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(71) Applicant: **Cannon Ergos S.P.A.**
20121 Milan (IT)

(72) Inventors:
- **VOLPATO, Marco**
  20121 Milan (IT)
- **BOSCARI, Luciano**
  35030 Saccolongo (PD) (IT)

(74) Representative: **Luppi Intellectual Property S.r.l.**
Viale Corassori, 54
41124 Modena (IT)

(54) **FLY CUTTING APPARATUS**

(57) A fly cutting apparatus (10) for cutting panels comprises a flat advancement and support structure (A) for supporting a panel (P) and having a longitudinal axis (X) along which the panel (P) advances that is intended to be cut transversely advances, and a movable crossbar (12) to follow the movement of the panel (P); the latter supports a cutting unit (13) for cutting the panel (P), a tightening pressing unit (14) for exerting a grasping and stabilizing pressure during cutting and an extraction hood (18) to suck the removed material produced during cutting; the apparatus (10) comprises a control unit (UC) configured to control the kinematic parameters of the cutting unit (13) and of the axes for cutting, following and resuming; the cutting unit (13) is provided with a cutting element (17) suitable for penetrating and disengaging from said panel (P).

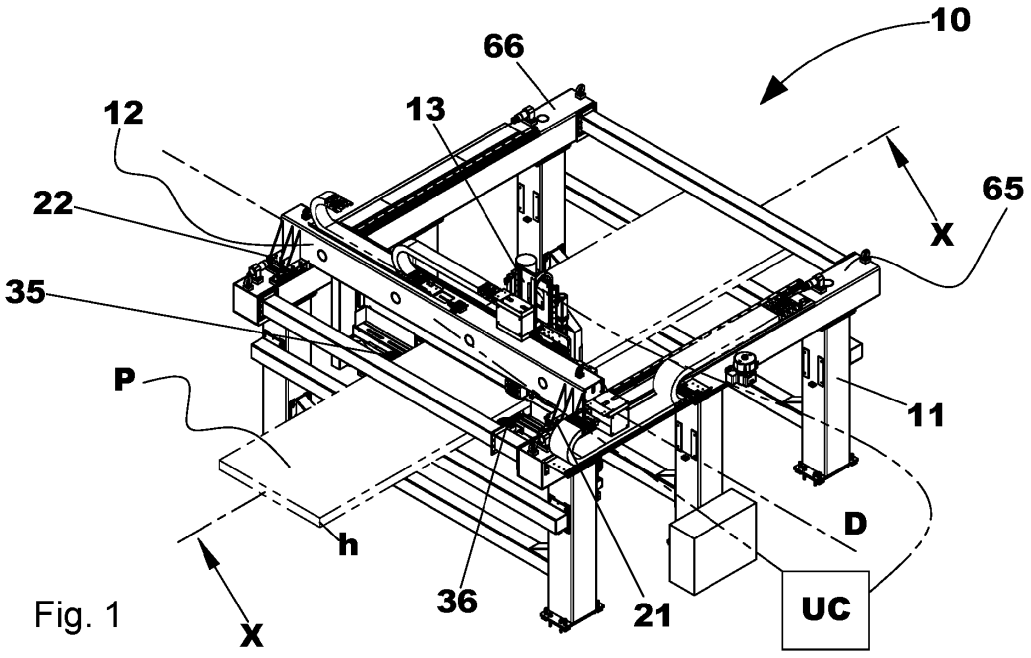

Fig. 1

EP 4 389 373 A1

Description

Background of the invention

[0001] The present invention relates to a fly cutting apparatus for cutting panels, intended to be installed on a panel production line, in particular on a panel production line obtained by continuous foaming.

Prior art

[0002] Sandwich panels for heat insulation are surface structures mainly consisting of an intermediate layer of expanded polyurethane coated externally by stiff or flexible protective and coating surfaces; these external surfaces being formed by sheets unwound from reels and consisting of paper, aluminium, glass fibre composites, sheet metal or the like.

[0003] Today, sandwich panels are widely used in the building field because of the excellent thermal and acoustic insulating properties with which they are provided.

[0004] Foamed sandwich panels are manufactured continuously on production lines along which different processing stations are present.

[0005] In particular, when the continuous panel is formed, it has to be processed by one of these stations that is dedicated to the transverse cutting of the panel so as to divide the panel into segments of determined length, a delicate task in which optimization and the correct compromise between cutting speed, cutting accuracy and the speed of the production line have to be found.

[0006] The cutting operation is performed by a fly cutting apparatus so as not to interfere with forming of the panel by continuous foaming that is the main plant process, optimizing and maximizing productivity; nevertheless, the apparatuses that are known today enable a maximum foaming line speed of about 60m/min to be achieved combined with cutting precision that is not greater than about 2mm and at a cutting speed that is not very high, with a resulting unsatisfactory foaming speed (a cutting speed that is not high limits the minimum panel length that can be produced) and a panel quality affected by great waste generation.

[0007] The fly cutting apparatuses used today do not enable satisfactory cutting precision to be achieved that meet currently requested precision specifications; further, owing to the wear to the control members in continuous alternating movement, maintenance tasks are necessary that often entail long plant downtime.

[0008] Apparatuses for cutting panels are known from documents US 4 117 754 A, CN 217 225 708 U, US 2007/206997 A1, CN 217 913 153 U and DE 35 00 751 A1.

[0009] In the light of what has been set out above, there is ample room for improvement for current fly cutting apparatuses for panels.

Objects of the invention

[0010] One object of the present invention is to improve current fly cutting apparatuses.

[0011] In particular, it is desired to provide an apparatus that requires minimum and rapid maintenance interventions and is able to ensure high combined productivity.

[0012] Another object of the present invention is to provide a fly cutting apparatus that enables the production speed of the foaming line to be maximized.

[0013] A further object of the present invention is to propose a fly cutting apparatus provided with great cutting precision and speed.

[0014] An additional object of the present invention is to provide a fly cutting apparatus that is able to minimize drastically the waste produced during cutting operations and is able to permit rapid and effective removal of the waste and residue arising from cutting.

[0015] Still another object of the present invention is to provide a fly cutting apparatus provided with a simplified and harmonized structural configuration benefiting mechanical reliability, configured so as to reduce mechanical vibrations and that has a reduced number of mechanical components subject to wear.

[0016] A further object of the present invention is to reduce the wear and vibrations produced during cutting.

Short description of the invention

[0017] The objects listed above and yet others are achieved by a fly cutting apparatus according to what is defined in the attached claims.

Short description of the drawings

[0018] The invention can be better understood with reference to the enclosed drawings that illustrate one embodiment thereof by way of non-limiting example, in which:

Fig.1 is a perspective view of a fly cutting apparatus according to the invention inside which a panel to be cut is positioned;
Fig.2 is a perspective view of a portion of the fly cutting apparatus of Fig. 1;
Fig.3 a perspective view of another portion of the fly cutting apparatus of Fig. 1;
Fig.4 is a frontal section view of the fly cutting apparatus with the panel to be cut of Fig.1;
Fig.5 is a top view of the fly cutting apparatus of Fig. 1;
Fig.6 is a detail of the apparatus of Fig.1 with elements removed;
Fig.7 is a longitudinal section of the apparatus of Fig. 1.

Detailed description of the invention

[0019] The general features of the present invention will be illustrated below by the embodiment provided by way of non-limiting example of the attached figures.

[0020] With reference to the attached figures, a fly cutting apparatus 10 is disclosed below for cutting the panels transversely, which is intended to be installed on a panel production line P, in particular on a panel production line obtained by continuous foaming.

[0021] With reference to Figs 1, 3 and 4, the fly cutting apparatus 10 for cutting panels comprises a flat advancement and support structure A for supporting a panel P, intended to be cut, which advances along a longitudinal axis X of the rest plane A. The apparatus 10 has, further, a portal structure with a movable crossbar 12, which can move along the longitudinal axis X and is supported by two longitudinal pads 52,53 that are slidable along longitudinal sliding guide elements 54,54bis with guides parallel to the transverse axis X to follow the movement of the panel P.

[0022] As shown in Fig.2, a cutting unit 13 is arranged and supported slidably along the transverse axis Y on the movable crossbar 12, the cutting unit 13 being suitable for cutting the panel P along a transverse axis Y transverse and perpendicular to the longitudinal axis X.

[0023] With reference to Fig. 4, a tightening pressing unit 14 is further connected by uprights 56,57 to the movable crossbar 12 to exert on the panel P a grasping and stabilizing pressure along a tightening axis Z1 during cutting.

[0024] As shown in Fig. 2, the cutting unit 13 is associated with an extraction hood 18 suitable for sucking material like chips or other residues in the form of granules or dust produced during cutting and is movable in a controlled manner along a suction axis Z2 so as to approach or move away from the upper surface of the panel P. The cutting unit 13 includes a motorized cutting element 17 that is movable in a controlled manner along an engagement/exclusion axis Z to penetrate or disengage from the section or thickness h of the panel P.

[0025] The command and control, in an independent and combined manner, of kinematic parameters of the cutting unit 13 is assigned to a control unit UC (Figs 1 and 7). In particular, the control unit UC is configured to control in an independent and synchronized manner both the kinematic parameters of the cutting unit 13 along the transverse axis Y and the kinematic parameters of the movable crossbar 12 along the longitudinal axis X, and the tightening pressing unit 14 (Fig.3).

[0026] The control unit UC, as schematized in Fig. 6, is configured to control in an independent and synchronized manner the kinematic parameters of the motorized cutting element 17 along the engagement/exclusion axis Z, so as to counteract and damp possible vibration triggering phenomena, thus containing the stresses to which the various members of the apparatus 10 could be subjected.

[0027] The control unit UC is configured to control in an independent and synchronized manner also the movement and the position of the extraction hood 18 so as to maximize the capacity thereof to capture and suck cutting residues (Fig.7).

[0028] With reference to Figs 2 and 6, the movement of the extraction hood 18 along the suction axis Z2 is performed and controlled by a suction electric cylinder 58 drivable by linear movement means controlled by an electric motor; in particular the suction electric cylinder 58 is drivable by a suction electric motor of brushless type 19 provided with a respective absolute encoder and drivable in a dedicated manner. In another embodiment that is not shown, the movement of the extraction hood 18 along the suction axis Z2 is performed and controlled by a pneumatic or hydraulic aspiration cylinder.

[0029] The flat advancement and support structure A is defined by oblong support and advancement elements 39,40,41,42,43,44 and by a horizontal plate 25 divided into two parallel abutting sections, as shown in Fig.3. Further, as visible in Figs. 1,3,4 and 5, the apparatus 10 is provided with lateral directing elements 33,34,35,36 suitable for ensuring sliding of the panel P during the cutting operation, by centring the panel P along the longitudinal axis X and preventing deflection thereof during a cut of limited length.

[0030] In particular, the abutting horizontal plate 25 is suitable for supportingly receiving the panel P, and is provided with a slit 27 that is suitable for making the excess cutting element 17 penetrate and slide below the lower surface of the panel P during transverse cutting of the panel P. In addition, as cutting of the panel P is performed at the slit 27 of the abutting horizontal plate 25, suction elements 37,38 are provided below the slit of the abutting horizontal plate 25 to suck the removed material produced during cutting.

[0031] Again with reference to Fig.3, the pressing unit 14 comprises a pressure crossbar element 15 that is movable along the uprights 56,57 with respect to the horizontal plate 25 according to the tightening axis Z1, by which the pressing unit 14 presses the panel P against the abutting horizontal plate 25, exerting the grasping and stabilizing pressure. In detail, the pressure along the tightening axis Z 1 is exerted by tightening electric cylinders 60,61 drivable by motor means; in particular the tightening electric cylinders 60,61 are drivable by tightening motors of brushless type 28,29 (Fig.4) that are fitted to the uprights 56,57 in a parallel configuration and commanded to move synchronized by the control unit UC, each of which is drivable independently and provided with a respective absolute encoder. Each of the tightening electric cylinders 60,61 is also provided with a control means to ascertain the contact of a respective part of the pressure crossbar element 15 with the panel P by active magnetic traction and zero speed traction signals or by pressure detection by means of a load cell.

[0032] In a further embodiment that is not shown, the pressure along the tightening axis Z 1 is exerted by a

servomotor with mechanical transmission and synchronized by mechanical connecting means.

[0033] The servomotor with mechanical transmission, for example, is of the rack-and-pinion type and the mechanical connecting means is, for example, of the rack-and-pinion type or of the belt-screws type.

[0034] The electrically controlled transmission means disclosed above enables the movement of the pressing unit to be controlled with a disengagement height that is settable, for example by 10 mm, so as to make the extension and the movement time very contained and therefore much more efficient than pneumatically or hydraulically controlled pressure means.

[0035] As visible in Fig. 6, the cutting element 17 is supported by an engagement/exclusion carriage 55 that is fitted slidably along the engagement/exclusion axis Z on a transverse stroke carriage 20bis, shaped as a plate.

[0036] In particular, the movement of the engagement/exclusion carriage 55 along the engagement/exclusion axis Z is performed by an engagement/exclusion electric cylinder 59 drivable by motor means arranged on the transverse stroke carriage 20bis; still more in particular, the engagement/exclusion electric cylinder 59 is drivable by an engagement/exclusion motor of brushless type 16.

[0037] The engagement/exclusion carriage 55, in detail, is provided with dedicated pads (not shown) for sliding along a respective sliding engagement/exclusion guides element 20, with guides parallel to the engagement/exclusion axis Z, arranged on the transverse stroke carriage 20bis.

[0038] Further, the engagement/exclusion carriage 55 has guides 99, parallel to the engagement/exclusion axis Z, for positioning according to the suction axis Z2 of the extraction hood 18. In detail, the extraction hood 18 is provided with appropriate suction pads 67,68 that couple slidingly with the aforesaid guides 99 to enable the extraction hood 18 to translate along the suction axis Z2 with respect to the engagement/exclusion carriage 55 and then with respect to the cutting element 17.

[0039] The engagement/exclusion motor of brushless type 16 is driven by the control unit UC independently and is provided with a respective absolute encoder to control position and movement.

[0040] The engagement/exclusion axis Z is so oriented orthogonally to the support and advancement plane A that the cutting element 17 is movable and positionable through the thickness h of the panel P.

[0041] In one alternative embodiment that is not shown, the movement of the cutting element 17 along the engagement/exclusion axis Z is performed by a pneumatic or hydraulic cylinder for controlling the engagement/exclusion movement coupled with a respective sliding engagement/exclusion guides element 20, parallel to the engagement/exclusion axis Z and arranged on the transverse stroke carriage 20bis.

[0042] The cutting element 17 can be, as shown in Fig. 4, a toothed circular blade 32 connected removably to the drive shaft of the cutting unit 13 to be able to be replaced rapidly so as to adapt the diameter and/or the toothing features thereof to the thickness h of the panel P. Further, as visible in Figs. 2 and 4, the cutting unit 13 comprises a protection and suction unit 23 suitable for housing the cutting element 17. In particular, the protection and suction unit 23 includes the extraction hood 18. By controlling the position of the extraction hood 18 along the suction axis Z2, the cutting element 17 is made to protrude from the protection and suction unit 23 only by the quantity or circular segment necessary for obtaining the cutting depth appropriate for performing the operation of cutting the panel P. If the cutting element 17 consists of a circular blade 32, as shown in Fig. 4, the protruding circular segment is also chosen in function of the diameter of the circular blade 32.

[0043] The protection and suction unit 23 comprises an openable access wall 45 to enable the aforesaid replacement of the circular blade 32 (or another removably connected cutting element 17). The access wall 45, for example, can be made openable owing to the use of a hinge and the relative opening device or knob provided with safety.

[0044] In the event of an interruption to the electricity supply or emergency stop, the cutting element 17 has to be disengaged from the panel P by lifting the panel P along the engagement/exclusion axis Z; the disengagement can be performed by a lifting unit (not shown) supplied by electric power taken from the engagement/exclusion linear motor of brushless type 16 during normal operation and accumulated in an accumulating device or by a pneumatic weight over-balancing device (not shown).

[0045] The movement of the cutting unit 13, and thus of the cutting element 17, along the transverse axis Y is performed, as visible in Fig. 2, owing to linear motor means; in particular owing to a transverse linear motor 62,24, controlled and drivable independently, and provided with a respective absolute inductive linear encoder for controlling movement and position, coupled with a respective sliding transverse guides element 26 with guides parallel to the transverse axis Y and arranged on the movable crossbar 12; the previously introduced sliding transverse guides element 26, has transverse damping elements 46,47 for damping the end stop of the movement of the cutting unit 13 along the transverse axis Y.

[0046] The transverse linear motor of brushless type 62,24 can be of synchronous or asynchronous type.

[0047] An active part of said transverse linear motor of brushless type 62,24, provided with coil magnetic elements for inducing controlled magnetic fields that exert magnetic forces to control the movement along the transverse axis Y is installed on the transverse stroke carriage 20bis.

[0048] The aforesaid active part of the transverse linear motor of brushless type 24 is provided with transverse pads 63,64 fitted to the transverse stroke carriage 20bis for sliding along the rails of the transverse guides element

26.

[0049] In particular, the active part of the transverse linear motor of brushless type 24 fitted to the transverse stroke carriage 20bis couples with the magnetic fields generated by a series of magnets comprised inside a transverse magnetic linear element 62 arranged parallel to the guides of the sliding transverse guides element 26 so as to permit the movement of the transverse stroke carriage 20bis, and thus of the cutting unit 13, along the transverse axis Y.

[0050] With reference to Fig. 1, the movement of the movable crossbar 12 along the longitudinal axis X is performed owing to linear motor means; in particular owing to longitudinal linear motors 21,30;22,31.

[0051] With reference in particular to Fig. 1, the movable crossbar 12 extends along a direction D, parallel to the transverse axis Y, and has distal ends E1, E2 at which active parts of longitudinal linear motors of brushless type 21,22 are positioned to implement the movement along the longitudinal axis X of the movable crossbar 12. The aforesaid active parts of the longitudinal linear motors of brushless type 21,22 comprise coil magnets to generate the magnetic fields for controlling the movement along the longitudinal axis X; further, as shown in Fig.4, respective longitudinal pads 52,53 are provided for sliding along the guides of the longitudinal sliding guide elements 54,54bis.

[0052] The active parts of the longitudinal linear motors of brushless type 21,22 are controlled by the control unit UC.

[0053] In detail, with reference to Fig. 5, the active parts of the longitudinal linear motors of brushless type 21,22 couple with the magnetic fields generated by a series of magnets included inside respective longitudinal magnetic linear elements 30,31 arranged parallel to the guides of the longitudinal sliding guide elements 54,54bis so as to enable the movable crossbar 12 to move along the longitudinal axis X. The longitudinal magnetic linear elements 30,31 are arranged and fixed on respective crosspieces 65,66 that are part of a frame 11. The longitudinal linear motors of brushless type 21,22 can be synchronous or asynchronous and the magnetic linear elements 31,30 can have permanent magnets or magnets that are activatable with electric coils; further, the longitudinal linear motors of brushless type 21,22 are provided with respective absolute encoders and are drivable independently with a coordinated control that ensures the synchronism thereof.

[0054] Similarly to the sliding transverse guides element 26, also the longitudinal sliding guide elements 54,54bis have respective longitudinal damping elements 48,49,50,51 to damp the arrest of the movement of the movable crossbar 12 along the longitudinal axis X.

[0055] In the embodiment shown in the attached figures, the transverse axis Y is perpendicular both to the longitudinal axis X and to the engagement/exclusion axis Z, the latter being in turn orthogonal to the longitudinal axis X and also parallel to the suction axis Z2 and to the tightening axis Z1.

[0056] The apparatus 10, further, has vibration sensors or accelerometers (not shown) coupled with the longitudinal axis X and with the transverse axis Y, which are configured to ascertain the correct operation of the apparatus 10 to detect possible faults and thus report the need for maintenance tasks.

[0057] An operating cycle of the apparatus 10 for cutting panels obtained by continuous foaming will be disclosed below.

[0058] First, the circular blade 32 is rotated at a rotation speed that is linked to various operating conditions, for example to the speed of the foaming line and to the thickness h of the panel P, but mainly depends on the diameter of the circular blade 32. In this step, the movable crossbar 12 and the cutting unit 13 are stationary in a start position, and the circular blade 32, the extraction hood 18 and the pressing unit 14 do not interact with the panel P.

[0059] Subsequently, a first cut is performed with a manual control that grasps the panel P with the tightening pressing unit 14 after automatically synchronizing the advancement speed of the movable crossbar 12 with the advancement speed of the panel P and then commands the transverse cut to identify the position of the subsequent cut (the distance measurement is automated) depending on the length of the panel P to be produced.

[0060] The aforesaid steps are performed only for the first operating cycle, whereas the steps that will now be disclosed are repeated for each (automated) cut performed.

[0061] At this point, the movable crossbar 12 is retracted in a direction opposite the direction of the movement of the panel P, and the cutting unit 13 is taken to an end of the crossbar 12, then the movement along the longitudinal axis X of the movable crossbar 12 is synchronized with the speed of the panel P and the pressing unit 14 applies the grasping and stabilizing pressure along the tightening axis Z1 by the pressure crossbar element 15; whilst the extraction hood 18 is brought near the panel along the suction axis Z2.

[0062] Subsequently, the circular blade 32 penetrates the panel P along the engagement/exclusion axis Z and the cutting unit 13 is moved along the transverse axis Y, with a movement that is simultaneous to the following movement along the longitudinal axis X, to perform cutting of the panel P.

[0063] After cutting is completed, the circular blade 32 disengages from the panel P, and both the extraction hood 18 and the pressure crossbar element 15 move away from the upper surface of the panel P.

[0064] The movement along the transverse axis Y of the cutting unit 13 is interrupted, the tightening pressing unit 14 disengaged and raised, and the cutting unit 13 returns to the start position; simultaneously, also the movable crossbar 12 returns to the start position with movement that is accelerated and opposite the movement direction of the panel P and the apparatus 10 is ready to perform a new cut.

[0065] Owing to the features disclosed above, the fly cutting apparatus 10 I successfully achieves the aforesaid previously set objects.

[0066] First, using linear motors of brushless type 21,22,24 that are coupled with the respective magnetic linear elements 30,31,62 and provided with respective absolute encoders and drivable independently enables the number of sensors used to be reduced compared with prior art apparatuses, increasing the reliability of the apparatus 10 and simplifying the construction and maintenance thereof. Linear motors of brushless type 21,22,24 coupled with the respective magnetic linear elements 30,31,62 also enable both cutting precision to be increased because they permit dynamic positioning of the moving axes in general and in particular during the acceleration and synchronization steps with the speed of the panel P, before activating the function of the tightening pressing unit 14, which other actuating systems do not achieve (precision guaranteed up to a few tenths of a millimetre), reducing waste, and the maximum cutting speed and foaming line speed (up to 70 m/min) to produce panels that are 4800 mm in length. Lastly, this solution also enables acceleration ramps to be set with management of derivative of acceleration (*Jerk*) during the initial and final application steps in order to damp effects due to sudden acceleration forces.

[0067] In addition, even using electric cylinders 59,58,60,61 drivable by respective motors of brushless type 16,19,28,29 provided with respective encoders that are absolute and in turn drivable independently enables the dynamic positioning precision to be increased when the axes are moving and accelerating; further, the movement actuating speeds are increased, thus reducing both implementing time and the number of sequence sensors necessary compared with those used in prior art apparatuses. Said prior art sensors are necessary to give the zero point in the use of incremental encoders so as to avoid interference during the movement sequences disclosed above, nevertheless, use thereof is critical because it increases the implementation time between one movement and the next and because, in the presence of shocks, vibrations and dirt, they often send false signals that interrupt the cutter actuation cycle.

[0068] In fact, the proposed solution enables, compared with traditional solutions with pneumatic or hydraulic cylinders, time in the order of a second to be saved during each operating cycle, permanent lubrication of this type of cylinder and the use of ramps linked to the possibility of setting the *Jerk.*

[0069] Lastly, by using an engagement/exclusion electric cylinder 59 driven by an engagement/exclusion motor of brushless type 16, provided with an encoder that is absolute and drivable independently, to move the circular blade 32 along the engagement/exclusion axis Z enables circular blades 32 having a different diameter to be used, and thus the use of blades with different or reduced blades, thus reducing the thickness of the material that will be shaved, minimizing waste. In current technology in fact, the use of pneumatic pistons that reach the stroke limit forces the stroke stop to be set according to the minimum protrusion of the circular blade of smaller diameter and the use of a circular blade of greater diameter causes excessive protrusion below the panel during cutting.

[0070] From what has been exposed above, it is clear that the fly cutting apparatus 10 according to the invention successfully achieves the previously mentioned set objectives.

[0071] What has been disclosed and chosen in the attached drawings has been provided by way of illustrative example of the innovative features of the fly cutting apparatus.

[0072] Variations on and/or additions to what has been disclosed and illustrated above in the attached drawings are possible.

Claims

1. Fly cutting apparatus (10) for cutting panels obtained by continuous foaming, comprising

    - a flat advancement and support structure (A) suitable for supporting a panel (P) and having a longitudinal axis (X) along which said panel (P) intended to be cut advances,
    - a portal structure with a movable crossbar (12) movable along said longitudinal axis (X), to follow said panel (P) and supporting

        - a cutting unit (13) suitable for cutting said panel (P) that is movable along a transverse axis (Y), which is transverse and perpendicular to said longitudinal axis (X), said cutting unit (13) comprising a motorized cutting element (17) that is movable along an engagement/exclusion axis (Z) to penetrate or disengage from the section or thickness (h) of said panel (P),
        - a tightening pressing unit (14) suitable for exerting on said panel (P)
        a grasping and stabilizing pressure along a tightening axis (Z1) during cutting, said apparatus (10) further comprising a control unit (UC) configured to control in an independent and combined manner the kinematic parameters of said cutting unit (13), in which said control unit (UC) is configured to control the kinematic parameters of said cutting unit (13) along said transverse axis (Y) and to control, in a synchronised manner, the kinematic parameters of said movable crossbar (12) along said longitudinal axis (X), linear motor means being provided to drive said cutting unit (13) and said movable crossbar (12).

2. Apparatus (10) according to claim 1, wherein said linear motor means includes longitudinal linear motors of brushless type (21,30;22,31), synchronous or asynchronous having active parts (21,22) provided with controlled coil magnets at distal ends (E1, E2).

3. Apparatus (10) according to claim 2 wherein at said active parts (21,22) of said longitudinal linear motors of brushless type (21,30;22,31) and at said distal ends (E1, E2) respective longitudinal pads (52,53) are installed to slide said movable crossbar (12) along longitudinal guide elements (54,54bis) parallel to said longitudinal axis (X).

4. Apparatus (10) according to claim 2 or 3, wherein said active parts (21,22) of said longitudinal linear motors of brushless type (21,30;22,31) are coupled with the magnetic fields generated by a series of magnets included inside respective longitudinal magnetic linear elements (30,31) arranged parallel to said guides of said longitudinal sliding guide elements (54,54bis), said longitudinal magnetic linear elements (30,31) being arranged on a frame (11) and being parallel to said longitudinal axis (X) to move said movable crossbar (12) along said longitudinal axis (X), said longitudinal linear motors of brushless type (21,30;22,31) being provided with respective absolute encoders and being drivable independently with a coordinated control so as to ensure the synchronism thereof.

5. Apparatus (10) according to any one of claims 1 to 4, wherein said linear motor means includes a transverse linear motor of brushless type (24,62), synchronous or asynchronous, drivable in an independent manner and controlled in position by a respective absolute linear encoder.

6. Apparatus (10) according to claim 5, wherein said transverse linear motor of brushless type (24,62) consists of an active part (24) provided with controlled coil magnets, installed on a transverse stroke carriage (20bis), shaped as a plate, the latter being provided with transverse pads (63,64) to slide said transverse stroke carriage (20bis) along a transverse guides element (26) arranged on said movable crossbar (12) and extending parallel to said transverse axis (Y).

7. Apparatus (10) according to claim 6, wherein said active part (24) of said transverse linear motor of brushless type (24,62) is coupled with the magnetic fields generated by a series of magnets comprised inside a transverse magnetic linear element (62) arranged parallel to said transverse guides element (26) so as to permit movement of said transverse stroke carriage (20bis) along said transverse axis (Y).

8. Apparatus (10) according to claim 6 or 7, wherein said cutting unit (13) comprises an engagement/exclusion carriage (55), fitted to said transverse stroke carriage (20bis) in a slidable way along said engagement/exclusion axis (Z), said engagement/exclusion carriage (55) supporting said cutting element (17).

9. Apparatus (10) according to claim 8, wherein said transverse stroke carriage (20bis) is provided with an engagement/exclusion guides element (20) with guides parallel to said engagement/exclusion axis (Z) and on which respective pads are slidable that are associated with said engagement/exclusion carriage (55) for sliding, according to the engagement/exclusion axis (Z), along said engagement/exclusion guides element (20) of said engagement/exclusion carriage (55).

10. Apparatus (10) according to claim 8 or 9, wherein said engagement/exclusion carriage (55) is provided with an engagement/exclusion electric cylinder (59), drivable by an engagement/exclusion motor of brushless type (16) which, in turn, is drivable independently and is provided with a respective absolute encoder for moving along said engagement/exclusion axis (Z) of said cutting element (17).

11. Apparatus (10) according to the preceding claim, wherein said cutting unit (13) is provided with a safety lifting system suitable for disengaging, in the event of a power outage or emergency, said cutting element (17) from said panel (P) along said engagement/exclusion axis (Z), said lifting system being supplied with energy taken from said engagement/exclusion linear motor of brushless type (16) during normal operation.

12. Apparatus (10) according to any one of the preceding claims, further comprising an extraction hood (18) associated with said cutting unit (13), suitable for sucking material such as chips or other residues in the form or granules or dust, produced during cutting, said extraction hood (18) being movable along a suction axis (Z2) so as to approach or move away from, in a controlled manner and position, the upper surface of said panel (P), and wherein said control unit (UC) is configured to control positioning of said extraction hood (18) so as to position itself near the surface of the panel (P) and maximise the suction capacity thereof.

13. Apparatus (10) according to the preceding claim as appended to one of claims 8 to 11, wherein said engagement/exclusion carriage (55) is provided with suction guides (99) parallel to said engagement/exclusion axis (Z) for positioning of said extraction hood (18) according to said suction axis (Z2), wherein said extraction hood (18) is provided with appropriate

suction pads (67,68) for sliding along said suction guides (99) with respect to said carriage (55).

14. Apparatus (10) according to claim 12 or 13, comprising an electric cylinder (58) for said extraction hood (18), drivable by a motor of brushless type (19), that is controllable independently and provided with a respective absolute encoder to move said extraction hood (18) along said suction axis (Z2).

15. Apparatus (10) according to any one of claims 12 to 14, wherein said cutting element (17) is a circular blade (32) connected removably to said cutting unit (13) to be able to be replaced rapidly so as to adapt the diameter thereof to said thickness (h) of said panel (P) and wherein said cutting unit (13) comprises a protection and suction unit (23) including said extraction hood (18) and provided with an openable access wall (45), suitable for housing said cutting element (17), the position control of said extraction hood (18) according to the suction axis (Z2) being such as to make said cutting element (17) protrude with respect to said protection and suction unit (23) by an amount necessary for the operation of cutting said panel (P) in function of said thickness (h).

16. Apparatus (10) according to one of claims 12 to 15 as claim 12 is appended to one of claims 8 to 11, wherein said control unit (UC) is programmed for the kinematic control of said movable crossbar (12) along said longitudinal axis (X), for the kinematic control of said transverse stroke carriage (20bis) along said transverse axis (Y), for the kinematic control of said engagement/exclusion carriage (55) supporting said cutting element (17) along said engagement/exclusion axis (Z) and for the kinematic control of said extraction hood (18), and is configured to counteract and damp vibration phenomena so as to contain the stresses to the various members apparatus.

17. Apparatus (10) according to any one of the preceding claims, wherein said engagement/exclusion axis (Z) is oriented orthogonally to said support and advancement plane (A) such that said cutting element (17) is movable along the thickness (h) of said panel (P).

18. Apparatus (10) according to any one of the preceding claims, wherein said support and advancement plane (A) is defined by oblong support and advancement elements (39,40,41,42,43,44) and by an abutting horizontal plate (25), and wherein directing elements (33,34,35,36) are provided to guide the advancement of said panel (P) along said longitudinal axis (X), and wherein said horizontal plate (25) is configured to receive supportingly said panel (P) and said pressing unit (14) comprises a pressure crossbar element (15) suitable for pressing said panel (P) against said abutting horizontal plate (25), said horizontal plate (25) being provided with a slit (27) that is traversable by said cutting element (17) during the operation of cutting said panel (P) and, further, suction elements (37,38) being provided, arranged near said horizontal plate (25), suitable for sucking the material produced during cutting.

19. Apparatus (10) according to the preceding claim, further comprising tightening electric cylinders (60,61) so configured that said pressure crossbar element (15) exerts a pressure along said tightening axis (Z1), said tightening electric cylinders (60,61) being drivable by tightening motors of brushless type (28,29) that are aligned and synchronized, each of said linear motors of brushless type being drivable independently and being provided with a respective absolute encoder and with a control means for checking the contact of a respective part of said pressure crossbar element (15) with said panel (P) via zero speed signal or by pressure detection by means of a load cell.

20. Apparatus (10) according to claim 18, further comprising pneumatic or hydraulic cylinders so configured that said pressure crossbar element (15) exerts a pressure along said tightening axis (Z1), said pneumatic or hydraulic cylinders being drivable by control valves and being synchronized by mechanical connecting means, and a control means being further provided for checking the contact of a part of said pressure crossbar element (15) with said panel (P) via zero speed signal or by pressure detection by means of a load cell.

21. Apparatus (10) according to any one of the preceding claims, wherein said cutting unit (13) is provided with a pneumatic weight over-balancing device that is suitable for disengaging, in the event of a power outage or emergency, said cutting element (17) along said engagement/exclusion axis (Z) from said panel.

22. Apparatus (10) according to any one of the preceding claims, wherein said movable crossbar (12) extends along a direction (D) parallel to said transverse axis (Y).

23. Apparatus (10) according to any one of the preceding claims, wherein said transverse axis (Y) is perpendicular both to said longitudinal axis (X) and to said engagement/exclusion axis (Z), the latter being orthogonal also to said longitudinal axis (X) and parallel also to said suction axis (Z2) and to said tightening axis (Z 1).

24. Apparatus (10) according to any one of the preceding claims, wherein vibration sensors are provided, coupled with said longitudinal axis (X) and said trans-

verse axis (Y), which are configured to check the correct operation of said apparatus (10) foreseeing possible faults or providing possible maintenance

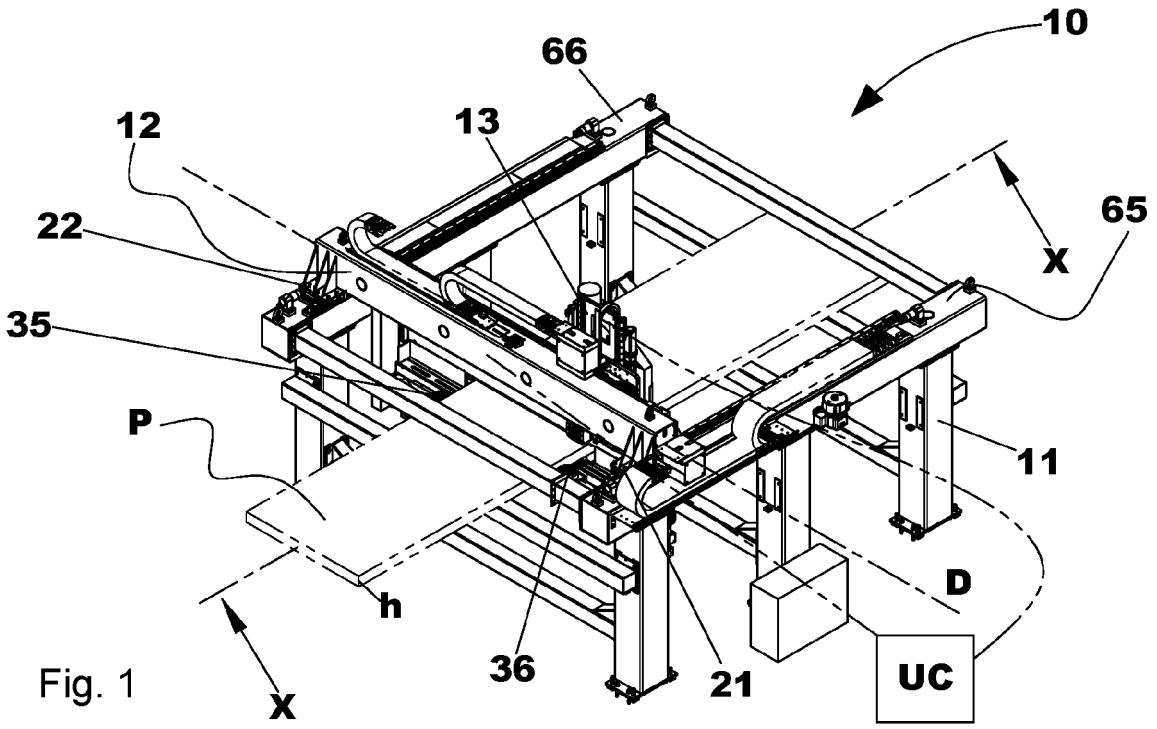
10
66
12
13
22
65
X
35
P
11
D
h
36
21
UC
X

Fig. 1

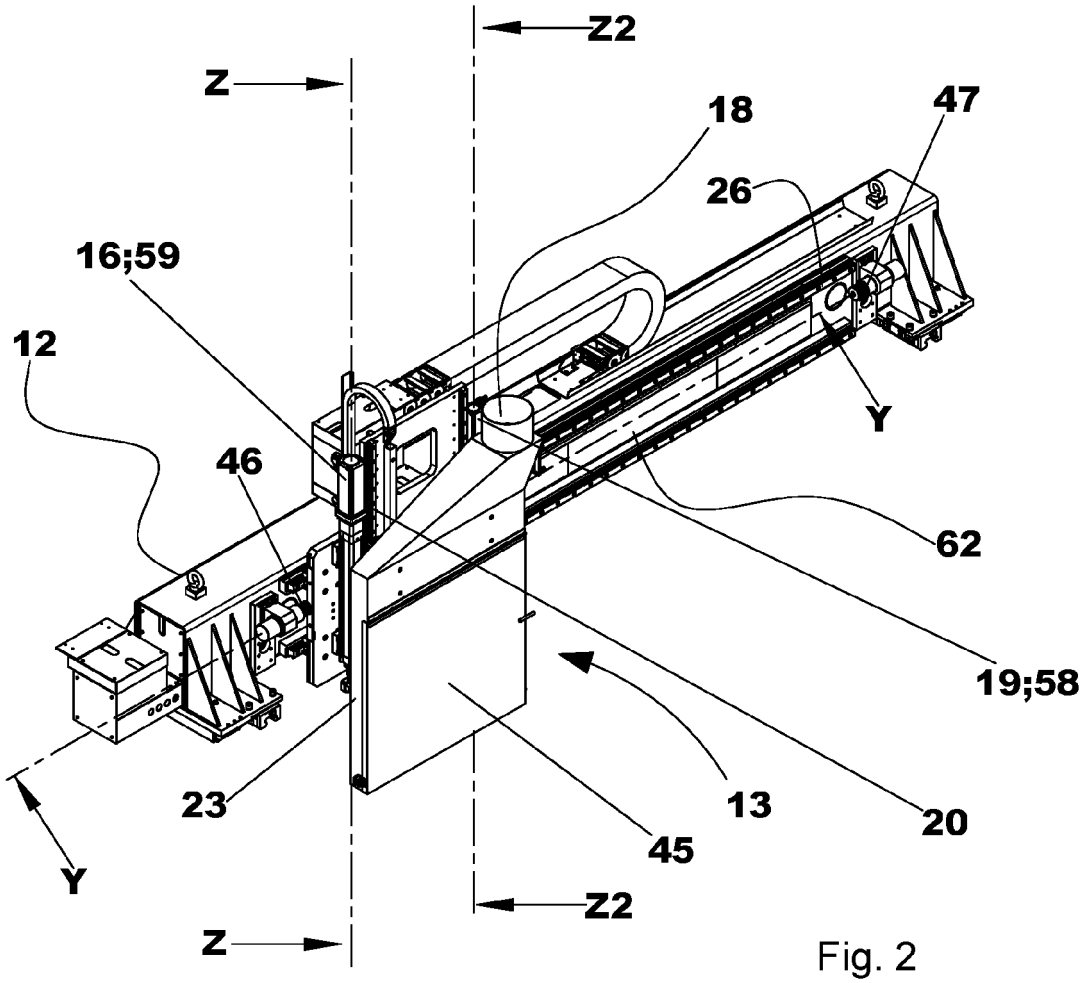
Z2
Z
18
47
26
16;59
12
Y
46
62
19;58
23
13
20
45
Y
Z2
Z

Fig. 2

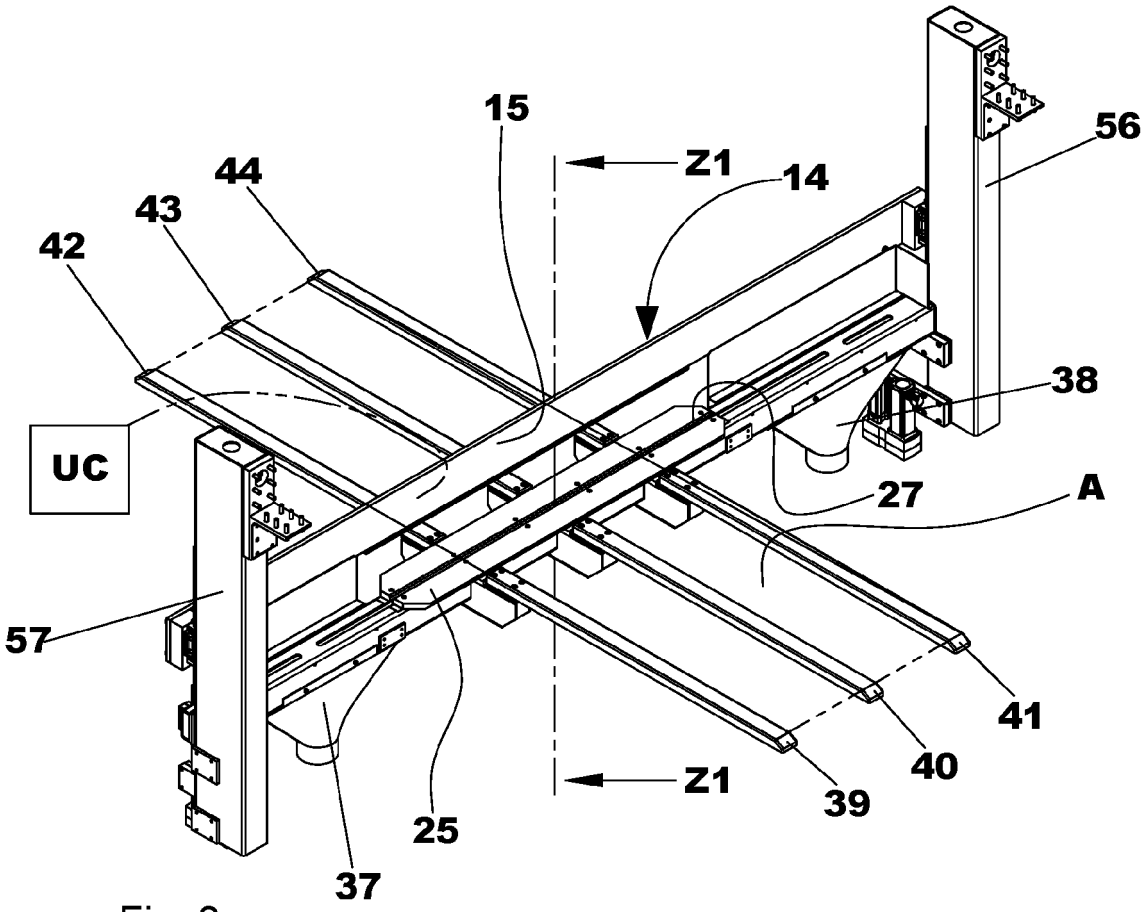
15
Z1
14
56
44
43
42
38
UC
27
A
57
41
40
Z1
39
25
37

Fig. 3

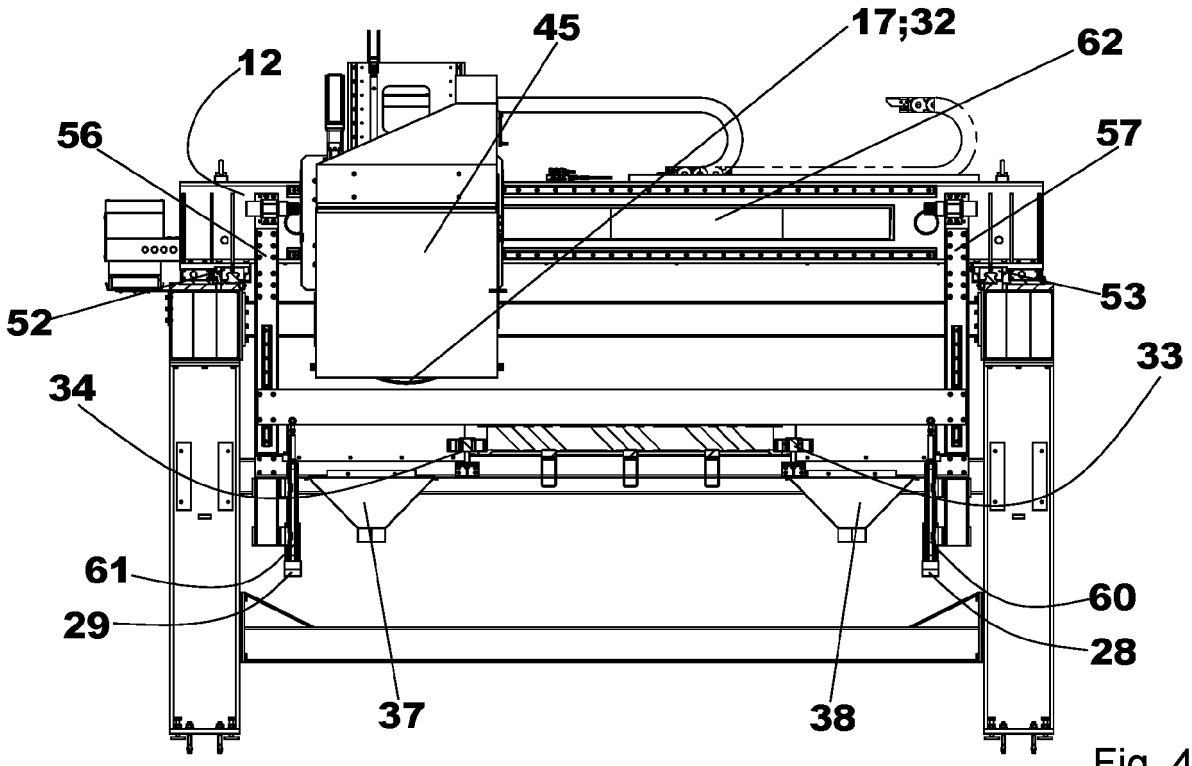
45
17;32
62
12
56
57
53
52
33
34
61
60
29
28
37
38

Fig. 4

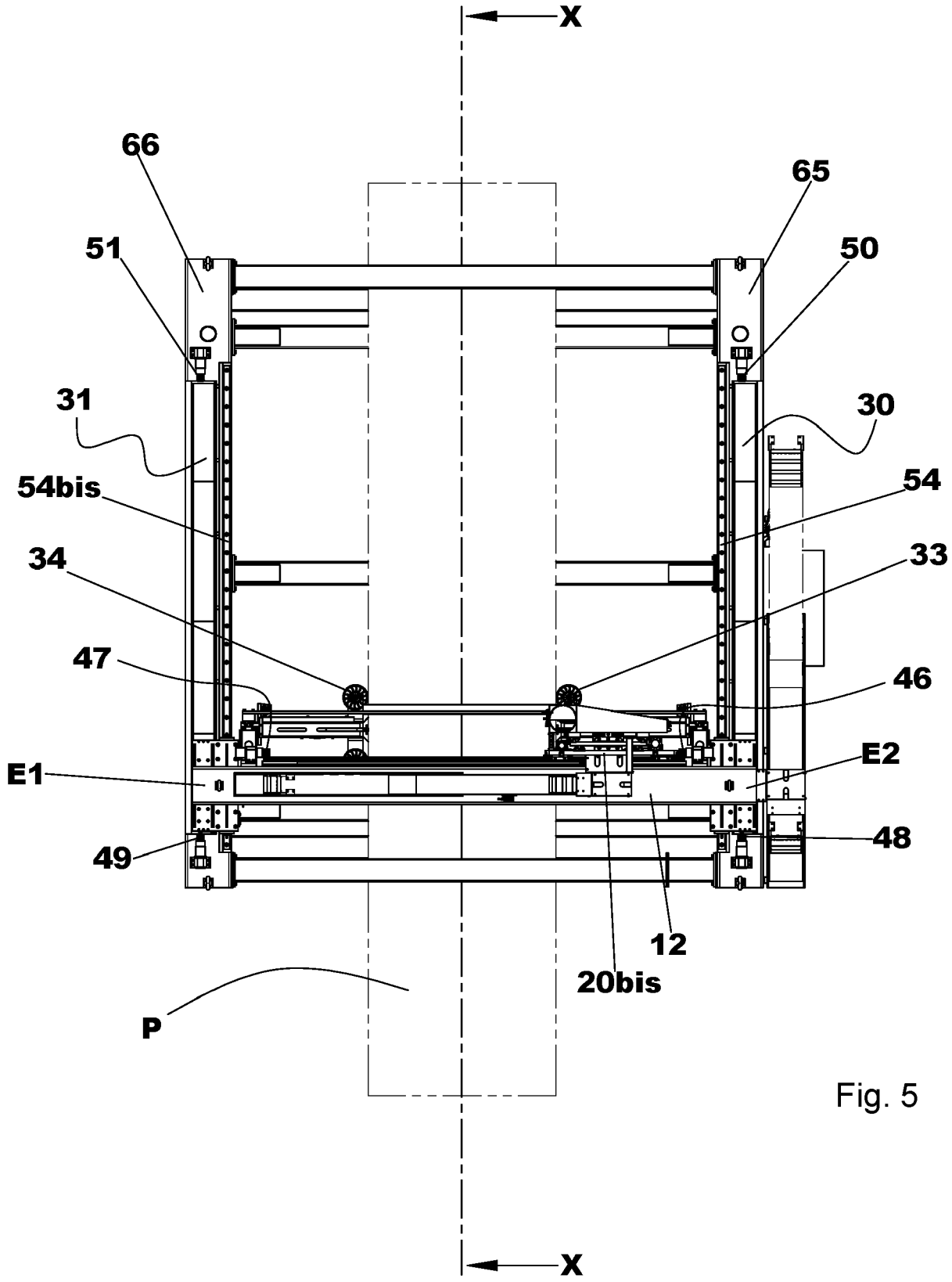

Fig. 5

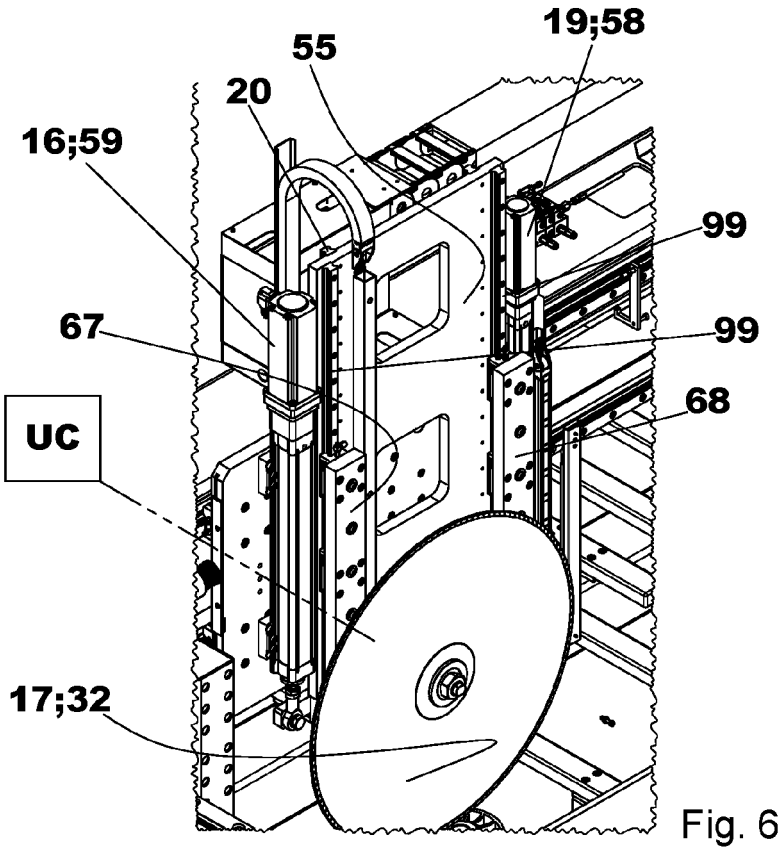

Fig. 6

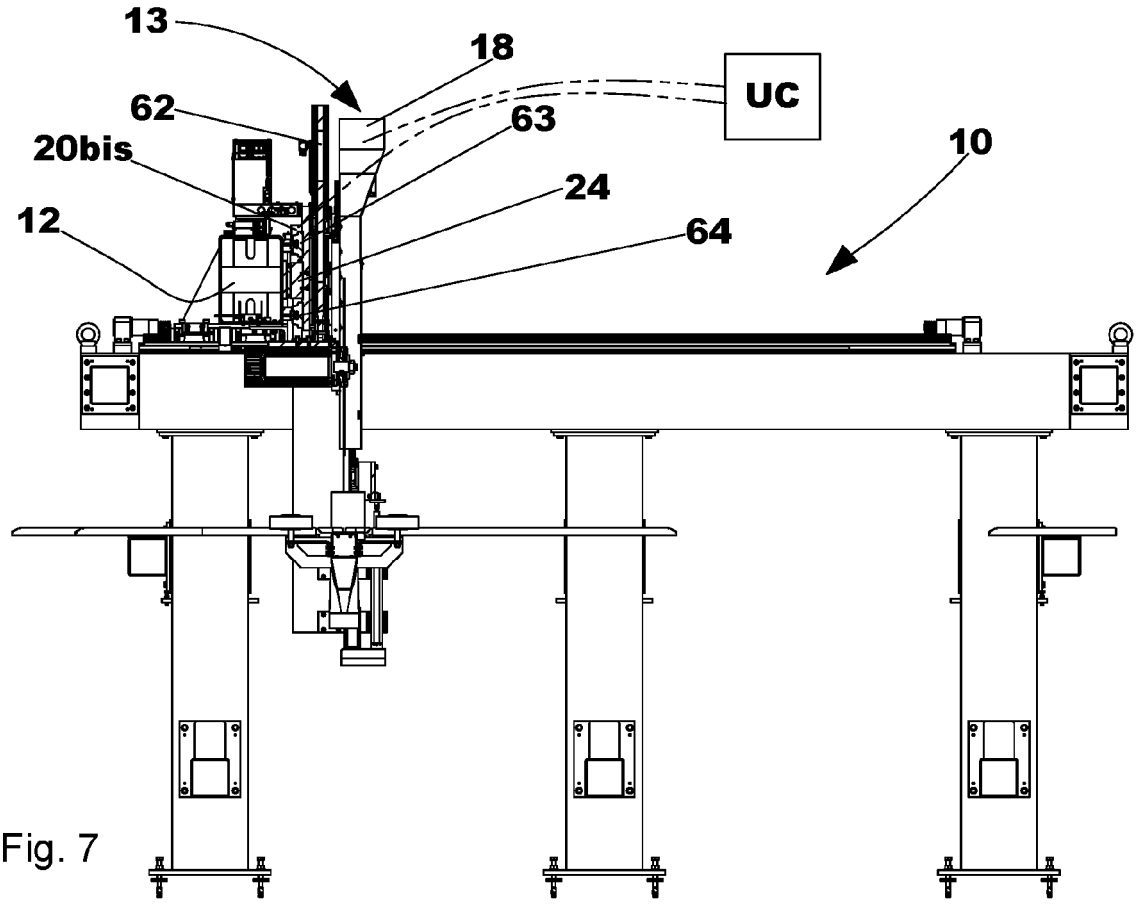

Fig. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 23 22 0009

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			B26D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 May 2024	Canelas, Rui

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10-05-2024

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