(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
26 October 2012 (26.10.2012)

WIPO | PCT

(10) International Publication Number
WO 2012/143958 A1

(51) International Patent Classification:
B23D 57/00 (2006.01) *B28D 1/08* (2006.01)

(21) International Application Number:
PCT/IT2011/000124

(22) International Filing Date:
19 April 2011 (19.04.2011)

(25) Filing Language: Italian

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **PELMINE S.R.L.** [IT/IT]; Viale delle Nazioni 8, I-37135 Verona (IT).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **PELEGRINI, Elena** [IT/IT]; Viale delle Nazioni 8, I-37135 Verona (IT).

(74) Agent: **PONCHIROLI, Simone**; Ruffini Ponchiroli e Associati S.r.l., Via Caprera 6, I-37126 Verona (IT).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

(54) **Title**: MACHINE FOR MULTIPLE WIRE CUTTING OF STONE MATERIALS

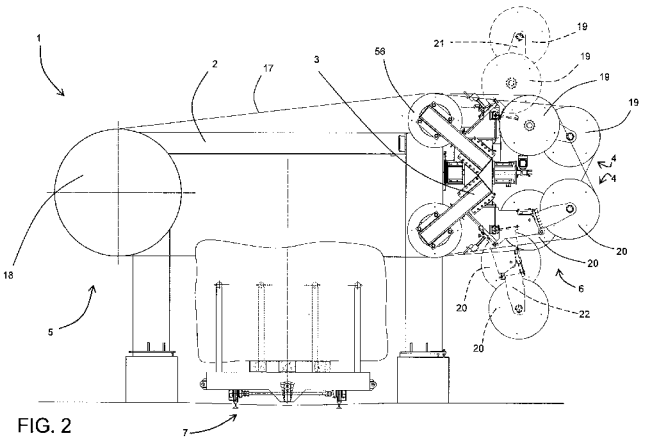

FIG. 2

(57) **Abstract**: A machine for multiple wire cutting of stone materials comprises a plurality of cutting devices (4) mounted on a supporting structure (3), the devices arranged parallel and drawn near to each other, each device in turn comprising a cutting wire (17) extending along an annular extension trajectory around driving means (18) and around at least one return pulley (19). The supporting structure (3) comprises one or more supporting arms (21) on each of which the return pulley (19) of at least one cutting device (4) is mounted. Each first supporting arm (21) can also be at least selectively moved relative to the rest of the supporting structure (3) between an operating position, in which the return pulley (19), (20) mounted on it is at least mainly facing other parts of the machine (1) which prevent it from being mounted and/or removed, and a maintenance position, in which the return pulley (19), (20) mounted on it is at least mainly not directly facing other parts of the machine (1), thus allowing an operator free access to it in Order to remove it from and/or mount it on the arm (21), (22).

WO 2012/143958 A1

MACHINE FOR MULTIPLE WIRE CUTTING OF STONE MATERIALS

* * *

DESCRIPTION

This invention relates to a machine for multiple wire cutting of stone materials of the type comprising a plurality of cutting devices arranged side by side.

In this type of machine each cutting devices comprises a diamond-coated cutting wire extending along an annular extension trajectory and looped around driving means and around at least one return pulley.

In most applications, the driving means comprise a single drum for all of the cutting devices. In contrast, depending on requirements, each cutting device may comprise either a single return pulley or a plurality of them (usually no more than three or four).

As indicated, the cutting devices are arranged side by side starting from a front first device as far as a rear last device, between which one or more intermediate devices are positioned. In many cases, the various devices are substantially all identical (as, for example, in the case of patents EP 1 024 314, WO 2007/036784, EP 1 131 179, ES 2 188 362 and WO 2009098721) so that each return pulley is substantially axially aligned with all of the corresponding pulleys of the other devices (with the exception of any deviations due to tensioning systems).

In contrast, in other solutions, such as that described in patent WO 2009040841, although they are similar to one another the cutting devices are made according to two different configurations which are mounted alternately on the machine so as to optimise their packing together and allow smaller cutting thicknesses to be obtained.

However, none of the prior art solutions are without a significant disadvantage in terms of carrying out maintenance operations on the return pulleys.

All multiple wire cutting machines are subject to significant wear, particularly

of the bearings of the various return pulleys, which must therefore for regularly substituted.

However, in all of the prior art machines, that operation is relatively complex and above all requires periods of time which may even be lengthy, depending which cutting device needs to be worked on. Indeed, due to the extremely close arrangement of the various cutting devices, it is practically impossible to gain access to the individual pulleys to remove them from the machine (or to mount them on it). Consequently, when a maintenance operation has to be carried out, it is necessary to remove all of the cutting devices which separate the one to be worked on from the front side or from the rear side of the machine.

It is easy to guess how much time is wasted especially when the pulleys to be worked on are those belonging to the least accessible devices.

That problem was partly dealt with in the case of patent WO 2009098721, where the entire return part of a cutting device can be removed from the machine without requiring action on the other parts. However, even that solution does not solve the problem, because in order to be able to remove the return part, action is required not only on the mechanical parts but also on the hydraulic circuit which feeds the operating fluid to the tensioning system.

In this context, the technical purpose which forms the basis of this invention is to provide a machine for multiple wire cutting of stone materials which overcomes the above-mentioned disadvantages.

In particular, the technical purpose of this invention is to provide a machine for multiple wire cutting of stone materials which allows the simplification of maintenance work on the return pulleys.

The technical need specified and the aims indicated are substantially achieved by a machine for multiple wire cutting of stone materials as described in the appended claims.

Further features and advantages of this invention are more apparent in the

detailed description below, with reference to several preferred, non-limiting embodiments of a machine for multiple wire cutting of stone materials, illustrated in the accompanying drawings, in which:

- Figure 1 is a front view of a first embodiment of a machine according to this invention, with all of the pulleys in the operating configuration;
- Figure 2 illustrates the machine of Figure 1, also showing some pulleys in a maintenance configuration;
- Figure 3 is a view of a detail of the machine of Figure 2, in two different positions.
- Figure 4 is a rear view of a further detail of the machine of Figure 2, in two different positions;
- Figure 5 is a bottom view of the detail from Figure 3 in the position represented with a continuous line;
- Figures 6 and 7 are schematic views of the extension of two adjacent cutting devices of the machine of Figure 1;
- Figure 8 is a three-quarter axonometric view of a detail of the machine of Figure 1, with some parts cut away to better illustrate others;
- Figure 9 is a partial schematic front view of an alternative embodiment of the machine of Figure 1;
- Figure 10 is a partial schematic front view of a second alternative embodiment of the machine according to this invention, transparent to better illustrate the various parts;
- Figure 11 is a partial schematic front view of a third alternative embodiment of the machine according to this invention, transparent to better illustrate the various parts;
- Figure 12 is a partial schematic front view of a fourth alternative embodiment of the machine according to this invention;
- Figure 13 shows the part of the machine of Figure 12 according to the line XIII - XIII;
- Figure 14 is a rear view, partly in cross-section, of a detail of the machine

of Figure 1; and

- Figure 15 is a front view, partly in cross-section, of a further detail of the machine of Figure 1.

With reference to the accompanying drawings, the numeral 1 denotes in its entirety a machine for multiple wire cutting of stone materials according to this invention.

A first embodiment of the machine 1 is represented in its entirety in Figures 1 and 2, where Figure 1 shows the machine 1 in the operating configuration, while Figure 2 also shows, with dashed lines, two possible maintenance configurations of the machine 1.

The machine 1 for multiple wire cutting of stone material according to this invention comprises first a main frame 2 which, in the embodiment illustrated, is gantry-shaped. Mounted on the main frame 2 there is at least one supporting structure 3 on which there is mounted a plurality of cutting devices 4 arranged parallel with each other in planes which lie substantially vertically. In particular, in the embodiment illustrated, the supporting structure 3 is divided into two separate sections, one (not visible but of the known type) intended to support the cutting devices 4 at a first side 5 of the machine 1 (the left side in Figure 1), and one intended to support the cutting devices 4 at a second side 6 of the machine 1 opposite to the first side relative to the actual cutting zone (the right side in Figure 1). The two sections are, however, able to move jointly, as is described in more detail below. However, in other embodiments, in the known way, said two sections of the supporting structure 3 may also be rigidly connected to each other to form a single supporting structure 3.

The machine 1 also comprises supporting means 7 for supporting at least one block 8 of stone material to be cut. These supporting means may be positioned under the cutting devices 4. In the embodiment illustrated in Figure 1 the supporting means 7 comprise a carriage 9 which can be brought under the cutting devices 4 by means of a track 10 fixed to the

ground. The carriage is equipped with a plurality of vertical slab holder rods 11 (of the known type and therefore not described in detail). When the block 8 to be cut is positioned on the carriage 9, spacer elements 12 are normally interposed between them to prevent the cutting wires from touching the carriage 9 at the end of cutting.

In the embodiment illustrated, the supporting structure 3 can also move vertically along the gantry between an upper home position, in which it allows insertion of a block 8 under the cutting devices 4, and a lower end of cutting position. Figure 1 shows an intermediate position in which the cutting has just been started.

However, in general the machine 1 comprises means for creating a relative movement in a substantially vertical direction, between the supporting means 7 and the supporting structure 3 with the cutting devices 4 mounted on it. The supporting structure 3 may even be held still and the supporting means 7 moved upwards. However, since both such solutions are of the known type, they are not described in detail herein.

Moreover, advantageously, the supporting structure 3 comprises at least one portion 13 for connection to the main frame 2 and one supporting portion 14 able to move by sliding relative to the connecting portion 13 in a substantially horizontal direction, parallel with the planes in which the cutting devices 4 lie. In the preferred embodiment, the machine 1 also comprises rough tensioning means 15 which act simultaneously on all of the cutting wires to substantially tension them before the start of cutting. Said rough tensioning means 15 comprise at least one actuator 16 mounted between the connecting portion 13 and the supporting portion 14 for pushing the latter towards the outside of the machine 1. In the embodiment illustrated the actuator 16 is of the electric type.

With reference to the cutting devices 4, each comprises first a cutting wire 17 extending along an annular extension trajectory. The cutting wire 17 is looped around at least driving means 18 and around at least one return

pulley 19, 20. Advantageously, the driving means 18 for the cutting wire 17 are mounted at a first side 5 of the device and are designed to make the cutting wire 17 run substantially along its own extension trajectory. In contrast, at the second side 6 of the device (the sides of the device coincide with those of the machine 1) there is at least one return pulley 19, 20. However, in the embodiment illustrated, each cutting device 4 comprises an upper return pulley 19 positioned higher up and a lower return pulley 20 positioned lower down.

The driving means 18 may have any form, according to requirements. However, in the embodiment illustrated they comprise a single drum for all of the cutting devices 4.

Moreover, amongst the cutting devices 4, there is a front cutting device 4, a rear cutting device 4, and a plurality of intermediate cutting devices 4 (for example, two in Figure 8, and twelve in Figure 13).

According to this invention, the supporting structure 3 in general comprises one or more first supporting arms 21 on each of which a first return pulley 19 of at least one cutting device 4 is mounted. If each cutting device 4 also comprises a second return pulley 20, advantageously the supporting structure 3 also comprises one or more second supporting arms 22 on each of which the second return pulley 20 of at least one cutting device 4 is mounted. In particular, in the embodiments illustrated the machine 1 comprises a plurality of upper first arms 21 and a plurality of lower second arms 22. In the same way, if each cutting device 4 comprises further return pulleys, the supporting structure 3 may comprise further similar supporting arms.

In other embodiments, not illustrated, there may even be several pulleys 19, 20 of the same cutting device 4 mounted on a single supporting arm 21, 22.

However, in the preferred embodiments, mounted on each supporting arm 21, 22 there are at least two return pulleys 19, 20 of two cutting devices 4 which are separate and side by side, advantageously positioned in such a

way that each pulley can be mounted on the arm 21, 22 or removed from it independently of the other pulley. The particular structure of the supporting arms 21, 22 of the embodiments illustrated, in which a part of the arm 21, 22 also acts as a system for tensioning the cutting wire 17, is described in more detail below.

According to the main innovative aspect of this invention, each supporting arm 21, 22 (first, second or other) can be at least selectively moved relative to the rest of the supporting structure 3 between an operating position and a maintenance position.

When the supporting arm 21, 22 is in the operating position (situation illustrated with a continuous line in Figures 2, 3 and 4), each return pulley 19, 20 mounted on it is at least mainly facing other parts of the machine 1 which prevent it from being mounted and/or removed. In the embodiment illustrated, at least for all of the intermediate cutting devices 4 this is due to the presence of the corresponding return pulleys 19, 20 of the other cutting devices 4.

In contrast, when the supporting arm 21, 22 is in the maintenance position (situation illustrated with a dashed line in Figures 2, 3 and 4), each return pulley 19, 20 mounted on it is at least mainly not directly facing other parts of the machine 1. In this way, an operator can have free access to it, for removing it from and/or mounting it on the arm 21, 22. As is clearly shown in Figure 2, in the embodiment illustrated, when the arm 21, 22 is in the maintenance position, although each pulley 19, 20 mounted on it, in front view partly overlaps with other pulleys 19, 20, access to it should be considered substantially free, since there is completely free access to the respective central hub which is used to fix the pulley 19, 20 to the supporting arm 21, 22.

In more detail, to achieve that freedom of access, in most applications it is sufficient that, when each supporting arm 21, 22 is in the maintenance position, the return pulley 19, 20 mounted on it is at least mainly outside the

annular trajectory which the respective cutting wire 17 defines when the arm 21, 22 is instead in the operating position (Figure 2).

Depending on the embodiments, the connection of each arm 21, 22 to the rest of the supporting structure 3 may be achieved in various ways. However, in the preferred embodiments, between each arm 21, 22 and the rest of the supporting structure 3 there is a rotary and/or sliding connection which can be at least selectively activated (the concept of selective activation is covered in more detail below). In this way, each arm 21, 22 can be moved between the operating position and the maintenance position by a rotation and/or a sliding movement relative to the rest of the supporting structure 3.

In particular, in the embodiments illustrated there is an exclusively rotary connection. Each arm 21, 22 pivots at the rest of the supporting structure 3. The structure of that connection is highlighted in Figures 3, 14 and 4, 15 with reference respectively to the case of a lower arm 22 and of an upper arm 21.

As shown in Figures 3 and 14, each lower arm 22 is connected to the rest of the supporting structure 3 at a first vertical lateral face 23 of a lower connecting flange 24 which, seen from the front, has the shape of a right-angled triangle. A first cathetus of the triangle, which corresponds to the first face 23, is positioned vertically and is facing towards the lower arm 22, whilst the other cathetus is positioned horizontally, and is facing upwards and is fixed to the rest of the supporting structure 3 by screws 25 or bolts (Figure 14). At the connection, the lower arm 22 comprises a substantially flat second face 26 which in the operating condition is directly coupled with the flat first face 23 of the connecting flange 24 positioned at the vertical cathetus. The rotary connection is obtained by means of a lower pivot 27 connected to a lower edge of the first face 23 and of the second face 26.

The structure is substantially similar for the upper arm 21 (Figures 4 and 15), the only difference being that the both the upper connecting flange 28

and the upper arm 21 are specular relative to the lower ones (relative to an intermediate horizontal plane between the two). Consequently, seen from the front, the upper connecting flange 28 has the shape of a right-angled triangle whose cathetus fixed to the rest of the supporting structure 3 is positioned horizontally and is facing downwards, while the other cathetus is positioned vertically and is facing outwards. At the connection, the upper arm 21 again comprises a substantially flat second face 29 which in the operating condition is directly coupled with the flat first face 30 of the connecting flange 28 positioned at the vertical cathetus. In contrast, the rotary connection is obtained by means of an upper pivot 31 connected to an upper edge of the first face 30 and of the second face 29.

Therefore, the upper arms 21 rotate upwards while the lower arms 22 rotate downwards.

As indicated above, the connection between each arm 21, 22 and the rest of the supporting structure 3 may be created in such a way that it can be only selectively activated. For that purpose, in the preferred embodiments of this invention the machine 1 also comprises fixing means 32 which can be selectively activated for fixing the supporting arm 21, 22 to the rest of the supporting structure 3, preventing it from moving, and which can be deactivated to allow movement of the supporting arm 21, 22 between the operating position and the maintenance position. Advantageously, as illustrated in Figures 14 and 15, the fixing means 32 comprise one or more fixing screws 33 or bolts fixed to each supporting arm 21, 22 and to the corresponding connecting flange 24, 28. Consequently, in the preferred embodiments, the movement of each arm 21, 22 from the operating position to the maintenance position may be performed only after deactivating the selective fixing means 32 (for example, by removing the screws 33 or the bolts).

Although the movement of the arms 21, 22 between the operating position and the maintenance position may achieved in any way, in the preferred

embodiment the machine 1 also comprises movement means 34 mounted or mountable between each supporting arm 21, 22 and the rest of the supporting structure 3 for causing the movement of the supporting arm 21, 22 between the operating position and the maintenance position. In the embodiments illustrated the movement means 34 are connected between each supporting arm 21, 22 and the respective connecting flange 24, 28.

As already indicated, the movement means 34 may be mounted or mountable between the arm 21, 22 and the rest of the supporting structure 3. Depending on the embodiments, the movement means 34 may be always connected between said parts or may be of the removable type, so that they can be mounted in position only at the moment when maintenance must be carried out. The embodiments illustrated in Figures 1 to 9 and 12 and 13 relate to this latter case, whilst in the embodiments of Figures 10 and 11 the movement means 34 are always mounted. However, it should be noticed that the removable movement means 34 are completely illustrated in Figures 2, 3, 4 and 5, only partially in Figure 1 and in contrast they are not illustrated in the other figures which show the case in which the movement means 34 are not mounted.

In all of the embodiments illustrated, except for that of Figure 11, the movement means 34 advantageously comprise at least one actuator 35 mounted or mountable between the supporting arm 21, 22 and the rest of the supporting structure 3, and in particular between a projection 36 of the arm 21, 22 positioned close to the respective pivot (above the upper pivot 31 in one case and below the lower pivot 27 in the other) and a projection of the furthest edge of the connecting flange 24, 28 (the one opposite the second face 26, 29). In general, the actuator 35 may be of the hydraulic, pneumatic or electric type.

In the embodiment in Figures 3 and 4, which refer respectively to a lower arm 22 and to an upper arm 21, the movement means 34 comprise a double acting hydraulic actuator 35, which can be activated by means of a

manually-activated diverter valve 37. The passage to the maintenance position is achieved by feeding an operating fluid in such a way as to cause a contraction of the actuator 35, while the reverse passage is achieved by feeding the operating fluid for extending the actuator 35. However, in all cases, it is also important to take into account the effect of gravity which is far from negligible. Operation in the two cases (upper arm 21 and lower arm 22) is similar but with some differences due to the fact that in the case of the lower arm 22 gravity acts in favour of the movement towards the maintenance position, while in the case of the upper arm 21 gravity acts in favour of the movement from the maintenance position to the operating position.

The embodiment in Figure 10 is the same, although in that case the hydraulic feed is not shown.

Figures 3 and 4 also clearly show fixing knobs 38 used for coupling and uncoupling the actuators 35 to/from the arm 21, 22 and to/from the connecting flange 24, 28.

In the embodiment in Figure 11, in place of the actuator 35 there is a device comprising a cable/chain 39 which is wound on, and unwound from, a suitable reel 40 (directly in the case of the upper arm 21, and by means of a return roller 41 in the case of the lower arm 22) and which is fixed, at one end, to the arm 21, 22. In particular, the passage from the operating position to the maintenance position is achieved by winding the cable/chain 39 relative to the upper arm 21 and unwinding it relative to the lower arm 22.

Although depending on requirements the supporting arms 21, 22 can have any shape and may support one or more pulleys 19, 20, in the embodiments illustrated the same structure is always used which allows simultaneous support for two return pulleys 19, 20, one of which is a fixed pulley 19, 20 for one cutting device 4, the other a tensioning pulley 19, 20 for a different cutting device 4.

In particular, each arm 21, 22 comprises a first, inner part 42 with which one

of the two pulleys 19, 20 mounted on it is associated (which forms the fixed pulley 19, 20 of one device), and a second, outer part 43 with which the other of the pulleys 19, 20 mounted on it is associated (the tensioning pulley). The second, outer part 43 can move relative to the first part 42, for moving the respective pulley 19, 20 in such a way as to vary the tensioning of the cutting wire 17 looped around it (thus varying the length of the annular path).

Moreover, according to this invention, if the upper pulley 19 of one cutting device 4 is mounted on the first part 42 or respectively on the second part 43 of an upper arm 21, the lower pulley 20 of the same cutting device 4 is of necessity mounted on the second part 43 or respectively on the first part 42 of a lower arm 22. In the preferred embodiment, if the upper pulleys 19 of two adjacent cutting devices 4 are mounted on the same upper arm 21, then the lower pulleys 20 of those cutting devices 4 are mounted on a single lower arm 22 in accordance with the methods indicated above.

As shown in Figure 1, in the preferred embodiment, the supporting arms 21, 22 have a direction of extension whose main component is substantially horizontal, meaning that the projections of the corresponding return pulleys 19, 20 (upper or lower) of two adjacent cutting devices 4 in a plane in which a cutting device 4 lies are offset relative to each other. The pulleys 19, 20 are advantageously offset by a distance greater than their radius in such a way that the central hub of each pulley 19, 20 is not opposite the pulley 19, 20 of the immediately adjacent cutting device 4.

With regard to the methods for fixing the pulleys 19, 20 to the arms 21, 22, advantageously each pulley 19, 20 mounted on a first part 42 is mounted cantilever-style, and each second part 43 is instead fork-shaped and supports the respective return pulley 19, 20 on both sides. Indeed, while the first part 42 may have a relatively large thickness, which allows cantilever-style support without problems, the second part 43 must have a relatively limited thickness, which makes support on both sides preferable to avoid

deformations.

Returning to the movement of the second part 43, it should be noticed that in the preferred embodiments it can move either by rotation or by sliding. The former case is illustrated in Figures 1 to 9 and 12 and 13, while the latter case is illustrated in Figures 10 and 11. However, in both case advantageously there are means 44 for shifting the second part 43, interposed between the first part 42 and the second part 43. In the preferred embodiments, the shifting means 44 comprise at least one hydraulic, pneumatic or electric actuator 45, but preferably a hydraulic actuator 45. Each second part 43 forms, with the relative shifting means 44, the precision tensioning means of the respective cutting device 4.

Figure 12, which shows only a lower arm 22, illustrates in detail the movement of the second part 43 relative to the first part 42. Indeed, the drawing with a continuous line shows an intermediate position of the second part 43, while the two drawings with dashed lines show the two limit positions which the second part 43 and the respective lower pulley 20 can adopt and which correspond to minimum tensioning (the upper one) and maximum tensioning (the lower one).

As Figure 3 more clearly shows, in the preferred embodiment the second part 43 of each lower arm 22 pivots at the first part 42 according to a first axis of rotation perpendicular to the plane in which the cutting device 4 lies. In more detail, the respective pivot 46 is made at a lower portion 47 of its side facing towards the first part 42. In turn, the shifting means 44 cause an increase in tensioning by making the second part 43 rotate downwards. For that purpose, the respective actuator 45 is positioned at an upper portion 48 both of the first part 42 and of the second part 43.

The structure is very similar to that relating to the upper arms 21, as shown in Figure 4 which illustrates an upper arm 21 seen from the rear relative to the front view of Figure 1. The only difference is that the upper arms 21 and the lower arms 22 are specular. The second part 43 of each upper arm 21 in

fact pivots at the first part 42 according to a further axis of rotation perpendicular to the plane in which the cutting device 4 lies, by means of a pivot 49 located at an upper portion 50 of its side facing towards the first part 42. In turn, the shifting means 44 in this case cause an increase in tensioning by making the second part 43 rotate upwards. As a result, the respective actuator 45 is positioned at the lower portion 51 both of the first part 42 and of the second part 43.

In contrast, in the embodiments in Figures 10 and 11, the second parts 43 can move by sliding. For this purpose, each second part 43 is slidably mounted on two horizontal guide bars 52 extending cantilever-style from the respective first part 42. Again in this case the shifting is achieved by means of an actuator 45.

In all of the embodiments, the shifting of the second parts 43 can be continuously monitored depending on system operation, for example using a control system such as that described in patent EP 1951464 whose content is incorporated herein by reference. As is clearly shown in Figures 3 and 4, a position detector sensor 53 is coupled to the shifting means 44.

While in the embodiment in Figure 1 the horizontal distance between the various cutting devices 4 is fixed, meaning that it is possible to vary the thickness of the slabs to be obtained only by removing several cutting wires, Figures 12 and 13 show an alternative embodiment in which the cutting thickness can be changed with greater freedom (but still by removing several of the cutting wires to obtain slabs which all have the same thickness). In this embodiment, the supporting portion 14 is equipped with one or more supporting shafts 54 (two in the accompanying drawings) which extend perpendicularly to the planes in which the cutting devices 4 lie. The upper arms 21 and the lower arms 22 are in turn slidably mounted on the supporting shafts 54 by means of connecting plates 55. Moreover, there are positioning means for varying the distance between the adjacent arms 21, 22 and consequently adjusting the cutting thickness. Advantageously, the

positioning means are simple spacers (not illustrated). Moreover, in the preferred embodiment, the connecting plates 55 are joined in pairs, constraining to each other the upper arm 21 and the lower arm 22 which support the same cutting devices 4.

According to requirements, the machine 1 according to this invention may comprise further elements such as guide rollers 56 for the cutting wire 17 (in themselves of the known type). Such guide rollers may be fixed both to the supporting portion 14 (Figure 1) and to the connecting portion 13 (Figure 9).

Operation of the machine 1 derives immediately from the description of the structure above.

This invention brings important advantages.

Thanks to this invention, it was possible to provide a machine 1 for multiple wire cutting of stone materials which allows extremely easy access to the return pulleys 19, 20 if maintenance work is necessary and which does not require any significant action on the cutting devices 4 which are not involved in the maintenance.

Finally, it should be noticed that this invention is relatively easy to produce and that even the cost linked to implementing the invention is not very high.

The invention described above may be modified and adapted in several ways without thereby departing from the scope of the inventive concept.

Moreover, all details of the invention may be substituted with other technically equivalent elements and the materials used, as well as the shapes and dimensions of the various components, may vary according to requirements.

* * *

CLAIMS

1. A machine for multiple wire cutting of stone materials comprising:

a main frame (2);

a plurality of cutting devices (4) mounted on the main frame (2) by means of at least one supporting structure (3), and arranged parallel with and drawn near each other in planes which lie substantially vertically;

supporting means (7) for supporting at least one block (8) of stone material to be cut, positionable under the cutting devices (4); and

means for creating a relative movement in a substantially vertical direction, between the supporting means (7) and the supporting structure (3) with the cutting devices (4) mounted on it;

each cutting device (4) in turn comprising:

a cutting wire (17) extending along an annular extension trajectory;

driving means (18) for the cutting wire (17) for making the cutting wire (17) run substantially along its own extension trajectory; and

at least a first return pulley (19);

the cutting wire (17) being looped around at least the driving means (18) and around the first return pulley (19), and the supporting structure (3) comprising one or more first supporting arms (21) on each of which there is mounted the first return pulley (19) of at least one cutting device (4);

characterised in that each first supporting arm (21) can be at least selectively moved relative to the rest of the supporting structure (3) between an operating position, in which the return pulley (19) mounted on it is at least mainly facing other parts of the machine (1) which prevent it from being mounted and/or removed, and a maintenance position, in which the return pulley (19) mounted on it is at least mainly not directly facing other parts of the machine (1), thus allowing an operator free access to it in order to remove it from and/or mount it on the arm (21).

2. The machine according to claim 1, characterised in that each cutting device (4) comprises at least one second return pulley (20) and in that the

supporting structure (3) comprises one or more second supporting arms (22) on each of which there is mounted the second return pulley (20) of at least one cutting device (4) and also being characterised in that, similarly to each first arm (21), each second supporting arm (22) can be at least selectively moved relative to the rest of the supporting structure (3) between an operating position, in which the return pulley (20) mounted on it is at least mainly facing other parts of the machine (1) which prevent it from being mounted and/or removed, and a maintenance position, in which the return pulley (20) mounted on it is at least mainly not directly facing other parts of the machine (1), thus allowing an operator free access to it for removing it from and/or mounting it on the arm (22).

3. The machine according to claim 1 or 2, characterised in that when each supporting arm (21), (22) is in the maintenance position the return pulley (19), (20) mounted on it is at least mainly outside the annular trajectory defined by the respective cutting wire (17) with the arm (21), (22) in the operating position.

4. The machine according to claim 1, 2 or 3, characterised in that it comprises between each arm (21), (22) and the rest of the supporting structure (3) a rotary and/or sliding connection which can be activated at least selectively, and also being characterised in that each arm (21), (22) can be moved between the operating position and the maintenance position by a rotation and/or a sliding movement relative to the rest of the supporting structure (3).

5. The machine according to any of the foregoing claims, characterised in that it also comprises movement means (34) mounted or mountable between each supporting arm (21), (22) and the rest of the supporting structure (3) for causing the movement of each supporting arm (21), (22) between the operating position and the maintenance position.

6. The machine according to claim 5, characterised in that the movement means (34) comprise at least one actuator (35) mounted or mountable

between the supporting arm (21), (22) and the rest of the supporting structure (3).

7. The machine according to claim 5, characterised in that the movement means (34) comprise a movement device comprising a windable cable/chain (39).

8. The machine according to any of the claims from 5 to 7, characterised in that the movement means (34) are removably mounted or mountable between each supporting arm (21), (22) and the rest of the supporting structure (3).

9. The machine according to any of the foregoing claims, characterised in that mounted on each supporting arm (21), (22) there are at least two return pulleys (19), (20) of two cutting devices (4) which are separate and side by side, also being characterised in that when each supporting arm (21), (22) is in the operating position all of the return pulleys (19), (20) mounted on it are at least mainly facing other parts of the machine (1) which prevent their mounting and/or removal, and also being characterised in that when the supporting arm (21), (22) is in the maintenance position all of the return pulleys (19), (20) mounted on it are at least mainly not directly facing other parts of the machine (1), in such a way as to allow an operator free access to them for removing them from or mounting them on the arm (21), (22).

10. The machine according to any of the foregoing claims, characterised in that it comprises a plurality of the supporting arms (21), (22).

11. The machine according to any of the foregoing claims, characterised in that it also comprises fixing means (32) which can be selectively activated for fixing the supporting arm (21), (22) to the rest of the supporting structure (3), preventing it from moving, and which can be deactivated to allow movement of the supporting arm (21), (22) between the operating position and the maintenance position.

12. The machine according to claim 11, characterised in that the fixing means (32) comprise one or more fixing screws (33) or bolts.

* * *

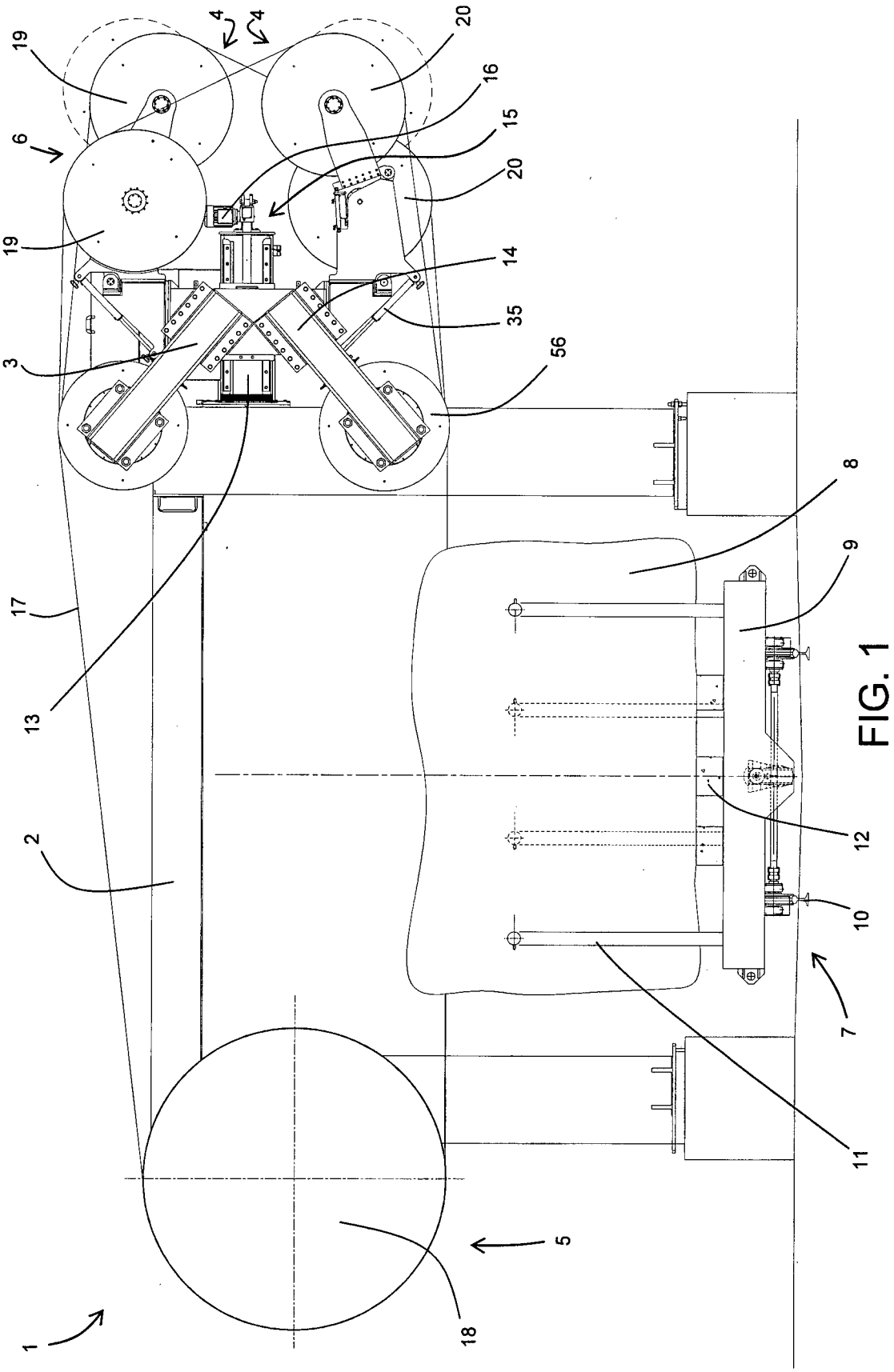

FIG. 1

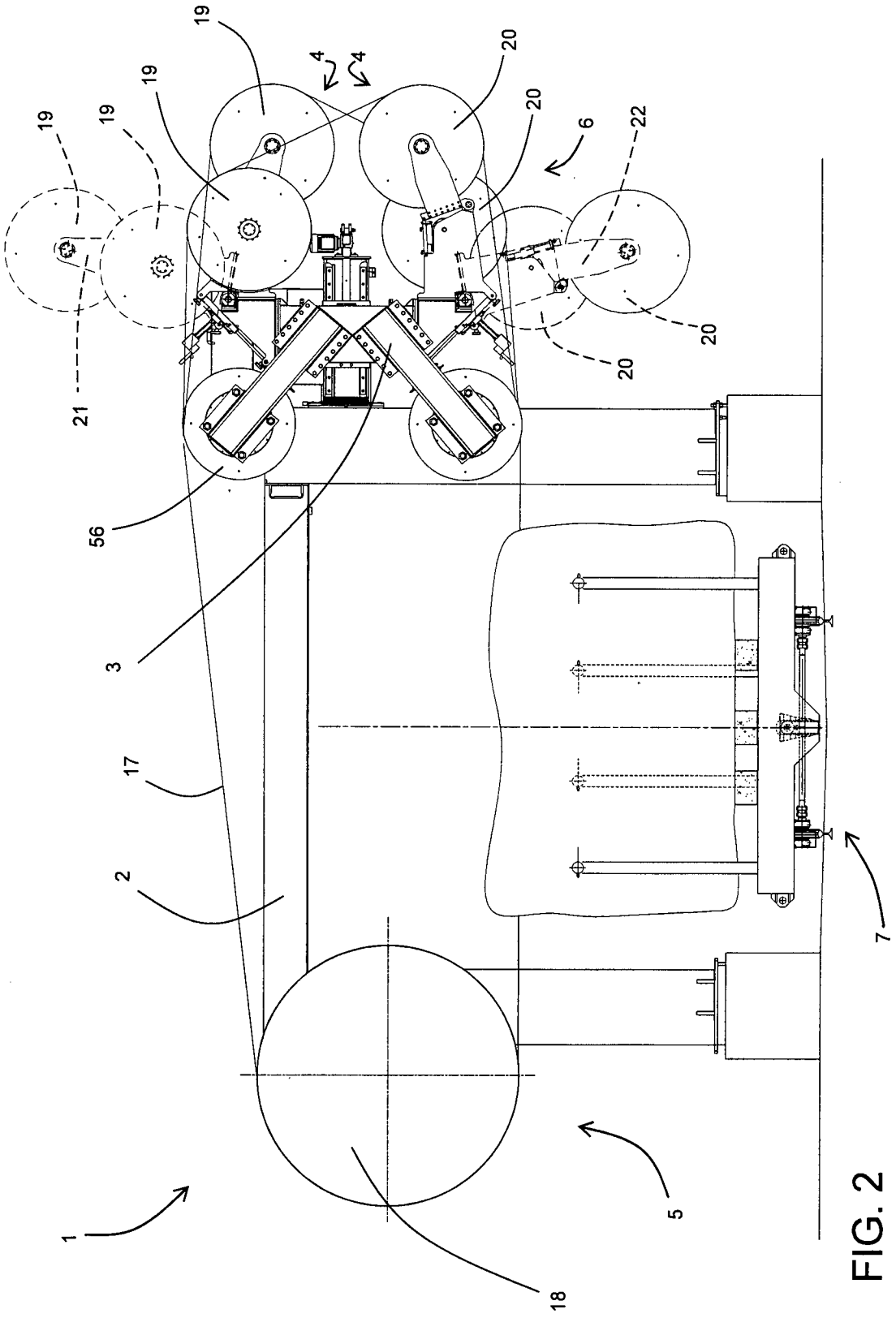

FIG. 2

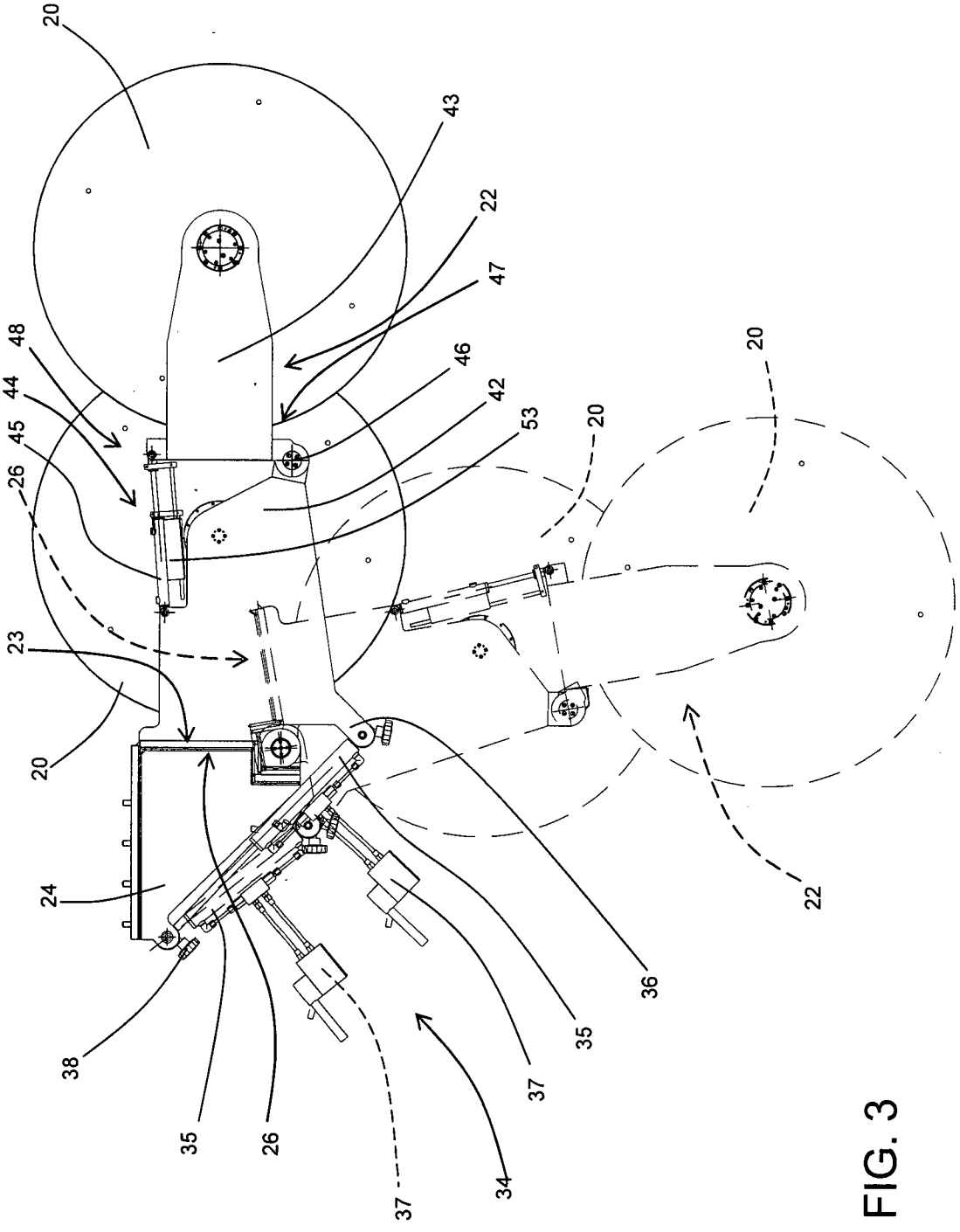
20
43
22
47
48
46
44
42
45
53
26
20
20
23
20
24
22
38
36
35
37
35
26
37
34

FIG. 3

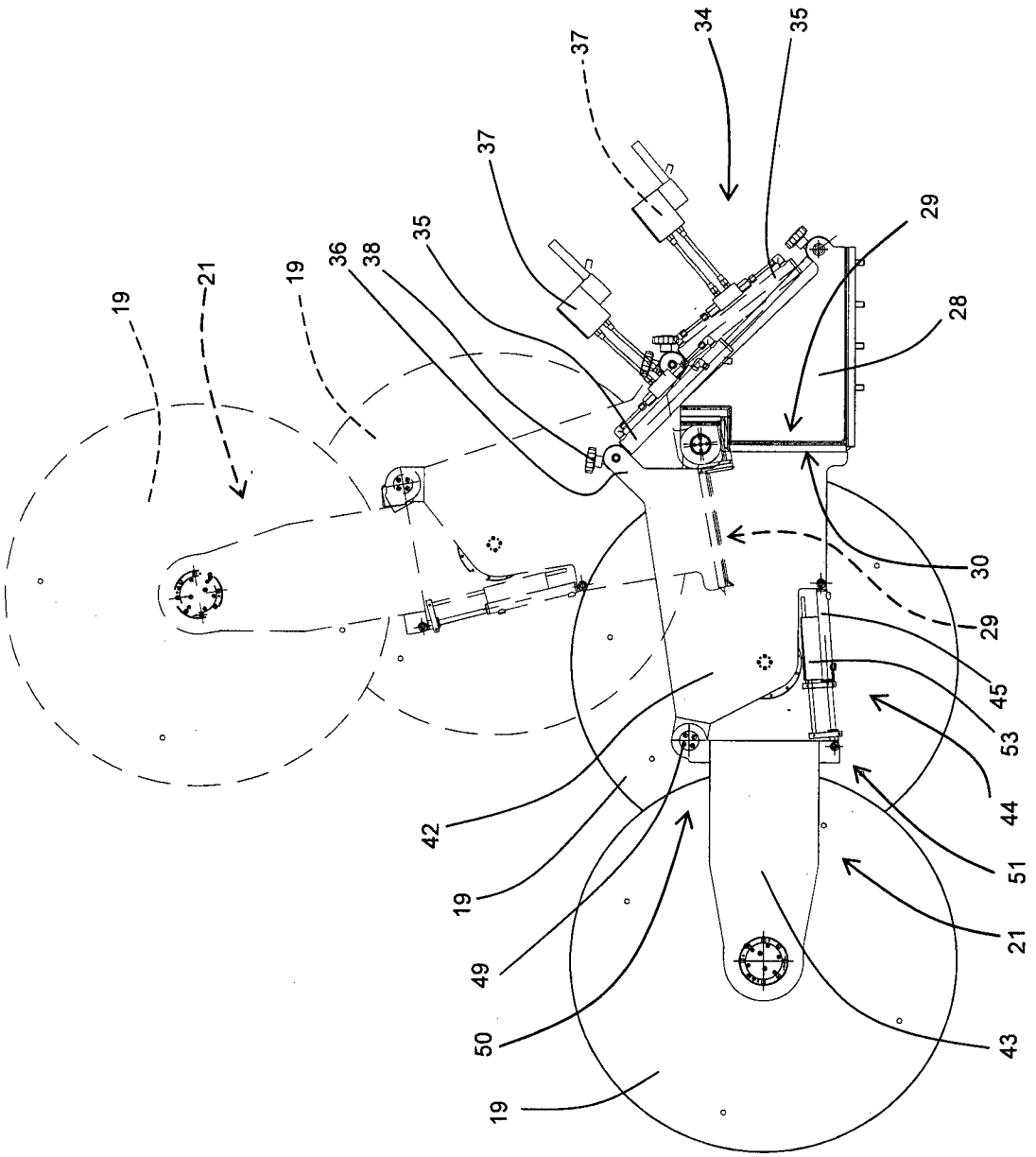
19
21
19
36
38
35
37
37
34
35
29
28
30
29
45
53
44
51
21
43
42
19
49
50
19

FIG. 4

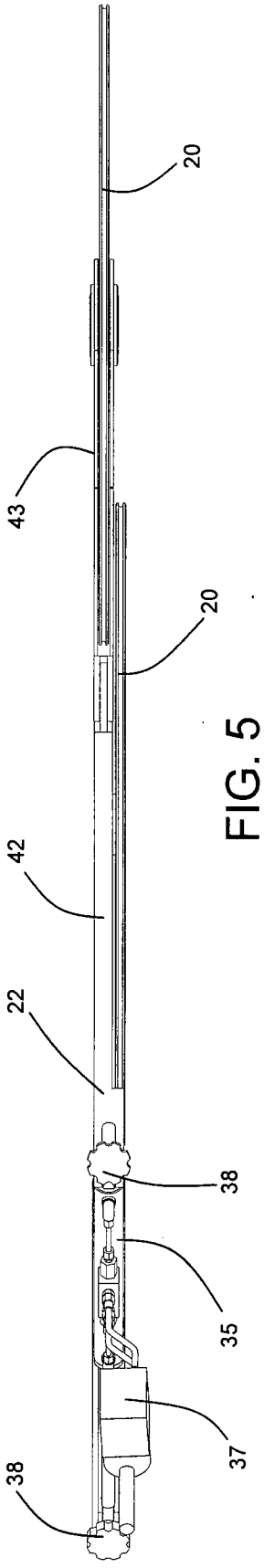

FIG. 5

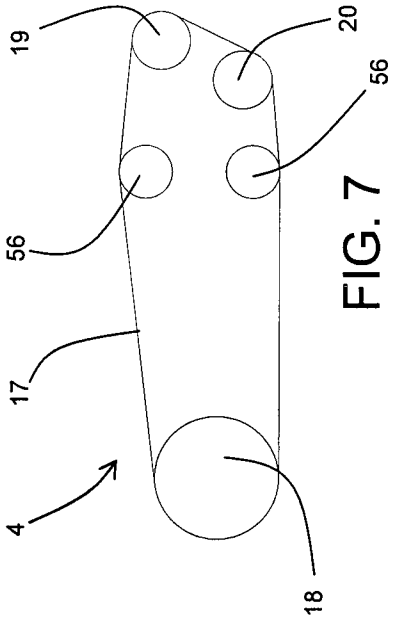

FIG. 7

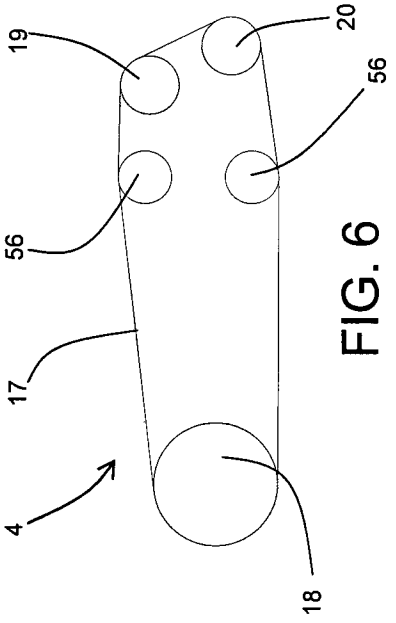

FIG. 6

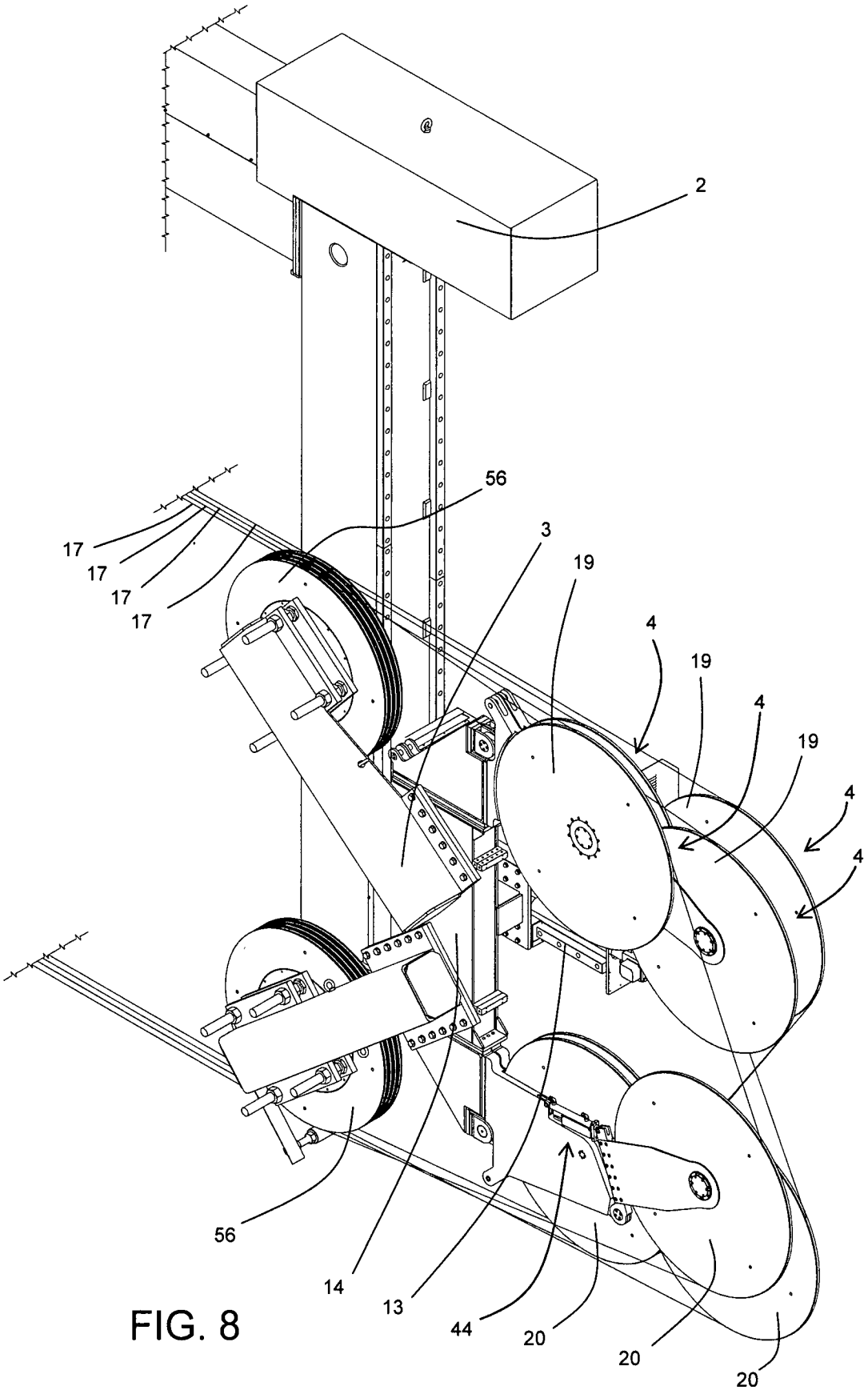

FIG. 8

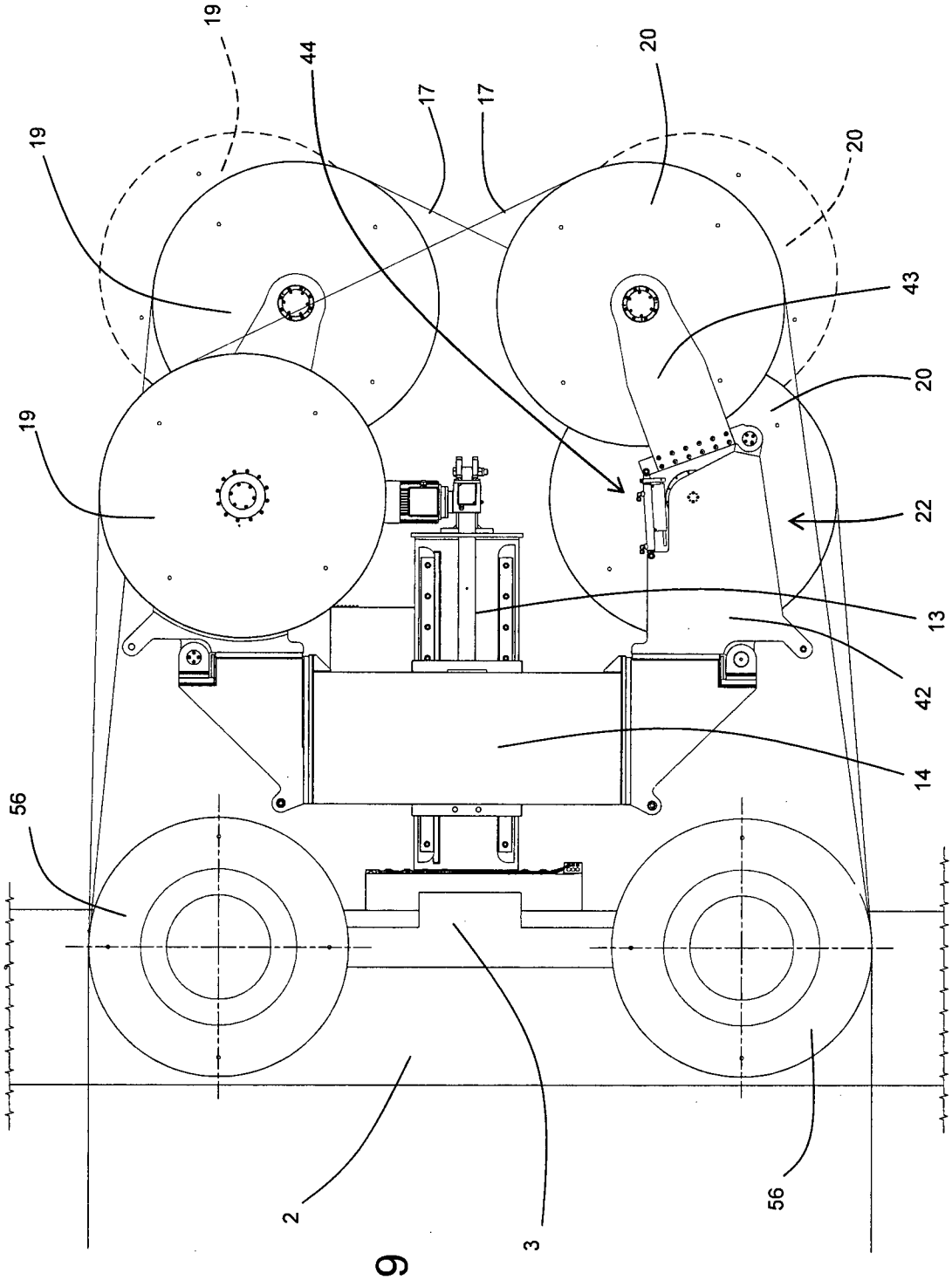

FIG. 9

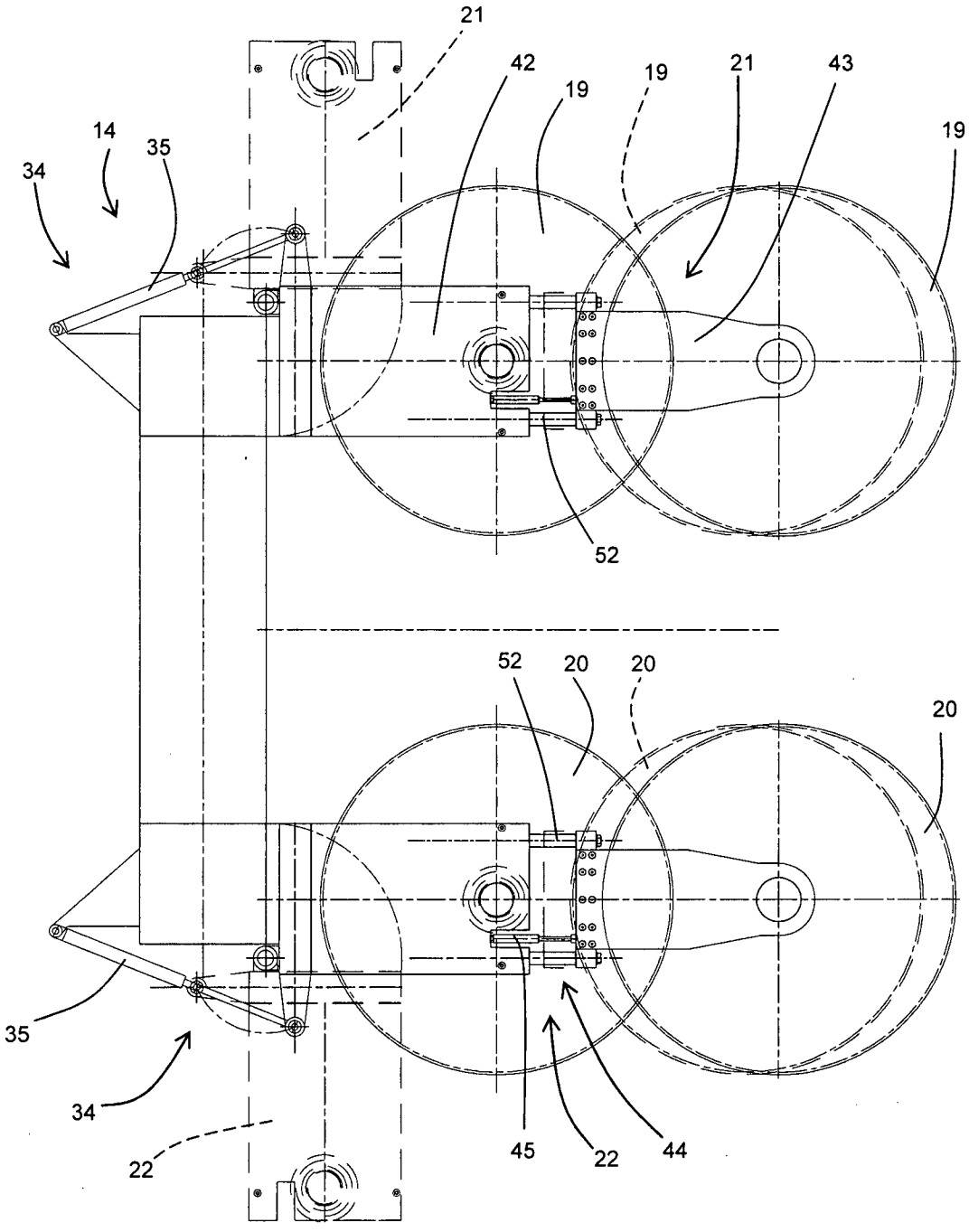

FIG. 10

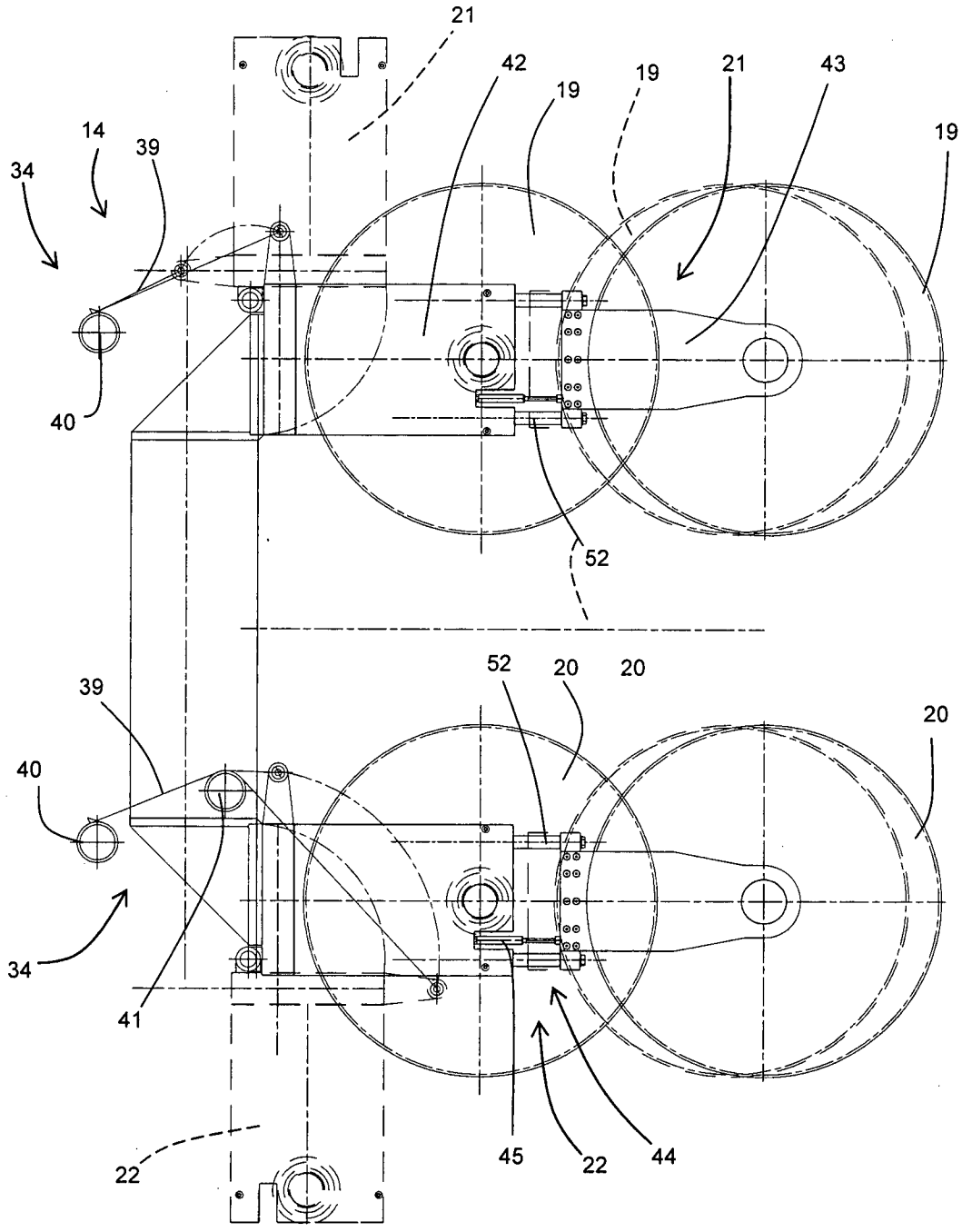

FIG. 11

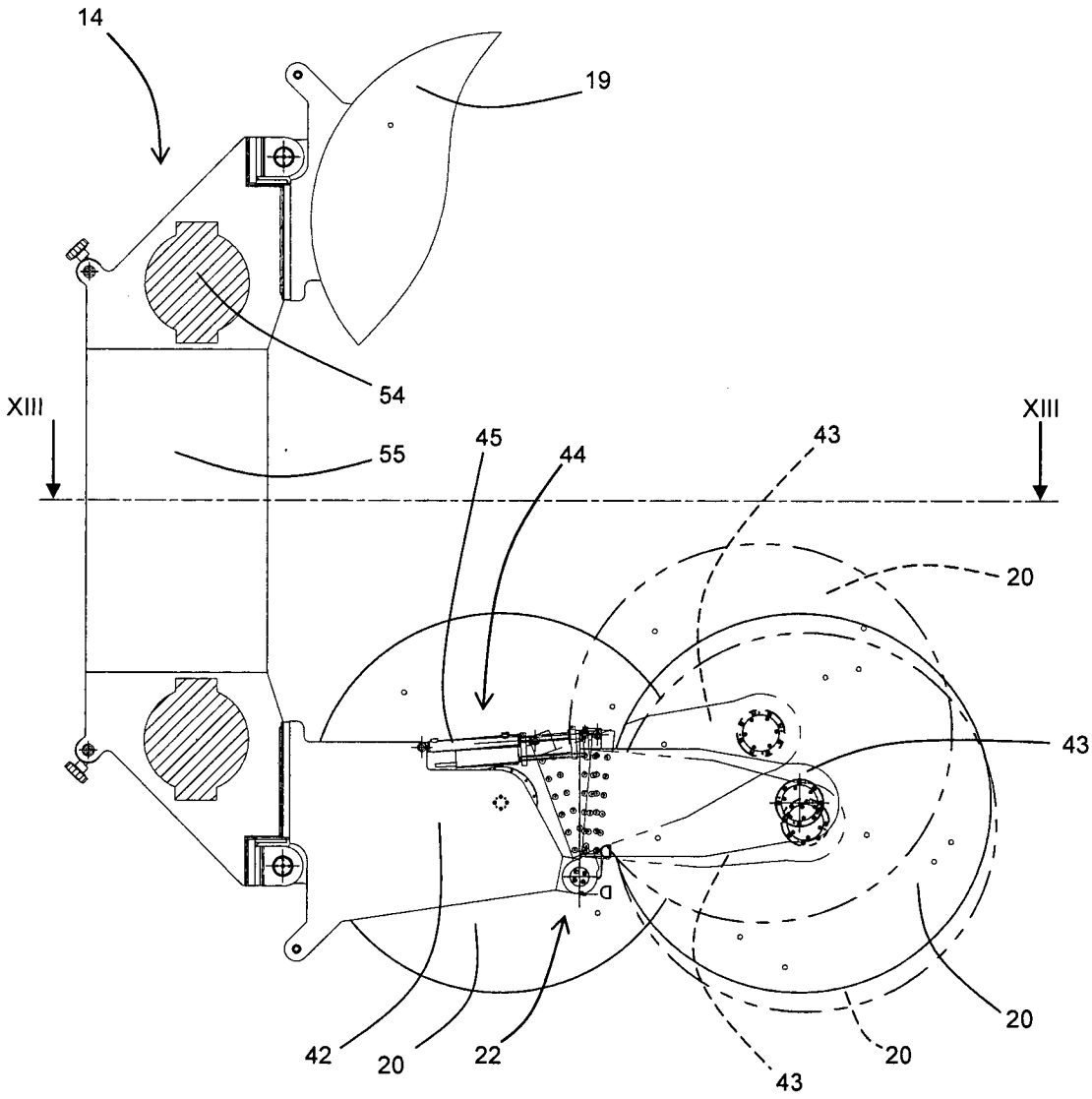

FIG. 12

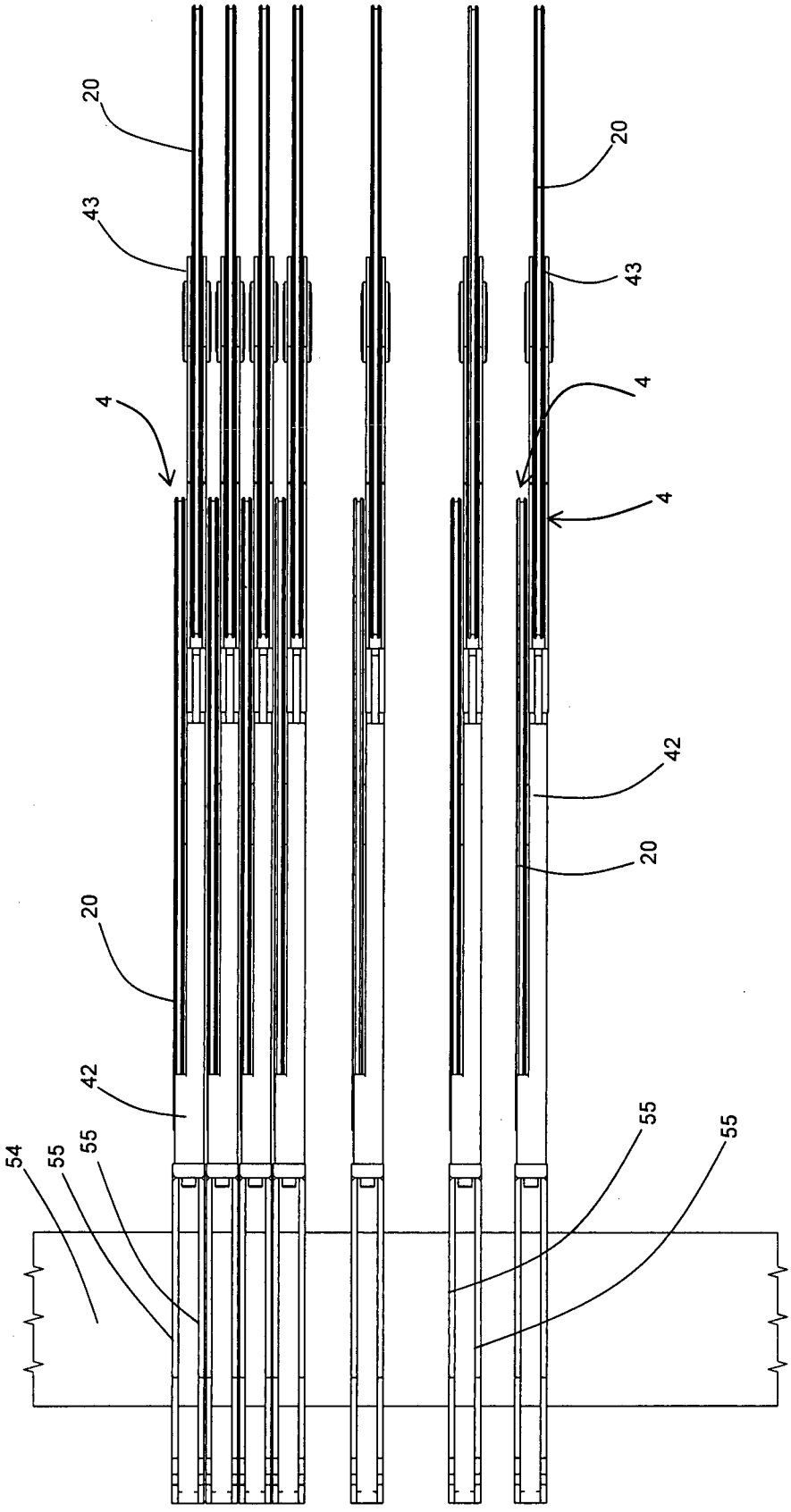

FIG. 13

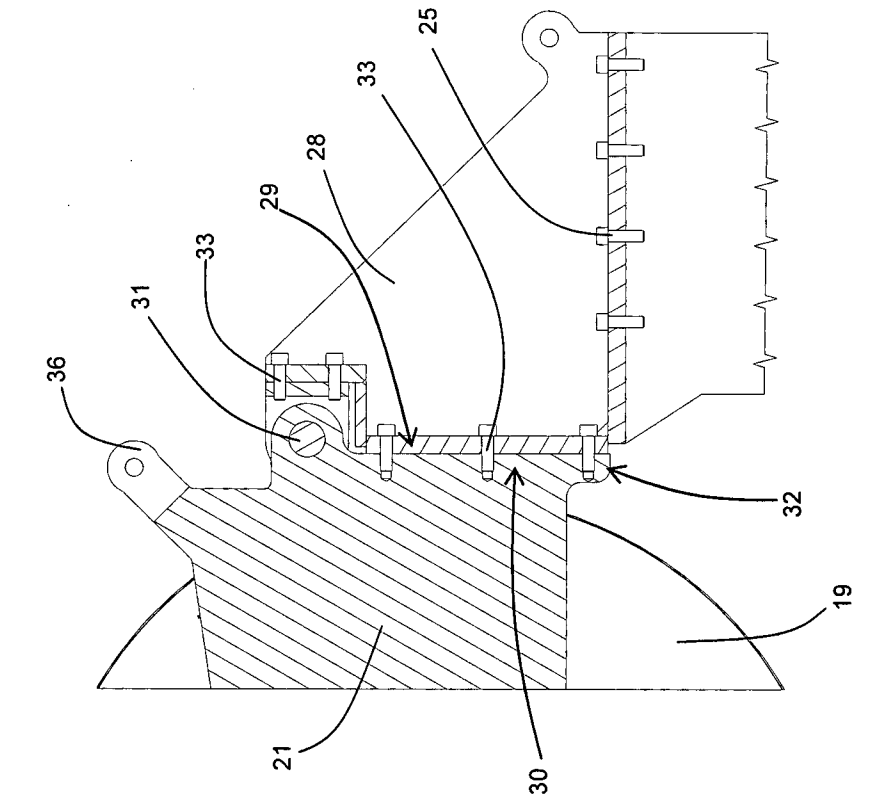

FIG. 15

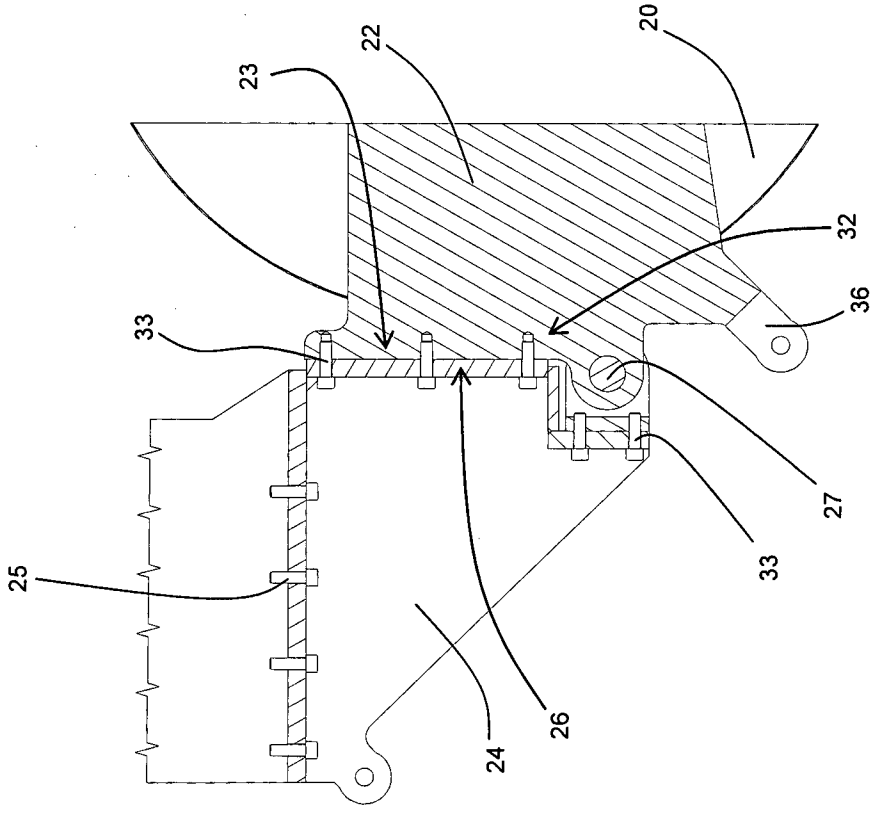

FIG. 14

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2011/000124

A. CLASSIFICATION OF SUBJECT MATTER
INV. B23D57/00 B28D1/08
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)
B23D B28D

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

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2009/098721 A1 (PELMINE) 13 August 2009 (2009-08-13) cited in the application page 10, lines 4-10; figures 6,6a	1-12
A	WO 2009/040841 A1 (PEDRINI LUIGI [IT]) 2 April 2009 (2009-04-02) cited in the application page 7, lines 22-32; figures 5-9	1-12
A	WO 2007/036784 A1 (CO FI PLAST S R L [IT]; BROCCO EMILIO [IT]) 5 April 2007 (2007-04-05) cited in the application page 8, lines 8-14; figures 6,7	1-12

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

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 February 2012	17/02/2012

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, Fax: (+31-70) 340-3016	Popma, Ronald

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IT2011/000124

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2009098721 A1	13-08-2009	NONE	
WO 2009040841 A1	02-04-2009	CN 101855037 A	06-10-2010
		EP 2205388 A1	14-07-2010
		SM AP201000050 A	13-07-2010
		US 2010212650 A1	26-08-2010
		WO 2009040841 A1	02-04-2009
WO 2007036784 A1	05-04-2007	AT 486680 T	15-11-2010
		BR PI0616397 A2	21-06-2011
		CA 2622851 A1	05-04-2007
		EP 1937436 A1	02-07-2008
		ES 2355290 T3	24-03-2011
		PT 1937436 E	01-02-2011
		US 2008257329 A1	23-10-2008
		WO 2007036784 A1	05-04-2007