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(71) **Applicant**: **G. D S.P.A.** [IT/IT]; Via Battindarno, 91, I-40133 Bologna (IT).

(72) **Inventors**: **PASTORE, Fulvio**; Via Masi 15, I-40011 Anzola Emilia (IT). **SELMI, Lorenzo**; Via IV Novembre 7, I-40033 Casalecchio Di Reno (IT). **GIOVANNINI, Emanuele**; Via Giovanni XXIII, 5, I-40033 Casalecchio Di Reno (IT). **SARTONI, Massimo**; Via Leandro Alberti, 79, I-40139 Bologna (IT).

(74) **Agent**: **BIANCIARDI, Ezio**; Via di Corticella, 87, I-40128 Bologna (IT).

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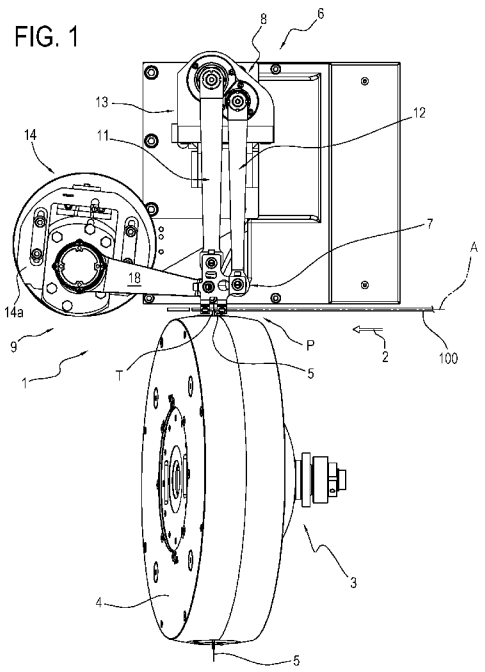
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(54) **Title**: DEVICE FOR CUTTING AT LEAST ONE CONTINUOUS ROD OF MATERIAL IN A MACHINE FOR MAKING SMOKERS' ARTICLES.

FIG. 1




(57) **Abstract**: This invention relates to a device for cutting at least one continuous rod (100) of material in a machine for making smokers' articles, comprising feeding means (2) by which at least one continuous rod (100) of material is directed along a predetermined feed path (P) extending along at least one main direction (A), a cutting unit (3) equipped with at least one head (4) rotatable about its axis of rotation (B) which is inclined at a predetermined angle to the main direction (A) and with at least one blade (5) connected to the head (4) and rotatable therewith, opposing means (6) located along the feed path (P) at the cutting zone (T) and equipped with at least one movable part (7) and at least one fixed part (8) and movement means (9) associated with the opposing means (6) and configured to move the movable part (7) with reciprocating motion along the main direction (A). The opposing means (6) comprise a pair of oscillating levers (1 1, 12) each extending between a first hinge point (1 1 a, 12a) pivoted to the fixed part (8) and a second hinge point (1 1 b, 12b) pivoted to the movable part (7) to define with the fixed part (8) and the movable part (7) a four-bar linkage (13).

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# DESCRIPTION

# DEVICE FOR CUTTING AT LEAST ONE CONTINUOUS ROD OF MATERIAL IN A MACHINE FOR MAKING SMOKERS' ARTICLES.

## Technical field

This invention relates to a device for cutting at least one continuous rod of material in a machine for making smokers' articles.

The invention is thus applicable to the sector of automatic machines and, more specifically, in the technical field of machines (known as *makers*) used for making smokers' articles.

## Background art

In the prior art, the manufacture of smokers' articles such as, for example, cigarettes or cigarette filters, involves making one or more continuous rods of material which are then cut into individual articles or pairs of articles by means of a cutting head which acts directly in process as the products move forward so that the production line is not slowed down.

To enable this to be done, the most common solutions involve the use of a rotary cutting blade rotating about an axis of rotation which is inclined and skew relative to the direction of rod feed so that blade feed follows rod feed.

By suitably calculating the inclination of the blade as a function of feed speed, it is now possible to obtain clean, transversal cuts which do not lead to tattered or torn products.

Clearly, to prevent the deformability of the product, that is, of the rod, from adversely affecting the cutting action, it is necessary to provide opposing means to keep the rod in position while it is being cut, thereby creating enough resistance to allow the blade to make clean cuts.

In order to adapt to the diagonal movement of the blade, the opposing means must be able to move translationally along the direction of rod

feed, which implies that the device must be equipped with oscillating movement means which produce the required reciprocating movement of the opposing means.

To enable rapid and efficient movement, several solutions for the translational movement of the opposing means have been proposed in the prior art.

In a first solution, known from patent application BO91A000313 in the name of the same Applicant as this invention, the opposing means are divided into a movable part, or slide, and a fixed part, mutually constrained and slidable relative to each other without touching.

More specifically, the solution concerned involves interposing magnetic means between the fixed part and the movable part, thus eliminating the need for lubricants and keeping the cutting zone of the device “clean”.

Disadvantageously, this solution, besides being expensive, gives rise to considerable problems of control and deterioration of the components which, being subjected to major stresses created by production speeds, makes the adoption of magnetic means impractical.

Other prior art solutions are known from documents US2008/0124696 and US2006/0065278, which describe the use of elastic connecting means between the fixed part and the movable part of the opposing means.

More specifically, in both of the solutions described therein, there is operatively interposed between the movable part and the fixed part a leaf spring whose size is calibrated to enable a very high number of oscillations of predetermined amplitude.

In this solution, the spring (or springs) extends between a first end which is rigidly fixed to the fixed part and a second end which is rigidly fixed to the movable part.

This solution, however, although it allows overcoming the problems related to the management of the magnetic field, is not itself free of disadvantages.

In effect, the use of elastic means for the management of such rapid oscillations leads to critical issues due not only to the anisotropy of the material used but also to the possible instability of the system linked mainly to the prior assessment of the deformability of the leaf springs, which, however accurate, is yet always subject to error.

Furthermore, since the leaf springs are rigidly fixed to the movable part of the opposing means, that is, to the carriage, the linearity of the motion thereof along the feed direction is directly linked to the properties of the individual spring and the accuracy of its assembly, which translates as variability of performance due not so much to design as to the skill of the individual assembler or maintenance person.

Moreover, it should not be forgotten that oscillation, by its very nature, causes vibrations and noise which, under certain conditions, may be troublesome or even dangerous for the operator.

Lastly, since the oscillation speed is closely linked to the elasticity of the spring, it is evident that a device such as that of the prior art described above can be used for a limited number of applications and is therefore not very versatile.

## Disclosure of the invention

This invention therefore has for an aim to provide a device for cutting at least one continuous rod of material in a machine for making smokers' articles to overcome the above mentioned disadvantages.

More specifically, this invention has for an aim to provide a device for cutting at least one continuous rod of material in a machine for making smokers' articles which is simple in design and easy to assemble.

Another aim of the invention is to provide a device which is stable and silent, for cutting at least one continuous rod of material in a machine for making smokers' articles.

A further aim of the invention is to provide a device which is highly

versatile, for cutting at least one continuous rod of material in a machine for making smokers' articles.

These aims are achieved by a device according to one or more of the appended claims, for cutting at least one continuous rod of material in a machine for making smokers' articles, and more specifically a cutting device comprising feeding means by which at least one continuous rod of material is directed along a predetermined feed path extending along at least one main direction, a cutting unit equipped with at least one head rotatable about its axis of rotation which is inclined at a predetermined angle to the main direction and with at least one blade connected to the cutting head and rotatable therewith in such a way as to cross the feed path in at least one cutting zone.

The device also comprises opposing means located along the feed path at the cutting zone and equipped with at least one movable part, structured to at least partly house the continuous rod during cutting and at least one fixed part, and movement means associated with the opposing means and configured to move the movable part with reciprocating motion along the main direction.

According to one aspect of the invention, the opposing means comprise a pair of oscillating levers each extending between a first hinge point pivoted to the fixed part and a second hinge point pivoted to the movable part to define with the fixed part and the movable part a four-bar linkage.

Advantageously, the device is thus easy to design and control, since the opposing means do not have any elastic or magnetic coupling.

Further, the hinge points connecting the movable part and the fixed part make assembling the device and subsequent adjustment of the levers easy, which in turn makes the installer's task much less critical.

## Brief description of the drawings

Further features and advantages of the invention are more apparent from

the following exemplary and therefore non-limiting description of a preferred and therefore non-exclusive embodiment of a device for cutting at least one continuous rod of material in a machine for making smokers' articles, as illustrated in the accompanying drawings, in which:

- Figure 1 shows a front view of a device for cutting at least one continuous rod of material in a machine for making smokers' articles according to this invention;
- Figure 1a shows a detail from Figure 1;
- Figure 2 shows a plan view of the cutting device of Figure 1;
- Figure 3 shows a cross section through line III-III of Figure 1a;
- Figure 4 shows a side view of the cutting device of Figure 1.

**Detailed description of preferred embodiments of the invention**

With reference to the accompanying drawings, the numeral 1 denotes a device for cutting at least one continuous rod 100 of material in a machine for making smokers' articles.

The device 1 (that is, the machine) is of the type comprising feeding means 2 by which at least one continuous rod 100 of material is directed along a predetermined feed path "P" extending along at least one main direction "A".

The feeding means 2 are preferably associated with a preceding forming station, or forming beam, (not illustrated) where the continuous rod 100 is made from a strip of paper material filled with shredded tobacco and filter material, alternately .

Thus, the feeding means are configured to feed the continuous rod 100 along the feed direction "A" at a predetermined linear speed.

It should be noted that in this text, the path "P" volumetrically defines the space occupied by the continuous rod 100 and by the pieces along the feed direction "A". Consequently, reference is hereinafter made mainly to the path "P" instead of the rod 100 since it is an integral part of the device

1.

In the embodiment illustrated, the feeding means 2 are configured to move a single continuous rod 100.

Alternatively, however, the feeding means might be configured to move two or more continuous rods 100 in parallel with each other (either side by side or one on top of the other).

Also associated with the feeding means 2 is a cutting unit 3 configured in such a way as to cut through the path "P" and separate the continuous rod 100 into a plurality of pieces of predetermined length.

In this regard, the cutting unit 3 is equipped with at least one rotary head 4 which rotates about a respective axis of rotation "B" which is inclined at a predetermined angle to the main direction "A".

It should be noted that the axis of rotation "B" is preferably skew to the main direction "A".

The angle of inclination between the axis of rotation "B" and the main direction "A" is set as a function of the linear feed speed imparted to the continuous rod 100 by the feeding means and the rotation speed of the rotary head 4.

The cutting unit 3 also comprises at least one blade 5 connected to the head 4 and rotatable therewith in such a way as to cross the feed path "P" in at least one cutting zone "T".

Thus the blade 5 projects radially from the head 4 in such a way that, as it rotates, it crosses the feed path "P" and, in so doing, severs the continuous rod 100.

Preferably, the blade 5 is also rotatable about a pivot axis lying in a radial direction, measured from the axis of rotation "B".

Advantageously, it is thus possible to further improve cutting precision.

In the embodiment illustrated, the cutting unit 3 has two blades 5 located on opposite sides of the head 4, that is to say, angularly spaced by approximately 180°.

Alternatively, however, there may also be more than two blades, depending on the production capacity of the device 1 and/or of the rotation speed.

As described in full detail above, the device 1 is also provided with opposing means 6 located along the feed path "P" at the cutting zone "T":

The opposing means 6 are structured to at least partly house the continuous rod 100, defining at least one lateral containment wall (transversal to the main direction "A").

The containment wall prevents the continuous rod 100 from bending, thus allowing the blade 5 to make a swift clean cut.

Since the blade 5 moves translationally along the main direction "A" during cutting, as mentioned above, the opposing means 6 are configured to move translationally along that direction.

In this regard, the opposing means 6 have at least one movable part 7 and at least one fixed part 8.

Also provided are movement means 9 associated with the opposing means 6 and configured to move the movable part 7 with reciprocating motion along the main direction "A".

The movable part 7 is structured to at least partly house the continuous rod 100 during cutting.

Thus, it is the movable part 7 which defines the above mentioned containment walls.

More specifically, the movable part 7 comprises at least a first stretch 7a and a second stretch 7b aligned with each other along the main direction A and structured to at least partly house the continuous rod 100.

To enable the blade 5 to cross, the first stretch 7a is spaced from the second stretch 7b by at least one indentation or opening 7c.

In the preferred embodiment, the first stretch 7a and the second stretch 7b are defined by respective tubular eyelets 10 which are aligned and coaxial with each other

According to one aspect of the invention, the opposing means 6 comprise a pair of oscillating levers 11, 12 each extending between a first hinge point 11a, 12a pivoted to the fixed part 8 and a second hinge point 11b, 12b pivoted to the movable part 7.

Consequently, the fixed part 8, the movable part 7 and the two rods 11, 12 define a four-bar linkage "Q".

In other words, the opposing means 6 comprise a first lever 11 and a second lever 12, both pivoted to the movable part 7 and to the fixed part 8.

In light of this, rotating the levers 11, 12 about the first hinge points 11a, 12a causes the movable part 7 to move translationally along the main direction "A".

More specifically, each lever 11, 12 is movable preferably between a first angular position and a second angular position defining, respectively, a start-of-stroke position and an end-of-stroke position of the movable part 7.

Advantageously, it is thus possible to obtain relatively rapid and friction-free movement of the movable part 7 without, however, introducing elements of instability in the system such as, for example, spring couplings and magnetic fields.

It should be noted that on account of the rotational movement of the levers 11, 12, the movable part 7 undergoes a slight change in height during the passage from the start-of-stroke to the end-of-stroke position.

Since the levers 11, 12 are much longer than the stroke of the movable part 7, however, this change of height can be minimized to such an extent as to be negligible.

In this regard, the four-bar linkage 13 is preferably an articulated parallelogram.

More precisely, the spacing between the first hinge point 11a and the second 11b of the first lever 11 is equal to the spacing between the first

hinge point 12a and the second 12b of the second lever 12.

The spacing between the first hinge points 11a, 12a of the first lever 11 and the second 12 is also equal to the spacing between the second hinge points 11b, 12b.

Structurally, also, the fixed part 8 of the opposing means 6 is located at a height above the movable part 7.

Thus, the levers 11, 12 are positioned mainly along a vertical direction.

In effect, it should be noted that each hinge point is associated with a respective bearing, which may be a ball bearing 15 or a roller bearing 16, depending on the embodiment (as will become clearer as this description continues).

Preferably, both the first lever 11 and the second 12 have an H-shaped transversal cross section defining a pair of longitudinal grooves 20.

Advantageously, the high strength linked to the moment of inertia of this geometry can be combined with a reduction in weight.

It should be noted that the expression “transversal cross section" denotes a cross section in a plane at right angles to a main (longitudinal) direction of extension of the lever 11, 12.

Preferably, also, the longitudinal grooves 20 are opposed to each other and directed away from each other along the main direction “A”.

Advantageously, the flat part of the lever is thus the only part that is exposed to the operator, thereby minimizing the risk of generating resonant vibrations.

Preferably, the movement means 9 comprise at least one crank mechanism 14 where the crank 14a is associated with a rotary actuator 17 and the connecting rod 18 is connected to the opposing means 6.

More specifically, the crank 14a is defined by a disc which rotates in a plane parallel to the main direction “A” and to which the connecting rod 18 is eccentrically pivoted.

Thus, the connecting rod 18 extends between its first end 18a, which is

pivoted to the crank 14a, and its second end 18b, which is pivoted to the movable part 7 of the opposing means 6.

It should be noted, with reference to the accompanying drawings, that the first lever 11 is closer to the movement means 9 than the second lever 12.

In the embodiment illustrated, the first hinge point 11a of the first lever 11 is located at a height above the corresponding first hinge point 12a of the second lever.

This creates in the movable part 7 the space needed to make a hinge point 19 for the second end 18b of the connecting rod 18.

In other words, the hinge point 19 for the second end 18b of the connecting rod 18 is located at a height proximal to that of the second hinge point 12b of the second lever 12.

The second hinge point 11b of the first lever 11, on the other hand, is located above the hinge point 19 for the second end 18b of the connecting rod 18.

Preferably, the bearing located at the second hinge point 11b of the first lever 11 is a roller bearing 16.

Similarly, the bearing located at the hinge point 19 of the second end 18b of the connecting rod 18 is also a roller bearing 16.

Advantageously, therefore, the two points primarily subjected to stress by the movements absorb most of the load and relieve the rest of the mechanism.

The other bearings, on the other hand, are preloaded ball bearings 15 which allow maximum precision of movement.

Preferably, in order to minimize inertias, the connecting rod 8 is made of a material whose specific weight is less than 7 $g/cm^3$, and more preferably, less than 5 $g/cm^3$.

Similarly, the levers 11, 12 and/or the movable part 7 of the opposing means 6 are also made of a material whose specific weight is less than 7 $g/cm^3$, and more preferably, less than 5 $g/cm^3$.

In the preferred, and tested, embodiments, the levers 11, 12 and/or the movable part 7 of the opposing means 6 are made of one of the following materials or an alloy thereof:

- magnesium;
- aluminium;
- titanium;
- carbon.

Preferably, the connecting rod 18 is also made of one of these materials.

In the preferred embodiment, the material used at least for the levers 11, 12 and the movable part 7 is magnesium alloy WE43.

Advantageously, thanks to the use of these materials, it is possible to maintain a high strength to weight ratio, reducing the loads and at the same time allowing the size of the pins, and hence of the bearings, to be reduced.

The invention achieves the above mentioned aims and brings important advantages.

Indeed, as mentioned above, driving movements using a four-bar linkage instead of elastic or magnetic means simplifies device design because the material is isotropic and calculation of the safety coefficients is more deterministic.

Further, removing the deformable couplings allows using the mechanism in a wider range of applications and speeds, making the device more versatile.

Furthermore, assembly of the levers and respective hinge points eliminates the need for rigid couplings, allowing simple adjustment or fine tuning of the system even after assembly, for example during setup, testing or maintenance.

Furthermore, since the parallelism of the movement is guaranteed by the presence of a rigid mechanism, the movable part of the opposing means is more stable.

Lastly, eliminating the deformable elements considerably reduces vibrations and noise.

## CLAIMS

1. A device for cutting at least one continuous rod (100) of material in a machine for making smokers' articles, comprising:

- feeding means (2) by which at least one continuous rod (100) of material is directed along a predetermined feed path (P) extending along at least one main direction (A);

- a cutting unit (3) equipped with at least one head (4) rotatable about its axis of rotation (B) which is inclined at a predetermined angle to the main direction (A) and with at least one blade (5) connected to the head (4) and rotatable therewith in such a way as to cross the feed path (P) in at least one cutting zone (T);

- opposing means (6) located along the feed path (P) at the cutting zone (T) and equipped with at least one movable part (7), structured to at least partly house the continuous rod (100) during cutting, and at least one fixed part (8);

- movement means (9) associated with the opposing means (6) and configured to move the movable part (7) with reciprocating motion along the main direction (A);

characterized in that the opposing means (6) comprise a pair of oscillating levers (11, 12) each extending between a first hinge point (11a, 12a) pivoted to the fixed part (8) and a second hinge point (11b, 12b) pivoted to the movable part (7) to define with the fixed part (8) and the movable part (7) a four-bar linkage (13).

2. The device according to claim 1, characterized in that the pair of levers (11, 12) comprises a first lever (11) and a second lever (12), where the distance between the first hinge point (11a) and the second hinge point (11b) of the first lever (11) is equal to the distance between the first hinge point (12a) and the second hinge point (12b) of the second lever (12).

3. The device according to claim 1 or 2, characterized in that the pair of levers (11, 12) comprises a first lever (11) and a second lever (12), where

the distance between the first hinge points (11a, 12a) of the first lever (11) and of the second lever (12) is equal to the distance between the second hinge points (11b, 12b) so as to define an articulated parallelogram.

4. The device according to any one of the preceding claims, characterized in that the fixed part (8) of the opposing means (6) is located at a height above the movable part (7).

5. The device according to any one of the preceding claims, characterized in that the movable part (7) comprises at least a first stretch (7a) and a second stretch (7b) aligned with each other along the main direction (A) and structured to at least partly house the continuous rod (100); the first stretch (7a) being spaced from the second stretch (7b) by at least one indentation or opening (7c) allowing the blade (5) of the cutting unit (3) to cross the feed path (P).

6. The device according to any one of the preceding claims, characterized in that the movement means (9) comprise at least one crank mechanism (14) where the crank (14a) is associated with a rotary actuator (17) and the connecting rod (18) is connected to the opposing means (6).

7. The device according to claim 6, characterized in that the connecting rod (18) is pivoted to the movable part (7) of the opposing means (6).

8. The device according to claim 5 or 6, characterized in that the connecting rod (18) is made of a material whose density is less than 7 $g/cm^3$,, preferably less than 5 $g/cm^3$.

9. The device according to any one of the preceding claims, characterized in that the levers (11, 12) and/or the movable part (7) of the opposing means (6) are made of a material whose density is less than 7 $g/cm^3$, preferably less than 5 $g/cm^3$.

10. The device according to claim 8 or 9, characterized in that the levers (11, 12) and/or the movable part (7) of the opposing means (6) and/or the connecting rod (18) are made of one of the following materials or alloys thereof:

- magnesium;
- aluminium;
- titanium;
- carbon.

11. The device according to any one of the preceding claims, characterized in that the levers (11, 12) have an H-shaped transversal cross section defining a pair of longitudinal grooves (20); the longitudinal grooves (20) being opposed to each other and directed away from each other along the main direction (A).

FIG. 1

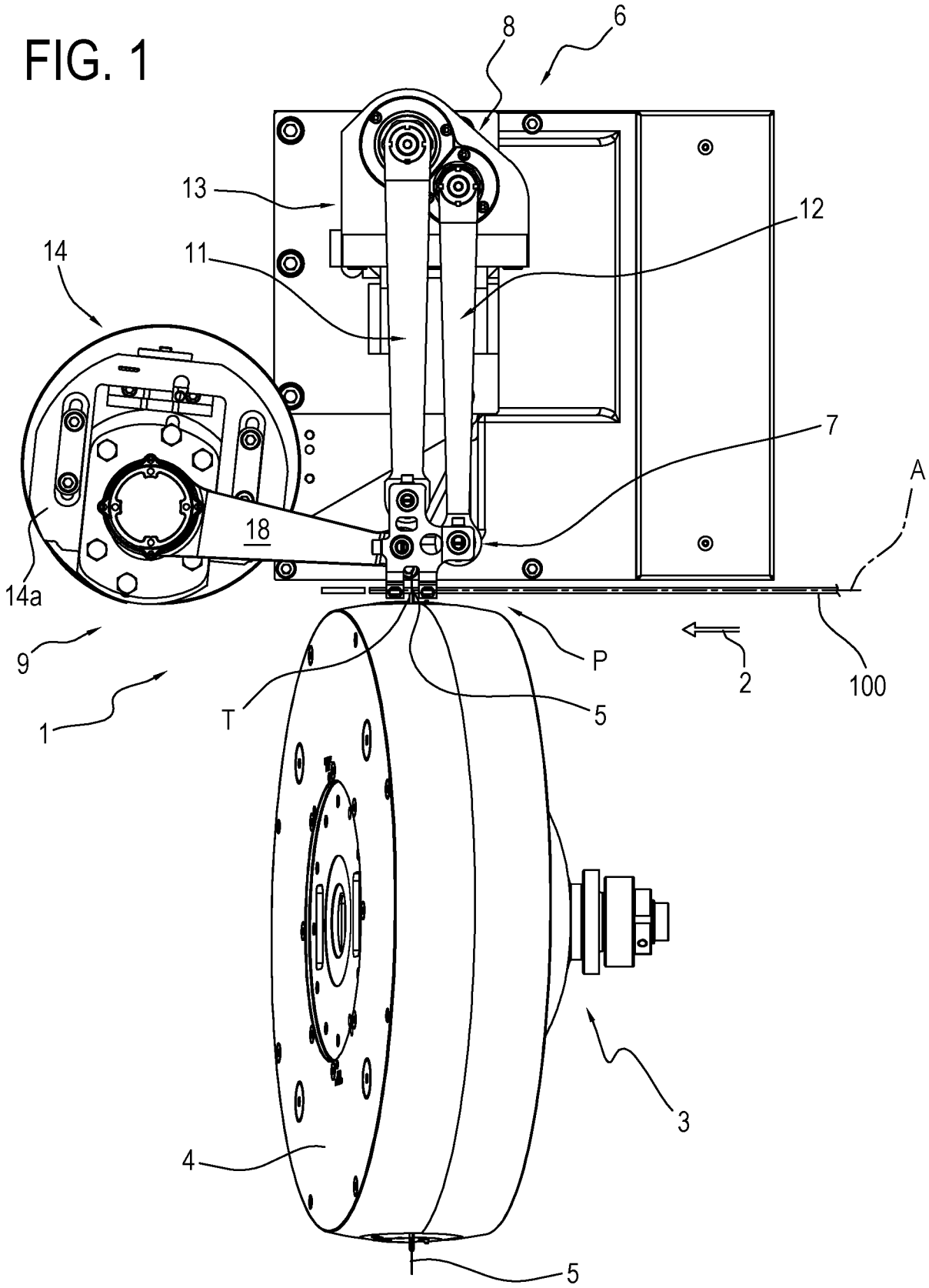


FIG. 1a

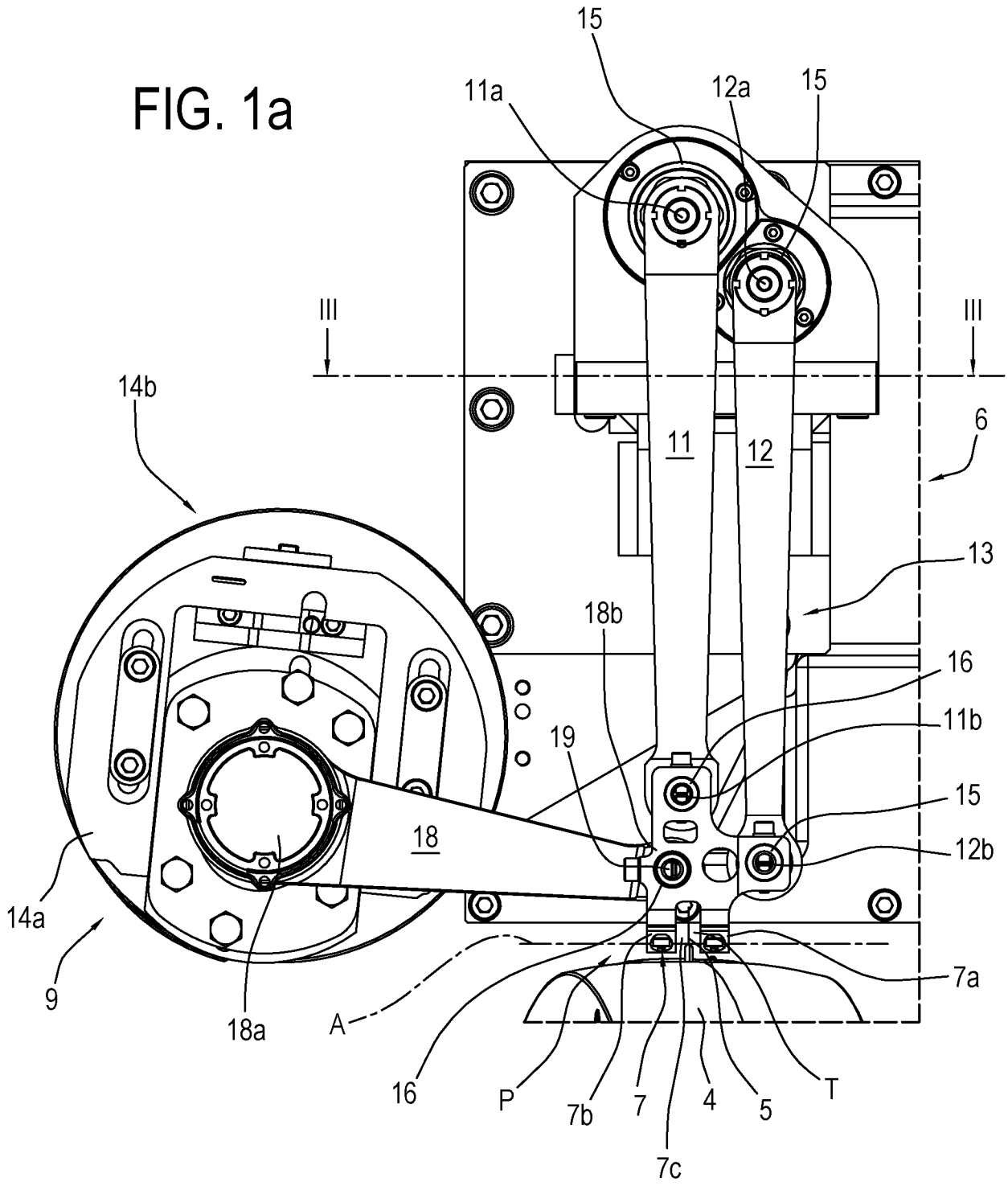

15
11a
12a
15
III
III
14b
6
11
12
13
18b
16
11b
19
15
18
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14a
9
18a
A
7a
16
P
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7
4
5
T
7c

FIG. 2

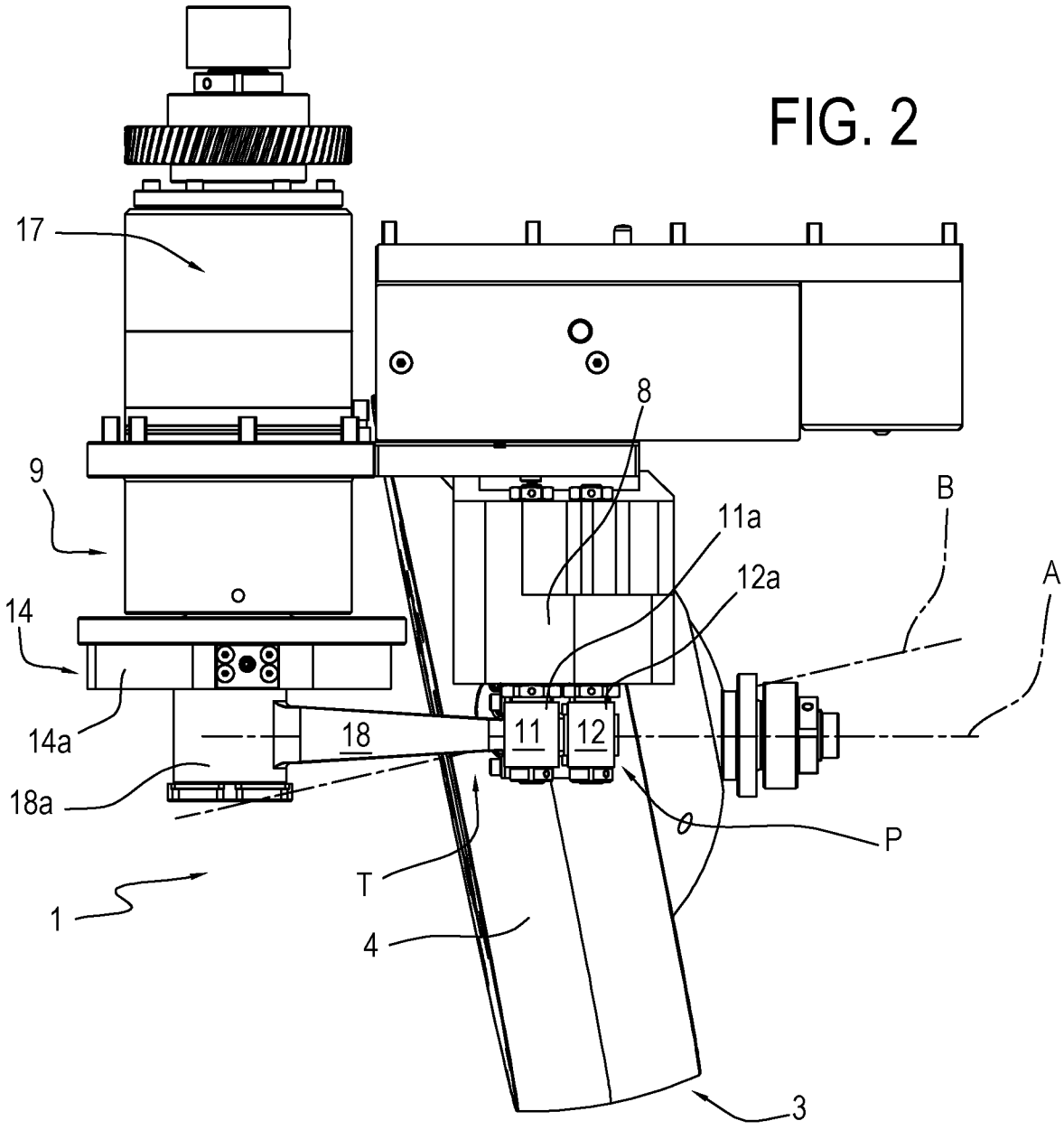



FIG. 3

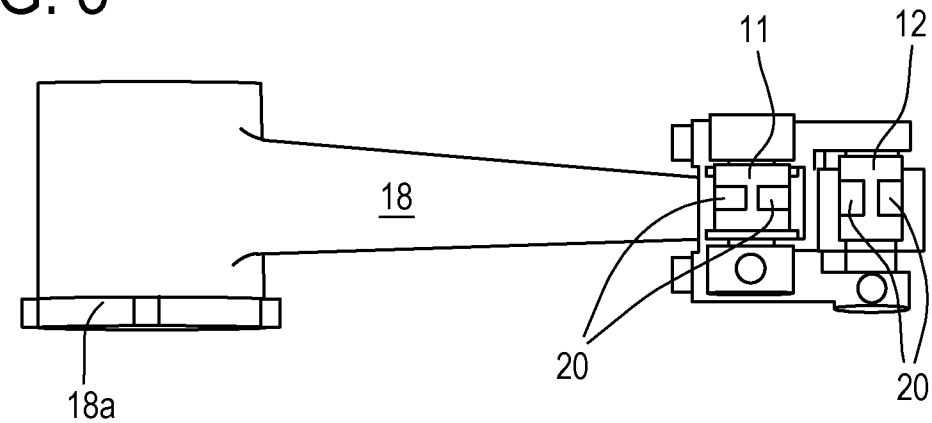
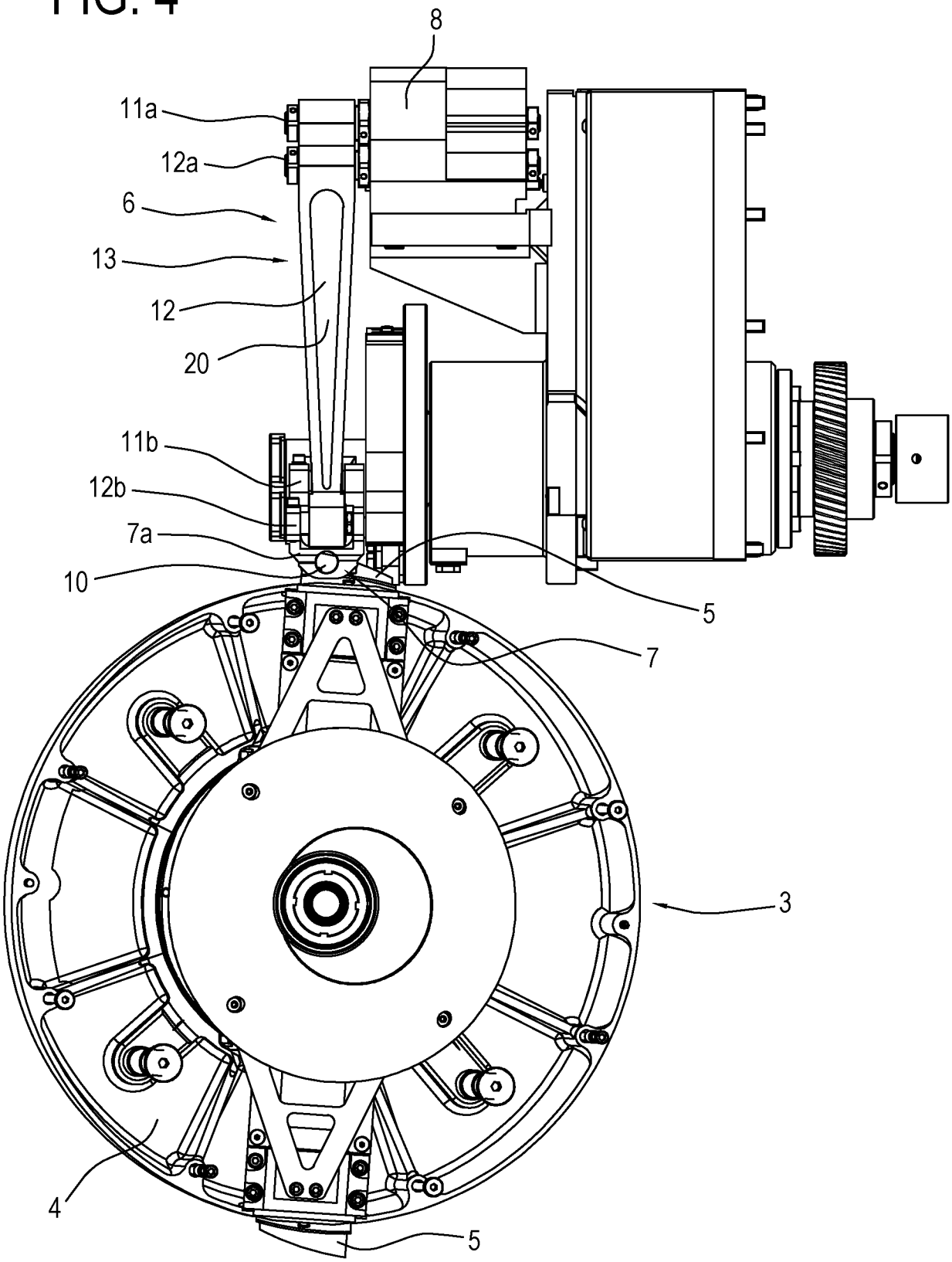


FIG. 4



# INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2015/055194

A. CLASSIFICATION OF SUBJECT MATTER
INV. A24C5/28
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A24C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | EP 1 108 367 A2 (HAUNI MASCHINENBAU AG [DE]) 20 June 2001 (2001-06-20) paragraph [0019]; figures | 1-11 |
| A | GB 2 258 992 A (GD SPA [IT]) 3 March 1993 (1993-03-03) abstract; figures | 1-11 |
| A | GB 2 196 230 A (MOLINS PLC MOLINS PLC [GB]) 27 April 1988 (1988-04-27) abstract; figures | 1-11 |
| A | DE 10 2010 004934 B3 (HAUNI MASCHINENBAU AG [DE]) 16 June 2011 (2011-06-16) the whole document | 1-11 |

☐ Further documents are listed in the continuation of Box C.

☒ 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 |
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| 21 October 2015 | 30/10/2015 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | Marzano Monterosso |

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