(19) LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

(11) N° de publication : **LU102878**

(12) **BREVET D'INVENTION** **B1**

(21) N° de dépôt: LU102878

(22) Date de dépôt: 15/11/2021

(51) Int. Cl.:
G01N 35/10

(30) Priorité:

(43) Date de mise à disposition du public: 15/05/2023

(47) Date de délivrance: 15/05/2023

(73) Titulaire(s):
STRATEC SE – 75217 Birkenfeld (Allemagne)

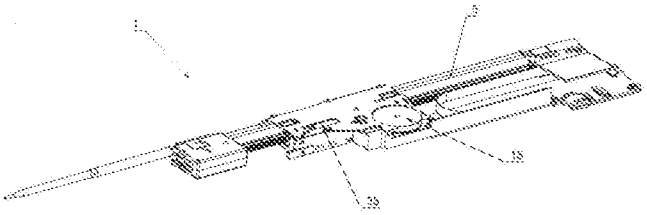
(72) Inventeur(s):
KUNZ Klaus – Allemagne, PHILIPP Klaus – Allemagne,
MASCHKE Uwe – Allemagne

(74) Mandataire(s):
Fortmann Tegethoff Patent- & Rechtsanwälte –
10117 Berlin (Allemagne)

(54) **PIPETTING UNIT.**

(57) The invention relates to a pipetting device, a system comprising said pipetting device and a system for handling liquids and provides a pipetting device, comprising a housing with two parallel flat surfaces with a maximal distance of 17.5 mm between them accommodating a Z-shaft mounted in a guiding and connected to a Z-drive for actuating the Z-shaft; and a Y-drive which is connected to the housing and comprises a Y-gear wheel that is arranged next to an opening in the housing

FIG. 1



PIPETTING UNIT

DESCRIPTION

Field of the Invention

[0001] The invention relates to a pipetting device, a system comprising said pipetting device and a system for handling liquids.

Brief description of the related art

[0002] Automated analyser systems for use in clinical diagnostics and life sciences are produced by a number of companies. For example, STRATEC® SE, Birkenfeld, Germany, produces a number of devices for specimen handling and detection for use in automated analyser systems and other laboratory instrumentation.

[0003] STRATEC designs and manufactures automated analyzer systems like diagnostic systems for biochemically processing samples, in particular patient samples. Such analyzer systems usually have a liquid handling device, which comprises a pipetting device for aspirating or dispensing liquids in receptacles like multi well plates which are flat plates having a plurality of wells for taking up or providing a liquid.

[0004] To speed up handling of liquids in automated analyser systems, multi-needle pipettors are often used to increase the throughput of samples to be analysed by pipetting in parallel from or into multiple wells.

[0005] With known multi-needle pipettors for pipetting distances of 9 mm which corresponds to a 9 mm grid of multi well plates, difficulties arise related to the arrangement of the components of a pipettor unit including drives and bearings for instance. The known designs of multi-needle pipettors do not allow the pipetting units to be arranged in any position because

of their hardware setup. The pipetting units cannot easily be exchanged and the adjustment and alignment of the axes of a pipettor unit's probe to each other requires considerable effort.

[0006] The pipetting units are usually arranged offset for multi-needle pipetting to be able to realise a pipetting distance of 9 mm. Powerful drives with encoders which are required to drive the pipetting units in the Y and Z directions, can be located at the top or bottom of the pipetting units. The arrangement depends on the respective positioning in the multi-needle pipetting unit. This nested structure results in different pipetting units that cannot be positioned arbitrarily in relation to each other. The Z-axis of a pipetting unit dips through the neighbouring pipetting unit. Removal of individual pipetting units is only possible with difficulty and represents a considerable effort in the service case.

[0007] Thus, there is a need for a pipetting unit allowing a simplified arrangement, positioning and exchange of the pipetting unit.

Object of the Invention

[0008] It is therefore the object of this invention to provide a pipetting unit which allows for a simplified arrangement, positioning and exchange of the pipetting unit.

Summary of the Invention

[0009] The present invention provides a pipetting device, comprising a housing with two parallel flat surfaces with a maximal distance of 17.5 mm between them accommodating

a. a Z-shaft mounted in a guiding and connected to a Z-drive for actuating the Z-shaft; and
b. a Y-drive which is connected to the housing and comprises a Y-gear wheel that is arranged next to an opening in the housing.

[0010] In a further aspect of the present invention, the Z-drive for the Z-shaft is a motor comprising a diametrically magnetised round magnet at a motor shaft's end of the Z-drive and an opposite, on a circuit board arranged encoder chip for determining the rotation angle of the magnetic field so that the position of the Z-shaft can be determined.

[0011] The housing may comprise a forked light barrier for initialising the Z-shaft in a further embodiment.

[0012] It is further envisaged that the Z-shaft comprises a Z-gear rack into which a Z-gear wheel connected to the Z-drive engages for actuating the Z-shaft.

[0013] In another embodiment, the Z-shaft comprises an integrated pipetting pump for providing or taking up liquids.

[0014] In another aspect of the invention, the Y-drive is a motor which is connected to the housing.

[0015] In a further embodiment, the position of the Z-gear wheel of the Z-drive for engaging into the Z-gear rack can be adjusted by a clamping screw.

[0016] The device may also encompass that the Z-gear wheel has a play compensation.

[0017] The invention relates also to a device, wherein the opening next to the Y-gear wheel comprises a ball bearing arranged opposite the Y-gear wheel.

[0018] The device may also comprise a Z-gear unit between the motor shaft's end of the Z-drive and the Z-gear wheel.

[0019] Another object of the invention is a system for handling of liquids, comprising a pipetting device as described in the previous paragraphs.

[0020] The system may also comprise a gear rack that is guided through the opening in the housing into which the Y-gear wheel of the Y-drive engages.

[0021] Another embodiment of the invention relates to a system, wherein the housing of the device is connected to an adjusting slide that moves in Y-direction on a guiding bar.

[0022] In another aspect, the system may encompass the adjusting slide comprising an upper ball bearing that is arranged on the upper side of the guiding bar and a lower ball bearing that is arranged on the lower side of the guiding bar.

[0023] In a further embodiment of the system, the at least one of upper and lower ball bearings is mounted on an eccentric for adjustment to a height of the guiding bar.

[0024] The system as described in the previous paragraphs may also comprise slide bearings which are arranged in openings of the housing for supporting movements of the pipetting device in Y-direction

[0025] Still other aspects, features, and advantages of the present invention are readily apparent from the following detailed description, simply by illustrating preferable embodiments and implementations. The present invention is also capable of other and different embodiments and its several details can be modified in various obvious respects, all without departing from the spirit and scope of the present invention. Accordingly, the drawings and descriptions are to be regarded as illustrative in nature, and not as restrictive. Additional objects and advantages of the invention will be set forth in part in the description which follows and in part will be obvious from the description, or may be learned by practice of the invention.

Summary of the Figures

[0026] The invention will be described based on figures. It will be understood that the embodiments and aspects of the invention described in the figures are only examples and do not limit the protective scope of the claims in any way. The invention is defined by the claims and their equivalents. It will be understood that features of one aspect or embodiment of the invention can be combined with a feature of a different aspect or aspects of other embodiments of the invention, in which:

[0027] FIG. 1 shows a single pipetting unit.

[0028] FIG. 2 shows a housing.

[0029] FIG. 3A shows a Z-drive comprising a flat motor-gear unit.

[0030] FIG. 3B shows the backside of a Z-drive comprising a flat motor-gear unit.

[0031] FIG. 3C shows a sectional view through a Z-drive comprising a flat motor-gear unit.

[0032] FIG. 4 shows the Z-drive motor gear unit.

[0033] FIG. 5 an inherently resilient Z-drive gear wheel.

[0034] FIG. 6 shows a compact gear motor as Y-drive which engages into a Y-gear rack.

[0035] FIG. 7 shows a spring-loaded adjustment slide.

[0036] FIG. 8 shows a cassette on a guiding bar.

[0037] FIG. 9 and FIG. 10 show a Z-shaft guiding in more detail.

Detailed Description of the Invention and the Figures

[0038] The technical problem is solved by the independent claims. The dependent claims cover further specific embodiments of the invention.

[0039] The present invention provides a universal pipetting unit which is a device that may be installed in an automated analyser systems like diagnostic devices wherein the pipetting unit has a maximum width of 18 mm. The compact design of the pipetting unit with a maximum width of 18 mm is necessary to realise a pipetting distance of 9 mm (grid of microtitre plates) when the pipetting units are arranged opposite and staggered to each other. To allow for tolerances, a maximum width of 17.5 mm is also envisaged for the pipetting unit. The design of the cassette housing is based on a very flat Z-axis drive with special gearing and a compact Y-drive to make it possible to comply with the maximum width. The housing of such a pipetting unit has two flat surfaces with a distance of 18 mm or 17.5 mm between the outer surfaces of the housing.

[0040] The pipetting unit can be installed or arranged in any position of a multi-needle pipettor due to the flat design. No conversion or individual adaptation of the pipetting unit is necessary. This saves costs for production, service and spare parts stocking. The following drawings show

embodiments of a multi-needle pipettor according to the present disclosure with exemplary arrangement of the pipetting units.

[0041] FIG.1 shows a single pipetting unit 1. The pipetting unit 1 comprises a Z-shaft 5 and a housing 10. The housing 10 which may also be designated as a cassette accommodates the Z-shaft 5 and further Z-drive 15, Y-drive 35 and associated electronics (not shown) for controlling the Z-drive 15 in the housing's 10 flat design. The housing 10 comprises further, guidings for the Z- and Y-shaft (not shown in detail).

[0042] The housing 10 (FIG. 2) can be made of different materials. It can be made of an injection moulded part with a stiffening plate, or alternatively it may be milled from a metal part or it can be made of zinc or aluminum via a die casting process.

[0043] The Z-drive 15 comprises a flat motor-gear unit 19, which is shown in FIG. 3A. The flat motor-gear unit 19 can be in an embodiment an EC gear motor 17 (FIG. 3B) which is used to move the Z-shaft. The drive contains a diametrically magnetized round magnet 21 at a first end of the motor shaft 22. The associated encoder chip 23 is located on a circuit board 24 on the opposite side of the motor axis and the magnet 21, as shown in FIG. 3C.

[0044] This arrangement is used to determine the angle of rotation of the magnetic field and to determine an exact position of the Z-shaft. The Z-shaft of the pipetting unit is initialised via a forked light barrier on the cassette housing. Compared to the state of the art, this arrangement is narrower and allows the identical pipetting units to be arranged in the 9 mm grid of the microtitre plates.

[0045] FIG. 4 shows the Z-drive motor gear unit 19. The play between a gear rack (not shown) and a Z-drive gear wheel 25 engaging in a gear rack is adjusted by means of a clamping screw 26 which fixes a plate 27. Once the adjustment has been made, plate 27 is fixed with clamping screw 26.

[0046] Alternatively, as shown in FIG. 5, an inherently resilient Z-drive gear wheel 25 can be used for the Z-drive in order to realize a backlash-free installation. Such a gear wheel 25 may have a design with an elastic material arranged between outer gearing 30 and a centrally arranged hole 31. Alternatively, the shape of a material between outer gearing 30 an the centrally arranged hole 31 may allow a play between them, as FIG. 5B shows an S-shape.

[0047] FIG. 6 shows that a Y-drive 35 which may be provided by a compact DC gear motor which is flexibly (elastically mounted in the X-direction) connected to the housing (not shown), and via a Y-gear wheel 37 that is mounted on the Y-drive motor shaft (not visible) for engaging into the toothed Y-gear rack 39. The Y-gear wheel 37 is guided by a deep-groove ball bearing for the Y-drive 41. A magnetic tape encoder 43 is integrated into the housing (not shown) to determine the respective Y-position of the pipetting unit. A magnetic tape (not shown) is attached to the toothed Y-gear rack 39.

[0048] The pipetting unit is guided in the Y-direction by slide bearings 55 (FIG. 10) on a cylindrical profile and by ball bearings 45 on a right-angled guiding bar 47 (FIG. 8). The position of the cassette on a guiding bar can be adjusted vertically via the eccentrically mounted ball bearing 45, 48 (FIG. 7, 8). The pressure spring in the spring loaded adjustment slide 51 of the second ball bearing automatically ensures a play-free movement between the ball bearing and the guiding bar.

[0049] FIG. 9 and FIG. 10 show a Z-shaft guiding in more detail. The guiding enables a horizontal positioning and vertical movement of the Z-shaft (not shown). The Z-shaft is supported by two L-bearings 50 with spring loaded counter bearings 52 in the housing 10. The friction must be high enough to hold the weight of the Z-shaft and at the same time small enough to keep the required force of the motor as low as possible.

[0050] During assembly or servicing, when the pipetting unit is in a de-energised state, the drive can be damaged if the Z-shaft is moved manually. To safeguard against this case of failure, the Z-shaft can be cushioned with a spring 54 (FIG. 9). Alternatively, the motor can be short-circuited via a relay in the de-energised state, so that a braking effect is created by the motor when the rack is pushed up manually.

[0051] FIG 10 shows Y-drive 35 and spring of counter bearing 52. FIG. 10 shows also slide bearings 55 which guide the pipetting unit in a Y-direction.

[0052] The advantages of a system according to the present disclosure relate to

a. Due to the compact design of the cassette with a module width of 17.5 mm, a modular design with 18 mm pitch is possible.
b. A pitch of 9 mm is possible with opposite construction.

c. The cassette can be installed in any position of the pipetting arm without conversion. This has great advantages especially in case of service.

d. It results in cost savings for production, service and for spare parts stocking:

   i. Less time required to replace (remove, adjust) individual Z-axes.

   ii. Lower spare parts inventory, as there is a smaller variation of spare parts.

[0053] The foregoing description of the preferred embodiment of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and modifications and variations are possible in light of the above teachings or may be acquired from practice of the invention. The embodiment was chosen and described in order to explain the principles of the invention and its practical application to enable one skilled in the art to utilize the invention in various embodiments as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the claims appended hereto, and their equivalents. The entirety of each of the aforementioned documents is incorporated by reference herein.

Reference Numerals

1	pipetting unit
5	Z-shaft
10	housing
15	Z-drive
17	EC motor
19	Z-drive motor gear
21	magnet
22	motor shaft
23	encoder chip
24	circuit board
25	Z-drive gear wheel
26	clamping screw
27	plate
30	gearing
31	hole
35	Y-drive
37	Y- gear wheel
39	Y-gear rack
41	ball bearing Y-drive
43	magnetic tape encoder
45	ball bearing
47	guiding bar
48	eccentric
50	L-bearing
51	spring loaded adjustment slide
52	counter bearing
54	spring
55	slide bearing

CLAIMS

1. A pipetting device, comprising a housing with two parallel flat surfaces with a maximal distance of 17.5 mm between them accommodating
   - a Z-shaft mounted in a guiding and connected to a Z-drive for actuating the Z-shaft; and
   - a Y-drive which is connected to the housing and comprises a Y-gear wheel that is arranged next to an opening in the housing.

2. The device of claim 1, wherein the Z-drive for the Z-shaft is a motor comprising a diametrically magnetised round magnet at a motor shaft's end of the Z-drive and an opposite, on a circuit board arranged encoder chip for determining the rotation angle of the magnetic field so that the position of the Z-shaft can be determined.

3. The device of claim 1 or 2, wherein the housing comprises a forked light barrier for initialising the Z-shaft.

4. The device of any one of claims 1 to 3, wherein the Z-shaft comprises a Z-gear rack into which a Z-gear wheel connected to the Z-drive engages for actuating the Z-shaft.

5. The device of any one of claims 1 to 4, wherein the Z-shaft comprises an integrated pipetting pump for providing or taking up liquids.

6. The device of any one of claims 1 to 5, wherein the Y-drive is a motor which is connected to the housing.

7. The device of any one of claims 1 to 6, wherein the position of the Z-gear wheel of the Z-drive for engaging into the Z-gear rack is adjusted by a clamping screw.

8. The device according to any one of claims 1 to 7, wherein the Z-gear wheel has a play compensation.

9. The device of any one of claims 1 to 8, wherein the opening next to the Y-gear wheel comprises a ball bearing arranged opposite the Y-gear wheel.

10. The device of any one of claims 1 to 9, comprising a Z-gear unit between the motor shaft's end of the Z-drive and the Z-gear wheel.

11. A system for handling liquids, comprising a pipetting device according to claims 1 to 10.

12. The system of claim 11, comprising a gear rack that is guided through the opening in the housing into which the Y-gear wheel of the Y-drive engages.

13. The system of any one of claims 11 or 12, wherein the housing of the device is connected to an adjusting slide that moves in Y-direction on a guiding bar.

14. The system of claim 13 wherein the adjusting slide comprises an upper ball bearing that is arranged on the upper side of the guiding bar and a lower ball bearing that is arranged on the lower side of the guiding bar.

15. The system of claim 14, wherein the at least one of upper and lower ball bearings is mounted on an eccentric for adjustment to a height of the guiding bar.

16. The system of any one of claims 11 to 15 wherein slide bearings are arranged in openings of the housing for supporting movements of the pipetting device in Y-direction.

ANSPRÜCHE

1. Pipettiervorrichtung, bestehend aus einem Gehäuse mit zwei parallelen, flachen Oberflächen mit einem maximalen Abstand von 17,5 mm zwischen ihnen, in dem
   - eine Z-Achse, die in einer Führung montiert und mit einem Z-Antrieb zum Betätigen der Z-Achse verbunden ist; und
   - einem Y-Antrieb, der mit dem Gehäuse verbunden ist und ein Y-Zahnrad umfasst, das neben einer Öffnung im Gehäuse angeordnet ist.

2. Vorrichtung nach Anspruch 1, wobei der Z-Antrieb für die Z-Achse ein Motor ist, der einen diametral magnetisierten Rundmagneten an einem Motorwellenende des Z-Antriebs und einen gegenüberliegenden, auf einer Leiterplatte angeordneten Encoderchip zur Bestimmung des Drehwinkels des Magnetfelds umfasst, so dass die Position der Z-Achse bestimmt werden kann.

3. Vorrichtung nach Anspruch 1 oder 2, wobei das Gehäuse eine Gabellichtschranke zur Initialisierung der Z-Achse aufweist.

4. Vorrichtung nach einem der Ansprüche 1 bis 3, wobei die Z-Achse eine Z-Zahnstange aufweist, in die ein mit dem Z-Antrieb verbundenes Z-Zahnrad zum Betätigen der Z-Achse eingreift.

5. Vorrichtung nach einem der Ansprüche 1 bis 4, wobei die Z-Achse eine integrierte Pipettierpumpe zur Bereitstellung oder Aufnahme von Flüssigkeiten aufweist.

6. Vorrichtung nach einem der Ansprüche 1 bis 5, wobei der Y-Antrieb ein Motor ist, der mit dem Gehäuse verbunden ist.

7. Vorrichtung nach einem der Ansprüche 1 bis 6, wobei die Position des Z-Zahnrades des Z-Antriebs zum Eingriff in die Z-Zahnstange durch eine Klemmschraube eingestellt wird.

8. Vorrichtung nach einem der Ansprüche 1 bis 7, wobei das Z-Zahnrad einen Spielausgleich aufweist.

9. Vorrichtung nach einem der Ansprüche 1 bis 8, wobei die Öffnung neben dem Y-Zahnrad ein dem Y-Zahnrad gegenüberliegendes Kugellager aufweist.

10. Vorrichtung nach einem der Ansprüche 1 bis 9, die ein Z-Getriebe zwischen dem Ende der Motorwelle des Z-Antriebs und dem Z-Getrieberad umfasst.

11. System zur Handhabung von Flüssigkeiten, umfassend eine Pipettiervorrichtung nach einem der Ansprüche 1 bis 10.

12. System nach Anspruch 11, umfassend eine Zahnstange, die durch die Öffnung im Gehäuse geführt wird, in die das Y-Zahnrad des Y-Antriebs eingreift.

13. System nach einem der Ansprüche 11 oder 12, wobei das Gehäuse der Vorrichtung mit einem Verstellschlitten verbunden ist, der sich in Y-Richtung auf einer Führungsschiene bewegt.

14. System nach Anspruch 13, wobei der Verstellschlitten ein oberes Kugellager, das auf der Oberseite der Führungsstange angeordnet ist, und ein unteres Kugellager, das auf der Unterseite der Führungsstange angeordnet ist, umfasst.

15. System nach Anspruch 14, bei dem das obere und/oder das untere Kugellager auf einem Exzenter zur Einstellung der Höhe der Führungsstange montiert ist.

16. System nach einem der Ansprüche 11 bis 15, bei dem Gleitlager in Öffnungen des Gehäuses angeordnet sind, um Bewegungen der Pipettiervorrichtung in Y-Richtung zu unterstützen.

FIG. 1

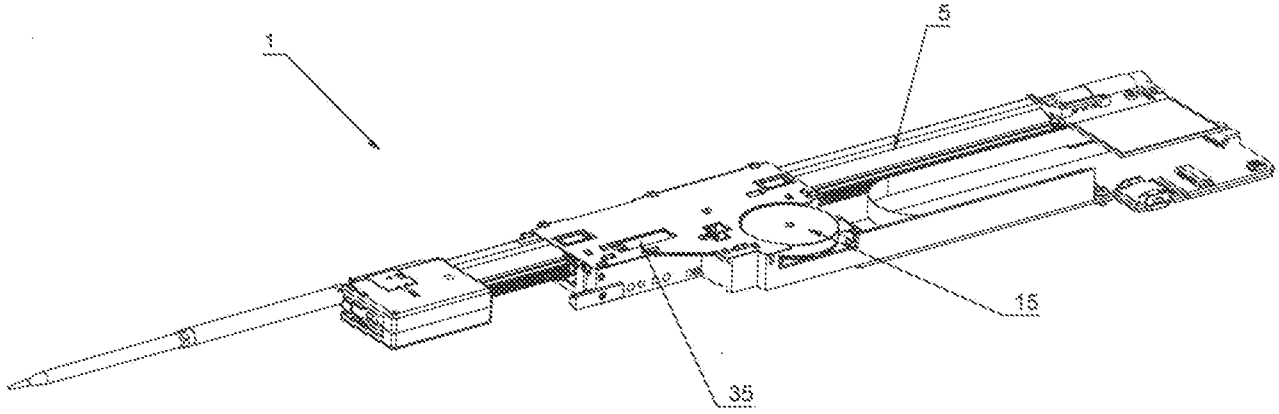


FIG. 2

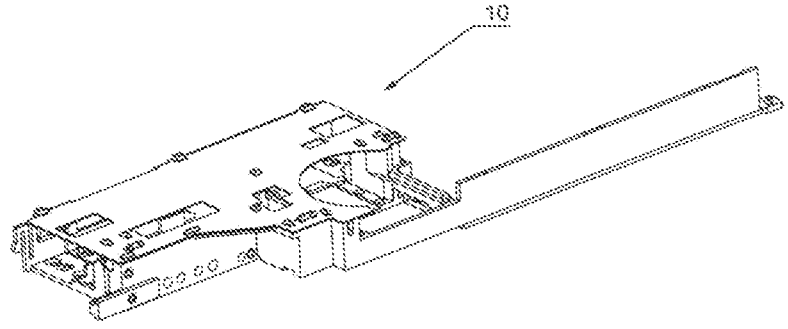


FIG. 3

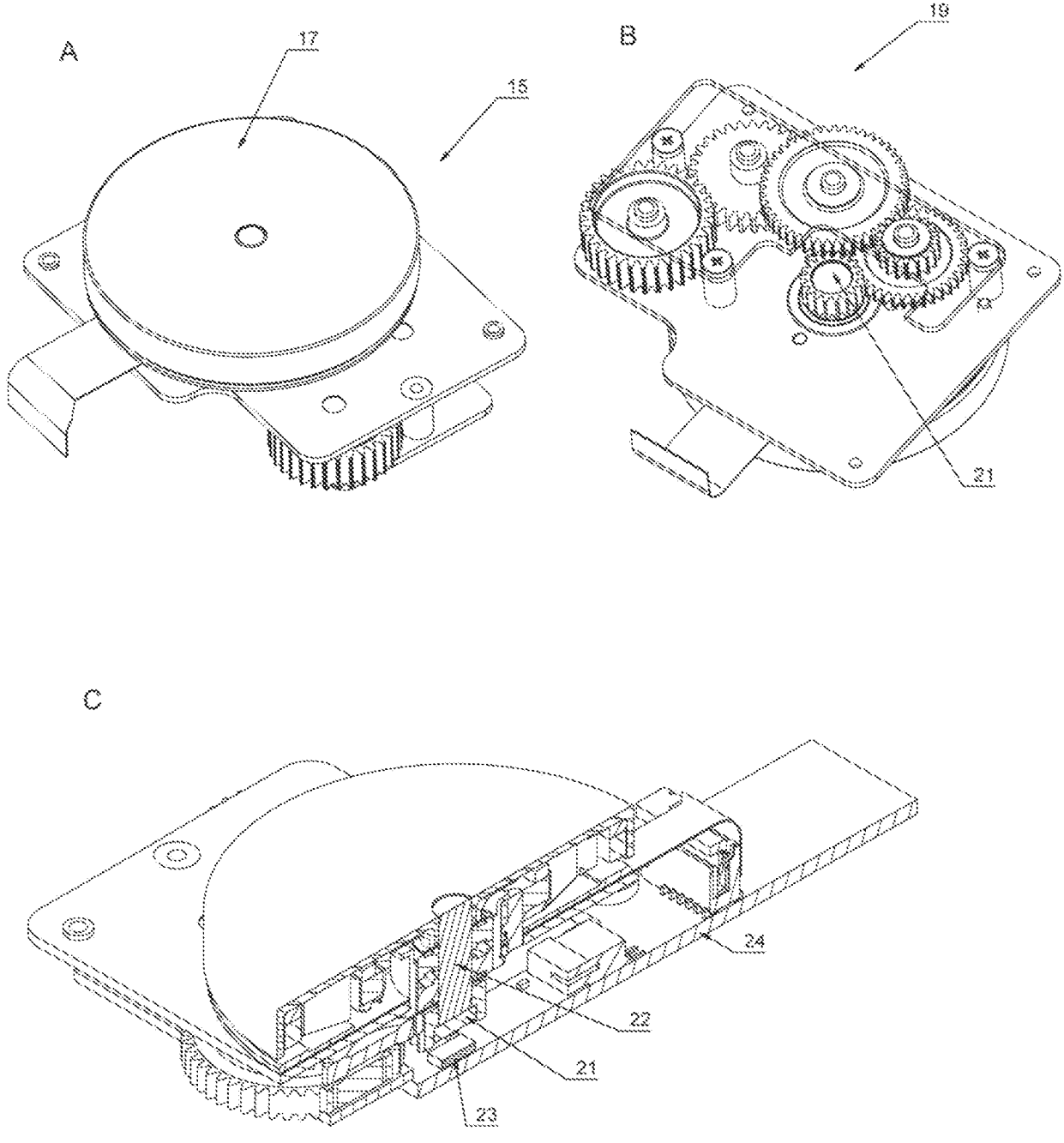


FIG. 4

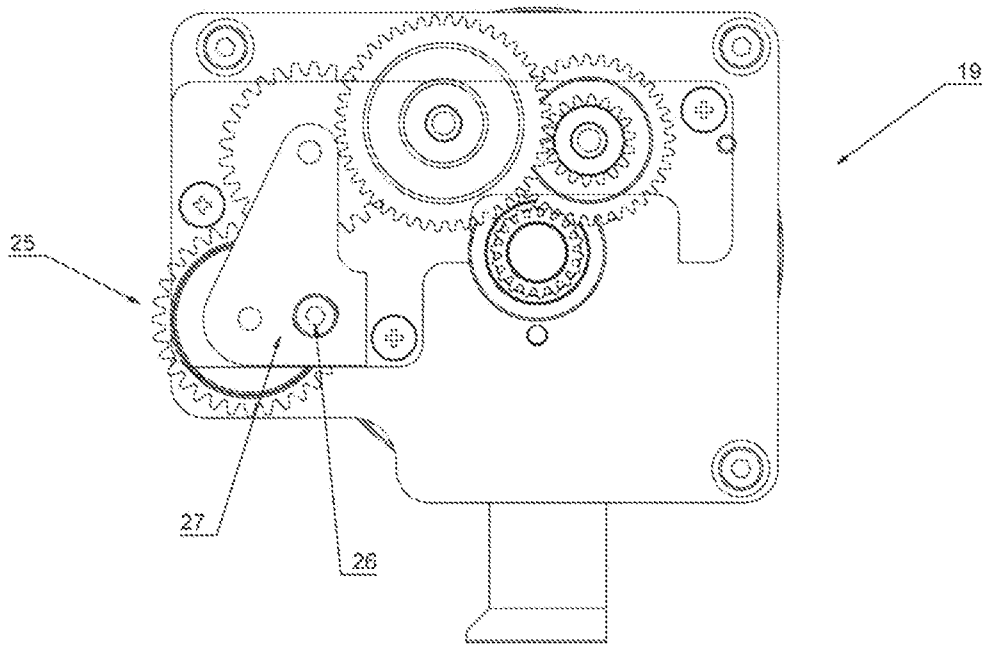


FIG. 5

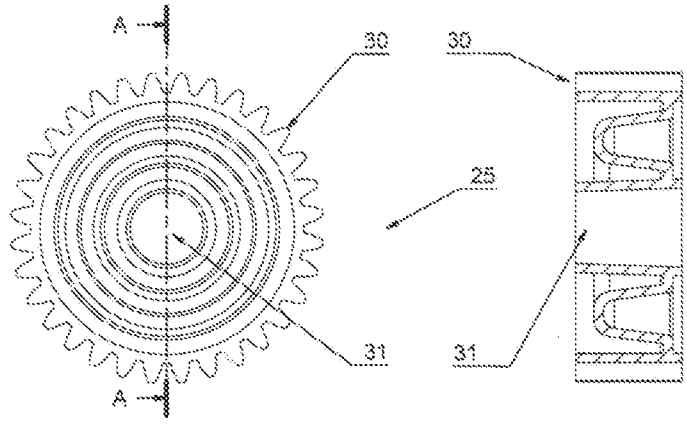


FIG. 6

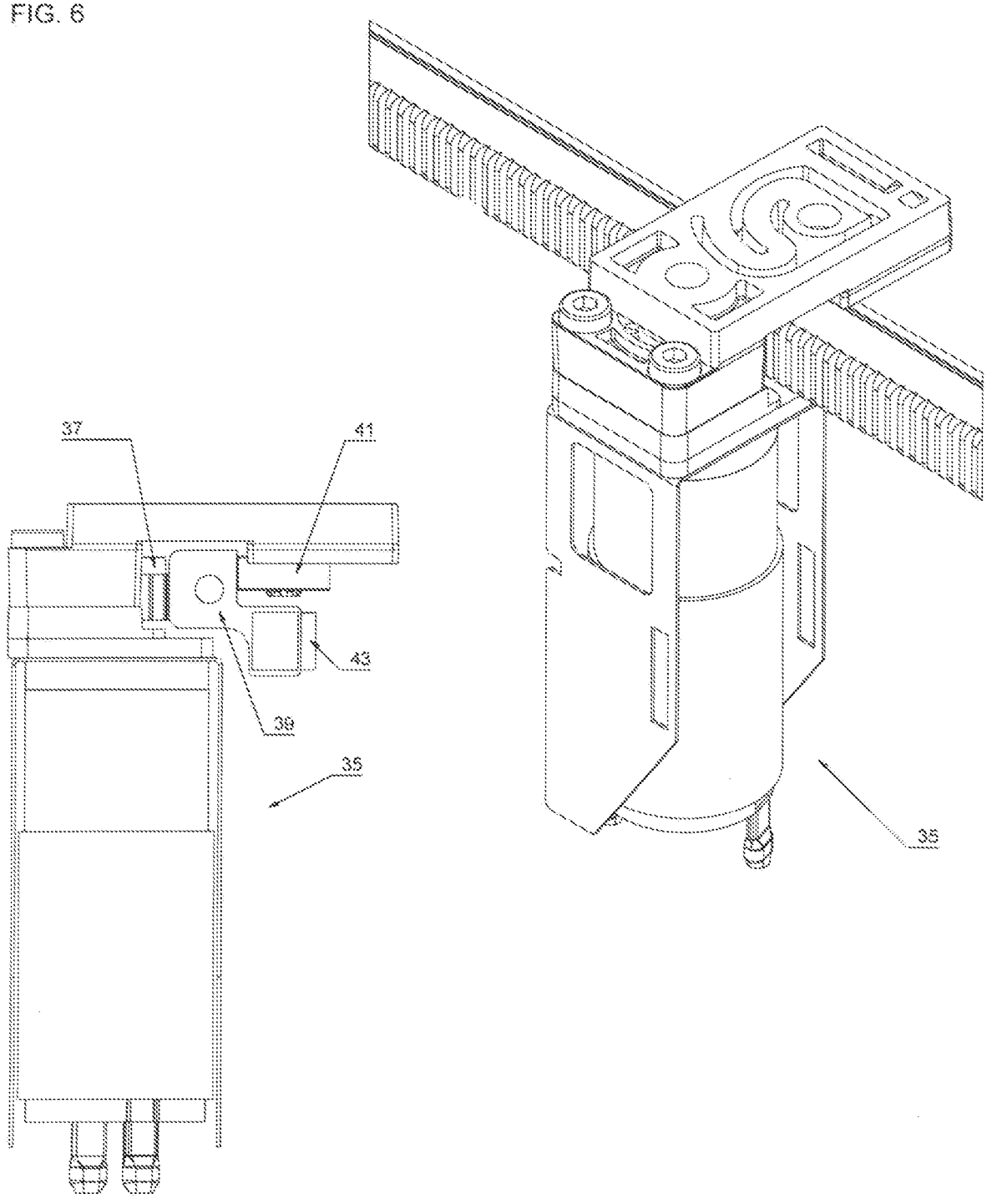


FIG. 7

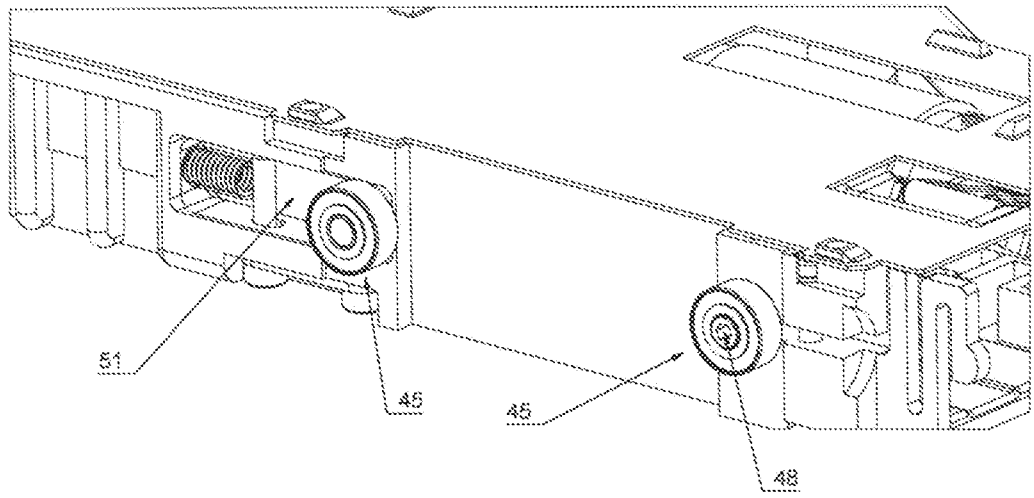


FIG. 8

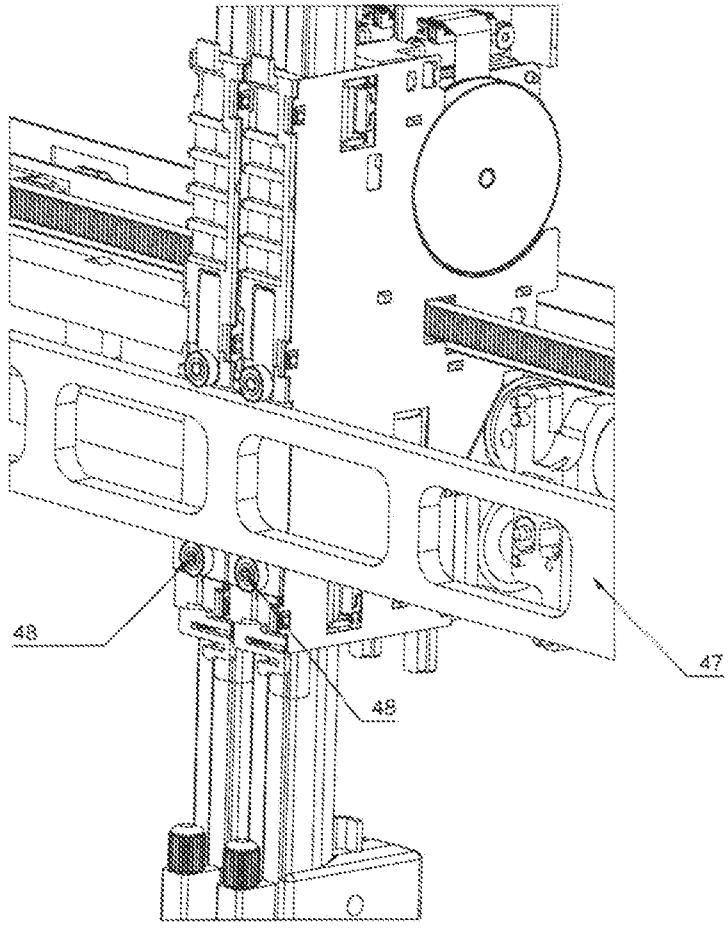


FIG. 9

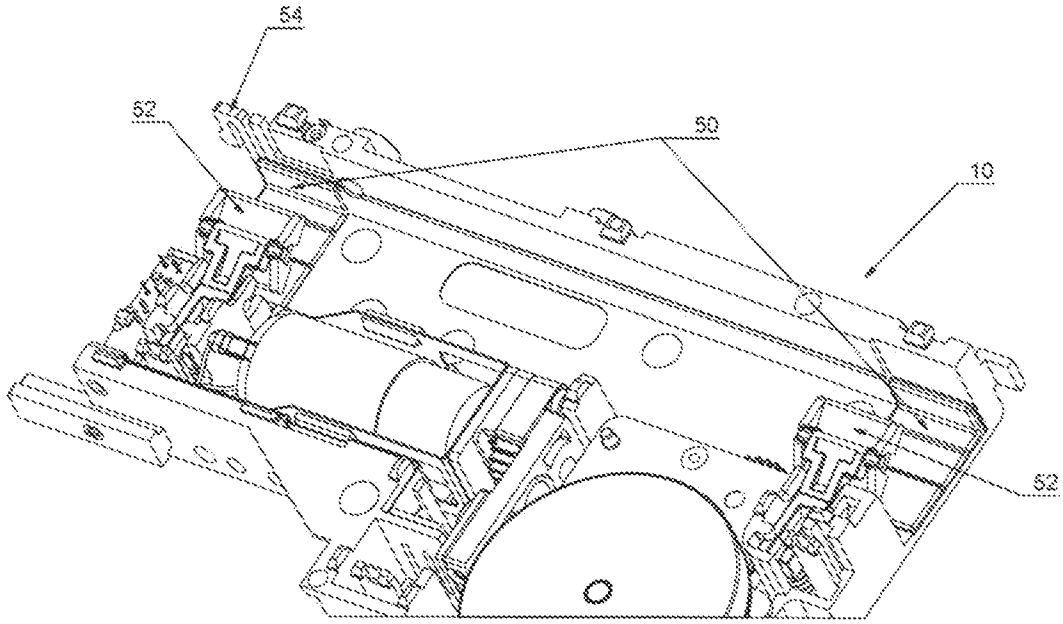


FIG. 10