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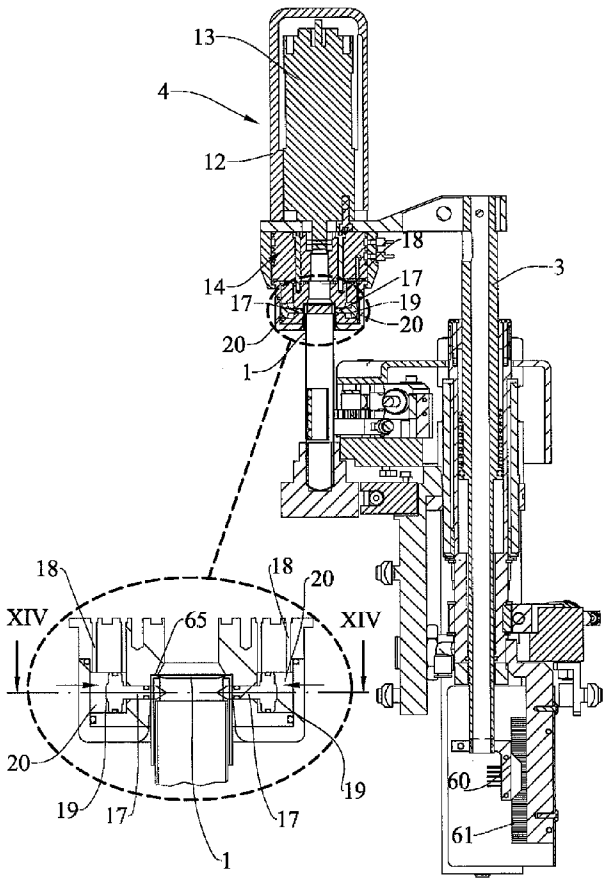
(54) **Title:** APPARATUS FOR REMOVING CAPS FROM TUBULAR CONTAINERS



(57) **Abstract:** It is described an apparatus for removing caps (1) from tubular containers (2), comprising a fixed frame (11) provided with grasping means (8) for holding a container (2) in a fixed vertical position and a head assembly (4) which is movable above containers of variable height along the vertical axis thereof. The head assembly (4) has a cap receiving cavity (15) with an upper abutment surface (65) for matching the upper surface of the cap of containers of variable size and is provided with a plurality of movable sharpened means (17) for catching the cap of the container when received in said cavity (15). There are provided first driving means (18) for moving said sharpened means (17) towards the cap of the container to catch it and second driving means (13, 14) for moving the sharpened means (17) in at least one further direction to remove the cap (1) from the container (2).

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"Apparatus for removing caps from tubular containers".

* * * * *

DESCRIPTION

The present invention concerns a decapper system, that is an apparatus for removing caps from tubular specimen containers.

As used herein, the term "container" means an article that contains a biological specimen and has a cap-closed tubular opening for access of the contents, e.g., a test tube.

In automated clinical chemistry laboratories, in order to access the biological specimen in the container, it is necessary to remove the cap from the container.

There are known decapper machines for pressure cap only and decapper machines for screw cap only.

In the decapper machines it is important not only to remove the pressure or screw cap without damaging it but also to be able to operate with containers of different size.

In addition, there is the problem that the container is to be removed from its carrier for the cap removal operation and then repositioned into the carrier. This may cause the potential risk that the container is repositioned into a different carrier thereby jeopardizing the specimen identification process in those cases in which the specimen identification is made through the container carrier identification.

Object of the present invention is now to provide a decapper apparatus which allows safe removal of screw caps and pressure caps.

Another object is to provide a decapper apparatus which can be self-adapting to containers of different sizes.

A further object is to provide a decapper apparatus which is able to remove the cap without removing the container from its carrier.

In view of the above objects the apparatus according to the present invention for removing caps from tubular specimen containers is

characterized by comprising a fixed frame provided with grasping means for holding a container in a fixed vertical position and a head assembly which is movable above the container along the vertical axis thereof; said head assembly having a cap receiving cavity with an upper abutment surface for matching the upper surface of the cap of containers of variable size and being provided with a plurality of movable sharpened means for catching the cap of the container when received in said cavity, there being provided first driving means for moving said sharpened means towards the cap of the container to catch it and second driving means for moving the sharpened means in at least one further direction to remove the cap from the container.

The characteristics and advantages of the present invention will appear evident from the following detailed description of an embodiment thereof illustrated as non-limiting example in the enclosed drawings, in which:

Fig. 1 is a perspective view of an apparatus according to the present invention in a rest position;

Fig. 2 is a top view of the apparatus of fig.1;

Fig. 3 is a sectional view according to line III-III of fig.2;

Fig. 4 is the same sectional view of figure 3 in a first working position;

Fig. 5 is a top view of the apparatus in a second working position;

Fig. 6 is a sectional view according to line VI-VI of fig.5;

Fig. 7 is the same sectional view of figure 6 in a third working position;

Fig. 8 is the same sectional view of figure 6 in a fourth working position;

Fig. 9 is the same sectional view of figure 6 in a fifth working position;

Fig. 10 is the same sectional view of figure 6 in a sixth working position;

Fig. 11 is the same sectional view of figure 6 in a seventh working position;

Fig. 12 is the same sectional view of figure 6 in a eighth working position;

Fig. 13 is an sectional view according to line XIII-XIII of figure 7;

Fig. 14 is a sectional view according to line XIV-XIV of figure 8;

Fig. 15 is a sectional view according to line XV-XV of figure 12;

Fig. 16 is a perspective view of a part of the apparatus including grasping means for the container and a sensor for detecting the diameter of the container, the grasping means being shown in open position;

Fig. 17 is a perspective view similar to fig. 16 with the grasping means in closed position.

A decapper or apparatus for removing a screw cap 1 from a tubular specimen container 2 is shown in figures 1-3 and comprises a rotatably and vertically movable shaft 3 upon which a head assembly 4 is mounted by means of a bracket 5. The shaft 3 is rotatably and slidingly supported by a fixed frame 11 and has fixed to its lower end an optical counter 60 cooperating with an optical ruler 61 (figs. 6-9) to form an optical encoder for detecting the vertical position of the shaft 3 enabling the head assembly 4 to self adapting to containers of variable height and being able to communicate said height to the decapper control unit.

The specimen container 2 is supported by a carrier 6 and is blocked by a grasping device 7 which is included in the housing 10 and comprises grasping arms 8 actuated by driving means 9 (Figs. 1, 2, 16 and 17).

A rod 62 is fixed to one of the arms 8 and cooperates with two optical readers 63 and 64 to detect the closed or open position of the grasping arms 8 (figs. 16 and 17).

The frame 11 connects the apparatus to a conveyor belt system (not shown) on which the carrier 6 is movable with its container 2.

Said head assembly 4 comprises a casing 12 in which a motor 13 for driving a rotor 14 is housed (fig. 3).

The rotor 14 is provided with a cavity 15 having an upper abutment

surface 65 (figs. 3, 7, 8,11 and 12) and peripheral radial holes 16 for guiding catching needles 17, with inward tips 30, which are radially movable, with respect to the vertical axis of the head assembly 4, by a pneumatic device 18 included in said head assembly 4.

Each needle 17 rotates with the rotor 14 and comprises a head member 19 included in a guiding chamber 20 of the rotor 14.

The apparatus comprises also a waste chute 21 for the removed cap 1.

Starting with the situation of Fig.1, the specimen container 2 is firmly blocked by the grasping arms 8 to make sure that the container is not removed from its carrier 6. Blocking of the container is detected by the sensor 63, 64 (figs. 16, 17).

The mounting shaft 3 now upraises (fig.4) and rotates of about 90° until the head assembly 4 is over the cap 1 of the container 2 (figs 5-6).

Then the mounting shaft 3 goes down until the cap 1 is coupled inside the cavity 15 (fig.7) in abutment with the upper surface 65 of the cavity. The optical encoder 61, 60 detects the vertical position of the shaft and provides a corresponding electric signal for the control unity of the automated laboratory system to which the decapper apparatus belongs. The abutment provided by the cavity surface 65 allows the cavity to receive containers of variable size.

The encoder 61, 60 detects the vertical stroke of the shaft 3, corresponding to the length of the container 2, and informs the control unit of the laboratory system.

The catching needles 17 are still in a rest outward position (see enlarged window of fig.7 and fig.13).

A control unit commands the pneumatic device 18 to move inwardly the needles 17 which go through the holes 16 and catch the cap 1 (fig.8).

The pneumatic cavity 18 injects air into the external portion of the chamber 20 pushing inwardly the head members 19 of the needles 17 (see enlarged window of fig.8 and fig.14).

By said catching needles 17, the cap is firmly caught in a plurality of points where the cap is slightly deformed but not perforated.

These deformations allow a firm grip by the head assembly 4 on the cap 1 without damage for the threads of the cap 1 and of the head of the container 2.

The catch force is perfectly balanced because the needles 17 have the same angular distance between each others and are pointed to the centre of a circle, defined by the casing 12, of which the needles 17 are the radiuses (figs.13-15).

Said apparatus is provided with eight needles 17, but it is also possible to have a good catch with less needles 17, three for example.

Nevertheless it is better to provide a plurality of needles 17, particularly more than four needles 17, because the catch force is increased and better balanced.

For removing the cap 1 from the head of the container 2, the motor 13 drives the unscrewing rotation of the rotor 14, with the needles 17, and simultaneously the head assembly 4 upraises (fig.9).

Finally the shaft 3 has a 90° back rotation, for positioning the removed cap 1, over the waste chute 21 (fig.10). When the head assembly 4 is gone down above the opening of the waste chute 21, the pneumatic device 18 drives outward the needles 17, allowing the cap 1 to fall into the waste chute 21 (figs 11-12, 15).

The apparatus comprises detecting (not shown) sensors on the head assembly 4 for detecting the catch of the cap 1, and in the waste chute 21 for detecting the release of the cap 1, that is the end of the decapping work.

This apparatus is also suitable for pressure caps. In this embodiment the steps for removing a pressure cap 1 are the same described above for a screw cap 1.

CLAIMS

1. Apparatus for removing caps (1) from tubular specimen containers (2), characterized by comprising a fixed frame (11) provided with grasping means (8) for holding a container (2) in a fixed vertical position and a head assembly (4) which is movable above the container of variable height along the vertical axis thereof, said head assembly (4) having a cap receiving cavity (15) with an upper abutment surface (65) for matching the upper surface of the cap of containers of variable size and being provided with a plurality of movable sharpened means (17) for catching the cap of the container when received in said cavity (15), there being provided first driving means (18) for moving said sharpened means (17) towards the cap of the container to catch it and second driving means (13, 14) for moving the sharpened means (17) in at least one further direction to remove the cap (1) from the container(2).

2. Apparatus according to claim 1, characterized in that said first driving means (18) comprise radially driving means (18) which moves radially inwardly said sharpened means (17) from a rest position until the cap (1) to be removed is peripherally caught, and moves radially outwardly said sharpened means (17) from a catch position to said rest position.

3. Apparatus according to claim 2, characterized in that said catching causes a slight deformation of the cap (1) in peripheral points where the sharpened means (17) engages said cap (1).

4. Apparatus according to claim 2 or 3, characterized in that said radially driving means comprises a pneumatic device (18).

5. Apparatus according to any of the preceding claims, characterized in that said sharpened means comprises catching needles (17) with inward tips (30).

6. Apparatus according to claim 5, characterized in that said catching needles (17) comprise head members (19) housed in chambers (20) arranged inside the rotor (14).

7. Apparatus according to any of claims 5-6, characterized in that said cavity (15) comprises peripheral passing holes (16), one for each catching needle (17).

8. Apparatus according to any of claims 5-7, characterized in that it is provided with three or more catching needles (17) arranged with the same angular distance between each other, with their tips (30) towards a centre of a virtual circle, being said centre on the axis of the container (2).

9. Apparatus according to any of the preceding claim, characterized in that said head assembly (4) comprises a driven rotor (14) for the rotation of said sharpened means (17).

10. Apparatus according to any of the preceding claims, characterized in that the removing of the caught cap (1) is provided by a combination of an unscrewing rotational motion of the sharpened means (17) and the upraise of the head assembly (4) respect to the container (2).

11. Apparatus according to any of the preceding claim, characterized in that the removing of the caught cap (1) from the container (2) is provided by the upraise of the head assembly (4) respect to the container (2).

12. Apparatus according to any of the preceding claims, characterized in that it comprises a grasping device (7) to block the container (2) for removing the cap (1).

13. Apparatus according to any preceding claim, characterized in that two sensors (62, 64) is associated to said grasping means (8) to detect the closed and open positions thereof.

14. Apparatus according to any preceding claim, characterized in that a sensor (61, 60) is provided to detect the length of the vertical movement of the head assembly (4).

15. Apparatus according to any preceding claim, characterized in that the head assembly (4) is mounted on a rotatably and vertically movable shaft (3) which is self adapting to any height of the container (2) and is capable, by using ruler sensors (60, 61), to detect and communicate the height of said

container (2) to a control unit.

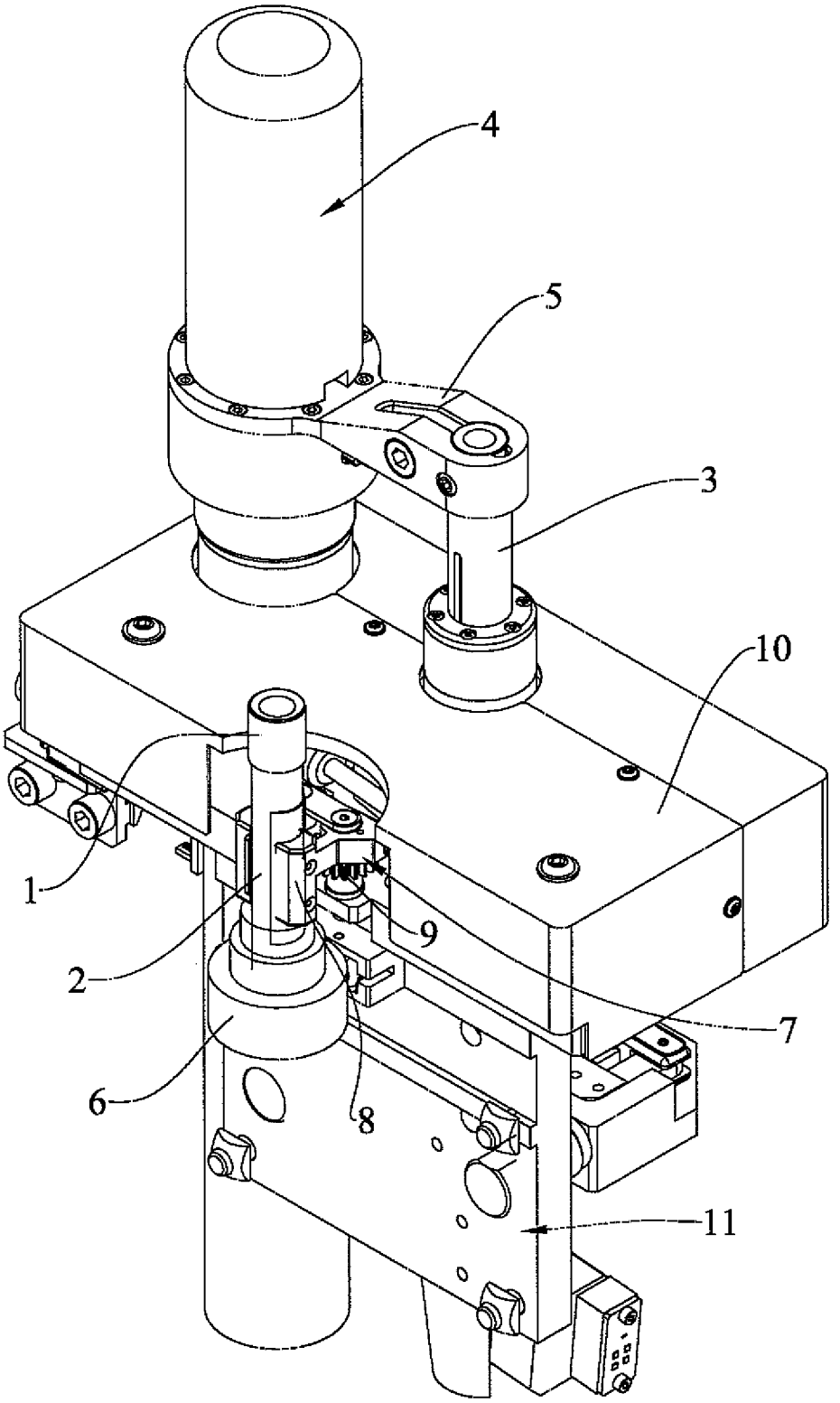

FIG.1

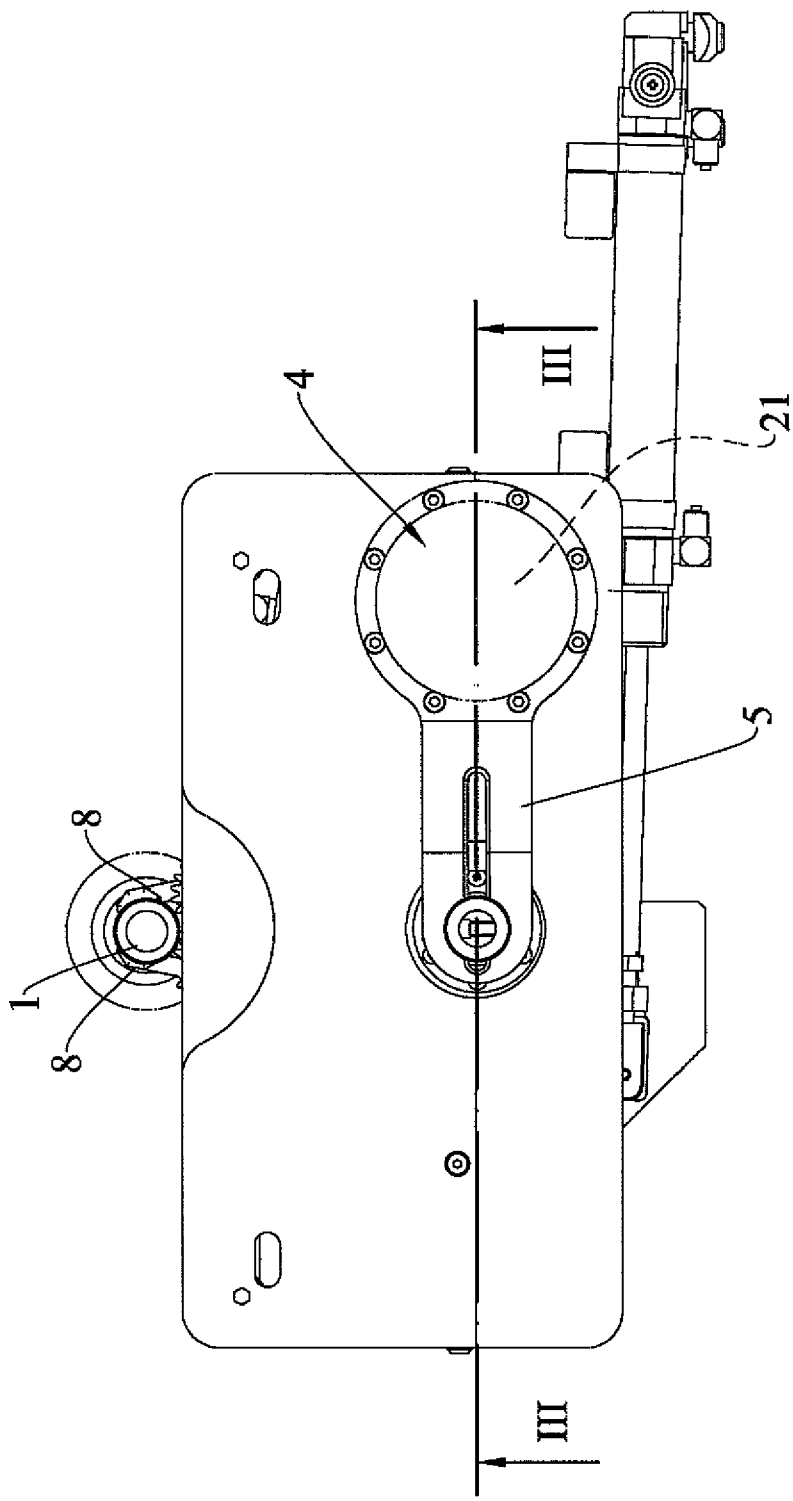

FIG.2

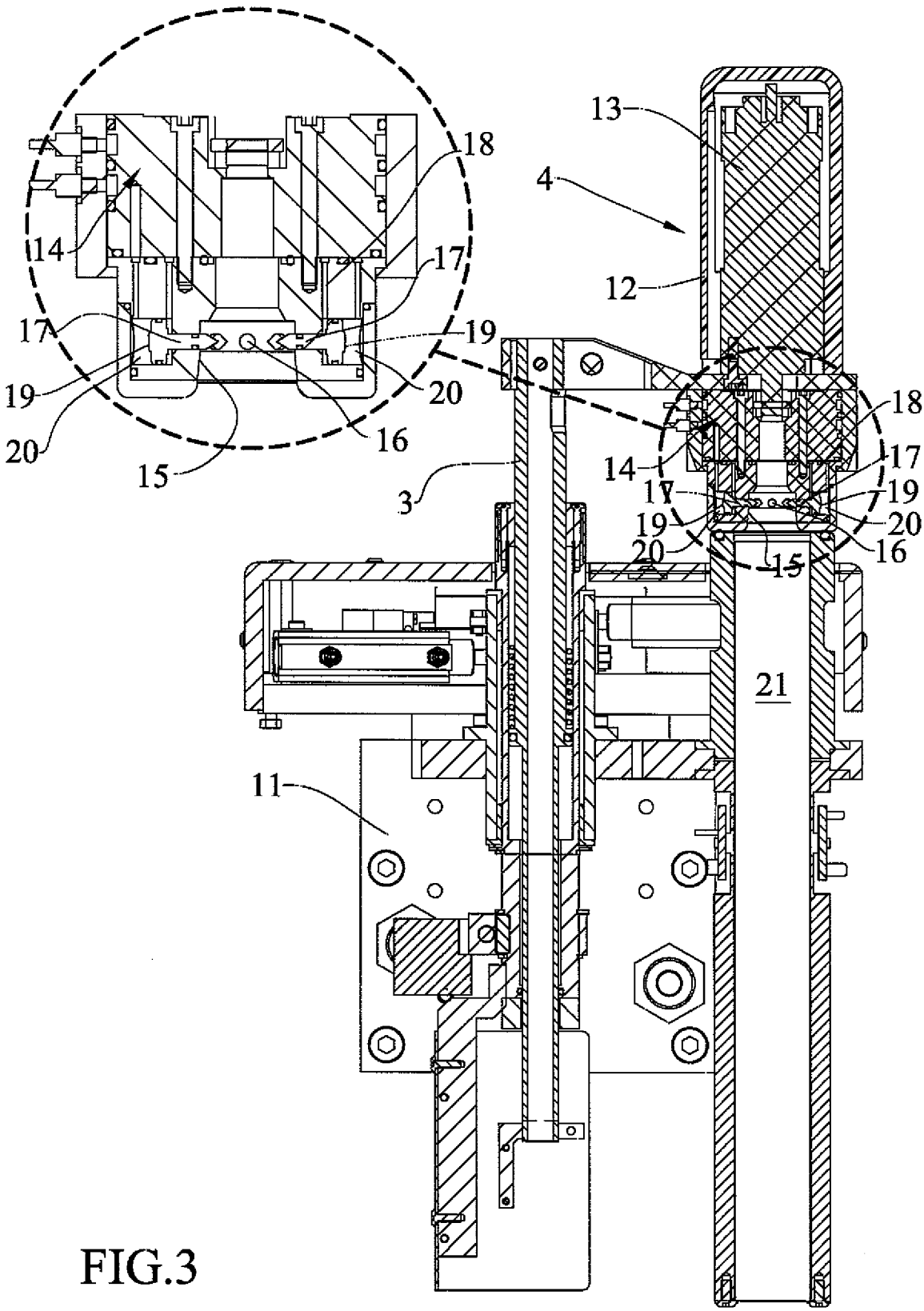
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FIG.3

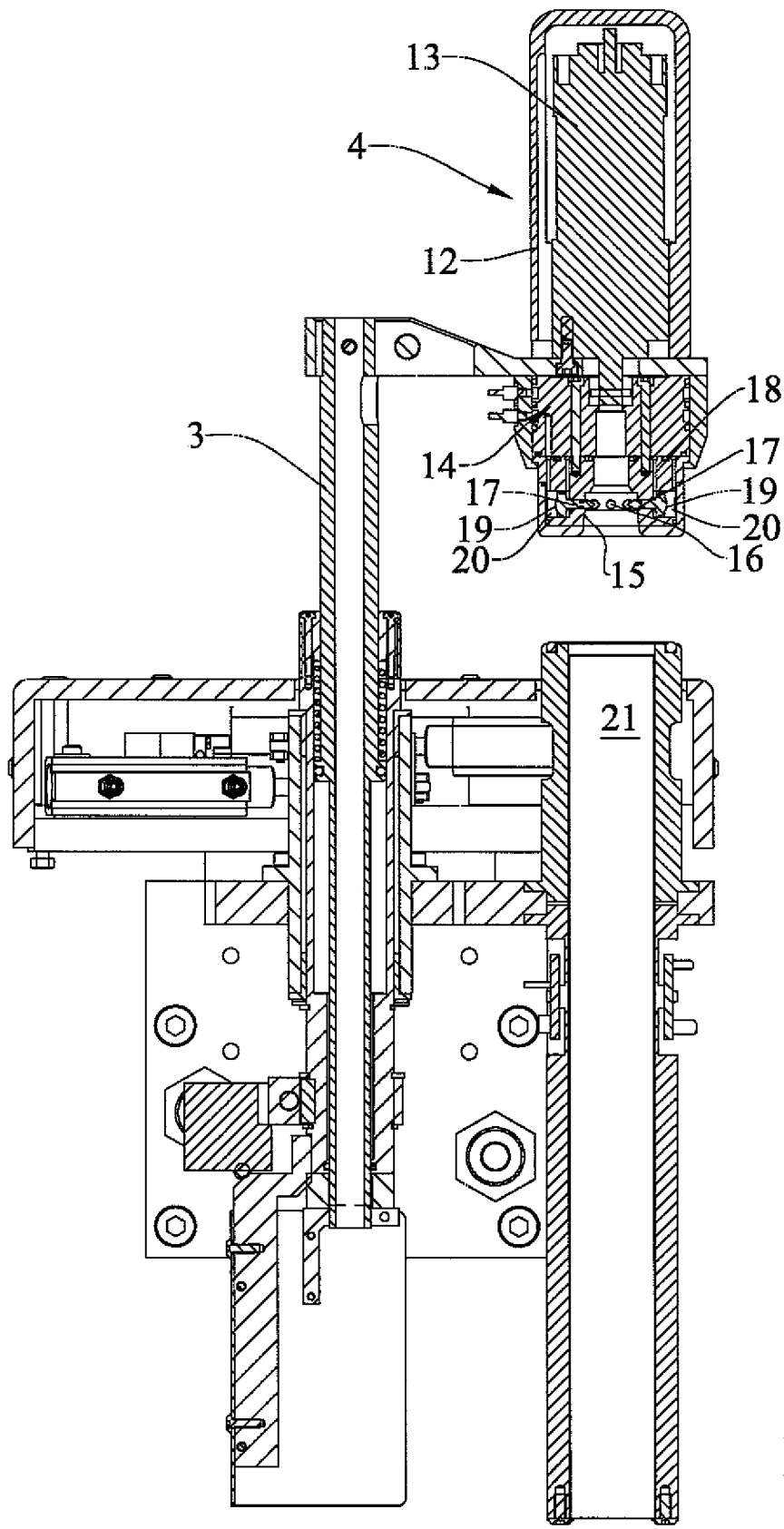


FIG.4

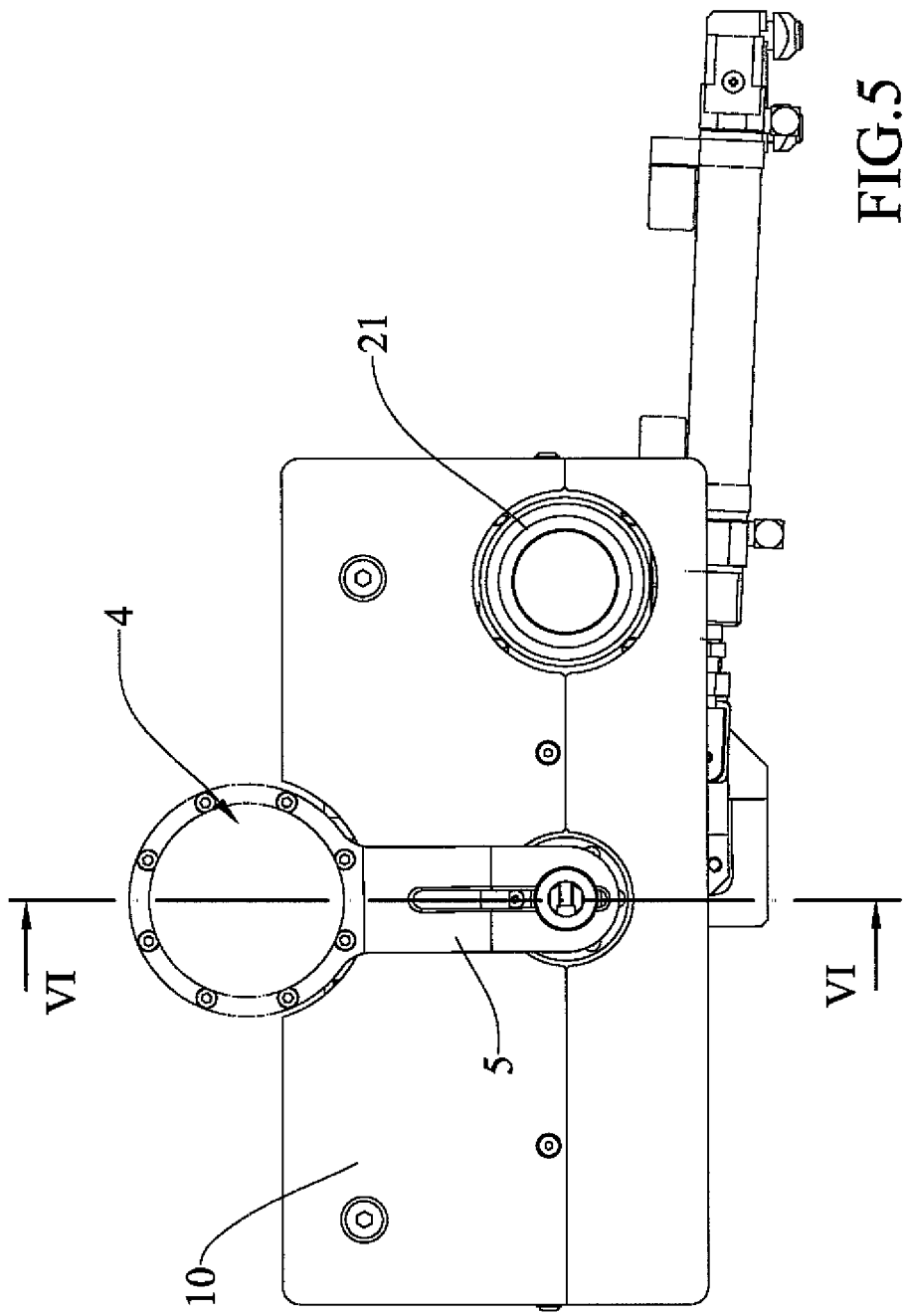


FIG.5

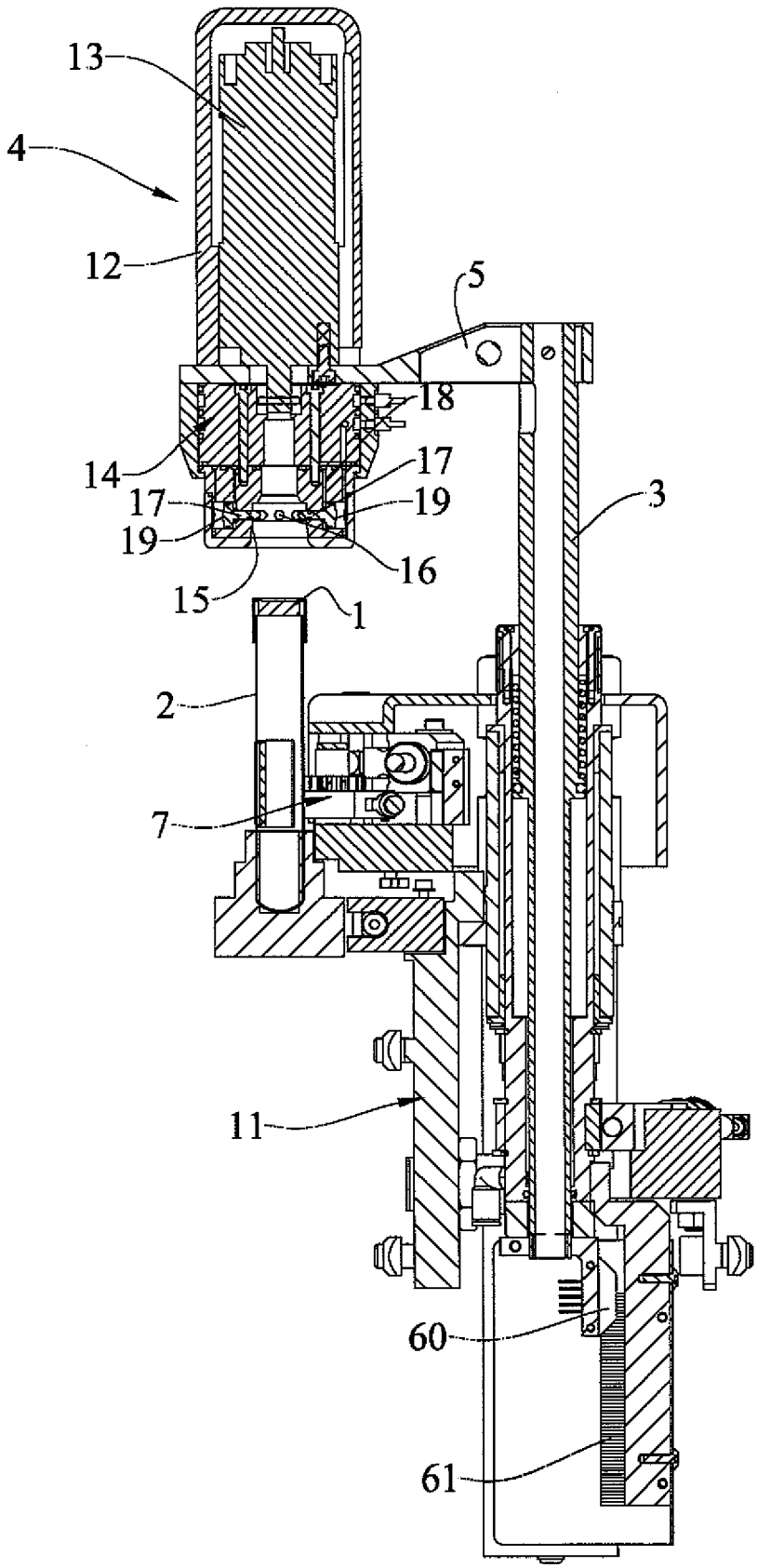


FIG.6

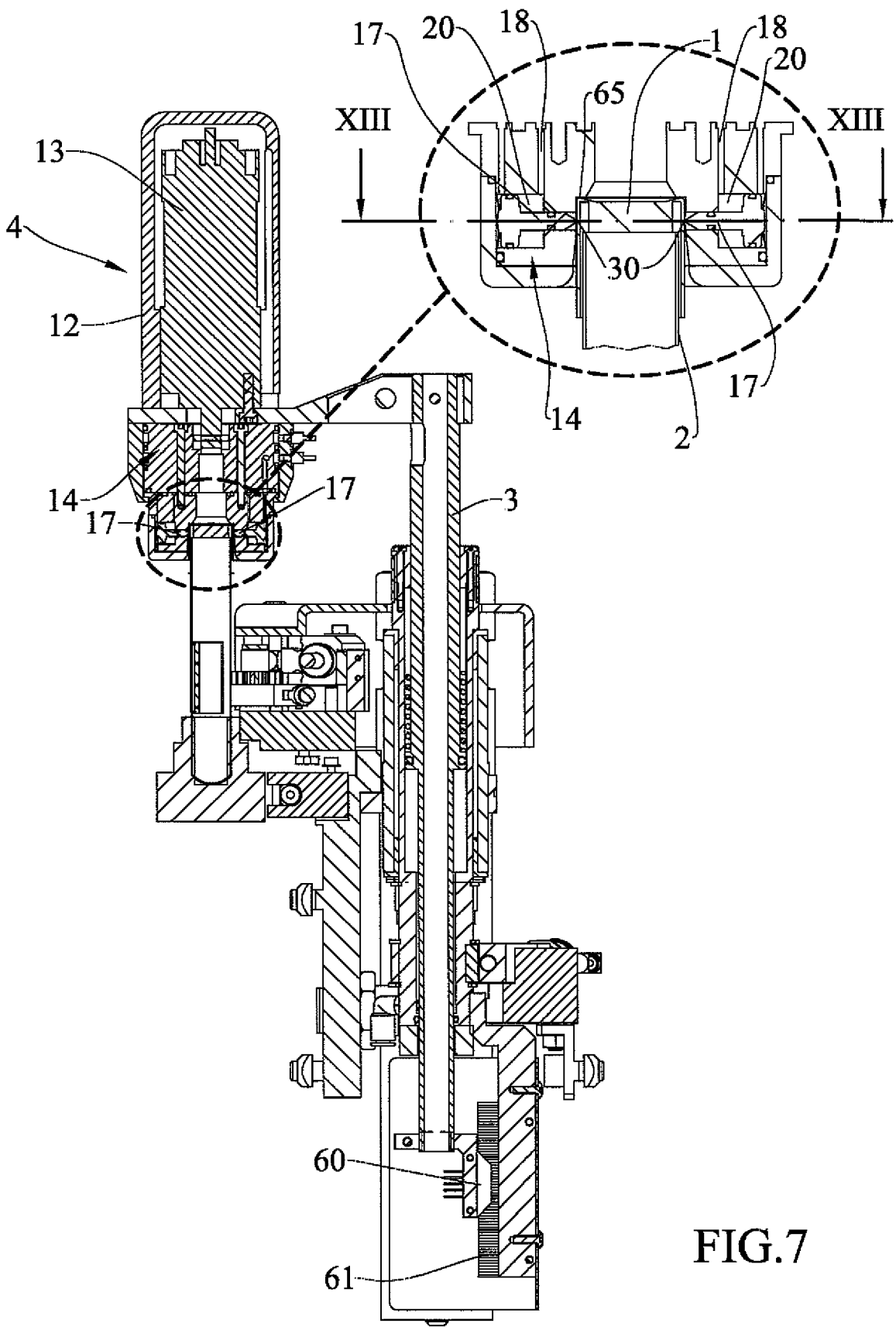
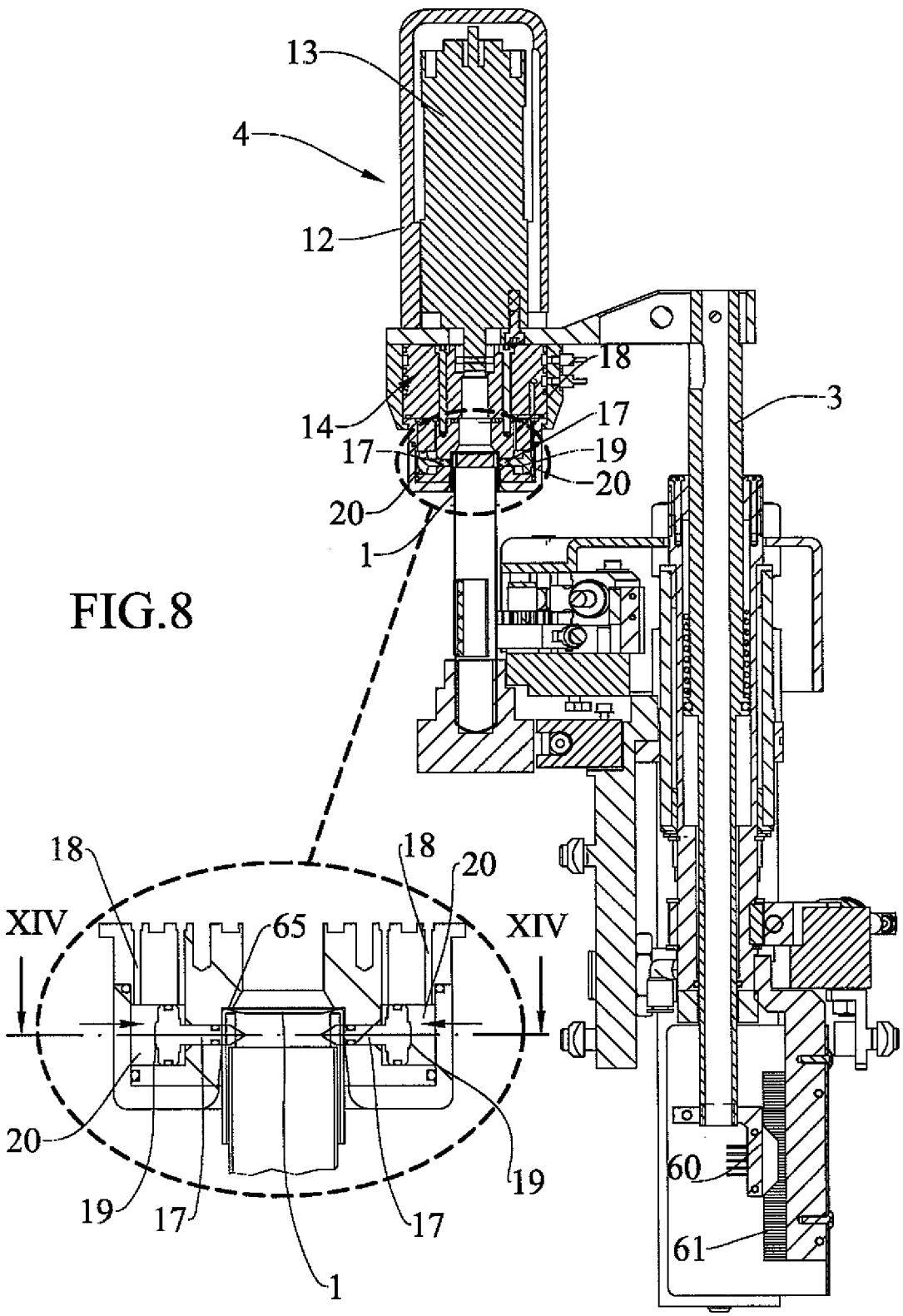


FIG.7

FIG.8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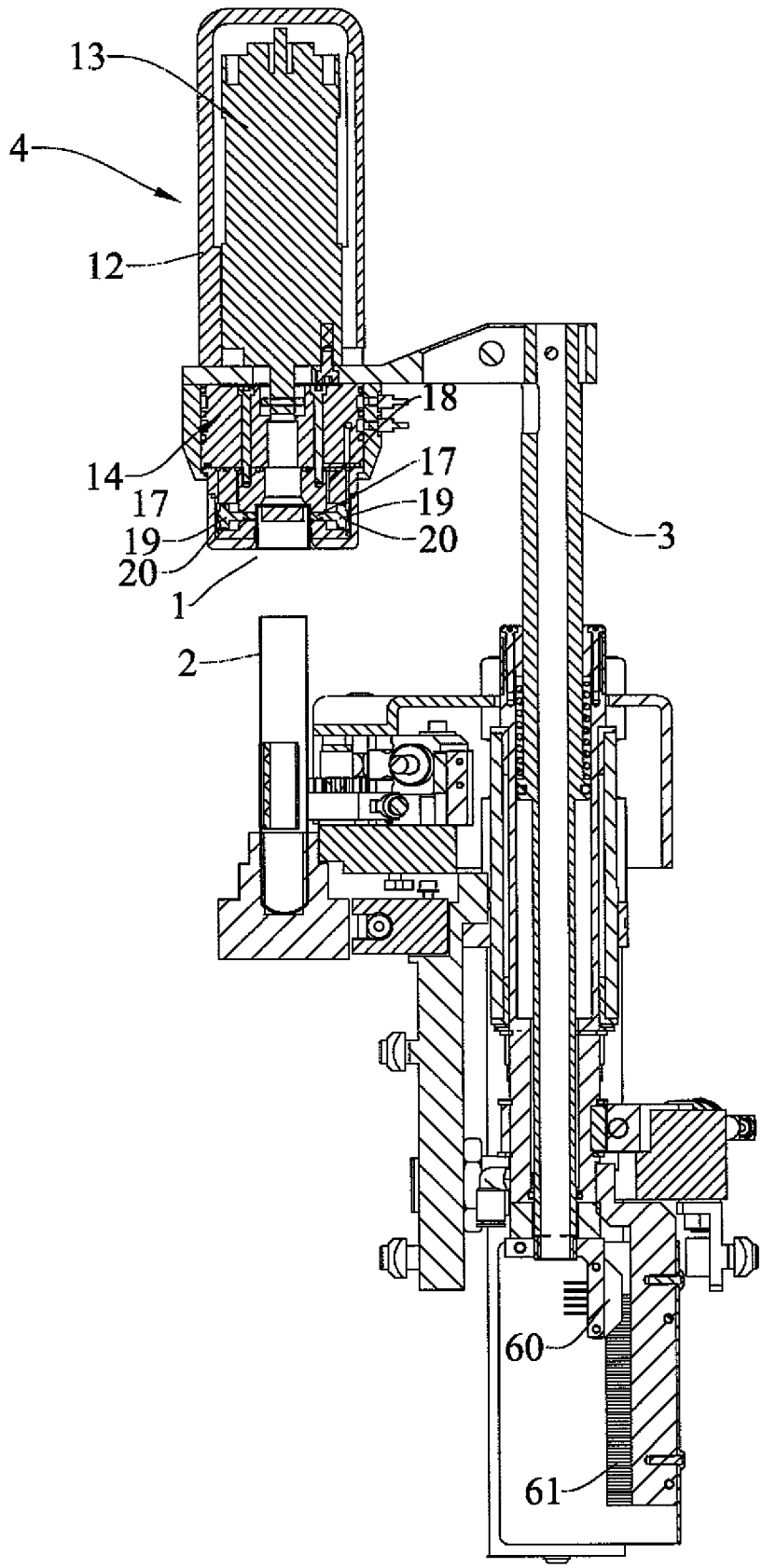

FIG.9

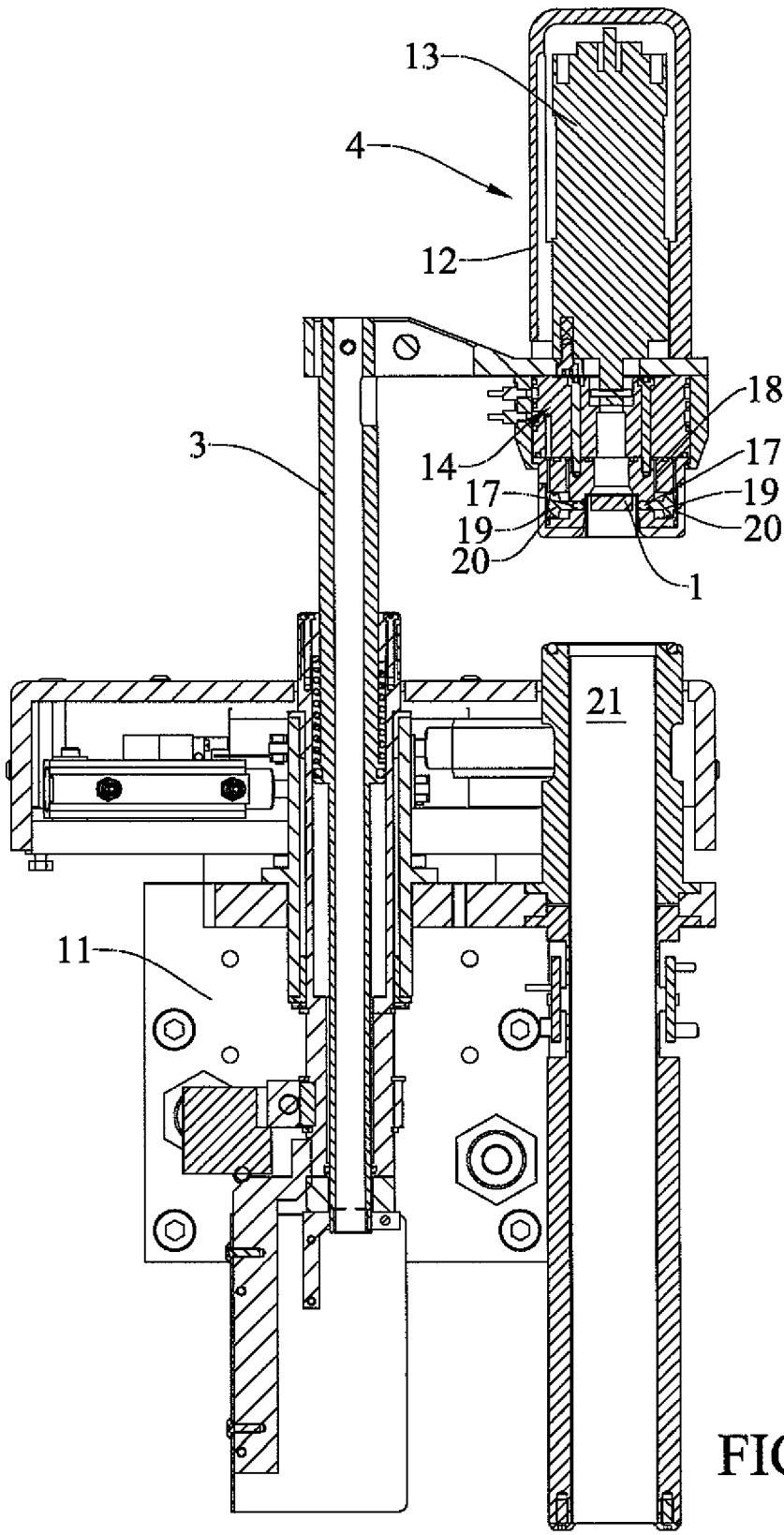

FIG.10

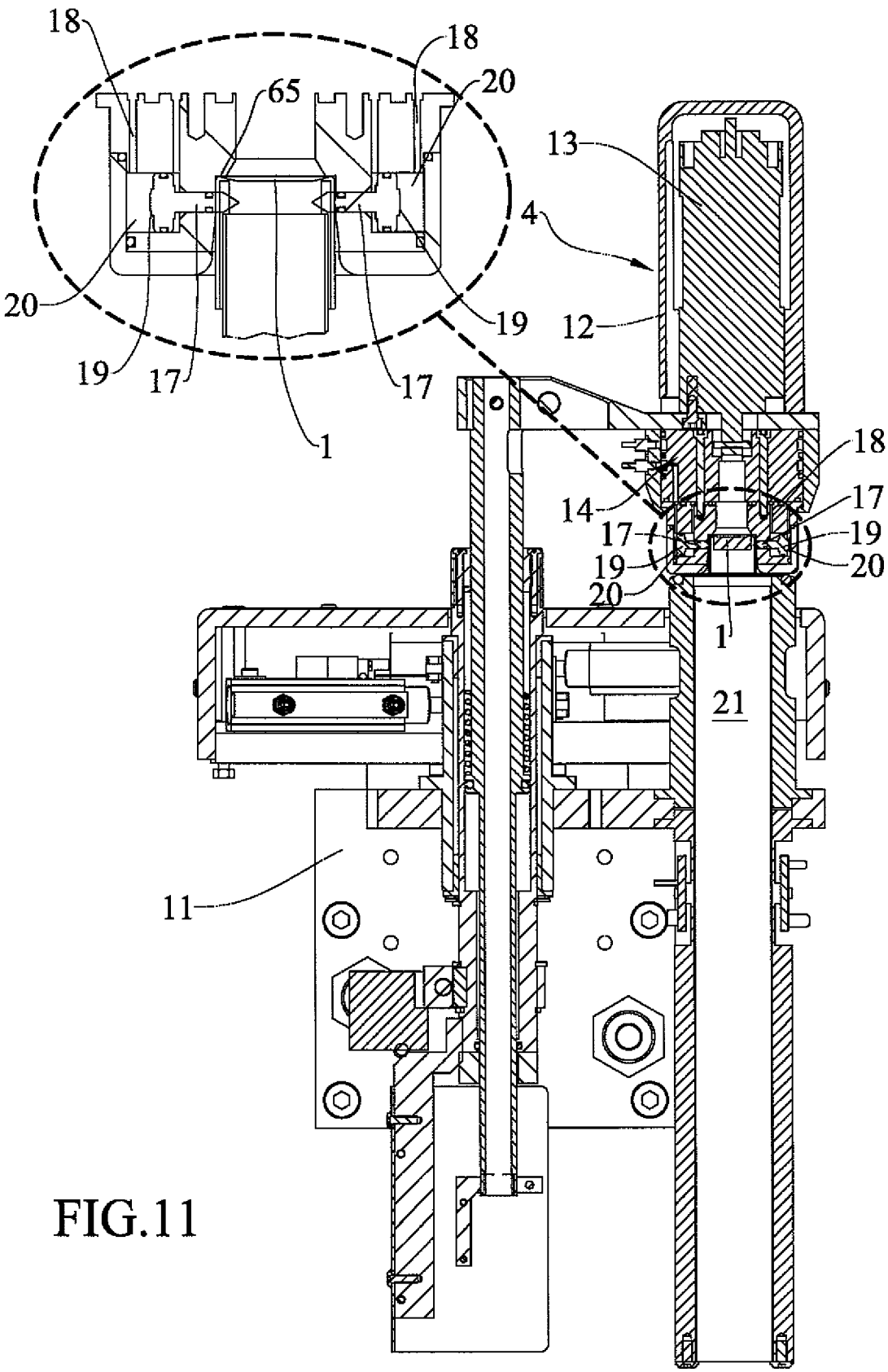

FIG.11

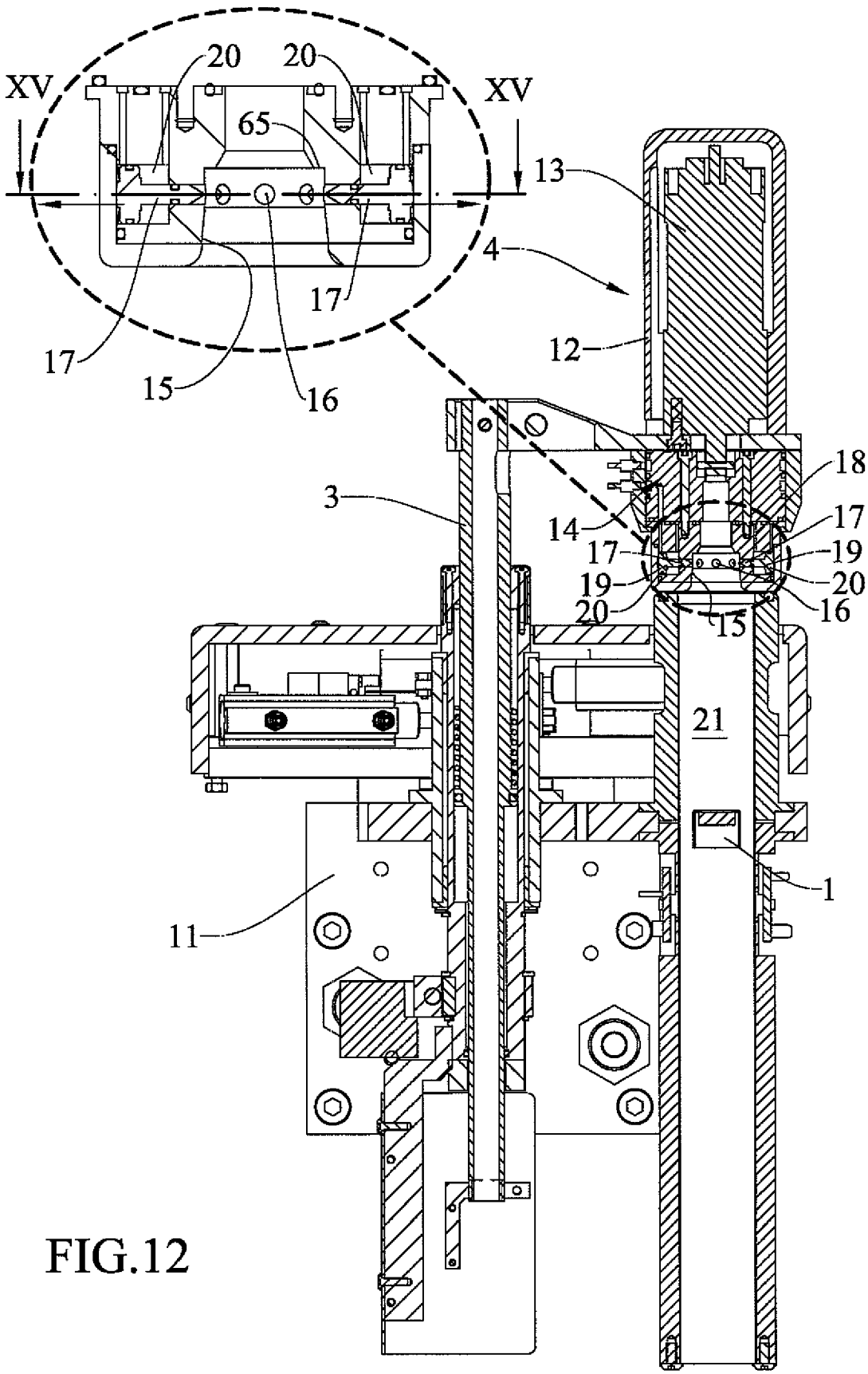

FIG.12

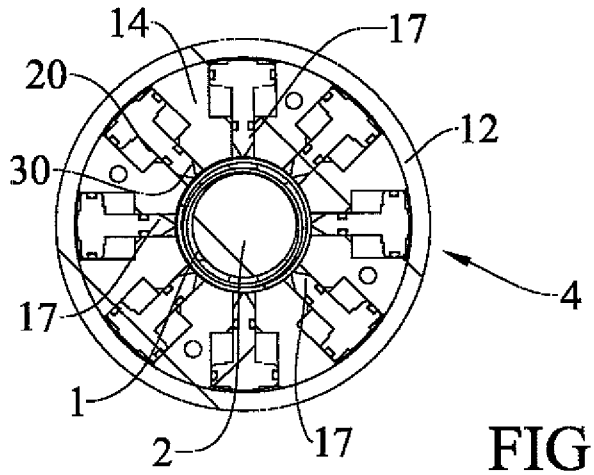

FIG.13

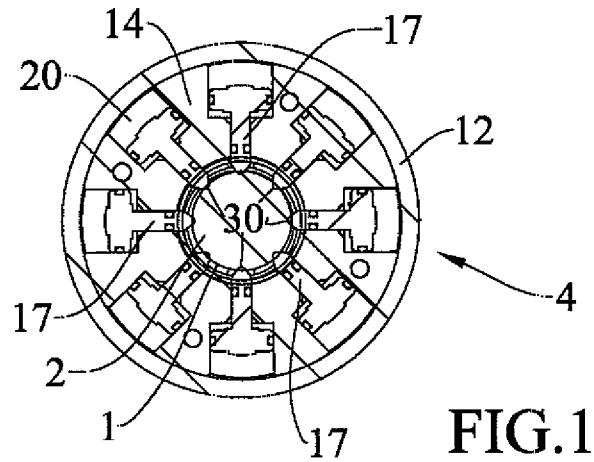

FIG.14

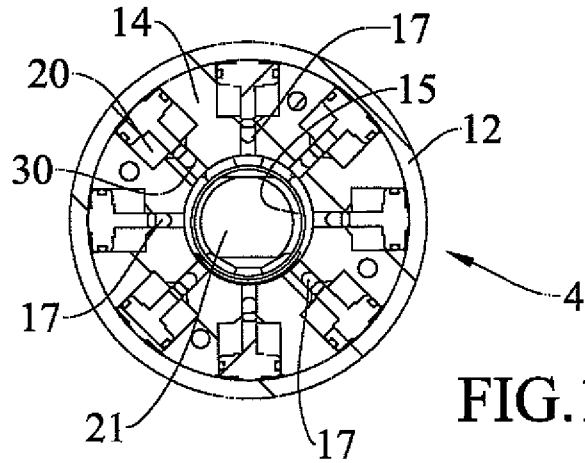

FIG.15

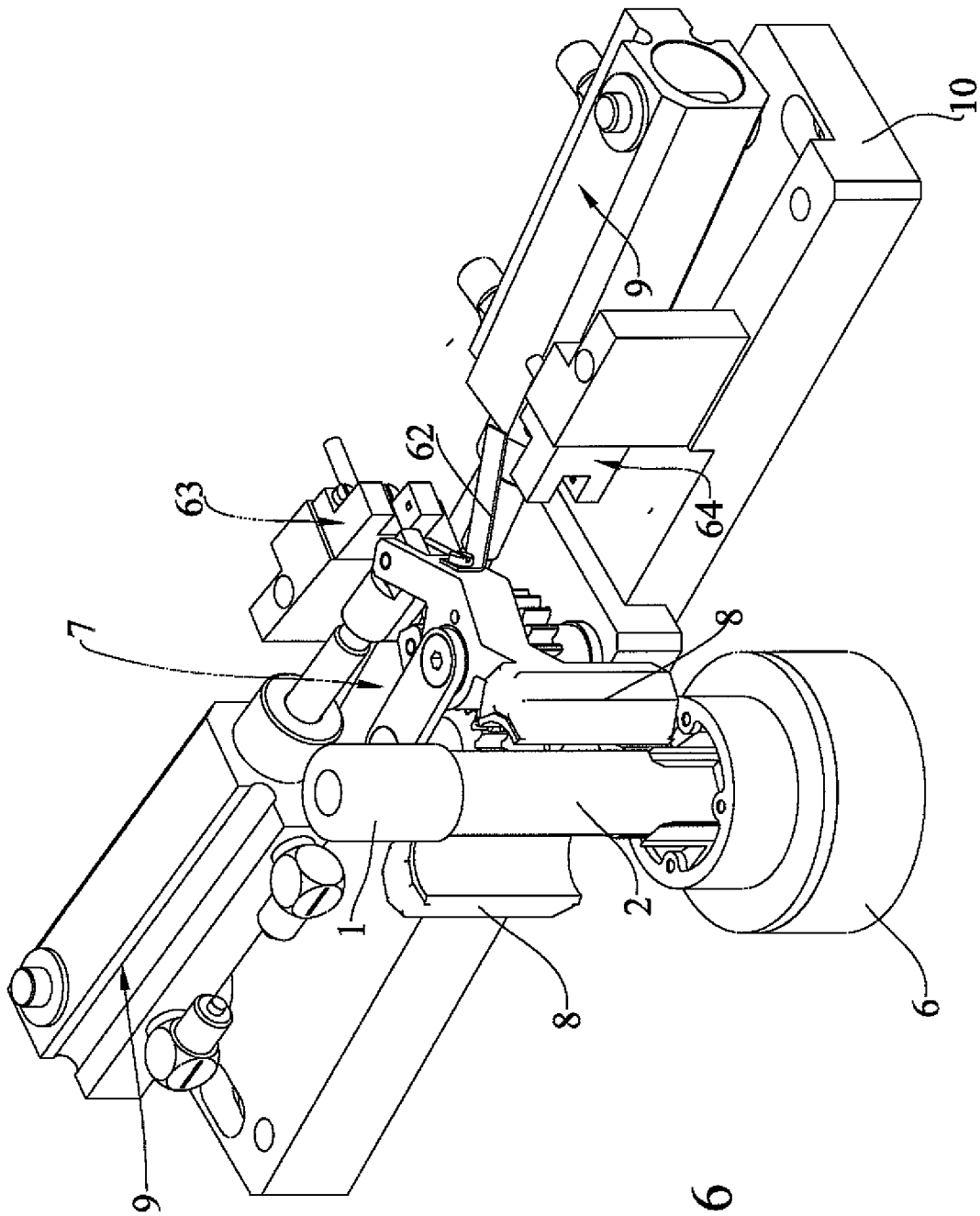

FIG.16

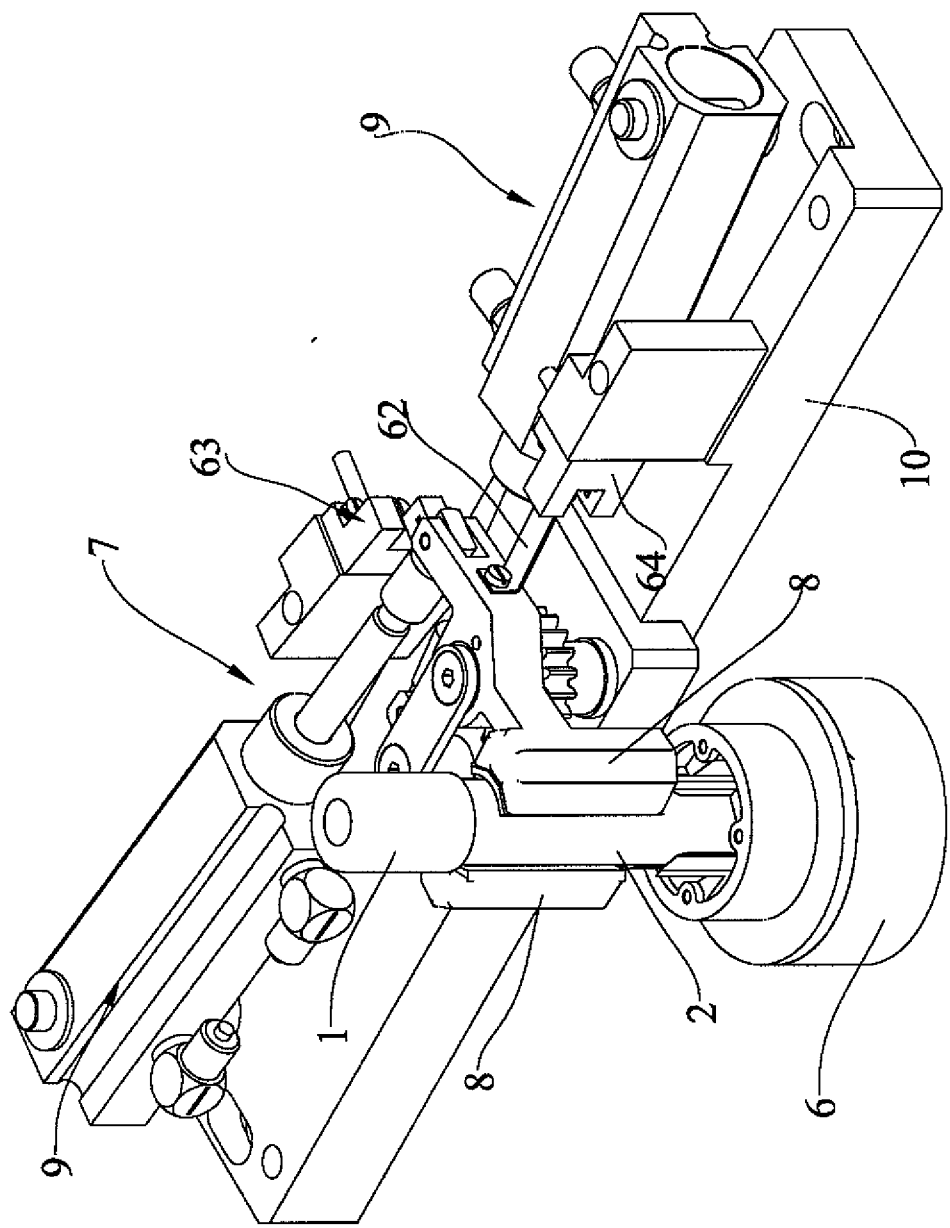

FIG.17

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2006/069251

A. CLASSIFICATION OF SUBJECT MATTER
INV. B01L3/14 G01N35/00

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)
B01L G01N

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)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
29 November 2007	11/12/2007

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Thomte, Peter

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2006/069251

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