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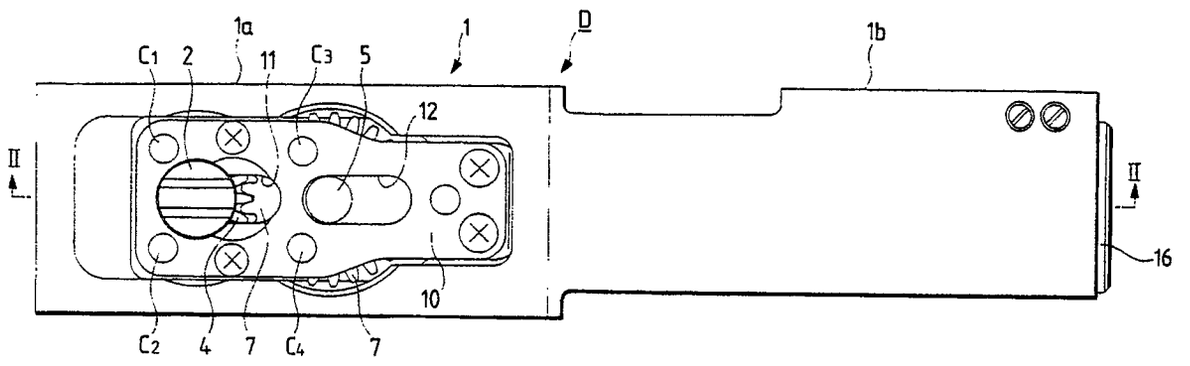
(54) Door Closer.

(57) A door closer (D) for a door is provided with a main shaft (2) to which a cam (3) is secured. The cam (3) is secured to a connecting rod (52) having a piston (14). A return spring (13) is urged by the linear movement of the piston (14). A sub-shaft (5) provided with a cam (6) is disposed near the main shaft (2), and the sub-shaft (5) and the main shaft (2) are connected through the gear engagement with a gear ratio of less than 1 so that the sub-shaft (5) is rotated by an angle of less than 180° even in a case where the main shaft (2) is rotated by an angle of more than 180°. Cam followers (C1 to C4) are disposed in association with the cams (3, 6) and secured to sliding plates (10) connected to the connecting rod (52). The cam followers (C1 to C4) are disposed in such a positional relationship as that when the door is rotated by a small angle, the cam (3) of the main shaft (2) contacts the associated roller (C1 to C2), and that when the door is rotated by a large angle, the cam (6) of the sub-shaft (5) contacts the associated roller (C3 or C4).

FIG. 1



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DOOR CLOSER

BACKGROUND OF THE INVENTION

The present invention relates to a door closer attached to a hinge member of a door and adapted to smoothly open or close the door.

In general, a door closer to be attached to a hinge member of a door comprises a main shaft to be connected to the hinge member of the door and a cam integrally secured to the main shaft. A cam follower is disposed in opposition to the cam and the cam follower is secured to a sliding plate bilaterally reciprocating in a casing, the sliding plate being connected to a connecting rod supporting a piston, which is accommodated in a cylinder in which a return spring is also accommodated. A hydraulic oil is contained in the cylinder.

When the door is rotated, the main shaft is also rotated. The rotation of the main shaft is converted into the linear movement of the connecting rod through the cam and the cam follower, whereby the piston is finally moved linearly in the cylinder while compressing the return spring.

In case that a general conventional door closer is utilized for a bilaterally openable door, and the door is rotated by more than 180°, the main shaft is rotated by more than 180° and, hence, the main shaft is liably to be further rotated in the same rotating direction by the returning force of the return spring. Namely, the return force of the return spring is not applied in a direction reverse to the door opening direction (door closing direction) but it is applied to the door so as to further open the same. Accordingly, in the door closer of the character described above, it is impossible to automatically close the door in a case where the door is rotated to open the same by more than 180°.

Furthermore, conventional door closers include a door closer of the type in which the return force is applied in a direction to close the door even in the door opening angles of more than 180°. However, with the door closer of this conventional type, the return force is applied only in one direction, i.e. counterclockwise or clockwise direction, and the door closer of this type is not utilized for the door which can be opened in the reverse direction. Thus, the door closer of this type is limited in the usage thereof in accordance with the opening direction of the door. Namely, it is required to provide individual door closers for the respective opening directions of a biparting door and a right and left swing door, thereby involving troublesome working and resulting in the cost increasing.

SUMMARY OF THE INVENTION

It is an object of the present invention to substantially eliminate the defects or drawbacks encountered to the prior art and to provide a door closer capable of applying door closing force to the door even if the door is opened in either one of the clockwise and counterclockwise directions over 180°.

This and other objects can be achieved according to the present invention by providing, a door closer comprises a main shaft rotated in accordance with rotation of a door and having a cam whose rotation causes a linear movement of a connecting rod connected to a piston thereby to accumulate a return force in a return spring, characterized in that a sub-shaft provided with a cam is disposed near the main shaft, the sub-shaft and the main shaft are provided with gears respectively through which the main shaft and the sub-shaft are operatively engaged with a gear ratio of less than 1 so that the sub-shaft is rotated by an angle of less than 180° even in a case where the main shaft is rotated by an angle of more than 180°, and rollers acting as cam followers are disposed in association with the cams of the main and subshafts and secured to sliding plates connected to the connecting rod, said rollers being disposed in such a positional relationship as that when the door is rotated by a small angle, the cam of the main shaft contacts the associated roller with the cam of the sub-shaft being separated from the associated roller and, that when the door is rotated by a large angle, the cam of the sub-shaft contacts the associated roller with the cam of the main shaft being separated from the associated roller.

According to the door closer of the present invention of the character described above, the sub-shaft is disposed near the main shaft which is rotated in accordance with the rotation of the door, and the main shaft and the sub-shaft are operatively connected through the gear engagement with each other with the gear ratio of less than 1 so that the sub-shaft is rotated by an angle of less than 180° even in a case where the main shaft is rotated by an angle of more than 180°. The cams are secured to the main and sub-shafts, respectively, and the rollers acting as cam followers are secured to the sliding plates so as to be in operative association with the corresponding cams. The sliding plates are connected to one end of the connecting rod having the other end to which the piston is connected so as to reciprocate linearly. The rollers are disposed in such a positional rela-

tionship as that when the door is rotated by a small angle, the cam of the main shaft contacts the associated roller with the cam of the sub-shaft being separated from the associated roller, and that when the door is rotated by a large angle, the cam of the sub-shaft contacts the associated roller with the cam of the main shaft being separated from the associated roller. In accordance with the gear ratio of the gears secured to the main shaft and the sub-shaft, the sub-shaft is rotated by an angle of less than 180° even in a case where the main shaft is rotated by an angle of more than 180°. When the door is opened widely, the piston is linearly moved through the connecting rod in association with the cooperation of the cam secured to the sub-shaft and the corresponding cam follower, and, during this operation, the cam secured to the main shaft and the corresponding cam follower do not function to move the piston. Accordingly, even in a case where the door is rotated by an angle of more than 180°, the sub-shaft is rotated by an angle of less than 180°, and, hence, the return force to close the door is applied to the door when the door is released. Therefore, the door can be automatically surely closed even in a case where the door is rotated by an angle of more than 180° in the counterclockwise and clockwise directions.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention and to show how to carry out the same, reference is now made, by way of a preferred embodiment, to the accompanying drawings, in which:

Fig. 1 is a plan view of a door closer according to the present invention;

Fig. 2 is a sectional view taken along the line II-II shown in Fig. 1;

Fig. 3 is a plan view, partially in section, showing a condition of the door closer with the upper one of the sliding plates removed;

Fig. 4 is a plan view, partially in section, of the door closer in a case where the door is rotated by an angle of about 5°;

Fig. 5 is a plan view, partially in section, of the door closer in a case where the door is rotated by an angle of about 20°;

Fig. 6 is a plan view, partially in section, of the door closer in a case where the door is rotated by an angle of about 90°;

Fig. 7 is a plan view, partially in section, of the door closer in a case where the door is rotated by an angle of about 180°; and

Fig. 8 is a plan view, partially in section, of the door closer in a case where the door is rotated by an angle of about 190°.

DESCRIPTION OF THE PREFERRED EMBODIMENT

One preferred embodiment of a door closer according to the present invention will be described hereunder with reference to Figs. 1 to 3, in which a door closer D of the present invention is provided with an outer casing 1 comprising a box-shaped driving unit 1a disposed on the leftside as viewed and a cylinder assembly 1b connected to the driving unit 1a. A main shaft 2 to be connected to a hinge member of a rotatable door is incorporated in the driving unit 1a, and a cam 3 having substantially circular configuration is secured integrally to a central portion of the main shaft 2. A gear 4 for the main shaft 2 is secured to the lower portion of the cam 3.

A sub-shaft 5 is also disposed adjacent to the main shaft 2 with a predetermined space on the longitudinal central axis of the door closer. The sub-shaft 5 is provided with a central portion at which a leaf-shaped cam 6 is disposed in a plane on which the cam 3 is also located. A gear 7 for the sub-shaft 5 is arranged below the cam 6. The gear 7 is meshed with the gear 4 with a gear ratio of less than 1, for example 1/1.7, so that even when the main shaft 2 is rotated by more than 180°, the rotation angle of the sub-shaft 5 is restricted to be less than 180°.

The driving unit 1a is closed by a lid member 30 to which a bearing 20a is mounted, and the main shaft 2 is supported in the bearing 20a to be rotatable. The lower end of the main shaft 2 is supported to be rotatable by a bearing 20b secured to the lower surface of the casing 1. The sub-shaft 5 is also supported to be rotatable at the upper end thereof by a bearing 8a secured to the inner surface of the lid member 30, and the lower end of the sub-shaft 5 is supported to be rotatable by a bearing 8b secured to the lower surface of the casing 1.

The upper and lower portions of the cams 3 and 6 of the main and sub shafts 2 and 5 are slidably guided by the sliding plates 10 and 10, respectively, and two rollers C1, C2 and two rollers C3, C4 acting as cam followers are supported to be rotatable between the sliding plates 10 and 10. The rollers C1 and C2 are disposed with a space in the widthwise direction of the casing 1 and operated in association with the cam 3 of the main shaft 2. The rollers C3 and C4 are disposed with a space in the widthwise direction of the casing 1 and operated in association with the cam 6 of the sub-shaft 5. The respective rollers C1 to C4 are secured to the sliding plates 10 in such a positional relationship as

that when the rotating angle of the main shaft 2 is small, the cam 3 contacts the rollers C1 and C2 with the cam 6 being separated from the rollers C3 and C4, and that, reversely, when the rotating angle of the main shaft 2 is large, the cam 6 contacts the rollers C3 and C4 with the cam 3 being separated from the rollers C1 and C2.

The sliding plates 10 are provided with a pair of slits 11 for the main shaft 2 and a pair of slits 12, separated from the slits 11, for the sub-shaft 5. These slits 11 and 12 act as guide holes for the bilateral sliding movements of the sliding plates 10. A restrictive roller P is provided for the sliding plates 10 on the side of the cylinder assembly 1b of the casing 1. The restrictive roller P serves to prevent the cam 6 from rotating at a time when the door is rapidly closed by an outer force such as wind, for example. These sliding plates 10 are secured to one end of the connecting rod 52 having the other end connected to the piston 14 through a pin 15.

In the cylinder assembly 1b of the casing 1 is accommodated a return spring 13, which is disposed between the piston 14 and the leftside inner wall, as viewed, of the cylinder assembly and adapted to be expanded or contracted when the piston 14 is moved bilaterally. In the cylinder assembly 1b is also accommodated the hydraulic oil, which is moved in accordance with the movement of the piston 14 between the pressure chambers A and B formed on both the sides of the piston 14. The front end of the cylinder assembly 1b is closed by an end plug 16 as shown in Fig. 3. An oil communication passage 18 extends from a portion near the end plug 16 through a thickened portion of the casing 1 and is opened to the pressure chamber A of the piston 14.

A passage 21 is formed in the central portion of the piston 14 and a ball valve 17 is incorporated in the passage 21 so as to move the hydraulic oil in the lefthand pressure chamber A to the righthand pressure chamber B when the piston 14 is moved leftwardly, as viewed in Fig. 2, for example, against the spring force of the return spring 13 when the door is opened. The ball valve 17 also acts as a check valve, and the hydraulic oil in the pressure chamber B is moved into the pressure chamber A through the passage 18 in case that the piston 14 is moved rightwardly in accordance with the return spring force of the return spring 13. In the manner described above, the smooth bilateral movements of the piston 14 can be ensured.

The cam 3 mounted to the main shaft 2 has a smaller diameter portion 3b positioned on the leftside as viewed in Fig. 3, a larger diameter portion 3a positioned on the rightside as viewed and two converting curved portions 3c connecting the smaller and larger diameter portions 3b and 3a with each other. The leaf-shaped cam 6 mounted to the sub-shaft 5 has two loosely curved portions 6a and 6a, a smaller diameter portion 6c having a small radius of curvature and two converting curved portions 6b and 6b connecting the smaller diameter portion 6c and the loosely curved portions 6a with each other. The loosely curved portions 6a are formed to be bilaterally symmetrical with the longitudinal axis of the cam 6, and the smaller diameter portion 6c is formed on the side opposite to the loosely curved portions 6a.

The door closer D of the structure described above will operate in the manner described hereunder.

Figs. 1 to 3 represent the condition of the door closer at a time when the door is fully closed, i.e. at a rotation angle of the door of 0°. In the illustrated condition, the inverting curved portions 3c and 3c of the cam 3 of the main shaft 2 are engaged respectively with the rollers as cam followers C1 and C2 secured to the sliding plates 10, and the curved portions 6b and 6b of the cam 6 of the sub-shaft 5 are loosely engaged with the rollers as cam followers C3 and C4 secured to the sliding plates 10. The piston 14 is positioned adjacent to the end plug 16 of the cylinder assembly 1b. Under the described condition, the sliding plates 10 are positioned at the most rightward position as viewed, and the main shaft 2 and the sub-shaft 5 are positioned near the leftside ends of the slits 11 and 12 formed in the sliding plates 10.

Fig. 4 represents the condition in which the door is rotated counterclockwisely by an angle of 5° to open the same. Referring to Fig. 4, when the door is rotated by an angle of 5°, the main shaft 2 is also rotated counterclockwisely by an angle of 5° and, hence, the sub-shaft 5 is rotated clockwisely by an angle of 2.9° because the gear ratio of the main shaft with respect to the sub-shaft is 1 : 1.7. During these rotations of the main and sub-shafts, the upper curved portion 3c, as viewed in Fig. 4, of the cam 3 of the main shaft 2 presses the roller C1 leftwardly, also as viewed, and the sliding plates 10 are moved leftwardly by the associated operation of the curved portion 3c and the roller C1. Accordingly, the piston 14 is moved leftwardly. During these operations, the rotation of the cam 6 of the sub-shaft 5 does not function to move the the sliding plates 10 in the bilateral direction.

Fig. 5 represents the condition of the door closer at a time when the door is further opened to an angle of about 20°, in which the main shaft 2 is rotated counterclockwisely by an angle of about 20°, and the sub-shaft 5 is rotated clockwisely by about 11.7° because of the gear ratio described above. During this operation, the cam 3 of the main shaft 2 is not operatively associated with the rollers C1 and C2, which are separated from the cam

surface of the cam 3. On the other hand, at this time, the lower curved portion 6b as viewed in Fig. 5, of the cam 6 of the sub-shaft 5 is operatively associated with the corresponding roller C4, whereby the piston 14 is moved leftwardly, as viewed, and the return spring 13 is compressed. In other wards, when the door opening angle reaches about 20°, the cam 3 and the associated rollers C1 and C2 does not function to move linearly the connecting rod 12 and, hence, the piston 14. In this state, the cam 6 and the corresponding roller C4 affect the linear movement of the piston 14.

Fig. 6 represents the door closer of the condition in which the door is further rotated counterclockwisely to an angle of about 90° to open the same. During this rotation of the door, the piston 14 is moved leftwardly, as viewed in Fig. 6, only by the cooperation of the lower roller C4 and the corresponding curved portion 6b of the cam 6.

Fig. 7 represents the door closer of the condition in which the door is rotated clockwisely to open the same by 180°. During this operation, the sub-shaft 5 is rotated clockwisely by an angle of 105.8° because of the gear ratio described above. Only the cooperation of the loosely curved portion 6a of the cam 6 and the roller C4 affects the leftward linear movement, as viewed in Fig. 7, of the piston 14.

Fig. 8 represents the door closer of the condition in which the door is rotated by about 190° to open the same in the clockwise direction. In accordance with this rotation of the door, the sub-shaft 5 is also rotated clockwisely by an angle of 111.7° and only the loosely curved portion 6a and the roller C4 affect the linear movement of the piston 14.

As described above, even if the door is rotated by an angle of more than 180°, the cam 6 secured to the sub-shaft is rotated by an angle of less than 180°. Under these conditions, when the door is opened, the sub-shaft 5 is rotated in the reverse direction by the spring force of the return spring 13, and, in accordance with the rotation of the sub-shaft 5, the main shaft 2 is rotated in the direction reverse to the rotating direction of the sub-shaft 5, resulting in the generation of the force in a direction to close the door.

In the foregoing descriptions of one preferred embodiment of the present invention, is disclosed a case in which the door is rotated in the counterclockwise direction, but the present invention is applicable to a case in which the door is rotated in the clockwise direction. Namely, in the door closer of the present invention, the cams 3 and 6 have the symmetrical shapes in their outer configuration, and the rollers C1, C2, C3 and C4 are arranged at portions symmetrical with respect to the longitudinal axis of the door closer, so that when the door is rotated in the clockwise direction, the sub-shaft 5 is rotated in the reverse direction. In this case, the roller C3 and the loosely curved portion 6a of the corresponding cam 6 are cooperated to thereby linearly move the piston 14. Accordingly, even in a case in which the door is rotated by an angle of more than 180° in either one of the counterclockwise and clockwise directions, the return force is always applied to the door and, hence, the door can be automatically closed when the door is released.

In a modification, the cam 6 may be provided with a cutout with which the roller C3 or C4 is engaged for attaining a door stop function.

It is to be understood by persons in the skilled art that the present invention is not limited to the described preferred embodiment and many other changes and modifications may be made without departing from the scope of the appended claims.

Claims

1. A door closer comprises a main shaft rotated in accordance with rotation of a door and having a cam whose rotation causes a linear movement of a connecting rod having a piston thereby to accumulate a return force in a return spring, characterized in that a sub-shaft (5) provided with a cam (6) is disposed near the main shaft (2), the sub-shaft (5) and the main shaft (2) are provided with gears (4, 7) respectively through which the main shaft (2) and the subshaft (5) are operatively engaged with a gear ratio of less than 1 so that the sub-shaft (5) is rotated by an angle of less than 180° even in a case where the main shaft (2) is rotated by an angle of more than 180°, and rollers acting as cam followers (C1, C2; C3, C4) are disposed in association with the cams (3, 6) of the main and sub-shafts (2, 5) and secured to sliding plates (10) connected to the connecting rod (52), said rollers (C1, C2; C3, C4) being, disposed in such a positional relationship as that when the door is rotated by a small angle, the cam (3) of the main shaft (2) contacts the associated roller (C1 or C2) with cam (6) of the sub-shaft (5) being separated from the associated roller (C3 or C4), and that when the door is rotated by a large angle, the cam (6) of the sub-shaft (5) contacts the associated roller (C3 or C4) with the cam (3) of the main shaft (2) is separated from the associated roller (C1 or C2).

2. A door closer according to claim 1, wherein a gear ratio of the gear (4) of the main shaft (2) with respect to a gear (7) of the sub-shaft (5) is about 1 : 1.7.

3. A door closer according to claim 1 or 2, wherein the cams (3, 6) have outer configurations symmetrical respectively with respect to the longitudinal

direction of the door closer (D).

4. A door closer according to one of claims 1 to 3, where in the rollers (C1 to C4) are arranged symmetrically respectively with respect to the longitudinal axis of the door closer (D).

5. A door closer according to one of claims 1 to 4, wherein said cam (6) a cutout with which said roller (C3 or C4) is engaged for attaining a door stop function.

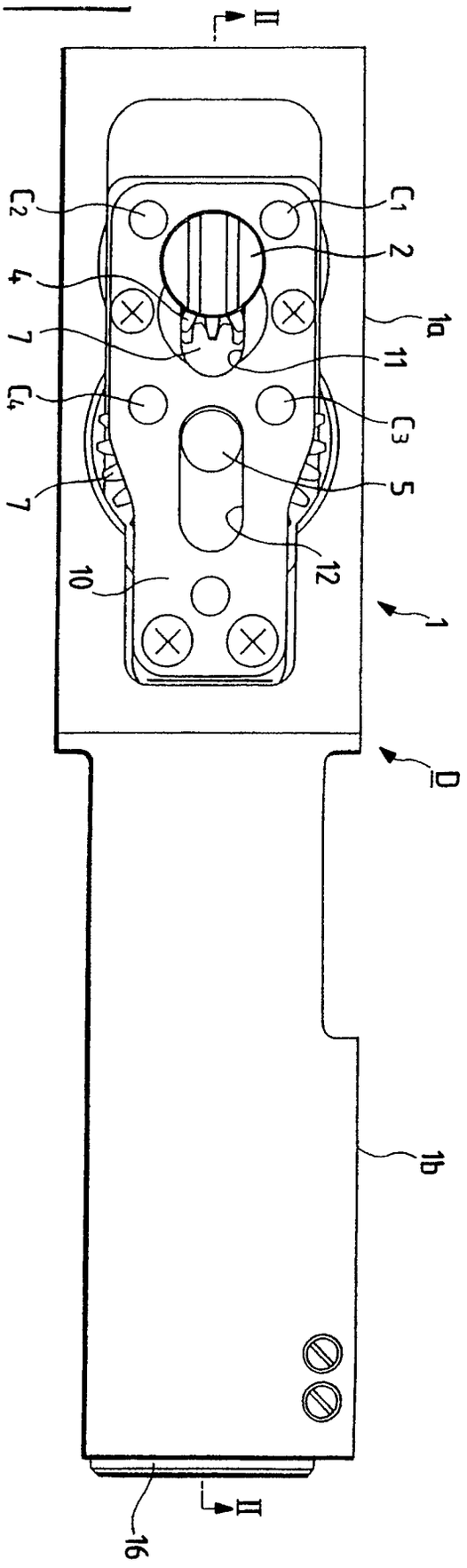
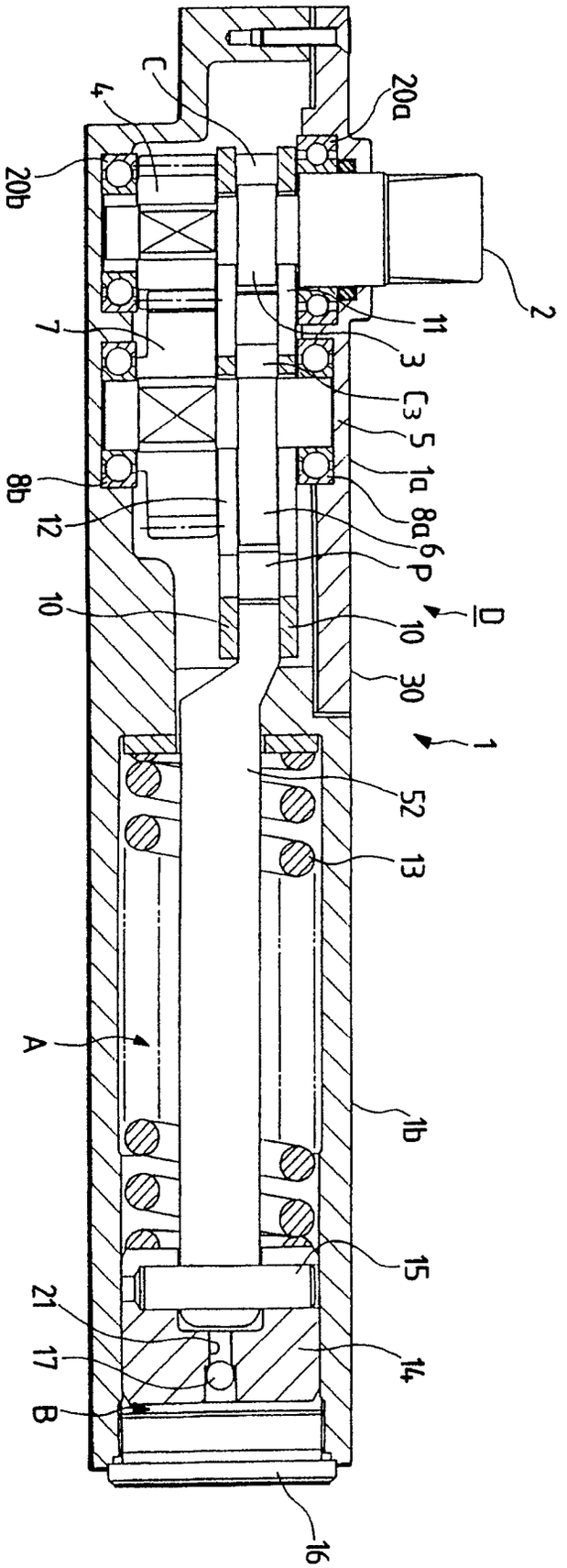


FIG. 1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20b
2
11
7
3
C3
5
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8a
8b
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10
30
1
52
13
A
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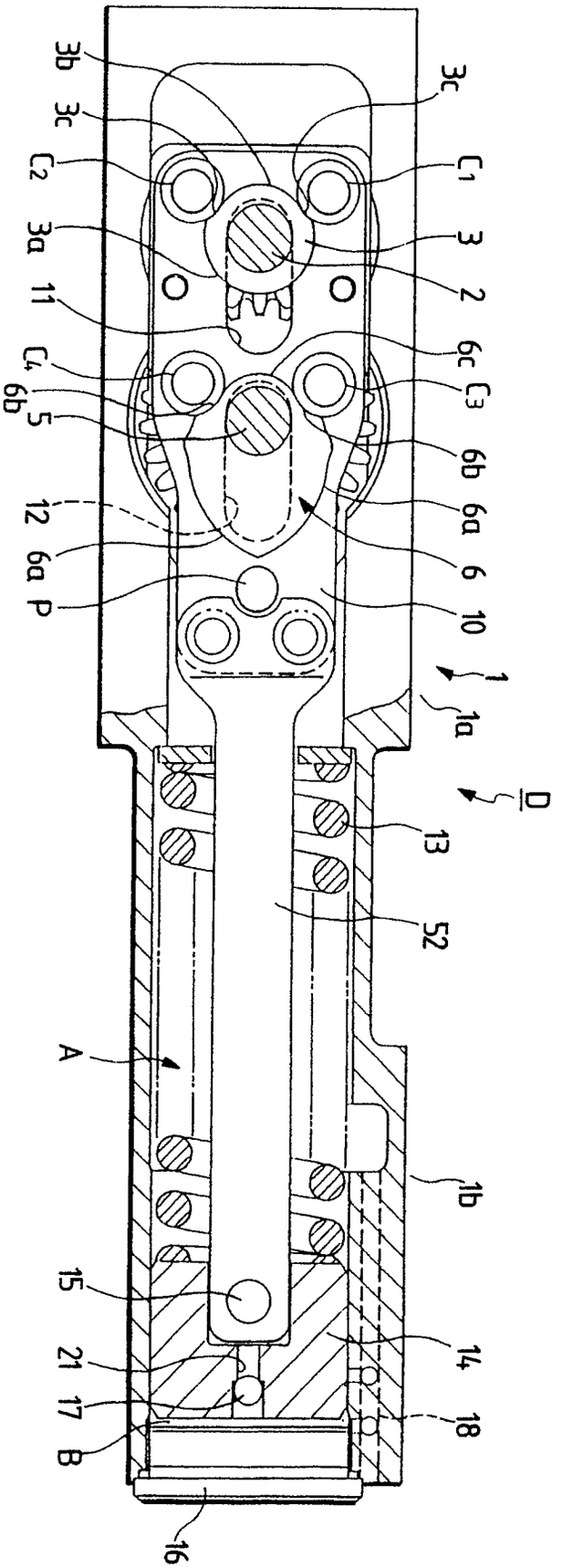
15
21
14
17
B
16

FIG. 2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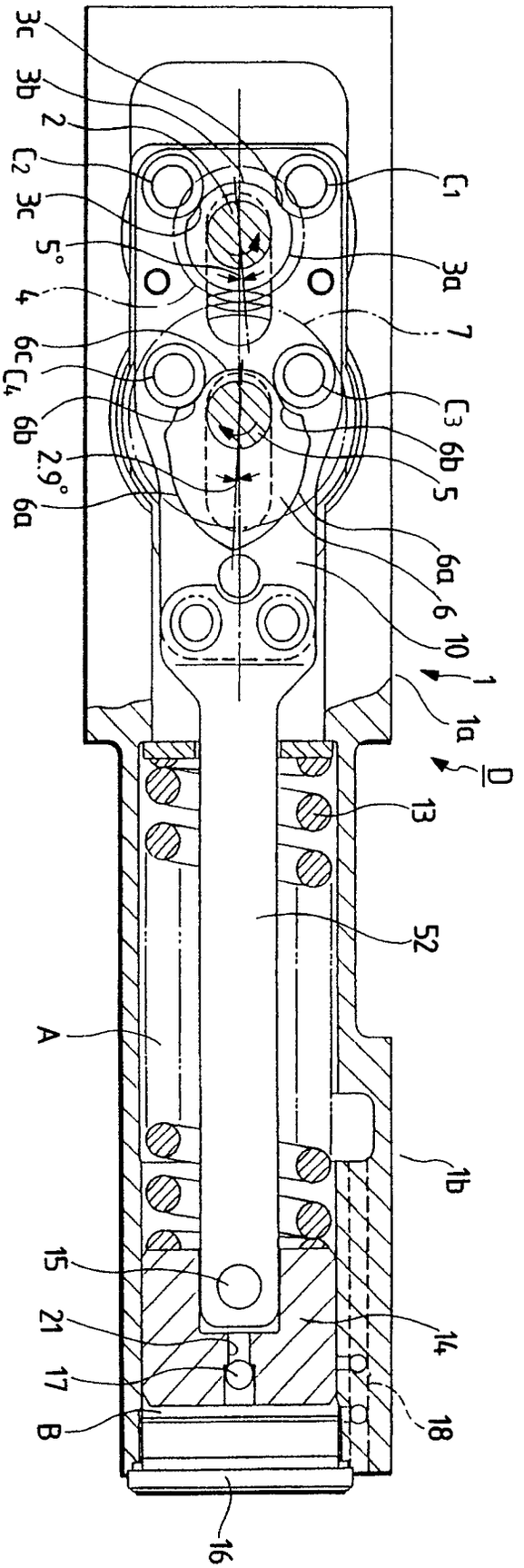
14
18

FIG. 3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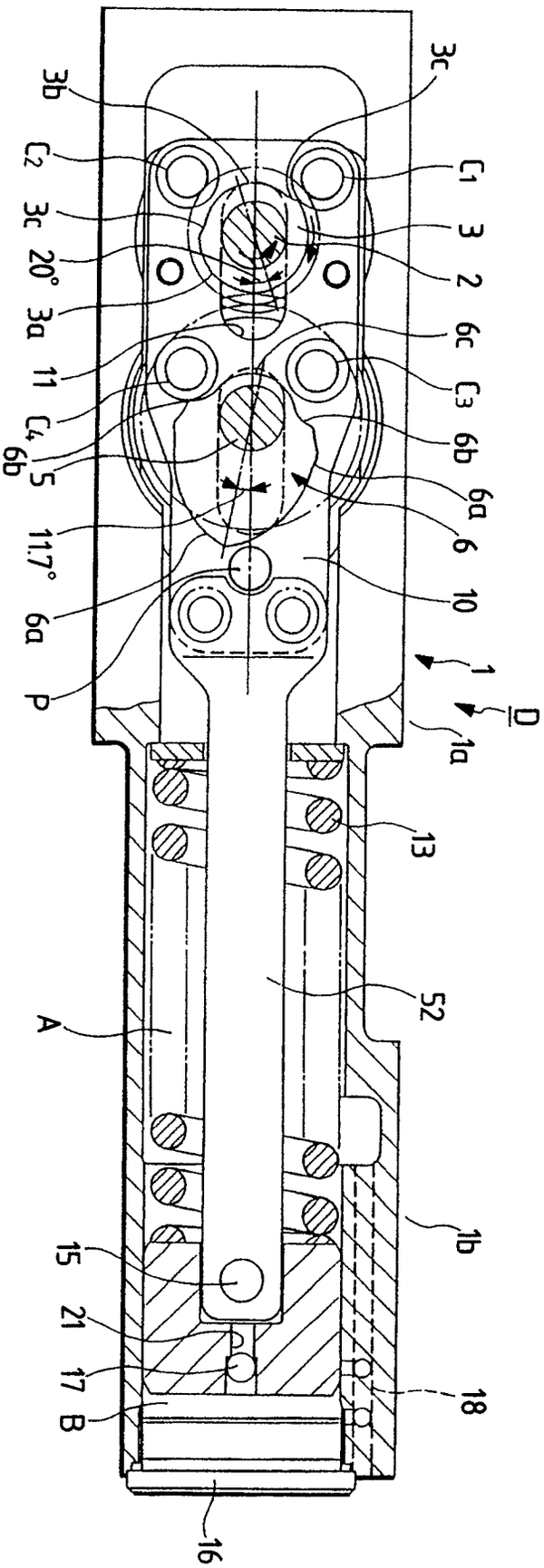
16

FIG. 4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11.7°
6
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D
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FIG. 5

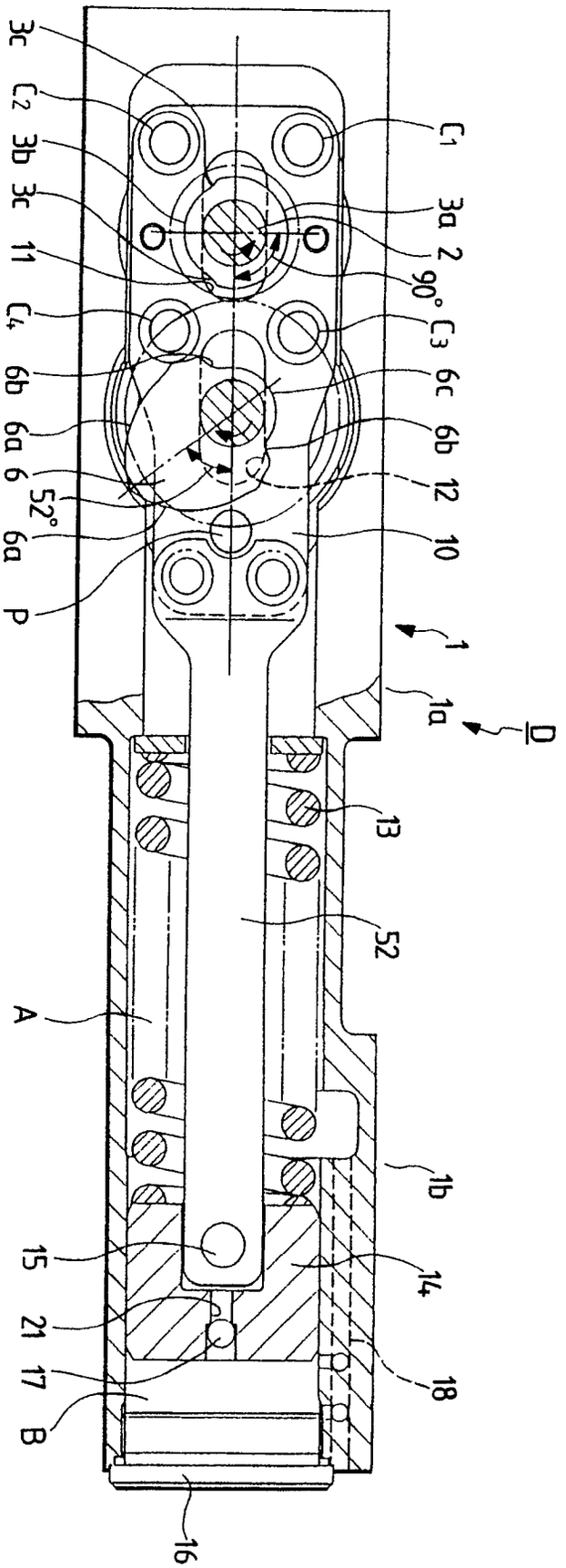
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FIG. 6

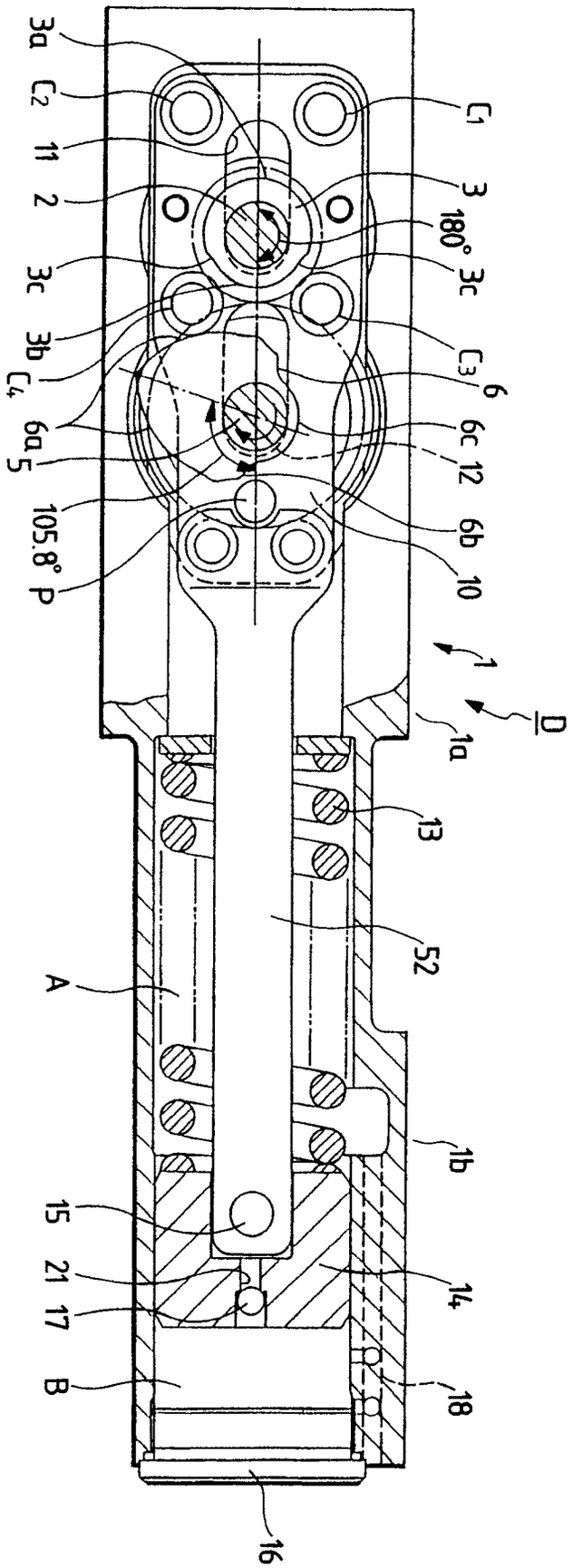
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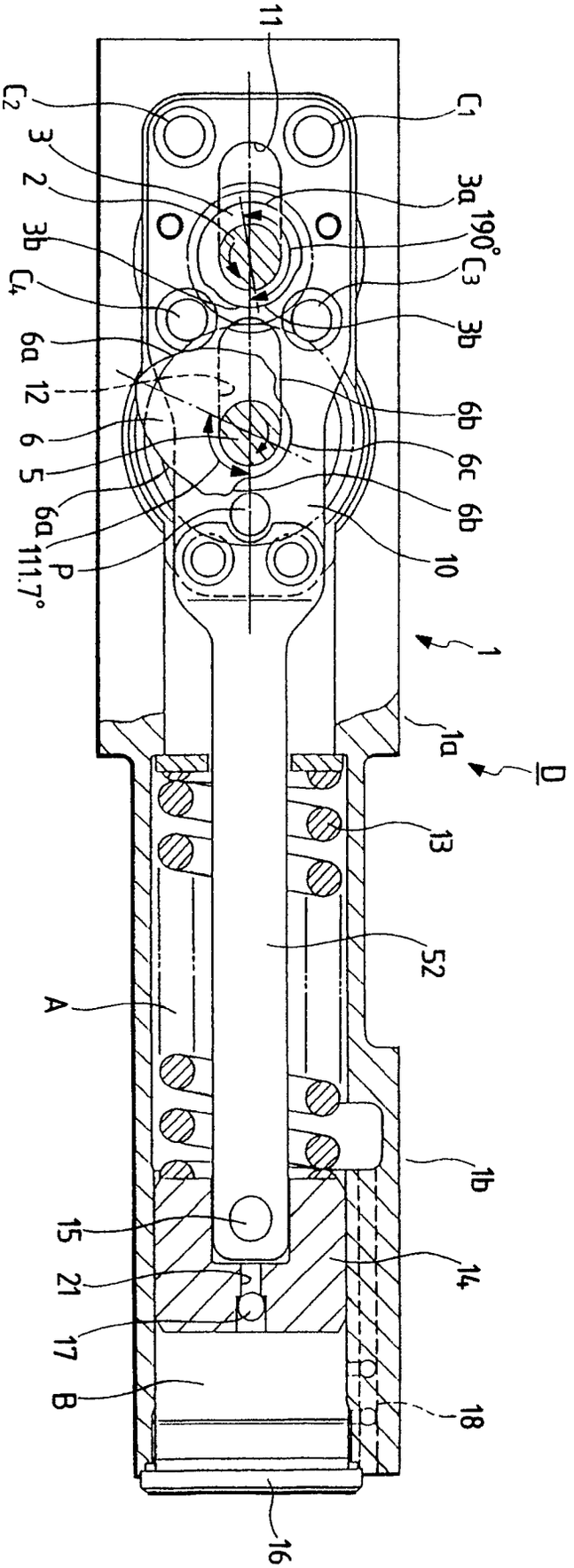
FIG. 7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6b
6c
6b
10
1
1a
D
13
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A
1b
15
21
17
B
14
18
16

FIG. 8

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 30 7621

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.5)
A	US-A-1978736 (BOMMER) * page 1, lines 1 - 17 * * page 2, lines 56 - 96 *	1, 3	E05F3/10
A	US-A-2962749 (SASSE) * column 1, lines 43 - 52 *		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			E05F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 SEPTEMBER 1990	GUILLAUME G.E.P.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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L : document cited for other reasons

& : member of the same patent family, corresponding document

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