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(54) **Apparatus for capping containers with threaded plastic caps**

Vorrichtung zum Verschliessen von Behältern mit Kunststoffschraubkapseln

Appareil de capsulage de récipients avec des capsules à vis en plastique

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(73) Proprietor: **Lenzi, Mauro**
I-56100 Pisa (IT)

(72) Inventor: **Lenzi, Mauro**
I-56100 Pisa (IT)

(74) Representative: **Mariani, Giulio et al**
Notarbartolo & Gervasi
Corso di Porta Vittoria 9
20122 Milano (IT)

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Description

[0001] The present invention relates to an apparatus for capping containers with plastic caps threaded in advance, where the screwing heads do not shift vertically but only rotate about their own axis. It should be noted that under containers mainly bottles and phials are intended.

[0002] As known to those skilled in the art, the current apparatus for capping bottles and phials by threaded caps are provided with screwing heads engaging the single bottles by both a shift movement to and from the bottles and a movement of rotation for screwing caps thereon. Because of the need to combine both movements, the construction of such heads and their supports is complex and liable to failures.

[0003] A copping apparatus corresponding to the preamble of claim 1 is known from patent document US 4 765 119 A.

[0004] The present invention, as defined by claim 1, seeks to provide an apparatus in which the screwing heads do not shift vertically as they only make a rotation movement. According to the invention this simplified operation is accomplished by bottle lifting means that lifts the bottle to the screwing head which seizes the cap to be applied before such operation still without making any vertical shift movement.

[0005] As better explained below the seizing of caps by the heads can be carried out in the apparatus by using an angle plate on which gear wheels are engaged as well as by using suitable shaped seizing "cones" formed in the heads.

[0006] The apparatus consists of a number of cap screwing heads arranged on a roundabout rotating about the main axis of the apparatus, each such screwing head being put in a rotation motion about its own axis, such rotation motion being taken off from the rotation of the roundabout causing a revolution movement of the screwing heads assembled on a support. Such movement occurs during the rotation of the support of a gear wheel secured to the support of each head, such gear wheel engaging a further gear wheel, which is secured to the external casing of the apparatus so that an epicyclical system is provided. A device which is stationary with respect to the external structure of the apparatus is able to insert a cap to be screwed into a seizing "cone" of each screwing head while the latter traverses above the device during the revolution movement about the main axis.

[0007] The bottle which is of plastic material in the embodiment shown and is provided with a support collar and to which the cap has to be screwed is engaged by a fork collar provided with seizing teeth while it is in the lowest position and is lifted to the screwing head through the collar which is fixed to an axis sliding vertically in its guide without rotating about its axis because of the engagement of a key. Therefore, the axis of the bottle is steadily aligned with the axis of the cap screwing head. A cam and a pin integral with the axis drive the longitudinal stroke of the axis.

[0008] The invention will now be described in more detail with reference to the accompanying drawings, in which:

Fig. 1 is a top plan view of the whole apparatus;

Fig. 1A is a similar view of a particular of Fig. 1;

Fig. 2 is a cut-away diametrical section showing two screwing heads in opposite diametrical positions;

Fig. 3 is a rather schematic view of a section similar to Fig. 2 in enlarged scale in which some construction details have been omitted;

Figs. 4 and 5 are fragmentary partial sections of a screwing head at different steps of operation;

Fig. 6 shows an alternate embodiment of the apparatus of Figs. 2 and 4 having a rigid construction;

Fig. 7 is a fragmentary view of an axial section in enlarged scale showing the step in which a cap is caught by one screwing head;

Figs. 7 (A,B,C) show in detail the cap feeding and catch members as used in the apparatus;

Figs. 8 (A,B,C) show a detailed, fragmentary view of the step in which a cap is caught by the seizing cone.

[0009] The main components of the apparatus are shown in the schematic cut-away top plan view of Figs. 1 and 1A in which numeral 20 designates the roundabout of the screwing heads 16, numeral 21 designates the input of the bottles BTL to be capped, numeral 22 designates the output of the capped bottles BTT, and numeral 23 designates the cap feeding system.

[0010] The apparatus includes (Figs. 1 and 2) a fixed portion consisting of a cover disc 11 supporting an upper fixed hub 12, and cylindrical members of an external wall 13. The apparatus includes in its inside a shaft 14 at the lower side driven in rotation by an electric motor (not shown). Shaft 14F is not rotating.

[0011] Pivotally connected to rotating shaft 14 and arranged between hub 12 and such shaft 14 is a cylindrical hollow support 15 to which the roundabout of screwing heads 16 is secured, each screwing head being supported by a device secured outside the rotating support 15. In the embodiment shown, the roundabout includes ten screwing heads 16.

[0012] Each screwing head support device includes (Figs. 2 and 4) a disc 30 integral with the rotating shaft 15 to which also a sleeve 31 is secured in which a member 32 is slidable vertically, at the base of which a fork collar 33 receiving the neck of the bottle BTL to be capped is supported.

[0013] As plastic bottles provided with a support collar have to be capped in the embodiment described and illustrated, fork collar 33 is provided with teeth 44 that stick into the plastic material of the collar of bottle BTL during the compression step against screwing head 16, Fig. 2A, and prevent the bottle from rotating during both cap screwing and tightening steps. The load, which is needed to stick teeth 44 and calibrate the cap compression thrust onto the bottle, is provided and calibrated by spring 81 placed inside screwing head 16.

[0014] Secured to the upper portion of the slidable member 32 (Fig. 2) is a pin 42 to which a cam follower roller 34 engaging a helicoidal channel cam 35 (Fig. 1B) is disposed. Such channel cam is formed in the outer surface of a fixed cylindrical sleeve 36 coaxial with hub 12 and secured to cover disc 11.

[0015] It is self-evident that the pitch of helicoidal channel cam 35 is equal to the vertical translation length of slidable member 32.

[0016] Cap screwing head 16 (Fig. 4) consists essentially of a tubular body 50 carrying a gear wheel 52 in such a position as to mesh with the fixed gear wheel with large diameter 40 integral with the cylindrical side wall members 13 of the stationary portion of the apparatus (Figs. 1 and 2).

[0017] In addition to the necessary components to provide a rolling friction, hermetic barrier against the entrance of dust, seepage of liquids and other, screwing head 16 includes an outside body 73 in which a sleeve 74 is inserted, and an inside cylindrical body 75 inserted in such sleeve 74.

[0018] Cylindrical body 75 has a portion with greater diameter 76 forming a step 77, and a similar step 78 is formed in sleeve 74 between the lower portion and the upper portion 79 with greater diameter.

[0019] Thus, between members 74 and 76 slidable on each other a cylindrical space with annular section 80 is formed which receives a helicoidal compression return spring 81 able to contrast any relative axial movement of the two members.

[0020] Screwing head 16 further has an axial core or rod 82 carrying at the upper side a head 83, a second helicoidal compression spring 84 being provided between head 83 and mouth 85 of cylindrical body 75 around axial core 82.

[0021] Central rod 82 is assembled in a stable position raised with respect to the seizing cone 88 of cap CPS and is inserted together with the latter in such cone aiming at expelling the cap by a downward shift caused by the thrust of rod head 83 by the stationary angle plate cam CPI. Such arrangement serves to overcome the problem that would arise in case of fortuitous lack of a bottle under the head with the result that cap CPS would remain inside cone 88 as it cannot be applied to the bottle. As a result, cone 88 takes the position again to receive a new cap from the Pick-and-Place device (trade name) even if it still contains the preceding not applied cap, with the consequence of failure in the operation cycle and possible damages of the head.

[0022] Another advantageous feature of the invention consists in the friction assembly, which the screwing head indicated at 100 in the exploded fragmentary view of Fig. 5 is equipped with. Such assembly secured to the body is illustrated in detail in such figure and forms a magnetic friction which can be calibrated continuously without need of tools. Furthermore, such friction has a very reduced inertia.

[0023] The assembly includes an annular support 101 and comprises bearings 102, which are held between annular member 103 and axis 112. Thus, a defined, reproducible positioning of bearings 102 is achieved with the resulting interchangeability of the whole assembly 100.

[0024] The magnetic friction consists of two annular tracks 104 and 105 in which a number of permanent magnets are disposed, with track 105 rotating together with the axis and track 104 being put in rotation by the attraction force of the magnets of the two tracks that produce the driving torque.

[0025] When applying to track 104 a counteractive torque, the maximum value of the driving torque can be reached, whereupon the rotation stops. The driving torque which is then the maximum torque applicable by the cone 88 to the cap to be screwed is a function of the distance between magnetic tracks 104 and 105 so that upon varying such distance the tightening torque applied to cap CPS steadily contained in the cone is varied.

[0026] Magnetic track 105 is integral with toroidal member 106, which is connected axially to member 101 through thread 108. Both members 101 and 106 have a toothing 109 with the same geometric dimensions at the outside cylindrical peripheral surface so that the outside ring 110 provided with an inside compatible toothing can slide axially on both toothings and, in case of engagement of both toothings, a steady mesh between members 101 and 106 that cannot rotate to each other is obtained.

[0027] With such a construction members 101 and 106 take a relative constant position.

[0028] If outside ring 110 is lifted, the toothing of member 106, that can then rotate, is disengaged and by means of thread 108 it can come near or move away from member 101. It is possible to block the position of members 101 and 106 again by causing the toothing to mesh with outside ring 110. Because of the geometry of the system, upon varying the relative positions of members 101 and 106, the distance between magnetic tracks 104 and 105 as well as the driving torque and then the tightening torque of the cap on the bottle is varied by the same amount.

[0029] Elastic ring 111 has the purpose of keeping outside ring 110 in a steady, stationary position with meshed toothing. It should be noted that the geometry of the assembled apparatus is such that outside ring 110 cannot be removed by shifting it upwards as it knocks against member 73, thus keeping its predetermined position with respect to member 101 in order to allow the positions,

that have been determined during the assembling, to be calibrated and regulated.

[0030] Axis 112 is secured to bearings 102 through ring 103 and carries magnetic track 104 embodied therein as well as cone 88 containing the cap to be screwed onto bottle BTL.

[0031] It should be noted that the whole assembly 100 can be applied onto other screwing heads used with conventional capping machines, thus taking advantage of such assembly, i.e. tightening means with very low inertia and easily and quickly adjustable torque according to known calibration without using tools.

[0032] Fig. 7 shows the component of the device to carry out the Pick and Place technique (trade name), i.e. the component that "inserts" cap CPS into cone 88 integral with screwing head 16.

[0033] Such device consists essentially of an axis 89 secured through flange 90 to disc 11 of the apparatus.

[0034] Member 91, i.e. the main body of the rotating member, is secured to bearings by an elastic ring and can rotate with respect to axis 89. Star wheel 92 is secured to member 91 through a flange and is shaped and positioned such as to be put in rotation about axis 89 by means of cylinders 73 entering spaces 97A while the roundabout of the screwing heads rotates about the central axis of the apparatus.

[0035] A thin shaped disc 93 with recesses 97 is secured to member 91 and blocked between flanges 94 and 95.

[0036] Shaped disc or star wheel 93, see Figs. 7A, 7B, 7C, has the same number of teeth as star wheel 92 and is blocked between flanges 94 and 95 with recesses 97 exactly timed with recesses 97A of star wheel 92 so that caps CPS driven by star wheel 93 on plate 99 and the slide channel formed of outside guide 100 and upper guide 102 are timed with cone 88 in the coincident position 101 of Fig. 7A. Such position is determined by the contact point of the rotation circumference of screwing heads 16 with the circumference of recesses 97 of star wheel 93 and then of caps CPS put in rotation by such star wheel.

[0037] The mutual positions of elements 92, 93, 99 and 89 are clearly shown in the section view of Fig. 7.

[0038] With reference to Fig. 8A there is shown the method of inserting cap CPS onto cone 88 without the need to lower screwing head 16 as it normally occurs in the currently used capping machines working with plastic caps.

[0039] The method consists of using an angle plate 105 on which wheel 93 pushes the cap and lifts it to the inside of cone 88. Angle plate 105 has such a slope as to allow the insertion of cap CPS inside cone 88 to be initiated at the area around the coincidence point 101 and to be further lifted thereafter so that at point 106, i.e. before star wheel 93 stops pushing the cap, the latter is already under full control of cone 88, i.e. pushed and partially inserted into the inside of the latter, as shown at 107, so that cone 88 can carry on to trail the cap by its movement along angle plate 105 till the top of the latter. Angle plate 105 ends in a plain length which serves to make completely straight the cap inside cone 88.

[0040] The inside shape of cone 88 is such as to facilitate and to allow the insertion movement of the cap in its inside when the latter is inclined. This is accomplished by a mouth 109 of the cone having an opening angle, which is equal to the slope of angle plate 105. Also the shape of angle plate 105 is such as to allow the described movement with the suitable graduality by regulating angle α of mouth 109 and the final slope 110 before the horizontal plane 108.

[0041] Balls 211 inside the cone are timed with the seizing teeth of cap CPS and have a dual function: firstly orienting the toothing of the caps during the insertion into the cone, with the corresponding teeth inside the cone allowing the screwing and the tightening of cap CPS onto the bottle; secondly holding the cap inside cone 88 during the way between the end of the angle plate and the support over the bottle BTL of Fig. 1.

[0042] Another preferred or alternate embodiment of each screwing head/bottle lifting system assembly is depicted in Fig. 6, in which only the left half of the apparatus of Fig. 2 is shown by simplicity, and consists of rendering the screwing head not elastic with respect to the compression of the bottle and rendering the bottle lifting system elastic. Such a construction allows the screwing head assembly to be simplified so that it just rotates about itself and is only provided with the friction to limit and to regulate the cap tightening torque and not with mechanical compression means. In Fig. 6 all of the elements corresponding to Figs. 2 and 5 are designated by the numerals beginning with 200 so that screwing head 16 of Fig. 1 becomes the element 216 of Fig. 6.

[0043] In such construction the magnetic friction assembly of Fig. 6 is the same as assembly 100 of Fig. 5. More particularly, the whole friction assembly of the screwing head is connected in the same way through a thread to rotating axis 250, which is supported by the bearings.

[0044] Cam 236 lifts through idle pin 234 bottle BTL resting on toothed collar 233 secured in turn to bracket 233S. The assembly consisting of axis, bush, tongue, spring, guide and screw has the function of the axis of Fig. 2 with the features of being axially elastic due to spring 253 but not rotatable, as well as axially sliding in the guide bush secured to body 230 but not rotatable because of suitable keys. Therefore, also in such construction the axis of bottle BTL is held coaxial to screwing head 216 in its coming near or moving away from the screwing head.

[0045] When the bottle is lifted from the toothed collar 233 and comes to the end of stroke with the cap inside cone 288, the necessary excess in the bottle lifting stroke compresses spring 253, thus allowing the teeth of collar 233 to run into the plastic material of the bottle collar and to prevent the latter from rotating. The compressed spring also allows the vertical stroke for screwing the cap onto

bottle BTL to be compensated still keeping its compression.

[0046] In operation, Fig. 7A, because of the slope of the feeding channel 108 and an air blow, the caps CPS come to plate 99 where they are caught by recesses 97 of shaped disc 93 which is in turn rotated by heads 16 carried by the roundabout. The bottles to be capped BTL coming from wheel 21 (Fig. 1) are engaged by fork collars 33 integral with slidable members 32 which are lifted by cam system 34-35. Therefore, the bottles are brought under the head and cone 88 in which a cap drawn as illustrated in Fig. 8 is already inserted.

[0047] As it is evident, heads 16 are rotated because of the engagement of their gear wheels 52 with fixed gear wheel 40 during the rotation of the roundabout integral with shaft 15. The capped bottles BTT are then extracted by wheel 22.

Claims

1. An apparatus for capping containers with plastic caps threaded in advance, in which a roundabout (20) carries a plurality of screwing heads (16), which do not shift vertically but only rotate each one about its own axis, each head (16) being placed at a same distance from a central rotating shaft (14), driven by an electric motor, and being provided with means for adjusting the screwing torque imparted to a cap (CPS) to be screwed onto a container (BTL), said means comprising a couple of annular magnetic tracks (104, 105) mounted respectively on a freely rotating element (88) and on a driver element (106), each head (16) being provided with a small gear wheel (52) meshed with a conjugated gear wheel (40) with larger diameter so that the requested rotation of each head (16) to apply the cap (CPS) contained in a cone (88) of screwing head is taken off from the rotation of the whole roundabout carrying screwing heads (16) inside gear wheel (40), **characterised in that** said gear wheel (40) is integral with the internal surface of the cylindrical side wall members (13) of the external stationary portion of the apparatus, said small gear wheels (52) meshing with an inner toothed part of gear wheel (40), and that said roundabout (20) carries also a plurality of members (32), each parallel to one of said screwing heads (16) and provided with a vertically slidable fork collar (33) apt to receive a neck of a container (BTL).

2. The apparatus of claim 1, in which each of said fork collars (33) is provided with teeth (44) to engage the neck of a container (BTL) and prevent it from rotating while capping.

3. The apparatus as in claim 1, in which said means for adjusting the screwing torque comprises a first toroidal member (101) fixedly connected to a rotating shaft (50), member (101) having on its outer cylindrical peripheral surface a toothing (109), holding internally bearings (102) and being provided with a thread (108), a second toroidal member (106) having a thread part axially connected to thread (108) and axially movable along said thread with respect to first member (101), such second member (106) having the same external diameter of member (101) and being provided on its external cylindrical peripheral surface of a toothing (109) having the same geometrical dimensions as toothing (109) of member (101) as well as of a magnetic track (105), and a third member (88) connected to axis (112) freely rotating inside bearing (102) and holding magnetic track (104) in front of magnetic track (105) at an adjustable distance thereof, a member (106) being vertically movable along thread (108) to modify distance between tracks (104, 105), an outer annular member (110) being axially slidable along toothing (109), downwardly to fixedly engage members (101) and (106) and upwardly to disengage member (106) in order to move it along thread (108) to adjust distance between tracks (104) and (105).

Patentansprüche

1. Vorrichtung zum Verschließen von Behältern mit Kunststoffkappen, die zuvor mit einem Gewinde versehen wurden, in der ein Karussell (20) mehrere Schraubköpfe (16) transportiert, die sich vertikal nicht verschieben, sondern sich nur jeweils um ihre eigene Achse drehen, wobei jeder Kopf (16) in einem gleichen Abstand von einer zentralen Drehwelle (14) angeordnet ist, die durch einen Elektromotor angetrieben wird, und mit Mitteln zum Einstellen des Schraubdrehmoments versehen ist, das einer Kappe (CPS) erteilt wird, damit sie auf einen Behälter (BTL) geschraubt wird, wobei die genannten Mittel ein Paar ringförmiger Magnetspuren (104, 105) umfassen, die an einem sich frei drehenden Element (88) bzw. an einem Mitnehmerelement (106) angebracht sind, wobei jeder Kopf (16) mit einem kleinen Zahnrad (52) versehen ist, das mit einem korrespondierenden Zahnrad (40) mit einem größeren Durchmesser in der Weise in Eingriff ist, dass die geforderte Drehung jedes Kopfs (16) zum Anbringen der Kappe (CPS), die in einem Kegel (88) des Schraubkopfs enthalten ist, der Drehung des gesamten Karussells entnommen wird, das die Schraubköpfe (16) in dem Zahnrad (40) transportiert, **dadurch gekennzeichnet, dass** das genannte Zahnrad (40) einteilig mit der inneren Oberfläche der zylindrischen Seitenwandelemente (13) des äußeren feststehenden Abschnitts der Vorrichtung ist, dass die genannten kleinen Zahnräder (52) mit einem inneren Zahnteil des Zahnrads (40) in Eingriff sind und dass das genannte Karussell (20) außerdem mehrere Elemente (32)

transportiert, die jeweils parallel zu einem der genannten Schraubköpfe (16) sind und mit einem vertikal gleitfähigen Gabelrand (33) versehen sind, der geeignet ist, einen Hals eines Behälters (BTL) aufzunehmen.

2. Vorrichtung gemäß Anspruch 1, in der jeder der genannten Gabelränder (33) mit Zähnen (44) versehen ist, die mit dem Hals eines Behälters (BTL) in Eingriff gelangen und verhindern, dass er sich während des Verschließens dreht.

3. Vorrichtung gemäß Anspruch 1, in der die Mittel zum Einstellen des Schraubdrehmoments ein erstes ringförmiges Element (101), das fest mit einer Drehwelle (50) verbunden ist, wobei das Element (101) an seiner äußeren zylindrischen Umfangsoberfläche eine Verzahnung (109) aufweist, innen Lager (102) hält und mit einem Gewinde (108) versehen ist, ein zweites ringförmiges Element (106), das ein Gewindeteil aufweist, das mit dem Gewinde (108) axial verbunden und entlang des genannten Gewindes in Bezug auf das erste Element (101) axial beweglich ist, wobei dieses zweite Element (106) den gleichen Außendurchmesser des Elements (101) aufweist und an seiner äußeren zylindrischen Umfangsoberfläche mit einer Verzahnung (109) versehen ist, die die gleichen geometrischen Abmessungen wie die Verzahnung (109) des Elements (101) sowie einer Magnetspur (105) aufweist, und ein drittes Element (88), das mit einer Achse (112) verbunden ist, die sich in dem Lager (102) frei dreht, und das die Magnetspur (104) in einem einstellbaren Abstand davon vor der Magnetspur (105) hält, umfassen, wobei ein Element (106) entlang des Gewindes (108) vertikal beweglich ist, um den Abstand zwischen den Spuren (104, 105) zu ändern, wobei ein äußeres ringförmiges Element (110) entlang der Verzahnung (109) axial nach unten gleitfähig ist, um die Elemente (101) und (106) fest in Eingriff zu bringen, und axial nach oben gleitfähig ist, um das Element (106) außer Eingriff zu bringen, um es entlang des Gewindes (108) zu bewegen, um den Abstand zwischen den Spuren (104) und (105) einzustellen.

Revendications

1. Appareil de capsulage de récipients au moyen de capsules en plastique déjà filetées, dans lequel un carrousel (20) porte une pluralité de têtes de vissage (16), qui ne se translatent pas verticalement mais qui tournent chacune uniquement autour de leur propre axe, chaque tête (16) étant placée à une même distance d'un arbre de rotation central (14), entraîné par un moteur électrique, et étant pourvue de moyens pour régler le couple de vissage exercé sur une capsule (CPS) à visser sur un récipient (BTL), lesdits moyens comprenant deux pistes magnétiques annulaires (104, 105) montées respectivement sur un élément de rotation libre (88) et sur un élément d'entraînement (106), chaque tête (16) étant pourvue d'une petite roue dentée (52) s'engrenant avec une roue dentée complémentaire (40) de plus grand diamètre de sorte que la rotation requise de chaque tête (16) pour appliquer la capsule (CPS) contenue dans un cône (88) de la tête de vissage est obtenue par la rotation du carrousel proprement dit portant les têtes de vissage (16) à travers la roue dentée (40), **caractérisé en ce que** ladite roue dentée (40) est solidaire de la surface interne des éléments de paroi cylindriques (13) de la partie fixe externe de l'appareil, lesdites petites roues dentées (52) s'engrenant avec une partie dentée interne de la roue dentée (40), et **en ce que** ledit carrousel (20) porte une pluralité d'éléments (32), chacun étant parallèle à l'une desdites têtes de vissage (16) et pourvu d'un collier en fourche (33) pouvant coulisser verticalement et apte à recevoir le col du récipient (BTL).

2. Appareil selon la revendication 1, dans lequel chacun desdits colliers en fourche (33) est pourvu de dents (44) pour venir en prise avec le col d'un récipient (BTL) et l'empêcher de tourner pendant le capsulage.

3. Appareil selon la revendication 1, dans lequel lesdits moyens pour régler le couple de vissage comprennent un premier élément toroïdal (101) relié de manière fixe à un arbre de rotation (50), l'élément (101) présentant sur sa surface périphérique cylindrique externe une denture (109), emprisonnant des roulements intérieurs (102) et étant pourvu d'un filetage (108), un second élément toroïdal (106) présentant une partie filetée reliée axialement au filetage (108) et pouvant être déplacé axialement le long dudit filetage par rapport au premier élément (101), ledit second élément (106) étant de même diamètre externe que le premier élément (101) et présentant sur sa surface périphérique cylindrique externe une denture (109) ayant les mêmes dimensions géométriques que la denture (109) de l'élément (101) ainsi qu'une piste magnétique (105), et un troisième élément (88) relié à l'axe (112) tournant librement à l'intérieur du palier (102) et maintenant la piste magnétique (104) en face de la piste magnétique (105) à une distance réglable de celle-ci, un élément (106) pouvant être déplacé verticalement le long du filetage (108) afin de modifier la distance entre les pistes (104, 105), un élément annulaire externe (110) pouvant coulisser axialement le long de la denture (109), vers le bas afin de venir en prise bloquée avec les éléments (101) et (106), et vers le haut pour mettre hors de prise l'élément (106) afin de le déplacer le long du filetage (108) pour régler la distance entre les pistes (104) et (105).

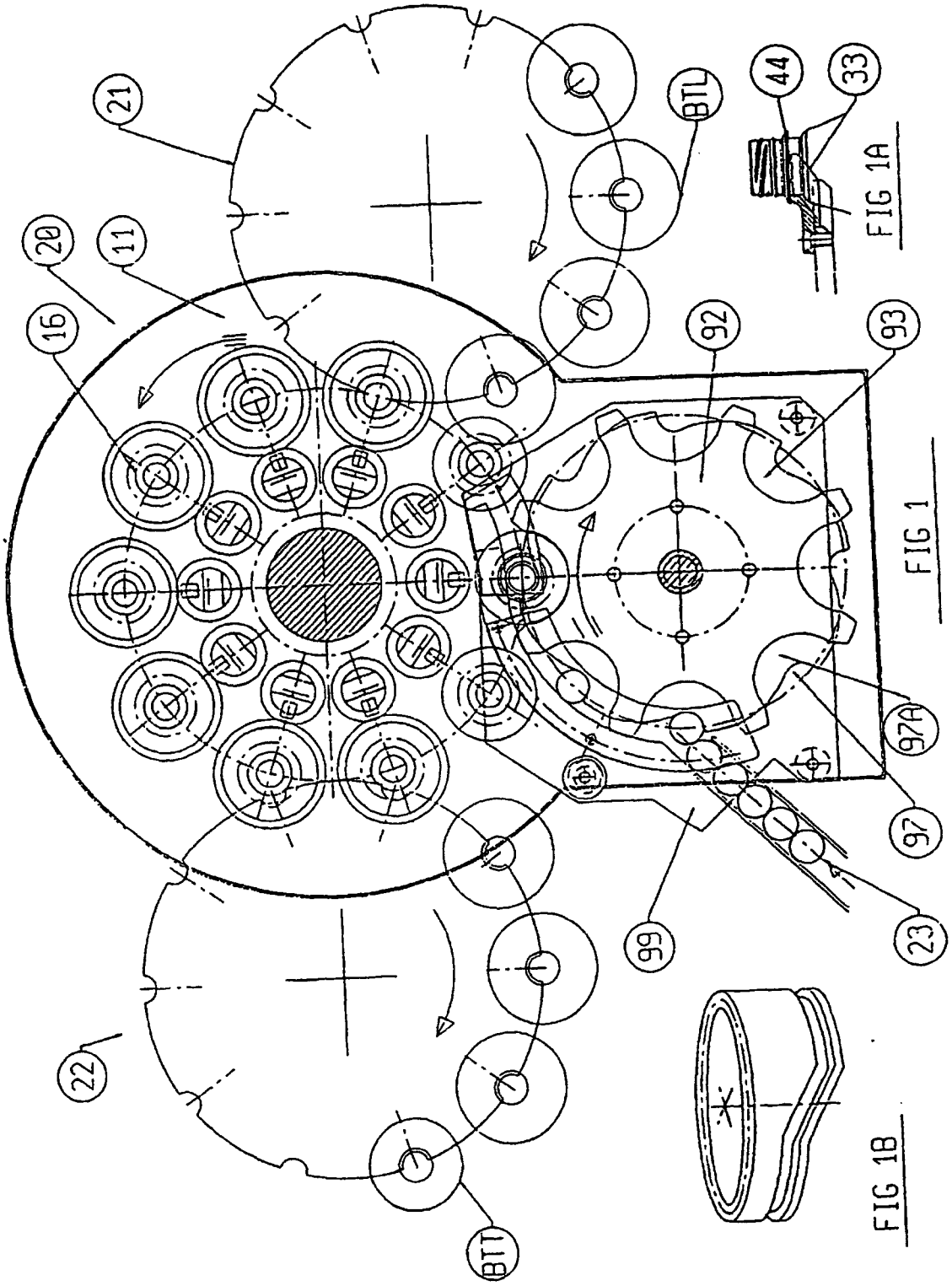


FIG 1

FIG 1A

FIG 1B

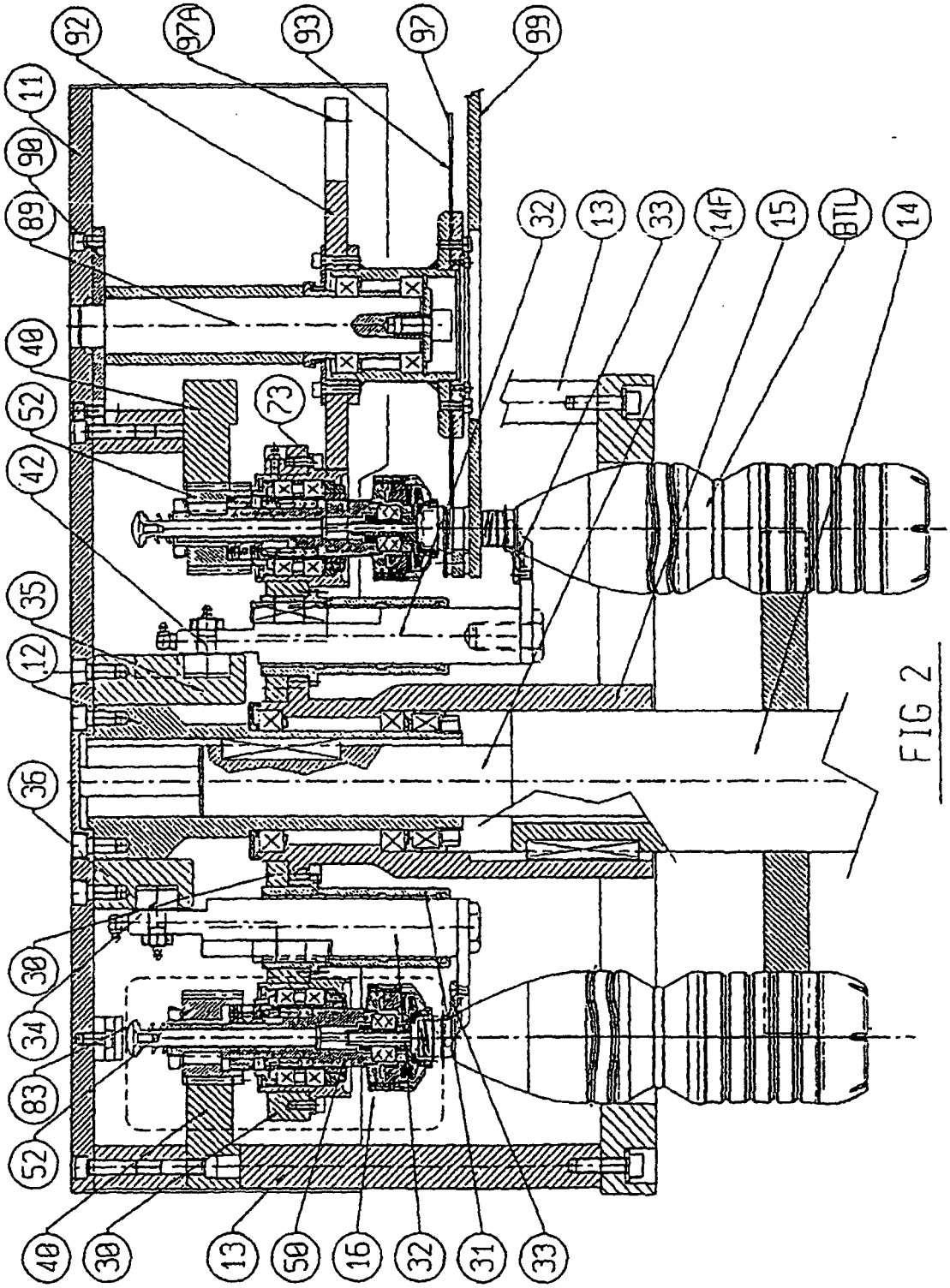

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97A
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14F
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BTL
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FIG 2

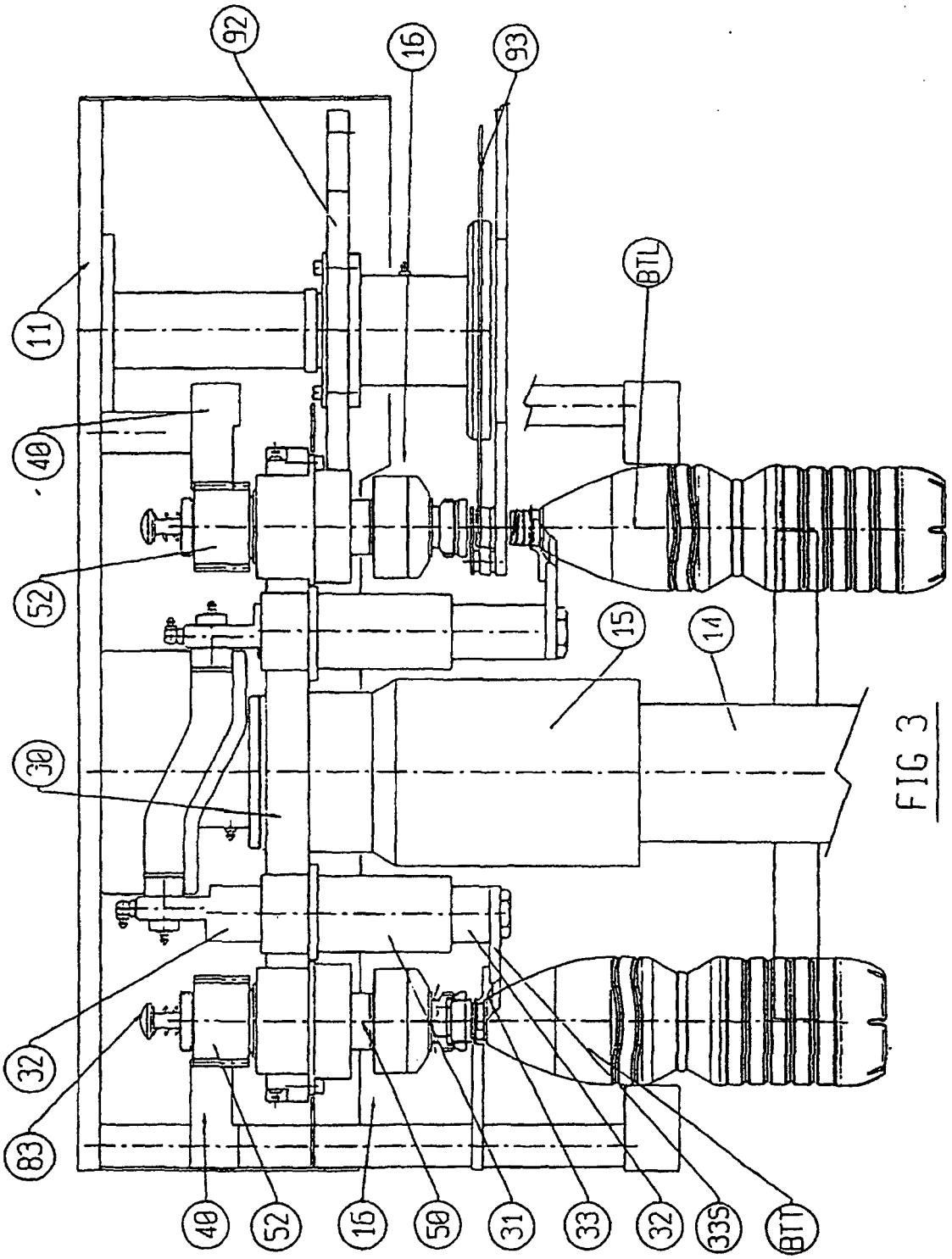
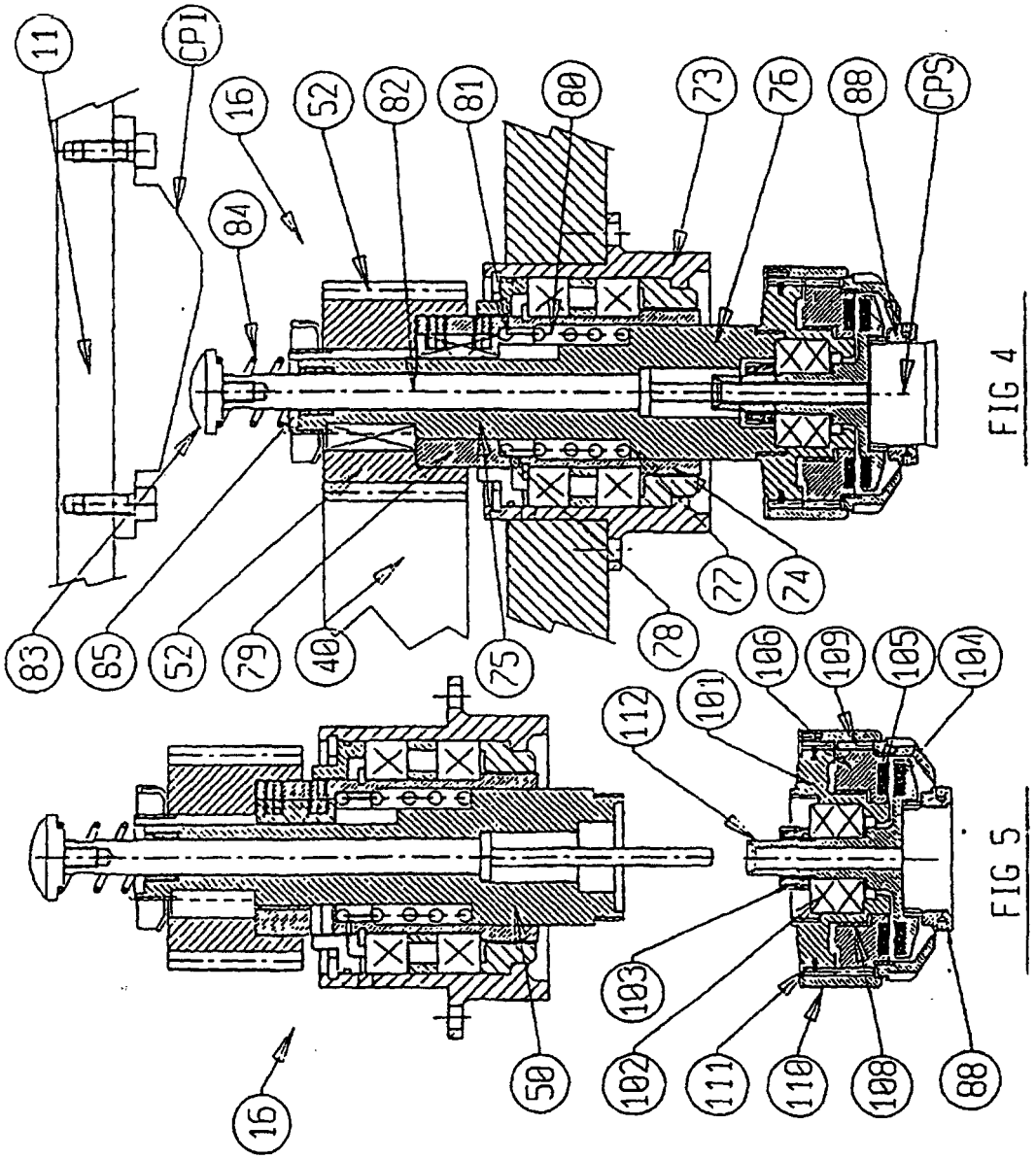


FIG 3


11
CPI
16
52
82
81
80
73
76
88
CPS
84
83
85
52
79
40
75
78
77
74
FIG 4
106
109
105
104
101
112
103
102
111
110
108
88
50
16
FIG 5

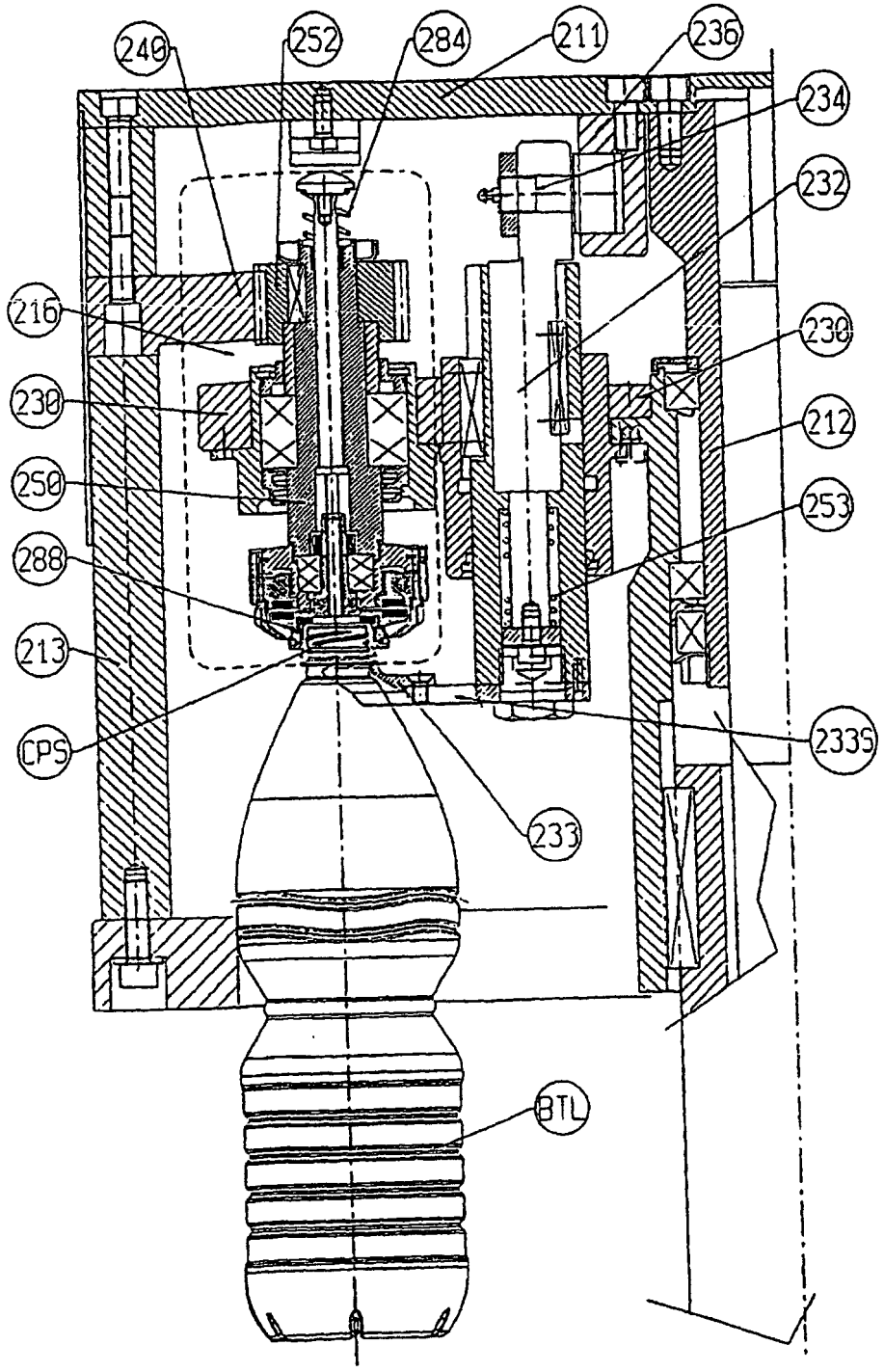

240
252
284
211
236
234
232
216
230
230
212
250
253
288
213
CPS
233
233S
BTL

FIG 6

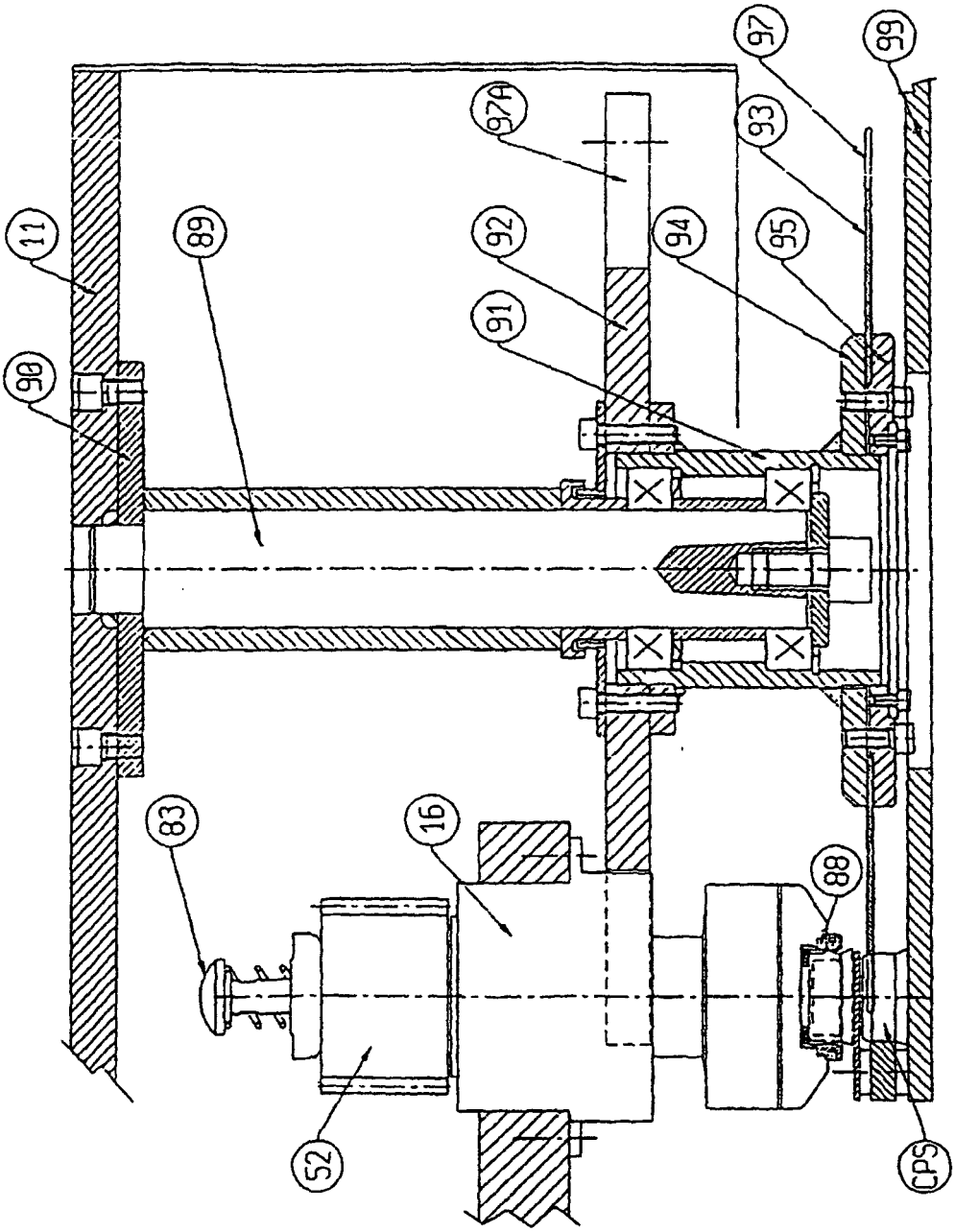


FIG 7

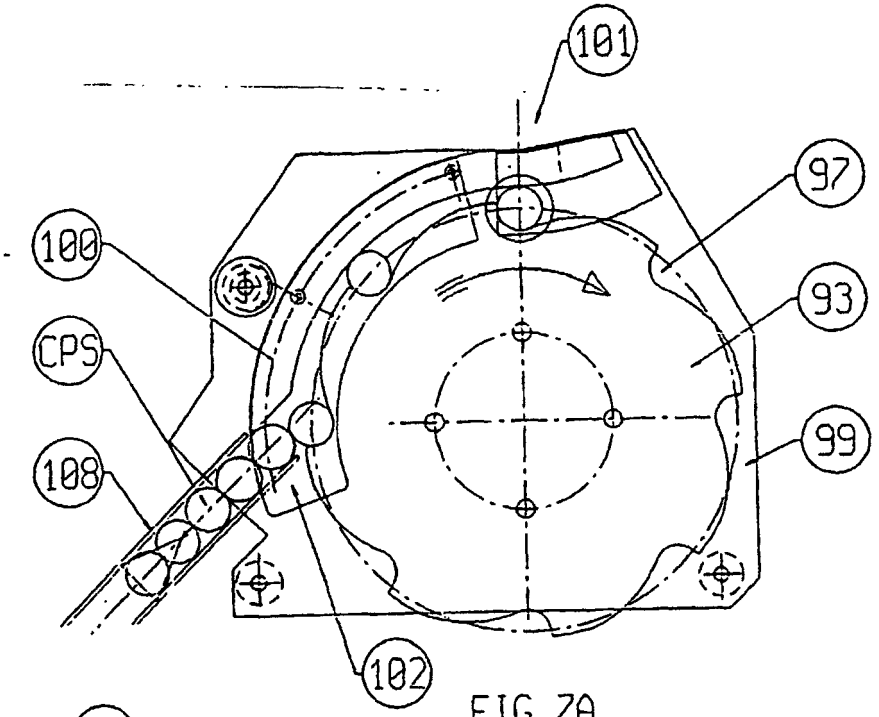


FIG 7A

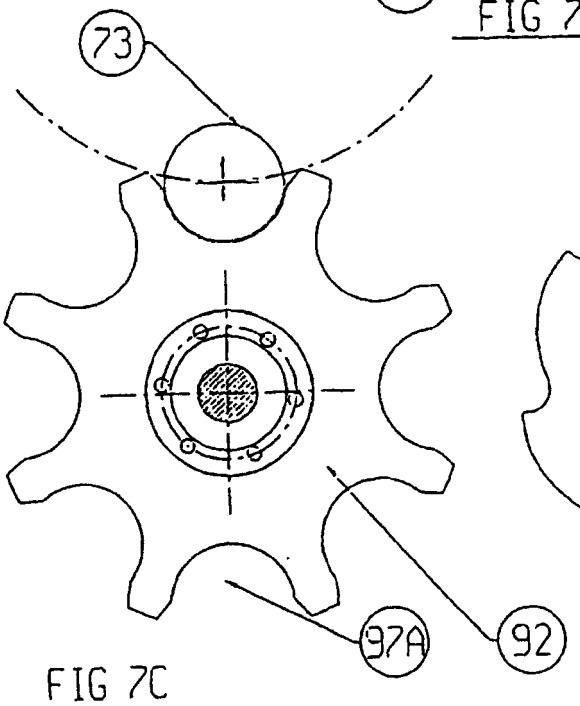


FIG 7C

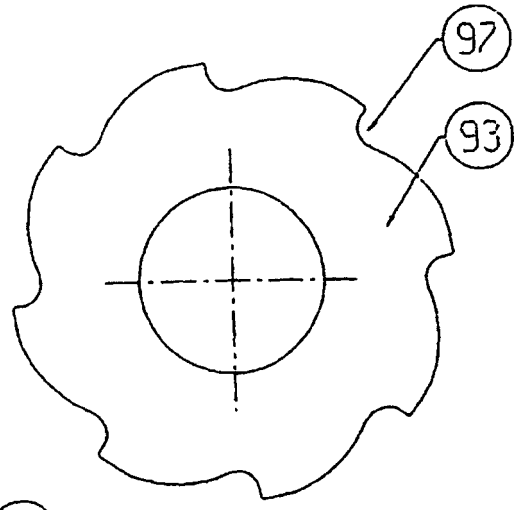


FIG 7B

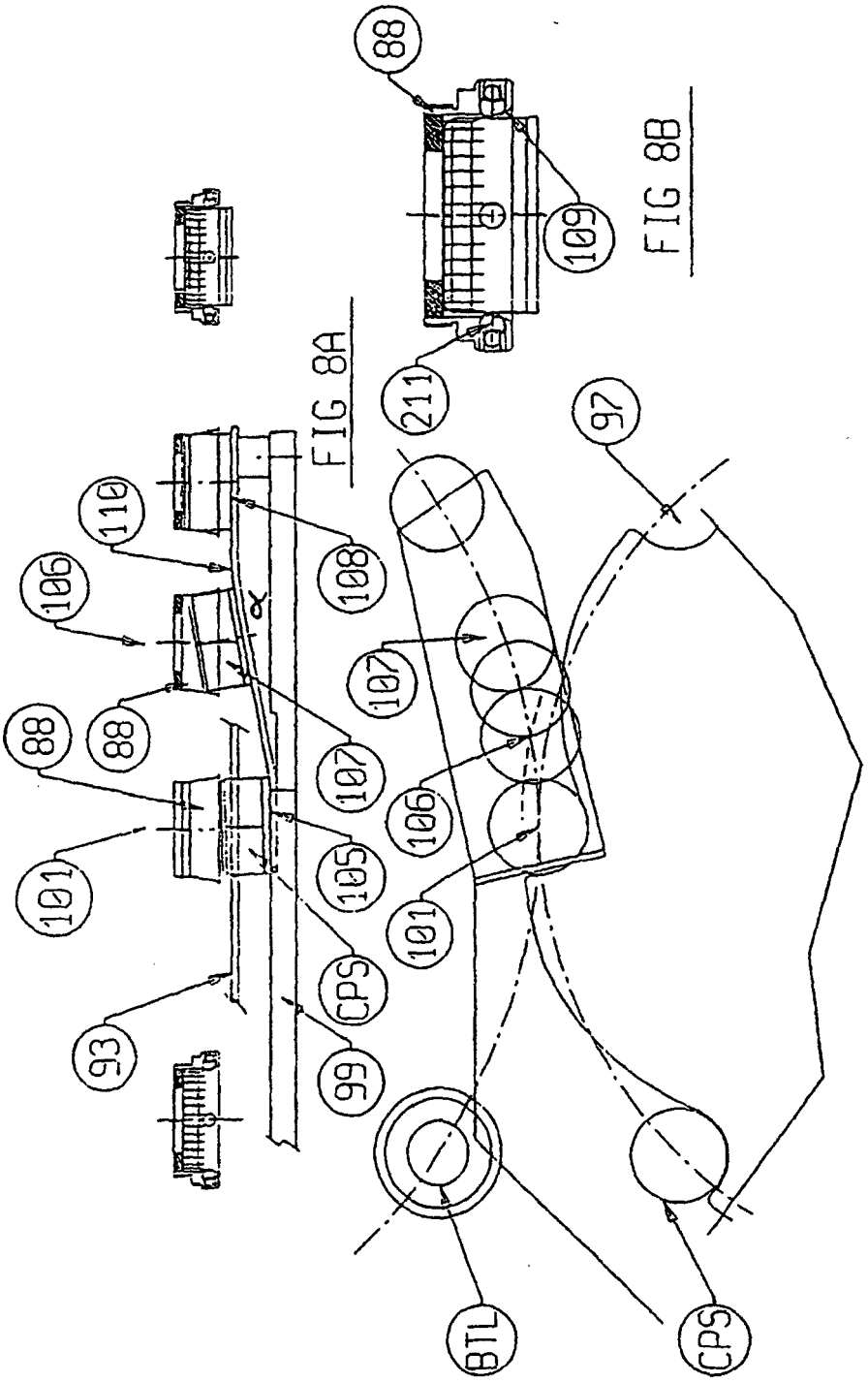


FIG 8A

FIG 8B

FIG 8