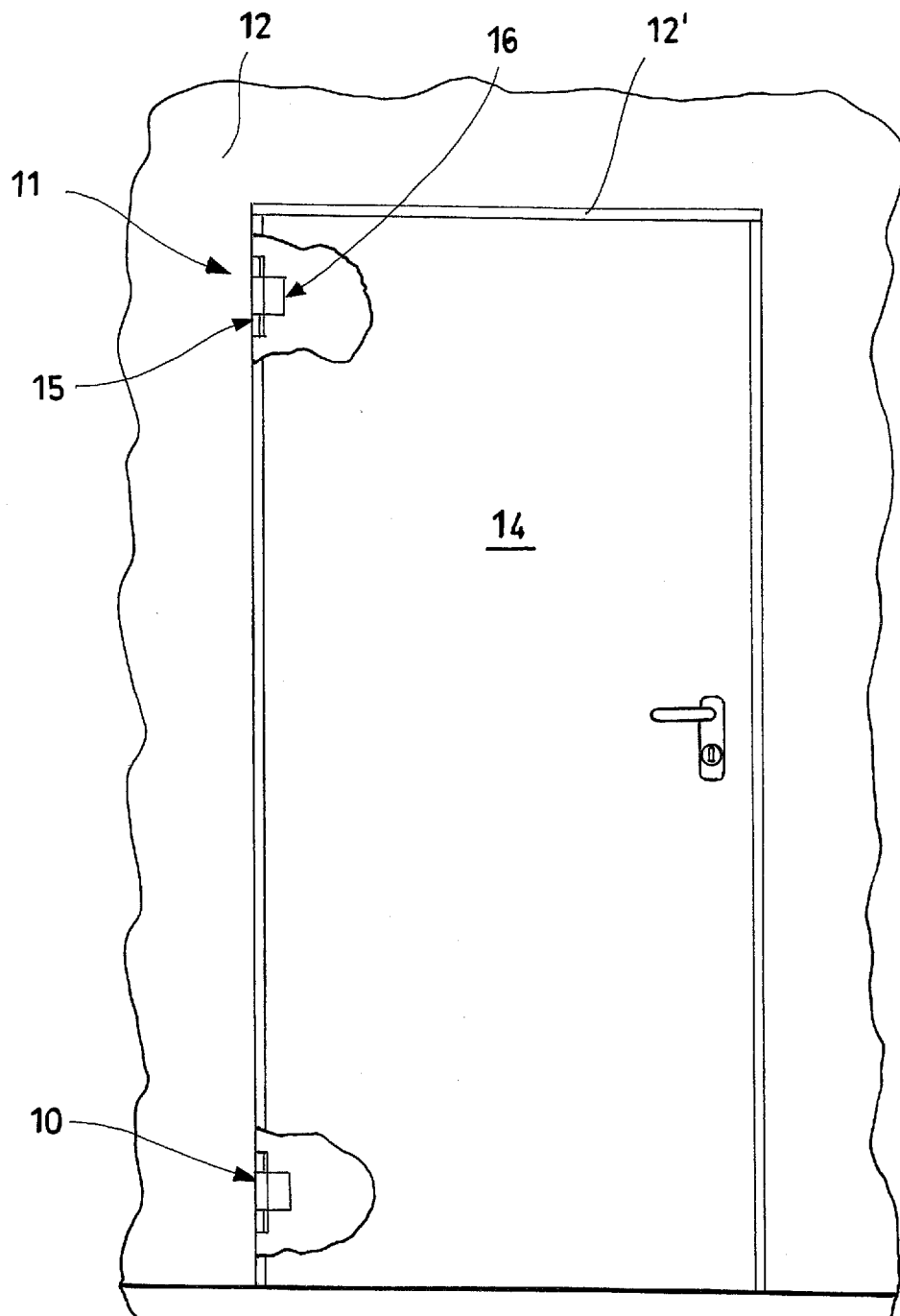


Fig.1

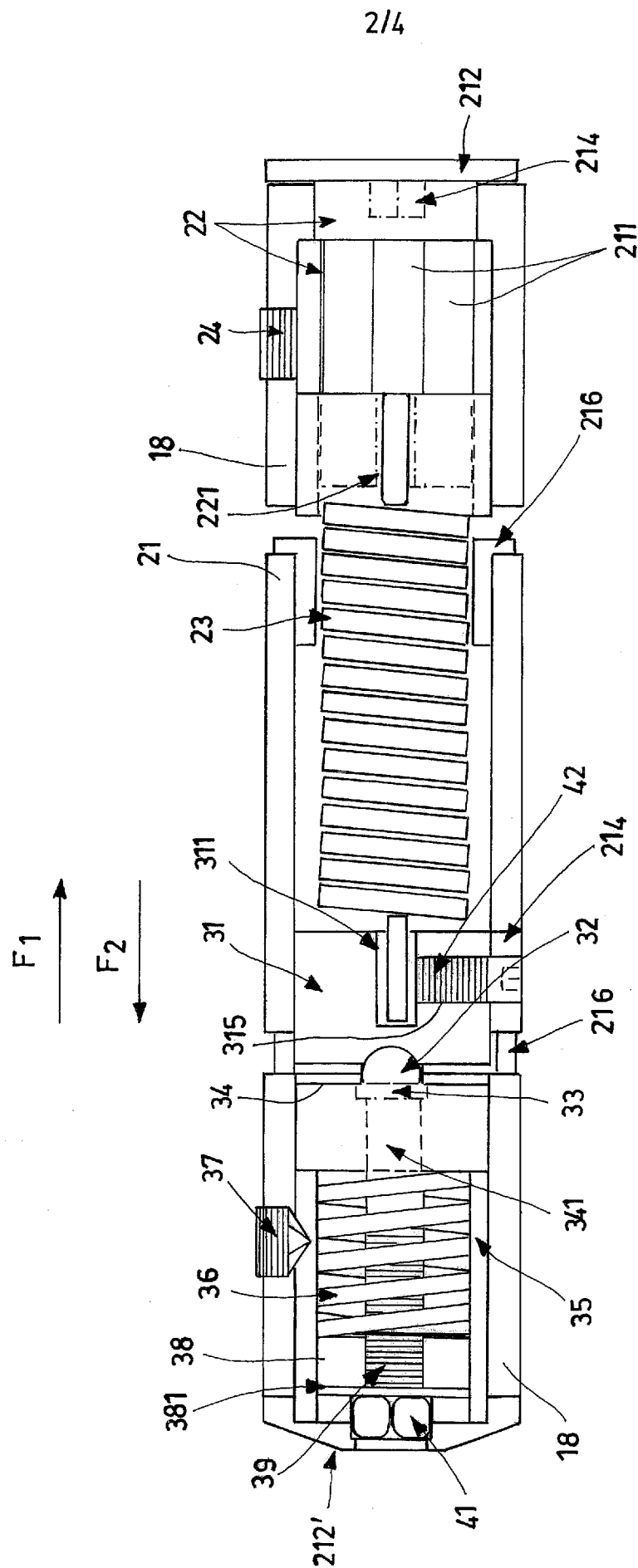


Fig. 2

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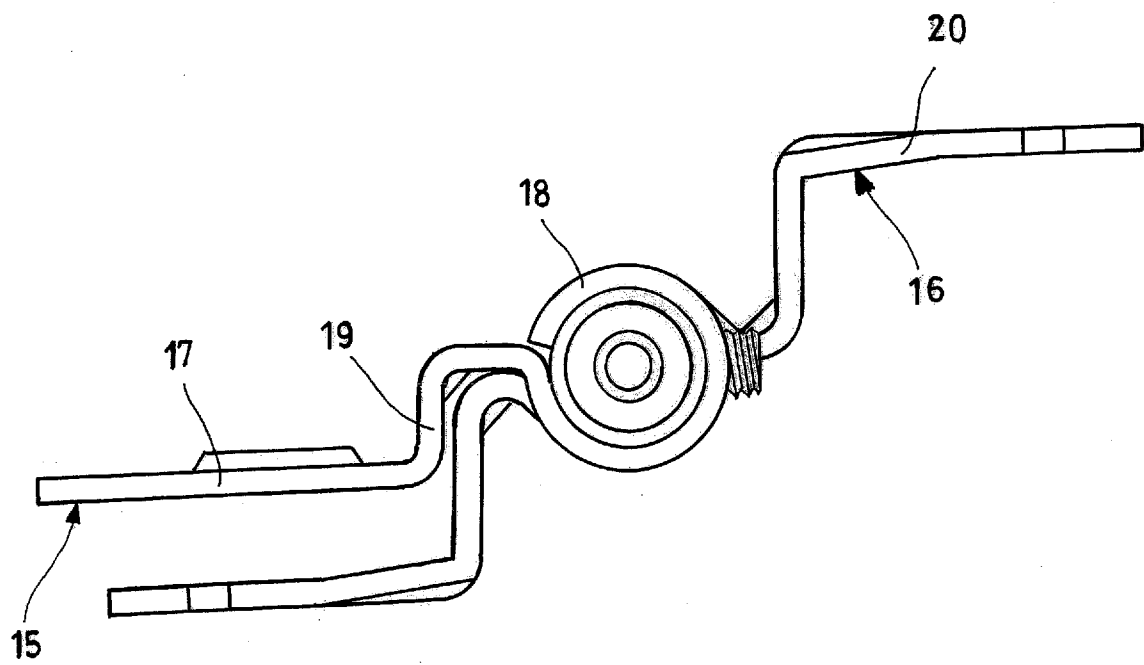


Fig.3

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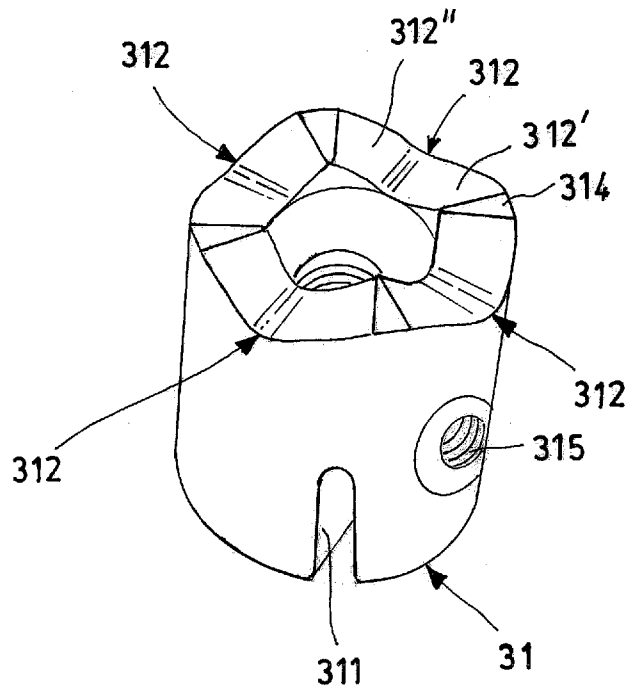


Fig.4a

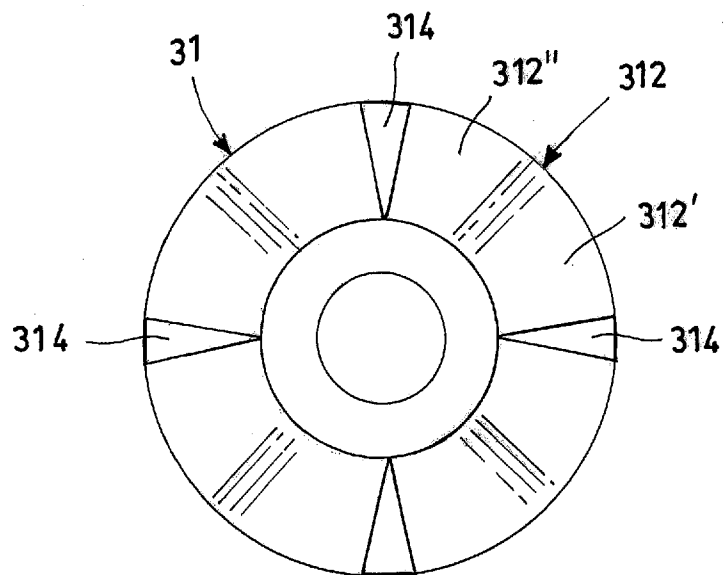


Fig.4b

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/054330

A. CLASSIFICATION OF SUBJECT MATTER
INV. E05F1/12 E05F3/20
ADD.

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)
E05F

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 practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2008/100035 A1 (JANG JONG-BOK [KR]) 21 August 2008 (2008-08-21)	1-6
Y	paragraphs [0035] - [0043], [0055] -	8-11
A	[0059], [0064] - [0074], [0080] - [0083]; figures 1-14	7
Y	----- WO 2012/131469 A1 (MAGGI S R L [IT]; MAGGI ROSELLA [IT]; MAGGI MARIO [IT]) 4 October 2012 (2012-10-04)	8-11
A	page 4, line 14 - page 9, line 11; figures 1-8	1
X	----- US 2013/205543 A1 (CHEN WATERSON [TW]) 15 August 2013 (2013-08-15) paragraphs [0025] - [0029]; figures 1-12	1-3,8,9



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2017/054330

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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